

Minimising mechanical prosthodontic interventions for adult patients with a shortened dental arch in South Africa

by

Saadika Khan

Dissertation presented for the degree of

Doctor of Philosophy

Faculty of Medicine and Health Sciences

Division of Health Systems and Public Health,
Department of Global Health

at Stellenbosch University

Supervisor: Professor Usuf ME Chikte
Co-supervisor: Professor Ridwaan Omar

December 2017

Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

“This dissertation includes six original papers published in accredited peer-reviewed journals. The development and writing of these published papers were the principal responsibility of myself and for each of the cases where this is not the case a declaration is included in the dissertation indicating the nature and extent of the contributions of co-authors.”

Date: December 2017

Summary

Background

A large body of high-end evidence suggests that shortened or posteriorly reduced dental arches (SDA or PRDA) are adequate for oral function. Such a finding has positive implications for patients from resource-constrained communities. Indeed, in the context of South Africa (SA), the SDA or PRDA concept has been embedded within its oral health policies since 1994, although no context-specific evidence appears to have informed this policy. The SDA concept, considered as a non-interventionist therapeutic approach, may be seen as a significant evidence-based primary healthcare solution for the underprivileged and under-resourced majority of SA, when applied appropriately.

The cost of current prosthodontics interventions, including removable, fixed or implant-retained prostheses are very high and not within the reach of the underprivileged majority. These prosthodontic appliances are not constructed at public health clinics and patients may only obtain these from dental teaching institutions and private practitioners.

From a human rights perspective, evidence-based research should guide practitioners and their practices as it can ensure patients' right of access to healthcare and the appropriate use of beneficial evidence whilst eliminating harmful ones. This stance has been made more explicit within the amended National Oral Health Strategy of SA.

Objectives

To determine the effectiveness (viz. oral function, patient satisfaction and OHRQoL) of a SDA or PRDA compared to a complete dental arch, with a view to minimizing expensive prosthodontic interventions for the South African partially dentate adult community.

Methods

A step-wise approach in study designs was implemented amongst a South African cohort. A *systematic review*, followed by an *overview of systematic reviews* was conducted to guide researchers with the literature, and in turn provide a scaffold for the *cross-sectional questionnaires* and *cross-sectional clinical study* for this cohort. Studies were conducted among dental practitioners, clinical teachers, and dental students to determine what was

currently taught and clinically practiced. A *randomized controlled trial* was subsequently conducted to determine patient satisfaction and quality of life with a SDA or PRDA.

Results

Studies conducted were from the top-end of the hierarchical evidence pyramid; thus their results are expected to have evidence of strong reliability and validity with respect to the benefits of the SDA or PRDA. The generalizability of outcomes obtained related to settings, subject, intervention, results and costs which were acceptable for this cohort. Aspects of knowledge translation (KT) such as *diffusion* (creating awareness of the SDA concept) and *dissemination* (publishing and conference presentations of the different research studies) were fulfilled.

Conclusions

This step-wise research approach highlighted the absence of the *implementation* aspect of KT, namely the application of the SDA or PRDA concept to clinical practice. The implication of this on the potential to positively impact patients' treatment costs, satisfaction and oral health-related quality of life within the SA context, is noteworthy. The evidence obtained and presented strongly questions the current non evidence-based aspects of prosthodontic curricula such as rehabilitation to complete arch status at the largest dental teaching institution in Africa. Moreover, the efficiency of the system is based on informed healthcare policies, emphasizing the need for evidence-based research both at an institutional and private practice level. Additionally, the contextual evidence derived from the research performed towards the present PhD highlighted key areas that may be grouped into important human rights, academic and economic aspects of all those who are impacted.

Opsomming

'n Groot aantal hoë-end bewyse dui daarop dat verkorte of posterior verminderde tandbogen (VT of PVT) voldoende is vir mondelinge funksie. So 'n bevinding het positiewe implikasies vir pasiënte uit hulpbronbeperkte gemeenskappe. In die konteks van Suid-Afrika (SA) is die VT - of PVT-konsep inderdaad in sy mondgesondheidsbeleid sedert 1994 ingebed, hoewel geen konteks-spesifieke getuienis hierdie beleid ondersteun nie.

Die PVT-konsep, wat beskou word as 'n nie-intervensionele terapeutiese benadering, kan gesien word as 'n belangrike bewys-gebaseerde primêre gesondheidsorg oplossing vir die minderbevoorregte meerderheid van SA, wanneer dit toepaslik toegepas word. Die koste van huidige prostodontiese ingrypings, insluitend verwyderbare, vaste of implantaatbevestigde prosteses, is baie hoog en nie binne die bereik van die minderbevoorregte meerderheid nie. Hierdie prostodontiese toestelle word nie by openbare gesondheidsklinieke aangebied nie en pasiënte kan dit slegs by tandheelkundige onderwysinrigtings en privaat praktisyns ontvang.

Uit 'n menseregte perspektief moet getuienis-gebaseerde navorsing praktisyns en hul praktyke rig, aangesien dit pasiënte se reg op toegang tot teopaslike en voordelige gesondheidsorg verseker, terwyl skadelike praktyke elimineer word. Hierdie houding is meer eksplisiet gemaak binne die gewysigde Nasionale Mondgesondheidstrategie van SA.

Doelwitte

Om die effektiwiteit (nl. Mond funksie, pasiënttevredenheid en mondgesondheidverwante lewensgehalte) van 'n VT of PVT te bepaal in vergelyking met 'n volledige tandheelkundige boog, met die doel om duur prostodontiese intervensies vir die Suid-Afrikaanse gedeeltelik dentate volwasse gemeenskap te verminder.

Metodes

'n Stewige benadering in studieontwerp is onder 'n Suid-Afrikaanse kohort geïmplementeer. 'n Sistematiese oorsig, gevolg deur 'n oorsig van sistematiese resensies, is gedoen om navorsers met die literatuur te lei en op sy beurt 'n steierwerk vir die dwarsnitte-vraelyste en kruis-seksie-kliniese studie vir hierdie kohort te verskaf. Studies is onder tandheelkundige

praktisyns, kliniese onderwysers en tandheelkundige studente gedoen om te bepaal wat tans onderrig en klinies toegepas word.

'n Gekontroleerde proef is gevolglik uitgevoer om die pasiënttevredenheid en lewensgehalte met 'n VT of PVT te bepaal. Studies wat uitgevoer is, was van die top-einde van die hiërargiese bewyse-piramide; dus word verwag dat hulle resultate bewyse het van sterk betroubaarheid en geldigheid ten opsigte van die voordele van die VT of PVT. Die veralgemeenbaarheid van uitkomst wat verkry is met betrekking tot instellings, vak, intervensie, resultate en koste was vir hierdie kohort aanvaarbaar. Aspekte van kennisvertaling (KV) soos diffusie (bewustheid van die VT-konsep) en verspreiding (publikasie en konferensie aanbiedings van die verskillende navorsingsstudies) is vervul.

Gevolgtrekkings

Hierdie stapsgewyse navorsingsbenadering het die afwesigheid van die implementeringsaspek van kennis vertaling (KV) beklemtoon, naamlik die toepassing van die VT- of PVT-konsep by die kliniese praktyk.

Die implikasie hiervan op die potensiaal om die pasiënt se behandelingskoste, bevrediging en mondgesondheidsverwante lewenskwaliteit binne die SA konteks positief te beïnvloed, is opmerklik. Die bewyse wat verkry en aangebied word, rig die huidige nie-bewysgebaseerde aspekte van prostodontiese leerplanne soos rehabilitasie om boogstatus by die grootste tandheelkundige onderwysinrigting in Afrika te voltooi.

Daarbenewens is die doeltreffendheid van die stelsel gebaseer op ingeligte gesondheidsorgbeleid, wat die behoefte aan bewysgebaseerde navorsing beklemtoon, sowel op institusionele as privaatpraktyk vlak.

Daarbenewens het die kontekstuele bewyse wat afgelei is van die navorsing wat na die huidige verhandeling (PhD) gedoen is, belangrike sleutelgebiede uitgelig in die belangrike menseregte-, akademiese en ekonomiese domein.

Acknowledgements

I dedicate this PhD dissertation to my parents (the late Dawood and Kulsum Khan) who instilled in me and my siblings the love and importance for all types of education and lifelong learning.

A Thesis towards a PhD is not possible without the guidance and wisdom of many individuals; those for whom giving advice and sharing knowledge come easily and unselfishly. And here I specifically refer to my Supervisors:

- Professor Usuf Chikte and
- Professor Ridwaan Omar

Without their guidance, critical input and knowledge related to aspects of research and academic writing, my work (research protocols, publications and dissertation) would not have been accepted at the level it has. Moreover, their experiences and progressiveness guided me to learn from the world, including the many distinguished personalities from different universities I visited, to the many conferences I attended the world over. All of these encounters have enriched me, expanded my world and transformed me to become confident and generous with what I have learnt.

Finally, I would like to include all those who supported me, enquired about my progress and well-being and shared in my joys (and at times moments of anguish):

- My family who showed extreme patience, understanding, interest and support,
- My friends who have shared my successes throughout this journey, and
- Colleagues from the University I work at and those from other Institutions I have met over the years at Conferences and/ or Workshops.

Table of Contents

	Page
Declaration	ii
Summary	iii
Opsomming	v
Acknowledgements	vii
List of Appendices	ix
List of PhD Articles	x
List of Abbreviations	xi
Definition of Terms	xii
Chapter 1: Introduction and Scope of Research	1
Chapter 2: Perceptions regarding the shortened dental arch among practitioners in the Western Cape Province, South Africa	18
Chapter 3: From Classroom Teaching to Clinical Practice: Experiences Of Senior Dental Students regarding the Shortened Dental Arch Concept	39
Chapter 4: Differences in Functional Outcomes for Adult Patients With Prosthodontically -Treated and –Untreated <i>Shortened Arches</i> : A Systematic Review	59
Chapter 5: Impact of removable dental prostheses on the function and oral health-related quality of life of a South African cohort with varied distributions of missing posterior teeth	97
Chapter 6: Outcomes of interventions with a posterior reduced dental arch Randomized Controlled Trial	115
Chapter 7: An Overview of Systematic Reviews related to a shortened dental arch in Adults	138
Chapter 8: Discussion and Conclusions	165
Appendices	187
PhD References	233
PhD Articles	243

List of Appendices

1.1.	Registration for a PhD in Community Health at Stellenbosch University	189
2.1.	Survey with Practitioners: Questionnaire	190
2.2.	Survey with Practitioners: Informed Consent Form	193
2.3.	Survey with Practitioners: Ethics Approval	194
3.1.	Mixed-Methods Education Research: Questionnaire	195
3.2.	Mixed-Methods Education Research: Individual and Group Interview Questions	196
3.3.	Mixed-Methods Education Research: Informed Consent Form	197
3.4.	Mixed-Methods Education Research: Ethics Approval	198
4.1.	Systematic Review: Ethics Approval	199
4.2.	Systematic Review: PRISMA Statement	200
5.1.	Cross-Sectional Quality of Life Study: OIDP-2012 Bilingual Questionnaire	202
5.2.	Cross-Sectional Quality of Life Study: Informed Consent Form	208
5.3.	Cross-Sectional Quality of Life Study: Ethics Approval	210
6.1.	Randomized Controlled Trial: Information Letter	211
6.2.	Randomized Controlled Trial: Demographic Details	212
6.3.	Randomized Controlled Trial: Global Visual Analogue Scale	213
6.4.	Randomized Controlled Trial: Informed Consent Form	214
6.5.	Randomized Controlled Trial: Ethics Approval	215
6.6.	Randomized Controlled Trial: Registration with <i>clinicaltrials.gov</i>	218
6.7.	Randomized Controlled Trial: CONSORT Statement	219
6.8.	Randomized Controlled Trial: Sample Size Estimation	221
7.1.	Overview of Systematic Reviews: AMSTAR Checklist	224
7.2.	Overview of Systematic Reviews: Ethics Approval	226
8.1.	List of Presentations	227
8.2.	Posters	228
8.3.	List of References	233
8.4.	Published Articles	243

List of PhD Articles

1. Perceptions regarding the shortened dental arch among dental Practitioners in the Western Cape Province, South Africa.
Khan SB Omar R Chikte UME. **SADJ (2012) 67 (2): 60-68**
2. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept.
Khan SB. Chikte UME. Omar R. **J Dent Educ 2014 78 (6); 906-913.**
Impact Factor: 1.018
3. Functional outcomes and relevance of prosthodontic interventions for shortened dental arches in adults: A Systematic Review.
Khan SB. Chikte UME. Omar R. **PLOS ONE J 2014 9 (7); e101143.**
Impact Factor: 4.092
4. An Overview Of systematic reviews related to aspects of the shortened dental arch and its variants.
Khan SB. Chikte UME. Omar R. **Int J Prosthodontics 2017 30 (4); 357-366,**
doi: 10.11607/ijp.5287
Impact Factor: 1.376
5. Outcomes with a Posterior Reduced Dental Arch: A Randomized Controlled Trial.
Khan SB. Chikte UME. Omar R. **J Oral Rehabilitation 2017**
(Accepted), August doi: 10.1111/joor.12549
Impact Factor: 1.926
6. Impact of removable prostheses on function and oral health-related quality of life of a South African cohort with varied partial dentate states.
Khan SB. Chikte UME. Omar R. **J Prosthodontics 2017**
(Accepted) June doi: 10.1111/jopr.12692
Impact Factor: 1.133

List of Abbreviations

AMSTAR	A measurement tool to assess systematic reviews
CDA	Complete Dental Arch
CONSORT	Consolidated Standards of Reporting Trials
CPD	Continuous Professional Development
CT	Clinical Trial
EBD	Evidence-Based Dentistry
FPDP	Fixed Partial Denture Prosthesis
GCP	Good Clinical Practice
GRADE	Grading of Recommendation Assessment Development and Evaluation Tool
KT	Knowledge Translation
NOHS	National Oral Health Survey/ Strategy
OHC	Oral Health Care
OHIP	Oral Health Impact Profile
OHRQoL	Oral Health-Related Quality of Life
OIDP	Oral Impact on Daily Performance
PICO	Patient Intervention Comparison Outcomes
POPs	Posterior occluding pairs of teeth
PRDA	Posterior Reduced Dental Arch
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QoL	Quality of Life
RPDP	Removable Partial Denture Prosthesis
RBB	Resin Bonded Bridge
RCT	Randomized Controlled Trial
SDA	Shortened Dental Arch
SR	Systematic Review
SU	Stellenbosch University
TMJ/D	Temporomandibular Joint/ Disease
UWC	University of the Western Cape
VAS	Visual Analogue Scale
WHO	World Health Organization

Definitions

Clinician-oriented treatment: The clinician selects and decides treatment goals and treatment option that he/she deems suitable for the patient.

Expressed need: When patients seek relief for what they identify as their predicament.

Knowledge translation: The assessment, review and utilization of scientific research to improve the conditions of patients in the appropriate context.

Lifelong-learning: The provision or use of both formal and informal learning opportunities throughout life in order to foster the continuous development and improvement of knowledge and skills needed for employment and personal fulfilment.

Normative need: Quantity of dental health care that experts consider ought to be consumed over a relevant period for people to remain or become dentally healthy.

Patient-centred care: The practice of caring for patients (and their families) in ways that are meaningful and valuable to the individual patient. It includes listening to, informing and involving patients in their care.

Perceived need: An individual's views and estimation of their own state of health and need for healthcare.

Sequential Explanatory Strategy: A mixed-methods design strategy involving collection and analysis of quantitative data followed by collection and analysis of qualitative data.

Student-centred learning: Refers to the wide range of educational programs, learning experiences, instructional approaches and academic-support strategies that address the distinct learning needs, interests, aspirations or cultural diversities of individual students.

Systematic Review: Is an appraisal and synthesis primary research studies using a rigorous and clearly defined methodology.

Teacher-centred teaching: Refers to methods, activities and techniques where the teacher decides what is to be learned, tested and how the class is to be run.

Triangulation: A technique that facilitates validation of data through cross verification from two or more sources.

Chapter 1

Introduction and Scope of the Dissertation

1. Introduction

The central theme for this dissertation entails the provision of contextual evidence that supports the preservation of a functional dentition as represented by a shortened or a posteriorly reduced dental arch (SDA or PRDA). Such a position may be regarded as one that challenges the long-standing, and ever prevailing, view that all partially dentate arches should be extended by means of removable, fixed or implant-retained partial prostheses so as to re-establish a 28-tooth occlusion [1]. To a large extent, the foregoing traditional prosthodontic treatment rationale forms the basis of undergraduate teaching globally, as well as in South Africa (SA), even though there has been little or no scientific basis or evidence that supports such a stand [1].

On the other hand, the SDA or PRDA concept may be considered as a functionally-effective evidence-based alternative treatment option whereby the provision of expensive prosthodontic mechanical interventions could be minimized [2-3]. As a central aim of the present research, the professional attitudes, educational practices and patient responses with respect to the SDA concept were investigated in a historically-disadvantaged community in the Western Cape (WC) Province of SA. The underlying reason for the chosen population setting was that such a non-interventionist approach would benefit these communities considerably whilst substantially reducing treatment costs; equally the greater accessibility of such a management option for large sections of communities, especially rurally-based groups, is evident [4-6].

Notwithstanding the fact that good contextual evidence on the SDA or PRDA concept may be produced and made available to clinicians, any new prosthodontic treatment concept, and perhaps especially one that is premised on less intervention, will require a major shift in clinical decision-making. Indeed, the challenge to the current clinical treatment approach and teaching practices related to a functional dentition for older partially dentate patients may be the biggest hurdle to overcome as regards more widespread implementation of the management approach [2-3]. Thus, such challenges to the implementation of beneficial concepts which could positively impact on patients' quality of life (QoL) and oral health-related quality of life (OHRQoL), to clinical practice within the SA context are further

explored in the present work. The implications of the communication required with key and relevant parties such as academic institutions and oral healthcare (OHC) policy-makers to effectively foster the translation of the appropriate evidence, knowledge and skills to existing educational platforms and clinical practices are discussed. Accordingly, explicit and, at times, implicit reference is made to the evidence supporting the implementation of the SDA or PRDA concept as a treatment option related to the clinical practice, economic and educational perspectives. In addition, inferences are made to other non-researched (human rights and economic) relational and non-clinical aspects, further emphasizing such support.

1.1. Background Literature

1.1.1. Evidence-Based Dentistry

The main aim of using evidence-based research (defined as ‘the means by which evidence is gathered’) is to guide practice, be it classroom teachings and/or clinical practices [7-8]. Evidence-Based Dentistry (EBD) is defined as “the integration of best research evidence in Dentistry with clinical expertise and patient values” [7-10]. EBD includes the principles of *Ask, Access, Appraise, Apply* and *Audit* [7-10, 11-12]. These principles encompass the process of *asking relevant questions and accessing* literature and acquiring information to search for best evidence and identify research gaps, reviewing literature to *evaluate* evidence (results and findings), *critically appraising* the outcomes and the *application* of relevant research evidence to provide optimum care to patients [9, 12]. The need for EBD is important when revising and improving current teaching material as necessitated by advances in technology, dental materials and the clinical procedures and care administered to patients [9, 11-15].

Many studies are conducted, but whether the evidence obtained guides best practice depends on the type of research methodology employed that would make implementation acceptable [16-18]. The paucity of rigorous clinical studies is a known shortcoming, and in the SA context it is no exception. Randomized controlled trials (RCTs), regarded as the gold standard of research methodologies should be encouraged [16-17]. The concept of EBD encompasses the biomedical perspectives of scientific research and a positivist philosophy [8, 11-14, 19-21]. Positivism defined, states that ‘science is the only way of learning the

truth,' thus EBD recognizes the objective and credible approach of scientific research [8, 12-14, 19-21].

Whilst EBD and evidence-based research is crucial to providing high quality care to patients, the focus generally tends to be one-sided being more disease- and clinician-oriented, and relying more on the clinician's experience and knowledge [7-12, 18-21]. On the other hand, studies that focus on the specific needs of patients (perceived needs) highlights the importance of including the patient in the clinical decision-making process [22-23]. Such a patient-centred approach encompasses the psychosocial concerns and uniqueness of each patient, allowing appropriate communication between them that is important for successful treatment outcomes [22-24].

1.1.2. Global Evidence

The SDA or PRDA treatment approach based on 35 years of research conducted globally, may be considered effective, when chosen appropriately and for patients presenting with specific clinical characteristics [2-6, 25-56]. Documented evidence suggests that the functional needs vary between individuals, and this has prompted several researchers to explore the degrees to which patients can function with less than a complete dentition [2-6, 25-56]. The SDA concept, introduced by Käyser in 1981 in the Netherlands, is such an alternative treatment strategy for partially dentate adult patients [2-3].

The classic SDA consists of 20 occluding anterior and premolar teeth [2]. Several variations on the SDA distribution have been proposed. Reduced posterior arches have been described, for example, in terms of number of occluding units, and studies indicate that 3-5 posterior occluding pairs (POPs) of teeth are adequate for chewing [2-3, 29, 51]. Research has also shown that the SDA can improve accessibility to treatment especially for the socially- and economically-deprived middle-aged and elderly partially dentate population [2, 27, 56].

Other associated benefits with the SDA as a treatment preference include enhanced oral hygiene maintenance, improved prognosis of the remaining teeth, patient compliance and a reduction in treatment costs for all patients, even though everyone is not in agreement with

some aspects [2-3, 26, 30, 38-40, 41-47, 51, 55-58]. Thus the clinical research related to the SDA and its variants cover large areas of function, comfort, temporomandibular joint concerns, patient satisfaction, QoL and OHRQoL [2-3, 26, 30, 38-40, 41-47, 51, 55-58]. In addition, several surveys have been conducted to investigate the knowledge, insights and clinical practices of dental practitioners related to the SDA [48, 59-60]. As a consequence of the large body of research, recommendations as to the appropriateness of the concept have been made to the various stakeholders [59], although no research exploring the formal and definitive teachings of the SDA concept has yet been performed.

On the basis of the foregoing overview, the SDA as a management concept has the assurance of being a beneficial intervention, especially for a developing country such as SA. The global evidence that informed this research is detailed in each of the studies conducted towards this dissertation.

1.1.3. South African Context

South Africa has a population of 48 million with 30 million belonging to the adult population and 5 million of these reside in the WC Province where the prevalence of caries in adults has been recorded to be highest (4). Edentulousness was recorded to be the highest at 37% in this province with 76% of adults being edentulous in one specific rural community (4). The reasons cited for this were: inaccessibility to clinics, high costs of dentures and no transport to public dental clinics (4). Proposed treatment for edentulousness include removable partial denture prostheses (RPDP), fixed partial denture prostheses (FPDP) and implant-retained prostheses.

The teaching of Prosthodontics at South African dental schools is largely based on the traditional model, namely one that conforms to the conventional principle of the need for restoring and extending dental arches following the loss of teeth. This has been termed the “28-tooth syndrome” [1]. In SA dental schools, any reference to the SDA concept is confined to the possible alternative management approach for mandibular distal extension cases, and not as a challenge to the overarching traditional concept of the necessity for complete arch integrity [5]. According to Omar (2004), the imperative of the treatment planning phase is not based only on a sound understanding of the clinical problem presented or its

technical management, but also the impact of patients' input in clinical decision-making and their psychosocial and economic circumstances related to treatment decisions [54].

The *SA National Policy for Oral Health* (which is largely based on the Primary Healthcare Approach) had as its goal the promotion of oral health by preventing and restricting oral diseases [24-25]. In addition to this, it stated how the implementation of the policy must be scientifically justified and that oral health services should be accessible, equitable and benefit the entire community [24]. Importantly, the SDA treatment option has already been accepted into policy since 1994 based on the WHO guideline of 'the retention of 20 functional teeth for young adults' [30, 61], but no contextual evidence to support this policy has since been obtained. With the subsequent amendments to the above policy, now referred to as *SA National Oral Health Strategy 2030*, the above guideline of retaining 20 teeth has been re-emphasised for young adults [62]. Additionally, the policy now explicitly prioritizes an evidence-based approach in healthcare, following the recommendations of the WHO and African Regional Oral Health Strategies 2025 [62]. It further emphasizes the importance of the above primary healthcare and evidence-based approach by making it part of eight National Health Strategy Goals [62]. The obligation of using evidence-based procedures for SA communities therefore needs no further justification.

From knowledge-into-action or from evidence-to-practice, entails the translation of best evidence obtained from rigorous research methodologies to didactic teachings, to clinical practice and to policy changes. The key role-players for this process include researchers, clinical practitioners (including dental students), clinical teachers, dental technicians, OHC policy-makers or insurers and institutional and governmental representatives.

1.2. Knowledge Translation

Knowledge translation (KT) refers to the assessment, review and utilization of scientific research to improve the conditions of patients in the appropriate context [63-65]. KT, however, is not just about the dissemination of research findings. Its definition explicitly describes the under-utilization of beneficial evidence in clinical practice that could influence behavioural change [63, 65]. With reference to the SDA or PRDA, primary and secondary

research has been conducted for the last 35 years [2-6, 26-27, 29-53, 66-74]. To date, the dissemination of the global and now the SA evidence has mostly occurred in the form of publications and presentations at both national and international levels [2-6, 29-53, 66-74]. The KT process consists of multiple stages from design to implementation including diffusion, dissemination and lastly implementation of evidence [63-65]. The success of implementation largely depends on the approach adopted; *how* (format), *to whom* (people) and the *medium* (professional and social media) by which evidence presentation, occurs. KT is thus an interactive and engaged process with different criteria for the multiple stages including several roleplayers such as researchers, populations or patients, OHC professionals and policy-makers [63-65, 75-76]. KT therefore involves high quality research that assists OHC policy-makers in making decisions that affect communities and institutional policies. Several models have been developed to ensure that KT occurs following strict processes [64-65].

The approach adopted by researchers for this process to occur and to be successful is even more important. Traditionally, scientific researchers are more concerned about whether an intervention works and if intervention A is better than intervention B [76]. But gauging from the earlier discussion, adopting a realist approach [76] where patient-centred care is key may guarantee greater success [76]. With the realist approach, it is important to focus on 'what works and for whom' and in 'what circumstances and why' which is in line with the functionality of the SDA or PRDA concept alluded to within this dissertation and its implementation [76]. Likewise, for patient-centred care, using both the relational and functional aspects are as important.

It is suggested that research that makes up this dissertation, namely focusing on the SDA and PRDA as a treatment option using an evidence-based approach whilst being informed by the goals and trends set by global and national workgroups seems not just reasonable but also justified [4-6, 24, 66]. Making available contextualized SDA or PRDA functional dentition research provides evidence for the guiding principles of the SA Oral Health Policy and Strategy and its objective of addressing human rights (access, effectiveness) and socio-economic concerns within communities [4-6, 24, 62, 66, 74].

Whereas the underlying purpose of the present work was to address an aspect of social concerns that could ultimately improve the conditions and/or circumstances of underprivileged SA communities, the specific objectives for the dissertation were to explore and investigate the oral functional needs and the impact on oral health-related quality of life related specifically to the partially dentate patient, and how these needs might most effectively be met at the levels of the profession, society and policy-makers. It follows that finding, defining and researching concepts that would address these varied questions needed to be set, and which unsurprisingly included concepts within the social sciences, such as need and demand [22-23].

1.3. Design of the Dissertation

1.3.1. Central Research Theme

The research question addressed for this dissertation is:

*In partially dentate adult patients (P),
how effective is shortened dental arch therapy (I)
compared to complete dental arches (C) in
terms of oral function, patient satisfaction and oral health-related quality of life (O)?*

1.3.2. Problem Statement

In different SA communities, major social and economic inequities resulted from poor governance. Oral healthcare services were no exception, and resulted in a large proportion of the population having very limited access to care. As regards partial edentulism, it is possible that the shortcomings in care delivery could be addressed by exploiting the SDA or PRDA concept as an appropriate treatment strategy. The SDA or PRDA may be regarded as a significant evidence-based treatment option for disadvantaged communities in post-apartheid SA, which is in line with its National Oral Health Strategy [30, 62]. Thus its utilization and implementation should be central to the goals of the OHC system, but this is clearly lacking. The efficiency of the OHC system is based on informed healthcare policies allowing the planned improvement in existing healthcare philosophies, the concepts that are taught to undergraduates and postgraduates alike, as well as the implementation of appropriate interventions. While evidence-based practice is an accepted method of updating

knowledge, direct educational interventions are found not to be very effective in influencing clinical behaviours and practices. Therefore, some of the aspects addressed in this research was related to the clinical attitudes and behaviour of practitioners, including dental students with respect to the SDA concept and furthermore how highlighting the evidence may positively impact on the clinical implementation of the concept.

1.3.3. Null Hypothesis

South African partially dentate adult patients cannot function (chewing-ability and mastication), and are not satisfied with the loss of posterior teeth or having a shortened or a posteriorly reduced dental arch.

1.3.4. Aim

The aim of this research is to determine the effectiveness (oral function, patient satisfaction and OHRQoL) of a shortened dental arch, compared to a complete dental arch for the South African partially dentate adult community.

1.3.5. Objectives of the Study

The objectives of the study to present the SDA or PRDA as an effective alternative treatment strategy for the partially dentate adult patient of SA where appropriate are:

- i) To determine the extent and success of research conducted internationally regarding utilization of the SDA concept by doing a systematic review;
- ii) To determine patient satisfaction and the impact on oral health-related quality of life related to shortened or interrupted dental arches restored with prosthetic interventions;
- iii) To establish the outcomes of different treatment options for a posteriorly reduced dental arch in a randomized controlled clinical trial (to emphasize the success of minimum clinical interventions for a SDA); and
- iv) To make recommendations to the professional bodies (dental academic institutions and OHC policy-makers) regarding the SDA concept to better facilitate translation and implementation of the clinical evidence.

Objectives ii) and iii), were explored through the conduct of clinical research within the SA context, whilst objective iv), which was to inform clinical practice and OHC policy, was addressed throughout the research studies. Objective iv) may be further advanced by using KT and knowledge-into-action frameworks so as to promote the SDA or PRDA concept on a broader level, but this is not within the scope of this dissertation.

Chapter one reviews published literature and evidence related to the SDA or PRDA and its significance within the SA context. The groundwork review also served to identify the direction for the PhD dissertation, with special reference to how SDA or PRDA concept currently align with the policies within SA, and it might be appropriate for the management of these communities' oral health and specifically their oral function.

Chapters two and three largely focus on the exploratory research conducted to inform the essence of the objectives set relating to the SDA or PRDA concept. These chapters focus on the knowledge of general dental practitioners, undergraduate dental students, and clinical teachers and furthermore what the content of the current undergraduate curriculum at the Faculty of Dentistry, University of the Western Cape, South Africa is with respect to the SDA or PRDA concept.

Chapter four highlights the synthesis of evidence determined from global research and emphasizes the conclusions with regard to the SDA, in the form of a systematic review [65]. The choice of doing a systematic review was largely based on the strict methodology that such a secondary research study design offers, with the potential of leading to rigorous and reliable outcomes and conclusions.

Chapter five directly addresses patients' needs and demands regarding RPDP usage and its impact on their quality of life using the oral impacts on daily performance (OIDP) index, a tool validated for the South African situation [22-23, 53, 77]. Quality of life studies are conducted with increasing frequency, and are important for obtaining patients' opinions and needs with regard to new concepts and interventions. Using validated tools is as important as employing very strict methodologies when undertaking research [77]. The

study outcomes will be more reliable, credible and may even be generalizable to different settings.

Chapter six reports on how a RCT was conducted within the SA context to determine patient satisfaction, QoL and OHRQoL with SDA or PRDA management approaches [6]. The need for conducting a randomized controlled clinical trial was once again based on its rigorous and unbiased methodology, the present lack of clinical research, the difficulties regarding generalizability of other global studies to the SA context given that only a few RCTs have been completed for SDA patients [6, 16-18, 77]. Evidence so obtained from a RCT could be used to strengthen the case to the institution for greater emphasis of the concept to be made in the curriculum. The evidence collected and synthesised could also be shared with general practitioners, OHC policy-makers and health insurers. More importantly, it could assist in the next phase of developing guidelines for the application of SDAs or PRDAs to different settings and ensuring implementation of the National Oral Health Policy related to SDAs [24].

Chapter seven included additional secondary research that sought to synthesise the findings from published SRs related to the SDA concept in the form of an overview of systematic reviews [74].

Chapter eight is the concluding chapter regarding the current position on SDA or PRDA research with the focus on the available global information, the local research conducted and the potential future of this management concept within the SA context.

1.4. Ethics

The research conducted towards this dissertation was aligned with good ethical practices as required by the Institutions that the candidate is associated with. Ethics approval for the PhD dissertation was firstly obtained from Stellenbosch University where the candidate is registered for the PhD [Appendix 1.1]. In addition, the candidate, who is based at the Faculty of Dentistry, University of the Western Cape, and where the research was largely conducted, was required also to obtain ethical clearance from the Institution for all stages of

the PhD research. Students, staff and patients who attended the Faculty of Dentistry were included for the various stages of the research, as required, as were clinical practitioners based outside of the institution. Thus informed consent (which included informing them of the purpose and nature of studies and any risks) was obtained from all involved for the different stages of the PhD research. This was in line with ethical rules of keeping their identities confidential; to not cause them any harm or inform them of any associated risks in being part of the study and lastly to ensure dissemination of findings. For all research proposals, individualised ethics applications including informed consent procedures were submitted to both Stellenbosch University and University of the Western Cape, and are included per study and for each chapter.

References

1. Zarb GA, Bolender CL, Carlsson GE, Boucher CO. Boucher's prosthodontic treatment for edentulous patients. 2004 London: McGraw-Hill.
2. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981 8:457-462.
3. Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 1989 9(6):426-49.
4. Khan SB, Chikte UME, Omar R. Perceptions of dental practitioners regarding the shortened dental arch. *SADJ* 2012 67(2):60-8.
5. Khan S, Chikte UME, Omar R. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014 78(6):906-13.
6. Khan S, Chikte UME, Omar R. Outcomes of interventions for patients with a posterior reduced dental arch: A randomized controlled trial. *J Oral Rehab* 2017 (Accepted). DOI: 10.1111/joor.12549.
7. Sackett DL, Rosenberg WM, Gray JA, Haynes R, Richardson W. Evidence-based medicine: what it is and what it isn't. *BMJ* 1996 312:71-2.
8. Ismail AI, Bader JD. Evidence-based dentistry in clinical practice. *JADA* 2004 135:78-83.
9. Akobeng AK. Principles of evidence based medicine. *Arch Dis Child* 2005 90: 837-40.
10. Akobeng AK. Evidence in practice. *Arch Dis Child*; 2005 90: 849-52
11. Rolfe SE, Sanson-Fisher RW. Translating learning principles into practice: a new strategy for learning clinical skills. *Med Educ* 2002 36:345-52.

12. Das K, Malick S, Khan KS. Tips for teaching evidence-based medicine in a clinical setting: lessons from adult learning theory. Part One. *J R Soc Med* 2008 101(10):493-500.
13. Biggs J. *Teaching for quality learning at university*. 2004 4thed. London: Open University Press.
14. Kreuger PM, Neutens J, Bienstock J, Cox S, Erickson S, Geonfert A, et al. To the point: reviews in medical education teaching techniques. *Am J Obstet Gynecol* 2004 191:408-11.
15. Carlsson GE, Omar R. The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil* 2010 37:143-56.
16. Webb P, Bain C, Pirozzo S. *Essential epidemiology: An introduction for students and health professionals*. 2005 Cambridge, UK; New York: Cambridge University Press.
17. Higgins JPT, Green S. *Cochrane Handbook for systematic reviews of interventions*. 2009 1st Edition. West Sussex, UK: Wiley-Blackwell.
18. Broden P, Bennet I, Appleton J, Bonta Y, Feher E, Fiehn NE, et al. Ensuring research productivity in the future faculty. *Eur J Dent Education* 2002 6 (Suppl 3):97-106.
19. Eckert S. The True Goal of Evidence-Based Dentistry. *Int J Prosthodont* 2006 19(2):128-9.
20. Gillette J. Striving for Excellence with Evidence-Based Dentistry. *J Evid Base Dent Pract* 2009 9:125-8.
21. Healy D, Lyons K. Evidence-based practise in dentistry. *New Zealand Dent J* 2002 98:32-5.
22. Bradshaw JS. A taxonomy of social need. In McLachlan G, editors. *Problems and Progress in Medical Care*. 1972 7th series, Oxford University Press; pp.69-82.
23. Narby B, Kronström M, Söderfelt B, Palmqvist S. Prosthodontics and the patient: Need becoming demand, Demand becoming utilization. *Int J Prosthodont* 2007 20:183-9.
24. Department of National Health and Population Development. *National Policy for Oral Health in South Africa*. National Policy for Oral Health 1990; Act 116.
25. Owen CP. Appropriatech: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont* 2004 17(2):261-2.
26. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. *Community Dent Oral Epidimiol* 2003 31(5):328-34.
27. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NHJ. Oral health

- status related to the shortened dental arch concept in Tanzania. *Eur J Sci* 2007 115(4):265-74.
28. Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all—and for life? The oral healthcare system needs revision. *J Oral Rehabil* 2013. DOI: 10.1111/joor.12082.
29. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin. Oral Impl. Res* 2007 18:34-45. DOI: 10.1111/j.1600-0501.2007.01436.x.
30. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003 16(4):409-14.
31. Thomason JM, Moynihan PJ, Steen N, Jepson NJA. Time to Survival for the Restoration of the Shortened Lower Dental Arch. *J Dent Res* 2007 86(7):646-50.
32. Luthardt RG, Marre B, Heineck A, Gerß J, Aggstaller H, Busche E, et al. The randomized shortened dental arch study (RaSDA): design and protocol. *Trials* 2010 11(15):1–9.
33. Walter MH, Weber A, Marre B, Gitt I, Gerß J, Hannak W, et al. The Randomized Shortened Dental Arch Study: Tooth Loss. *J Dent Res* 2010 89(8):818-22.
34. McKenna G, Allen PF, Flynn A, O’Mahony D, DaMata C, Cronin M, et al. Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodont* 2012 29:e883–e890. DOI:10.1111/j.1741-2358.2011.00579.x.
35. McKenna G, Allen PF, Flynn A, O’Mahony D, DaMata C, Woods N, et al. A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodont* 2012 28:1–7.
36. Budtz-Jørgensen E, Isidor F. 5-year longitudinal study of cantilever fixed partial dentures compared with a removable partial denture in a geriatric population. *J Prosthet Dent* 1990 64:42-47.
37. Isidor F, Budtz-Jørgensen E. Periodontal conditions following treatment with a distally extending cantilever bridge with removable partial dentures in elderly patients: A 5-year study. *J Periodontol* 1990 61:22-6.
38. Cruegers NHJ, Witter DJ, Van’t Spijker A, Gerritsen AE, Kreulen CM. Occlusion and Temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 2010 1-7. DOI:10.1155/2010/807850.
39. Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in

- shortened dental arches. *Aust Dent J* 1987 32(3):178-82.
40. Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010 8:126-39.
 41. Witter DJ, van Elteren P, Käyser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988 15:413-420.
 42. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 1989 16:27-33.
 43. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. Oral comfort in shortened dental arches. *J Oral Rehabil* 1990 17:137-143.
 44. Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Signs and symptoms related to temporomandibular disorders- Follow-up of subjects with shortened and complete dental arches. *J Dent* 2007 35:521-527.
 45. Sarita PT, Kreulen CM, Witter DJ, Creugers NHJ. Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 2003 16(3):265-70.
 46. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003 16(4):375-80.
 47. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008 35:337-44.
 48. Korduner EK, Söderfelt B, Kronström M, Nilner K. Attitudes toward the shortened dental arch concept among Swedish general dental practitioners. *Int J Prosthodont* 2006 19:171-6.
 49. Van Waas MA, Meeuwissen JH, Meeuwissen R, Käyser AF. Oral function in dentate elderly with reduced dentitions. *Gerodontol* 1993 10(1):40 -3.
 50. Meeuwissen JH, Van Waas MA, Meeuwissen R, Käyser AF, van't Hof MA, Kalk W. Satisfaction with reduced dentitions in elderly people. *J Oral Rehabil* 1995 22(6):397-401.
 51. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008 21(1):72-4.
 52. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998 25:649-61.

53. Khan S, Chikte UME, Omar R. Impact of removable partial dental prostheses on the function and oral health-related quality of life of a South African cohort with varied distributions of missing posterior teeth. *J Prosthodont* 2017. DOI: 10.1111/jopr.12692
54. Omar R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ* 2004 59(6):228-37.
55. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996 23:481-5.
56. Kanno T, Carlsson GE. A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil* 2006 33:850-62.
57. Wong MC, McMillan AS. Tooth loss, denture wearing and oral health-related quality of life in elderly Chinese people. *Community Dent Health* 2005 22(3):156-61.
58. Creugers NHJ, Van't Spijker A. Tooth wear and occlusion. Friend or foes? *Int J Prosthodont*, 2007 20:348-50.
59. Sarita PT, Witter DJ, Kreulen CM, Creugers NHJ. The shortened dental arch concept – attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol*, 2003 31:111-5.
60. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996 23:481-5.
61. World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Copenhagen: WHO Europe regional office, WHO Technical Report; 1982 Series No. 826:16-7.
62. Department of National Health and Population Development. National Oral Health Policy and Strategy for South Africa 2017: 1-30.
63. Straus SE, Tetroe J, Graham I. Defining knowledge translation. *Can Med Ass J* 2009 181(34):165-8.
64. Grimshaw JM, Eccles MP, Lavis JN, Hill SJ, Squires JE. Knowledge translation of research findings. *Implementation Science* 2012 7:50.
65. National Centre for the Dissemination of Disability Research. What is Knowledge Translation? Technical Brief 2005 10:1-4.
66. Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated Shortened Dental Arches: A Systematic Review. *PLOS 1* 2014 9(7):e101143. DOI: 10.1371/journal.pone.0101143.

67. Shahmiri RA, Atieh MA. Mandibular Kennedy Class I implant-tooth-borne removable partial denture: a Systematic Review. *J Oral Rehabil* 2007 37:225-34.
68. Zhang Q, Kreulen CM, Witter DJ, Creugers NHJ. Oral Health Status and Prosthodontic Conditions of Chinese Adults: A Systematic Review. *Int J Prosthodont* 2007 20:567–72.
69. Faggion CM. The shortened dental arch revisited: from evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 2011 38:940-9.
70. Faggion CM, Giannakopoulos NN, Listl S. How strong is the evidence for the need to restore posterior bounded edentulous spaces in adults? Grading the quality of evidence and strength of recommendations. *J Dent* 2011 39:108-16.
71. Fueki K, Yoshida E, Igarashi Y. A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011 47:167-74.
72. Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: partially absent dentition. *Cochrane Database SR* 2012 Issue (2) Art No: CD003814. DOI: 10.1002/14651858.CD003814.pub2.
73. Liang S, Zhang Q, Witter DJ, Wang Y, Creugers NHJ. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: A Systematic Review. *J Dent* 2015 43:1185-94.
74. Khan S, Chikte UME, Omar R. An Overview of Systematic Reviews related to a shortened dental arch in adults. *Int J Prosthodont* 2017. DOI:10.11607/ijp.5287.
75. Kitson A, Straus SE. The knowledge-to-action cycle: identifying the gaps. *CMAJ* 2010 18 (2).
76. Greenhalgh T. *How to implement evidence-based healthcare*. 2017 Oxford, UK; Wiley Blackwell.
77. Hobdell M, Tsakos G, Ladrillo TE, Ross MW, Myburgh N, Gordon N, et al. Using an oral health-related quality of life measure in three cultural settings. *Int Dent J* 2009 59:381-8.

Chapter 2

Exploratory Research

Perceptions regarding the shortened dental arch among practitioners in the Western Cape Province, South Africa

Perceptions regarding the shortened dental arch among practitioners in the Western Cape Province, South Africa

This Chapter focuses on exploratory research related to the shortened dental arch concept conducted to determine the knowledge, opinions and stated clinical practices of practitioners.

SUMMARY

There is no literature alluding to the knowledge, opinion and clinical practices of general dental practitioners in South Africa (SA) related to the shortened dental arch (SDA). Before any meaningful clinical studies are conducted related to a concept, it is always appropriate to determine what people in the field know about the particular concept before conclusions are drawn about their practices. Using a cross-sectional survey, the level of knowledge and stated clinical practices relating to the SDA concept of general practitioners residing in the Western Cape Province, SA was studied.

A questionnaire survey was sent out to a group obtained by random sampling of general dental clinical practitioners, prosthodontic specialists, researchers and Faculty of Dentistry clinical staff working in the Western Cape Province. Quantitative methods were applied to determine the knowledge, opinions and clinical practices with respect to the topic. In this regard, it is noted that practitioners are required, for the purposes of valid registration, keep abreast of new knowledge by reading published research, participating in continuous education and professional development programmes, and scientific meetings. While starting with the academic aspects, (gauging of practitioners' knowledge, opinions and clinical practices), their attitudes regarding cost-benefits to patients and patients' role in decision-making were explored indirectly. Practitioners were very forthcoming with the former aspect of enquiry, although for the latter aspects information could only be extrapolated from the information provided.

Even though a small response rate was obtained, many of the practitioners (62%) indicated that they have never read any research related to the SDA, and those (40%) who have heard of the concept were mostly from the younger age group. The non-response bias may be linked to these results, where participants who have no knowledge of the concept and have

been replacing all lost teeth for years, were not keen to complete the questionnaires. Most importantly though is the fact that 80% of respondents agreed that patients may be able to function with a shortened dental arch, but generalizability of results may still be a concern due to the poor response rate. Broad aspects relating to human rights, academic and economic perspectives were touched upon.

PUBLICATION

This paper has been published in the South African Dental Journal; Publication citation: Khan SB, Chikte, UME, Omar, R. (2012). Perceptions of dental practitioners regarding the shortened dental arch. SADJ; 67 (2): 60-68.

For this component of the project, the PhD candidate developed the protocol (with guidance from the supervisors), developed the questionnaire, submitted the protocol for ethics approval, independently obtained all information related to research participants, collection of data, assessed the data (the statistician assisted with analysing the data) and also interpreted the final data. The manuscript, including all corrections from both supervisors and journal reviewers who provided guidance and critical comments, was completed by the candidate. All authors approved the final manuscript.

The Questionnaire, consent form and Ethics approval are included as Appendices 2.1-2.3.

ABSTRACT

Aim and Objectives

This survey was conducted to determine the knowledge of and opinions related to the shortened dental arch (SDA), among dentists in the Western Cape Province, South Africa.

Methods

The study sample included two consecutive groups, drawn by a process of random sampling from the registered dentist population that included general dentists, specialists, those who had emigrated and retired dentists. A self-administered questionnaire was mailed, e-mailed and/ or faxed to those selected. Reminders were either e-mailed or made by telephone over a period of six months.

Results

A final sample of 84 respondents with a mean age of 43 years (SD=11.9) was obtained. This represented a response rate of 23% (n= 84) from the final working sample (n=368), derived from the target group (n=618) originally contacted. All participants completed an informed consent form in which confidentiality was assured. Several respondents (40%) said they had heard about the SDA while at university, which would be in line with the age range of respondents in relation to introduction of the concept into dental curricula. As many as 62% had never read any research articles related to the concept which could partly account for the low response rate. The majority (86%) felt that patients can function with a SDA and that they would recommend acceptance to their patients.

Conclusion

Respondents know of the potential benefit that the SDA may have for their patients and see it as a viable alternative treatment option for the partially dentate patient, even though their level of current knowledge of the subject must be considered questionable.

Keywords: Tooth loss; shortened dental arch; attitudes; perceptions; knowledge; quality of life.

2.1. Introduction

The treatment objective of the complete restoration of dental arches lacks compelling scientific and clinical research support, yet steadfastly remains the therapeutic standard of care amongst practitioners [1, 2]. Whereas tooth loss in general is perceived negatively by most people [3], the loss of anterior teeth is more profoundly felt [4]. There is also an increasing recognition that a patient's occlusal functional need cannot be defined solely by professionals [5]. Specifically, the need for full restoration of missing posterior segments is increasingly being questioned and the functional satisfaction that may be derived from less than a complete dentition in some patients, particularly in older adults, is both recognized and documented [4, 6-14].

As originally defined, the classic shortened dental arch (SDA) consisting of twenty occluding anterior and premolar teeth [6], was initially proposed as a treatment strategy for the older, partially dentate patient [6, 15]. Several variations to the classic SDA occlusal pattern, including discontinuous or interrupted arches, were proposed and the reduced posterior arches have been described in terms of the number of occluding units that can ensure adequate chewing function [6-7, 11-12]. The SDA concept is a cost-effective treatment option that has been extensively studied and has been advocated as being viable for many industrialized as well as developing countries [9, 12-22]. The SDA and its variations improve the accessibility of treatment for large sectors of the population, especially the socially- and economically-deprived middle-aged and elderly communities. It follows that disparities related to oral health that exists within and between populations, as in South Africa, can be addressed utilizing the SDA concept as an appropriate treatment strategy [2, 16].

Effecting improvement and/or change in an oral healthcare system depends upon appropriately distributing and using available resources for better health outcomes. An inability to meet the needs and demands of partially dentate patients causes oral healthcare providers, healthcare policy- makers, and third party funders to call for more evidence- based practices in dentistry [2-5, 14-15]. The literature reports several clinical trials and other research studies where the success of treatment using the

SDA concept has been demonstrated [3, 6-8, 10-15]. The assertion that this will provide effective treatment, reduce costs and allow equitable distribution of resources seems reasonable. For a country such as South Africa, contemporary treatment planning strategies, such as those based on the SDA concept, need to be considered and should be researched locally for relevance amongst the local population. The results may be able to support a proposal for implementation. Healthcare providers, however, will be at the front line in delivering such a management strategy to patients, and it is thus important that their understanding of, and attitudes towards, such a 'novel' treatment concept be gauged.

Studies have been conducted globally to determine the opinions and practices of dental clinicians regarding the SDA, but differences in sampling have been noted and considered before undertaking the current research [8, 19, 16, 26]. The convenience of samples drawn from consultants and departmental staff ensured a high response rate in some studies [8, 10, 16, 26].

For this questionnaire-based study, a survey was conducted amongst registered dentists practicing in the Western Cape Province, South Africa, with the objective of assessing their knowledge and current practices related to the SDA as an appropriate management approach in the partially dentate adult patient.

2.2. Materials and Methods

Ethical clearance for the research project (No. 10/2/13) was obtained from the Research and Ethics Committee of the University of the Western Cape (WC), South Africa. The first cycle of data collection was conducted as a pilot study amongst the staff (n=15) in the Department of Restorative Dentistry in the latter part of August 2009. The initial questionnaire was distributed amongst them to solicit their input and expertise so that ambiguities in the questions could be eliminated. The final self-administered questionnaire (Figure 1), cover letter and consent form were then distributed by post, fax and/or e-mail to randomly selected dentists practicing in the public and private sectors of the WC Province. The design of the questionnaire assessed respondents' opinions, knowledge, understanding and current clinical practices

regarding the SDA concept. It also included questions designed to obtain the demographic profile of practitioners, the types of practices dentists worked in and the diversity of patients treated.

The population of dentists in the WC included in this study was all registered practitioners and included general dentists in the public and private domains, as well as retired dentists and specialists in the fields of prosthodontics, periodontics and orthodontics. Excluded from the study were dentists whose interests do not especially include treatment of the partially dentate state, such as maxillofacial and oral surgeons, oral pathologists and community-dentistry specialists.

Through a compilation of records obtained from the Health Professions Council of South Africa (HPCSA), South African Dental Association, Public Health Clinics and Messrs. Wright-Milner's Dental (the largest dental supplier in the region), it was recognized that the list of dentists and specialists registered with the HPCSA from the WC Province included many who had retired, specialized, emigrated or are no longer in practice. We used random sampling (accomplished through computer-generated numbers) for the second and third cycles to obtain a final sample of 652 active practitioners. For the third cycle, the information sheet was modified to indicate that an incentive would be received on completion of the questionnaire. This was decided upon after discussions with the statistician, to improve the response rate. After taking statistical advice, the pilot study sample (n=15) was included in the final study sample as these practitioners were all on the registered lists of dentists. In addition, several of these (academic) dental practitioners either have their own dental practices or work for other private practitioners.

Practical difficulties experienced included a large number of non-responders, outdated registered contact details, a number of disinterested practitioners including some retired practitioners and previous emigration of registered practitioners; thus the period for obtaining completed questionnaires from the three cycles was extended to six months (from late August 2009 to January 2010). A research assistant followed up the non-responders who did not return the questionnaires, with participants receiving monthly reminders for at least two months via telephone, fax

and e-mail in an effort to obtain as representative a sample as possible. The final collection and recording of data was completed by the researcher (SK).

Sample size, random sampling methods, questionnaire format, type of study and the statistical analysis of data (type of tests) were initially discussed with the statistician. Data extracted from completed questionnaires were analysed using the Excel Statistical package. The categorical data were analysed by means of residuals based on observed and expected values. The data consisted of categorical and ordinal observations, as well as paired comparisons. A lexicographical analysis was also included for question 18 (which states 'what would prevent respondents from implementing the SDA as a treatment option?') and it involves determining the specific responses for each given response option in a systematic sequence [27].

2.3. Results

From the three cycles, the final working sample (n= 368) included registered and willing participants and excluded all the practitioners who were registered but had emigrated, were not practicing, some who had retired, those who had obtained a specialization which was excluded, those who declined to participate and those whose current contact details were unavailable.

Of the 15 questionnaires distributed amongst the staff for the pilot study, 13 were completed. Together with those obtained in the second and third cycles, the final sample resulted in 84 completed questionnaires (23%). The demographic details are included in Table 1. The ages of respondents ranged from 24 to 75 years, with a mean age of 43 years (SD=11.9) and with most respondents being males at 62%. Many retired dentists, who were intentionally included so that the changes in teaching and practice over the years might be determined, did not participate. Respondents were from diverse academic backgrounds with dental qualifications having been obtained locally and/or internationally [Table 1].

Almost three-quarters (74%) of respondents (n=62/84) reported that their practices were mainly restorative in nature. One-fifth of respondents (20%) further indicated that fixed prostheses and removable partial dentures were their treatments of choice in the management of partially dentate patients. Patients treated ranged from under 10-to-65 year-olds, with only three respondents indicating that they do not treat adult patients.

The unusual practice of anterior-tooth extractions, a cultural habit observed in the WC Province, necessitated that the questionnaire contain questions specific to the practice. Only 25% (n= 21/84) of respondents stated that requests for such extractions were not made. The majority of the responding dentists had been asked to extract anterior teeth and even though 82% of respondents said they did not accede to these requests, almost 20% said that they do extract these teeth to satisfy patients' requests. To see whether any relationship existed between requests by patients for anterior extractions and the subsequent reaction of dentists, a Chi-squared test ($\chi^2=17.81$, df. =4, p-value<0.005) was performed (Table 2). These results suggest that the frequency of demands by patients for anterior extractions is influenced by the compliance of dentists to accede to these requests (i.e. a strong relationship between demand for anterior extractions by patients and compliance by dentists exists, and vice versa). Of all other tooth types extracted in the WC Province, lower molars were the most commonly reported at 67%, which is line with global studies.

Prostheses provided for replacement of missing posterior teeth, in order of frequency, were acrylic partial dentures, metal-based partial dentures, fixed bridges and implants. Responses to questions relating to the replacement of missing molar teeth would appear to be influenced by knowledge of the SDA concept ($\chi^2 = 6.79$; df. = 1; p-value=0.0092). Even though 48% of respondents (n=40/84) indicated that they had heard about the SDA at university, and 32% in a journal, 21% indicated that they heard about it for the first time from this survey. Those respondents (48%) who had heard about the concept at university were of a mean age of 43 years, which is in line with the likelihood that they would have been taught the concept during the 1990s.

Table 3 refers to the responses to questions related to the SDA and here data imputation was managed by dichotomization: thus for the answers definitely no and no, these were settled as a no response. As regards their 'having read any research' relating to the SDA concept, as many as 62% of respondents (n=52/84) indicated not having done so. On the other hand, 86% said that 'patients will be able to function adequately' with a SDA, even though most had not read any literature on the subject. A large majority of respondents (83%) said that they would 'present it as a treatment option,' while 82% indicated that it would 'benefit their patients'. Many respondents (67%) believed its application should not be 'limited to patients with physical disabilities' only.

Examining the results of questions referring to the treatment options proposed by practitioners compared with patients' requests for SDA treatment approach revealed distinct differences in responses. From the final sample (n= 84), 83% of dentists suggested the provision of acrylic and metal dentures, but patients requested implant therapy and either acrylic or fixed prostheses (and in that order). A clear difference existed in what patients perceived their needs and desires to be (irrespective of the finances involved) and what practitioners proposed and what was the final administered treatment.

For question 18, 'what would prevent respondents from suggesting a SDA treatment option', respondents were presented with a range of options and their answers revealed some interesting responses: only 5% of respondents (n=4/84) admitted that 'loss of income' whereas 37% said 'nothing' would prevent them from proposing and implementing the SDA concept as a treatment option. It was then decided to conduct a lexicographical analysis of the responses for this question. This type of systematic analysis is used for data with several variables as responses, where the analysis includes several options or combinations of options [27]. For this question with four options, 16 different combinations could be provided. Interestingly, 93% of observations were found in four combinations with 49% of observations sitting in one combination only. This distribution fits the information (or Pareto) principle, [28] which states that for most cases in life, 80% of effects come from 20% of the causes.

A description of this combination includes, for example: no income; no knowledge; limited research and not viable versus 'nothing' will prevent the practitioner from suggesting a SDA. And within this combination, 73% (30/41 respondents) said 'nothing' will prevent them from suggesting a SDA. This type of analysis gave very specific responses to these options [27], revealing that the respondents expressed a very positive attitude towards this SDA concept as a treatment option for their partially dentate patients.

The benefits of using this concept were obvious to the dentists, even though many of them had indicated not having read any research related to the concept.

2.4. Discussion

Questionnaire-based studies are a useful tool in dental research, but can be a mixed blessing. Response rates among general practitioners have been shown to be dropping [29]. They also are at risk, if not sufficiently robustly framed, of conveying what respondents' state they believe, or would do, and even what they believe the interviewer wishes to hear [30].

The present research brought into focus some of these difficulties, in particular the lower than expected overall response rate (n= 84). On the other hand, the response rate in the pilot study (n= 13/15) was very good, but that was conducted in a controlled environment. Data thus derived are at risk of bias. In addition, the very high response rate would likely have been due to the pilot group being colleagues who felt obligated to cooperate. This pleasing effect could also have contributed as a source of bias. Such effects (opinion research and doing research in the same department) have been reported in the literature (Table 4) [8, 19, 16, 26].

Efforts were made to reduce the risks of bias during the second and third cycles of the study. Reminders were limited to a maximum number of telephone calls, faxes and e-mails and over a short period of time. With the third cycle, it was hoped to improve the response rate and thus increase the sample size by offering an incentive. This was done to improve the internal validity and generalizability of the study and to eliminate any sampling error that could occur. Possible confounders could not be

identified as such, but how representative of the target population of general dental practitioners the sample was that could affect the generalizability of the study must be highlighted. Moreover with the small sample size, had the sample been stratified for age, gender and race, reduction of sampling error would have been achieved to some extent. For this study conducted amongst the registered population of dentists, the final sample size was still relatively small (n= 84) and may not give an accurate estimate for the total practitioner pool. In comparison, other global studies were conducted using convenience samples and within a controlled environment, thus reflecting larger response rates (Table 4) [8, 10, 16, 26].

The non-response of participants for this study could be attributed to the time-consuming nature of completing a questionnaire; disinterest; lack of knowledge regarding the topic, dentists being retired and/or their refusal to respond, and the South African oral healthcare system operating under a fee-for-service structure which conflicts with the underlying 'non-interventional' concept under study. The final decisions for treatment are guided by the financial constraints of the most requested treatment option (implants) for a SDA. It is a situation that can be easily manipulated either way, in favour of the dentist or the patient. More importantly, it is a setting that should be used to guide and educate patients of the workable cost-effective solutions in the form of the SDA, if only practitioners had adequate knowledge of the SDA concept. It has been shown elsewhere that salaried public sector practitioners (e.g. academics) are more positively inclined towards the SDA concept in their clinical decision-making.³¹ Some of the earlier studies that looked at the attitude of dentists toward the SDA were conducted in a controlled environment, had fewer participants, and in some cases had even longer questionnaires [8, 10, 16, 26]. Notwithstanding the differences amongst the listed studies, it is evident that the present findings compare well with those found globally (Table 4) [8, 10, 16, 26].

The condition of not having read any research related to the SDA had obvious bearings on this study. It is possible that a lack of knowledge related to the topic

might cause reluctance to complete the questionnaire and so affect the response rate. In addition to this, the uncertainty expressed regarding the relationship between the SDA and oral-health related quality of life by the non-committed responses can also be explained by the respondents' limited knowledge. Oral health-related quality of life (OHRQoL), defined as the impact of the oral cavity and related diseases on the quality of life, teeth, psychological, functional and cultural factors [32-33]. In the context of tooth loss, the degree to which OHRQoL is impacted is most likely context dependent [22], with location and distribution of missing teeth being important [3]. Patients who have lost teeth usually seek treatment, primarily to address their esthetic concerns, and the desire to replace posterior teeth is less and reduces with the passage of time after extraction [4, 32]. Whereas RPDPs address and satisfy the esthetic concerns of many patients, research has questioned the efficacy of especially the distal extension denture [24-25]. Furthermore, these dentures are not regularly worn by up to 50% of patients, and providing them amounts to a considerable waste of resources and time [11, 15, 24,-25].

More importantly, the need for a questionnaire survey among South African dentists to gauge their attitudes towards the SDA concept, as was attempted in this study, appears to have been warranted. Notwithstanding the low response rate reported here, and the limitation this places on making the generalization to all practitioners in SA, some cautious extrapolations from the present findings might reasonably be made. Firstly, the awareness by most respondents of the SDA concept, the belief by most that reduced posterior arch lengths can provide adequate function and indeed benefit certain patients and the readiness by most to offer the SDA option for consideration in the management of suitable partially dentate patients are all positive indicators of a possible shift in prosthodontic treatment planning. A clinical trial to assess the success of treatment using the SDA concept can thus be instituted with such positive feedback from practitioners.

Gauging the epidemiological data of the South African population, from the total of 48 million, approximately 30 million form the adult population of 20-80 year-olds and about five million (10.9%) of the country's population reside in the WC Province [34].

Historically, the population was segregated into four broad groups by legislation, with socio-economic status also closely aligned with these divisions. The prevalence of periodontal disease, dental caries and tooth loss vary across the country, but are recorded to be the highest in adults (and children) in the groups living in the WC Province, concurring with other studies [34-35]. The WC Province also has the highest prevalence of adult edentulousness (37%) in the country (with farm-workers at 76%), but only 27% of edentulous patients had acquired complete removable dentures. The reasons cited for this are inaccessibility to clinics, high cost of dentures and no transport facilities to clinics [34]. It is evident from the foregoing that the oral health status, and pertinently the prosthetic aspects, of the population living in the WC Province fall far short of being acceptable.

According to Owen (2004), the inequities experienced in the South African healthcare system need to be addressed with appropriate primary healthcare measures [36]. The SDA can be seen as unique and as a significant evidence-based solution for South Africa. It can, in principle, be seen as an appropriate therapeutic approach for many patients in SA through which major inequities in the healthcare system can be addressed [2]. In an environment of limited resources, the concept has the potential to overcome barriers of financial access that are associated with conventional interventional options such as complete and partial removable dentures, fixed prosthodontics or implant-retained procedures [2, 15, 34].

Concerted efforts need to be made to improve the knowledge, and with it, interest in the topic. While Continuing Professional Development is an accepted method of up-dating knowledge, such direct educational interventions are considered to be not very effective in influencing clinical behaviours. Furthermore, while guidelines may improve the knowledge of dentists, they do not improve clinical decision-making skills [37-38]. It would seem that an important aspect that needs research attention is the process of the translation of knowledge of available evidence into best practice [39]. Such a task may be easier to inculcate at the undergraduate level, hence a survey of this nature completed with senior dental students as respondents would be an

excellent indicator of what is being taught and how students translate such teachings into actions.

Equally pertinent, the patient should play a meaningful role in effecting healthcare, in terms of informed inputs into choices and consent. However, the patient is exposed to a surfeit of non-scientific information, imposing upon the dentist the need to enhance communication skills which must be learnt and practiced [40]. Thus determining the needs of patients and placing less reliance on normative approaches in decision-making, would be prudent in terms of introducing new concepts. It would seem that in the latter regard in particular, clinical decision making that encompasses SDA options would be beneficial.

2.5. Conclusions

The participants in this study felt that patients can benefit from the implementation of the SDA concept. In addition, they alluded to the fact that patients with a SDA will be able to function adequately and that it should thus be presented to them as a treatment option. The benefit of implementing this questionnaire survey amongst practitioners, whose reading of research on the subject was seen to be limited, has been revealing and points to the urgent need for further such surveys on a larger, more broadly-based and thus a more representative sample. More precise information and continued research are prerequisite for any further consideration of the SDA concept as an appropriate treatment strategy for the country.

References

1. Müller F, Naharro M, Carlsson GE. What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe? *Clin Oral Impl Res* 2007 18(Suppl. 3):2-14.
2. Omar R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part ii. Case for a sustainable dentition? *SADJ* 2004 59(6):228-37.
3. Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010 (8):126-36.

4. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998 (25):649-61.
5. Narby B, Kronström M, Söderfeldt B, Palmqvist S. Prosthodontics and the patient: What is oral rehabilitation need? Conceptual analysis of need and demand for prosthodontic treatment. Part 1: Conceptual analysis. *Int J Prosthodont* 2005 (18):75-9.
6. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981 (8):457-62.
7. Käyser AF. The shortened dental arch: A therapeutic concept in reduced dentitions and certain high risk groups. *Int J of Perio and Rest Dent* 1989 9(6):426-49.
8. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996 (23):481-5.
9. Steele JG, Walls AW. Strategies to improve the quality of oral health care for frail and dependent older people. *Qual Health Care* 1997 (6):165-9.
10. Korduner EK, Söderfeldt B, Kronström M, Nilner K. Attitudes toward the shortened dental arch concept among Swedish general dental practitioners. *Int J Prosthodont* 2006 (19):171-6.
11. De Sa e Frias V, Toothaker R, Wright RF. Shortened dental arch: A review of current treatment concepts. *J of Prosthodont* 2004 13(2):104-10.
12. Kanno T, Carlsson GE. A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil* 2006 33:850-62.
13. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NHJ. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Sci* 2007 115(4):265-74.
14. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin. Oral Impl. Res* 2007 18:34-45. DOI: 10.1111/j.1600-0501.2007.01436.x.
15. Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aust Dent J* 1987 32(3):178-82.
16. Sarita PT, Witter DJ, Kreulen CM, Creugers NHJ. The shortened dental arch concept – attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol*, 2003 31:111-5.
17. Witter DJ, van Elteren P, Käyser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988 15:413-420.

18. Wolfart S, Heydecke G, Luthardt RG, Marre B, Freesmeyer B, Stark S et al. Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: results from the pilot-phase of a randomized multicentre trial. *J of Oral Rehabil* 2005 32:815-822.
19. Witter DJ, de Haan AF, Käyser AF, van Rossum GM. A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 1994 21:113-25.
20. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008 35:337-44.
21. Zeng X, Sheiham A, Tsakos G: Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008 35:37-44.
22. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008 21(1):72-4.
23. Gerritsen AE, Sarita P, Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Esthetic perception of missing teeth among a group of Tanzanian adults. *Int J Prosthodont* 2008 21:169-173.
24. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 1989 16:27-33.
25. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003 16(4):409-14.
26. Witter DF, Allen PF, Wilson NHF, Kayser AF. Dentists' attitude to the shortened dental arch concept. *J Oral Rehabil* 1997 24: 143-147.
27. <http://www.math.mit.edu>.
28. <http://en.wikipedia.org/wiki>.
29. McAvoy BR, Kaner EFS. General practice surveys: a questionnaire too far? *BMJ* 1996 313: 732-33
30. Helminen SE, Vehkalati M, Murtomaa H: Dentists' perception of their treatment practices versus documented evidence. *Int Den J* 2002 52:71-74.
31. Körduner EK, Söderfelt B, Kronström M, Nilner K. Decision making among Swedish general dental practitioners concerning prosthodontic treatment planning in a

- shortened dental arch. *Eur J Prosthodont Rest Dent* 2010 18:43-47.
32. Sheiham A, Tsakos G. Oral health needs assessments. In: Pine CM, Harris R, editors. *Community Oral Health: Wright Publishers, Oxford, 2004, Chapter 4, pages 1-3, 8, 11.*
 33. Inglehart MR, Bagramian RA. Oral Health-Related quality of Life. In: Inglehart MR, Bagramian RA eds. *Oral Health-related Quality of Life. Carol Stream: Quintessence 2002:1-6.*
 34. National Oral Health Survey of South Africa (1988/89). A report: Department of Health. Pages: 24-31; 57-60; 62; 93-100.
 35. Naidoo S, Chikte UME, Moola H, Steyn K. Perceptions of oral health: The South African Demographic and Health Survey of 1998. *SADJ* 2001 56(11):505-10.
 36. Owen CP. Appropriatech: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont* 2004 17(2):261-2.
 37. Van der Sanden WJM, Mettes DG, Plasschaert AJM, Grol RPTM, Mulder J, Verdonchot EH. Effectiveness of clinical practice guideline implementation on lower third molar management in improving clinical decision-making: a randomized controlled trial. *Eur J Oral Sci.* 2005 113:349-354.
 38. Grol R. Successes and failures in the implementation of evidence based guidelines for clinical practice. *Med Care* 2001 39 (Suppl. 2): II46-II54.
 39. Haynes B, Haynes GA. What does it take to put an ugly face through the heart of a beautiful hypothesis? (Editorial). *Ann Intern Med.* 2009 17 150: JC3-2, JC3-3.
 40. Kay EJ, Blinkhorn AS. A qualitative investigation of factors governing dentists' treatment philosophies. *Br Dent J* 1996 180: 171-176.

Figure 1: Survey: Dental practitioners of the Western Cape

Please answer all questions. More than one option is required for certain questions, mark your response with an X						
1. Percentages of procedures treated in your practice per week? (To the nearest 10% and adding up to 100%)	Extraction%	Crowns & Bridges%	Fillings%	Ortho%	Dentures%	Other, specify%
2. Age categories of patients seen in your practice? (Mark all applicable ages)	Under 10	10– 18 yrs	18 - 35 yrs	35 -65 yrs	65 rs or more	
3. Reasons for extracting teeth in your practice are? (Give a % for all options, to the nearest 10%, adding up to 100%).	Caries%	Perio Dis%	Trauma%	impaction%	Ortho%	Patient request%
4. Percentages of the different teeth extracted are? (Give a % all options, to the nearest 10%, adding to a 100%)	Upper incisors%	Premolars%	Lower molars%	Upper molars%	Canines%	Lower incisor%
5. Do your patients demand the extraction of anterior teeth?	Always	Sometimes	Rarely	Never		
6. Do you comply to requests for extraction of patients' anterior teeth?	Definitely yes	Yes	No	Definitely no		
7. Patients with decayed teeth are advised to save at least their anterior and premolar teeth?	Always	Sometimes	Rarely	Never		
8. What appliance do you commonly use for replacement of missing teeth?	Plastic dentures	Metal dentures	Fixed bridges	implants	Other, specify	
9. Do you always replace missing molar teeth with distal extension dentures?	Definitely yes	Yes	No	Definitely no		
10. Do you advise patients not to replace missing molars with bridges or dentures?	Always	Sometimes	Rarely	Never		
11. Where did you first hear about the Shortened Dental Arch (SDA)?	University	Journal	This survey	Colleague	Other, specify	
12. Have you read any research related to the SDA conducted locally or internationally?	Definitely yes	Yes	No	Definitely no	Don't know	
13. Do you agree that patients can function adequately with a SDA?	Definitely yes	Yes	No	Definitely no	Don't know	
14. The SDA should be presented to patients as an alternative treatment option?	Definitely yes	Yes	No	Definitely no	Don't know	
15. Treatment options that you usually propose to patients with a SDA are? (More than 1 entry is allowed, to the nearest 10% and adding to 100%)	Plastic dentures%	Metal dentures%	Cantilever bridges%	implants%	No treatment%	Other%
16. Would patients benefit from an SDA treatment option?	Definitely yes	Yes	No	Definitely no	Don't know	
17. An SDA treatment option must be limited to special cases only, e.g. the handicapped patient?	Definitely yes	Yes	No	Definitely no	Don't know	
18. What will prevent you from presenting the SDA as a treatment option?	Loss of income	Lack of knowledge	Limited research	Not viable option	Nothing	Other, specify
19. Patients most often request the replacement of missing molars with?	Plastic dentures	Metal dentures	Fixed bridges	Implants	No Treatment	
20. Not replacing missing molars will affect the patients' Oral-health- related quality of life	Definitely yes	Yes	No	Definitely no		
21. Extracting anterior teeth will negatively impact on patients' Oral- health- related quality of Life.	Definitely yes	Yes	No	Definitely no	Don't know	

Table 1

Table 1: Demographic details of respondents				
Age range	24 – 35yrs	36 – 45yrs	46 – 59yrs	60+ yrs
	28	2	2	8
Gender	Fem	M	Not Recorded	
	31	5	1	
Institutions attended (could be more than one)	University of the Western Cape	Stellenbosch University	Other South African Universities	International Universities
	24	4	1	4
Qualifications	BChD	PDD	MChD	BSc/MSc/ PhD
	84	3	1	2
Employment	Private/ Public Health		Academic institution	
	73		31	
Details (dual appointments)				

Table 2

Table 2: Anterior extractions: patient demand and dentist reaction				
Perceived demand for anterior extractions	Compliance by dentists with patient demand for anterior extractions			
	Definitely No	No	Yes	Total
Never	21	6	5	27
Rarely	14	14		33
Sometimes	7	7	8	22
Total	42	27	13	82
(Chi-squared test = 17.81, df. = 4, p-value < 0.005)				

Table 3

Table 3: Summary of results related to questions focusing on the shortened dental arch			
	Definitely yes and Yes	Definitely no and No	Don't know
Read research	38%	62%	
Agree can function	86%		11%
As treatment option	83%		10%
Benefit to patients	82%		8%
Limit to special cases only	25%	67%	
Absent molars – affect OHRQoL	46%	43%	

Table 4

Table 4: Comparison of the design and results of this study with similar studies conducted globally					
Country	UK	Sweden	Tanzania	Netherlands	South Africa
Authors	Allen, 1993	Korduner, 2003	Sarita, 1998	Witter, 1997	Khan, current
Sample (n)	91	189	77	64	84
Reminders information sheet	Mail Yes	Mail Yes	Mail Yes	Mail Yes	Fax, telephone, e-mail Yes
Sample	Restorative consultants	GPs	GPs, public sector dentists	Department staff	GPs, Department staff, specialists
Comparison of data requested in Questionnaire					
Demographic details	Yes	Yes	Yes	Yes	Yes
Opinions	Yes	Yes	Yes		Yes
Experiences		Yes	Yes	Yes	Yes
Implemented	Yes	Yes	Yes	Yes	Yes
Conclusions	Accepted, but not practiced	Affirmative	Accepted, but uncertain of practice	F or contemporary practices	Would benefit South Africans
Comments	Reservation; No premolar occlusion	Few risks	89% use acrylic RPD for SDA	SDA useful if patients accept it	Produces no income; lack of knowledge
Problems	Drifting; age; knowledge	Decreased benefits for GPs	Acceptable for practice	Special needs only; TMJ/periodontal problems	Non-response

Chapter 3

Exploratory Research

From Classroom Teaching to Clinical Practice: Experiences of Senior Dental Students regarding the Shortened Dental Arch Concept

From Classroom Teaching to Clinical Practice: Experiences of Senior Dental Students regarding the Shortened Dental Arch Concept

Chapter 3 is a report of the second study investigating the *status quo* at the Faculty of Dentistry regarding the knowledge of students, and what is taught in the classroom and in the clinics regarding the SDA concept. It was important to ascertain whether the concept, which was explicitly stated within the National Oral Health Policy since 1994, and now also included in the amended version called the National Oral Health Strategy 2030 of South Africa for adults until 40 years old, is taught, applied clinically and researched at the largest dental teaching institution in the country.

SUMMARY

It was discovered that general dental practitioners (as indicated in Chapter 2) do not have much knowledge about the SDA concept and it was assumed (amongst many other reasons) that is why that study had such a low response rate. It was thus important to ascertain what students are taught in classroom and clinics. The aim of this cross-sectional study was to determine what is formally taught regarding the SDA concept, and the (consequent) knowledge and practices of undergraduate dental students and their clinical teachers based at the Faculty of Dentistry, University of the Western Cape, South Africa. Exploring this aspect would shed light on why practitioners' knowledge was sparse or even why they were reluctant to respond to the survey.

A mixed-methods research approach was performed in three different phases, using three very different epidemiological methodologies, and different analyses to arrive at its outcomes. The phases were as follows:

- a) A survey was conducted among senior dental students and the quantitative data analysed using the appropriate statistical tests as stated in the associated article.
- b) A survey was also conducted among the specific clinical teachers who are responsible for the clinical teaching of these same students.
- c) A group interview was also included as the qualitative methods applied allowed more in-depth questioning and analyses.

d) Lastly, individual interviews were conducted with this class; these qualitative questions elicited an even better insight into how students understand, perceive what they learnt in the classroom and clinical setting, and what their clinical experiences are in regard to the SDA concept. Furthermore, being senior dental students, their perceptions and expectations of what their future roles as clinicians and life-long learners mean to them were also explored.

A convenience sample of all final year dentistry students was included for the questionnaire survey, the quantitative part of the study. A purposive sample for the group (N=10/group) and individual interviews (N=10) were finalized for the qualitative aspect of the study from the provided class list. The participants, settings and questions were set, as well as the type of data recording methods.

The qualitative questions were rather intensive and probing and the aspects explored for this component of the project related to the academic perspectives (how new knowledge that although it may be included in the classroom, is not implemented clinically) and economic perspectives (the potential benefits to the patients), and human rights perspectives (from a student's point of view as it relates to what he/she was taught and his/her patients' choices in treatment). The insights revealed were only possible with the qualitative (a more interpretive type of research) interviews which provided more clarity to specific questions related to this topic. Moreover, engaging students at this level not only educated students more about the SDA concept, but it also apparently brought out an expression of greater understanding of the SDA concept, and empathy for, the circumstances of their patients. The advantage of this type of research methodology allowed the researcher some control of how the questions were directed and the responses obtained, and it could be argued that students answered in a way to please the researcher [37-38].

Moreover, generalizability of study outcomes is not a main concern with both types of sampling used for this study, as long as the aims of the study were addressed [37-38]. Compared to random sampling, with purposive sampling, choosing those who can best answer the research question is the aim [37-38]. With random sampling, you have no

control of who forms the sample and with negative consequence at times (refusal to participate, biasing results for whatever reason or unwilling participants) [37-38].

PUBLICATION

This paper has been published in the Journal of Dental Education; Publication citation: Khan, SB. Chikte, UME. Omar, R. (2014). From Classroom Teaching to Clinical Practice: Experiences of Senior Dental Students regarding the Shortened Dental Arch Concept. J Dent Educ. 78 (6); 906-913.

For this component of the study project, the PhD candidate developed the protocol and the questionnaires (used for quantitative and qualitative aspects) and submitted the protocol for ethics approval. She independently obtained all information related to the research from the participants (students and staff) by conducting both the individual and group interviews, checked data coding, extracted the data and assessed the data (the statistician assisted with analysis of the quantitative data with her input). She also developed the themes of the qualitative aspects using the literature as a guide and interpreted the final data. The manuscript, including all corrections from both supervisors and journal reviewers who provided guidance and critical comments, was completed by the candidate. All authors approved the final manuscript.

The Questionnaires, Consent Form and Ethics Approval are included as Appendices 3.1-3.4.

SUMMARY

This study explored the barriers to a meaningful translation of didactic classroom instruction to clinical practice, using the shortened dental arch (SDA) concept as a case study.

A combination of questionnaire survey, and individual and group interviews (a mixed-method approach) were used in data collection to assess responses related to the SDA concept. The cohort included senior students (n=73) and their clinical teachers (n=16).

Triangulation was employed to eliminate bias and strengthen the reliability of the research.

Quantitative analysis: most senior students disclosed having heard about the SDA concept at university, but that its clinical implementation is evidently lacking. Students agreed that patients can function adequately with SDAs, and approved its presentation as a treatment option to patients. Qualitative analysis: a *“change in the clinical requirements”*, *“being empowered by exposing them to SDA literature”* and *“health policies”* could all be measures to address the appropriate implementation of the SDA concept clinically.

Students were positive towards the SDA as a treatment option, but not having adequate related knowledge or encouragement in its clinical implementation is perceived as a hindrance. Clinical instruction and clinical teacher knowledge needs to include evidence-based concepts.

Keywords

Dental education, shortened dental arch, transfer of concepts, clinical instruction, clinical diagnostic reasoning, minimum clinical requirements

3.1. Introduction

Best available evidence is increasingly accepted as an essential guide for best practice [1]. The process begins in the classroom and the implementation then needs to manifest in the clinical setting. Alongside this, dental schools are adopting a more patient-oriented approach in their clinical educational programs [1-3]. There is the assumption that there is continuity and coherence with the implementation of best evidence from classroom teaching to clinical practice [4-6]. To what extent this translational learning outcomes is realized, has long absorbed educators and clinicians.

Considering the many theories of learning, the literature describes the constructivist paradigm as one that alludes to the role of students and the teacher in facilitating the learning of concepts [2, 7-8]. Studies have emphasized the significance of a student-centered teaching strategy which encourages a deep approach to experiential learning and knowledge transfer, resulting in more effective conceptual understanding of content [2, 4, 7-12]. Researchers refer to traditional forms of lecturing (which restricts learning largely to passive modes) as the least effective method of knowledge acquisition [2, 13]. Active learning of concepts occurs in clinical practice and this needs to be a guided process, placing the focus on the role of clinical teachers to facilitate this deep approach to learning [1, 10].

Since effective learning of the clinical process, from decision making to implementation, depends on the quality of the clinical teaching [5-6, 14], the choice of clinical teachers becomes crucial: they must have the ability to mediate the experiential learning of students, to appropriately guide them to do *'what's best for the patient'* (viz. adopting a patient-centered approach) as well as critically assessing student performance [1-3, 5-8, 12, 14]. Kreuger et al (2004) indicated that students *'forget'* theoretical information when commencing clinical practice, and are subsequently unable to transfer concepts to different contexts [13]. To ensure that any disjuncture between classroom and clinical practice is minimized or avoided is key [5-6].

Assessment within module-based clinical curricula should include student performance based not only on their understanding and clinical application of concepts, but also the

completion of predetermined clinical procedures [15]. Hay mentions that '*assessment drives learning*', an assertion supported by the finding that students in clinical modules are apparently contented with mere completion of the predetermined clinical procedures [2-3, 16]. At the same time, entrenched institutional and traditional practices can impede the inclusion of newer clinical concepts that are based on best evidence. Such a situation can be regarded as ethically questionable [3, 14, 17].

From the foregoing, it would seem that the nature of the alignment of two educational outcomes: (i) the transfer of concepts from classroom instruction to clinical practice and (ii) the clinical competence (i.e. readiness and ability) of dental students to prescribe evidence-based therapeutic solutions, needs exploring. For the purpose, it was decided that the shortened dental arch (SDA) concept, which is a clinical management approach that is documented as being compatible with the functional needs of many older, partially dentate populations, lends itself well to exploring these questions. Given the background, and the fact that institutional policies are keen to find clinical solutions for historically disadvantaged South African communities, the SDA seems to be a logical case study.

Specifically, the SDA concept was chosen as a case study to examine the extent to which the transference of theoretical concepts to clinical practice occurs amongst senior dental students. The *classic SDA* consists of twenty occluding anterior and premolar teeth, and represents a functional approach to managing partially dentate middle-aged and elderly patients, and sometimes young, high-risk patients, from the conventional ones [18]. The reduced posterior arches ensure adequate chewing function and the research presents the SDA concept, as a clinically beneficial treatment option, albeit within defined clinical conditions [1, 15, 18-29]. From a socio-economic point of view, it offers the additional advantage of being a compelling primary healthcare measure relevant for many underprivileged groups, such as some of South Africa's (SA) communities [29].

Traditionally, removable partial denture prostheses (RPDPs) are used to restore functions deemed essential in partially dentate patients [18-24]. The necessity for such an approach has long been questioned (more so in the context of limited resources), and evidence is ubiquitous that the profession still resists modifying traditional clinical practice accordingly

[15, 18-34]. This apparent resistance to prescribing the SDA concept in specific conditions can be related to several factors: an indifference towards including evidence-based findings during teaching and in practice, utilizing practices based on tradition and peer-input, misplaced confidence in traditional practices, the need to complete a procedure to satisfy patients, profit-based practices, the inadequacy of knowledge transfer to clinical practice, and/or a general disinclination of clinicians to apply new concepts [13, 17]. Although there are attempts to change oral healthcare policies based on clinical research [15, 18-28, 30, 33], there is a void on the subject of translation of classroom teaching to clinical implementation.

The aim of this study was to determine the relationship between what dental students are formally taught in class regarding the SDA concept for managing partially dentate patients and the extent to which clinical implementation of this treatment protocol actually occurs.

3.2. Methods

Ethical clearance (Registration No. 11/1/51) was obtained from the Research and Ethics Committee of the University of the Western Cape (UWC), South Africa. Written informed consent was obtained from the participants according to the Declaration of Helsinki [35].

A mixed-method approach was used in data collection (quantitative and qualitative) and analysis [36-38]. *Triangulation* was employed to eliminate bias and increase the validity and strengthen the reliability of the research [37-38]. It draws on the *sequential explanatory strategy* in data collection and analysis and for subsequent inclusion of the semi-structured interview phases (*qualitative* data) following the completion of a survey (*quantitative* data) [36-38].

For the *first phase*, a survey was conducted amongst the senior dental students (n=73) and their clinical teachers (n=16) at UWC from January to March 2011 (Table 1). The selection of students for the quantitative part of the study included a convenience sample of final year dentistry students, because they had completed the theory and related biomechanical principles of RDPDs [37-38]. Furthermore, their minimum clinical requirements included the

completion of acrylic- and metal-based RPDPs for patients with shortened, interrupted or discontinuous arches.

The self-administered questionnaire was distributed and collected among the students and staff by the researcher (SK) (Table 1). The quantitative data (categorical and ordinal observations, as well as paired comparisons) were analyzed by a statistician using the MS Excel statistical package [39]. The categorical data were analyzed by means of residuals based on observed and expected values and using frequency distribution, Spearman rank correlations and Chi-squared statistics [39]. The data were managed by dichotomization (*definitely yes* and *yes*, to a *yes* response) and this collapsed table strengthened the pattern of analysis [39].

For the *second* and *third phases* of the study qualitative interviews were conducted to supplement the findings from the students' survey with a qualitative discussion [36, 38]. Smaller samples of students were selected for the semi-structured individual interviews (n=10) and for one semi-structured group interview (n=1, including 10 students); both of which were conducted from April to June 2011 [36-38]. These participating students were purposively selected from the class (n=73) [37]. The interviews permitted a more comprehensive, interpretive discussion and understanding of *why* students were not suggesting or implementing the SDA as a treatment option [9, 38].

The semi-structured *individual* interviews with the students were of one-hour duration each and responses were transcribed by SK [36-38]. Another group of ten senior dental students was also purposively chosen for the semi-structured *group* interview [36-38]. The Crawford slip-method allowed students to record their responses without any bias and avoid them being influenced by the thinking and responses of the group [40-41]. The use of this method allowed students to give their own independent opinions when answering the questions and it ensured maximum participation from all students [40-41].

The qualitative data (semi-structured individual and group interviews) were analyzed using the analytical abstraction method (which has a clear, logical step-by-step analysis approach) [38, 42]. Themes present in the literature review were used as a guide in the basic coding process [37-38, 42]. These themes include a discussion at the *basic level* (actual words of

respondents) and a *higher level* (inferences of responses) [37-38, 42]. The recorded text from both interviews used in the analysis ensured an accurate account of student responses, and member-checking was implemented where students had to check that their responses were transcribed *verbatim* and that this was reflected in the subsequent interpretation [38].

Furthermore, three emergent themes which became apparent from the basic analysis of the qualitative data were extrapolated, and all these themes are discussed in the results section [37-38, 42]. A *conceptual analysis* of the data including an interpretation and discussion thereof is also presented [37-38]. The above strategies and sampling were intentionally included to increase the validity and strengthen the reliability of the research, and at the same time reduce any bias encountered by the role of the researcher [37-38].

3.3. Results

The *quantitative data* from the student and clinical teacher surveys are presented in Table 2. The survey response rates are recorded at a 100% for the students' (n=73) and 78% for the clinical teacher (n=16) surveys respectively.

3.3.1. Quantitative Data Analysis:

(a) Student survey responses

Eleven percent of student respondents indicated having heard about the SDA concept from this survey only, and ascribed this to having missed lectures, not paying attention in class or the lecturer placing little emphasis on this concept and without encouraging its use clinically. According to the Spearman rank correlation (0.565), a strong relationship existed between students not having read the research (77%) and their lack of knowledge of the different SDA variants (77%).

Many respondents indicated their proposed treatment for a SDA to include either metal (69%) or acrylic (53%) dentures, or a combination of these with other treatment options such as implants (Table 3). Only 3% chose '*no treatment*' as a suggested treatment alternative for a patient with a SDA, which prompted extensive questioning in the interviews

regarding their knowledge, classroom teaching and clinical use of the SDA. Twelve percent of respondents indicated “*quota requirements*”, but 86% said “*not having any knowledge*” of the SDA will prevent clinical use thereof. More importantly, students were totally unaware of the financial benefits for patients with the SDA treatment option. The response of students to the question: “*whether they would insist on making a denture for a clinical quota*,” was recorded as 50% saying ‘no,’ and this was unexpected as students’ main concern is the completion of minimum clinical requirements (Table 2).

When correlating the questions referring to the “*making of a denture for a quota*” versus the “*suggestions to implement the SDA as a treatment option*” the distribution of the suggestions varied significantly ($p < 0.05$): these significant differences were observed with the responses of ‘no suggestion’ versus a ‘quota change.’ Nineteen percent of students said ‘yes’ whilst 39% said ‘no’ to the question of “*no suggestion to the making of a denture for a quota*” ($\chi^2 = 9.9627$; d. f. = 4; $p\text{-value} = 0.0411$). The responses suggesting ‘*a quota change*’ was recorded at 53% of students saying ‘yes to a quota change’ (to include the SDA) versus 19% who said ‘no to a quota change.’

(b) Clinical teacher survey responses

The clinical teachers’ responses ($n=16$) indicated that they have read the research, know of the different SDA variants and agree that patients can function with a SDA (Table 1). However, their responses are of some concern as these clinical teachers still indicated that they would replace molars in all patients with a SDA. The disparity between knowing theoretical concepts and the lack of clinical implementation is obvious. Moreover, it can only be speculated that the teaching and implementation of evidence-based findings that are needed to inform students is absent.

3.3.2. Qualitative Data Analysis:

The qualitative findings explain what happened during lectures and clinical implementation from the students’ point of view. These are reported under 3 broad categories: *Basic* and *higher levels* and then *conceptual analysis* of these two levels. The basic and higher levels are reported in themes, firstly guided by the literature and then secondly, those that became apparent after the analysis.

(a) Basic and Higher Level Analysis

The themes guided by the literature include: *definition of the SDA concept, classroom and clinical instruction and minimum clinical requirements.*

Student respondents commented on the SDA concept used in class: “No term SDA” or “a term interchange” and “SDA was not used.” The definition of the SDA stated in class (and used for distal extension dentures include teeth up to the first molars) is very different from that cited in the literature [19-21]. In spite of the rather indistinct definition of the SDA concept, students suggested that this SDA “be used if it is advantageous to” or “benefits patients.” Many students suggested that a separate lecture be given for an alternative treatment option such as the SDA as they are unaware of the extensive research conducted and expressed the need to be informed.

Student respondents said the classroom teaching of the SDA included “no explanation when teaching the concept” and “the way it was mentioned we regarded it as insignificant.” Because of this brief mentioning of the SDA, students clearly consider the concept as unimportant and forget about it [11-12]. Thus its use clinically by students on their own initiative can hardly be expected. Instead, the clinical teacher needed to assume the role of reminding them about the appropriate use of the SDA rather than ignoring situations where its use could have greatly benefited their patient [11-12]. Students were very conscious of the difference between classroom and clinical teachings and expressed their dissatisfaction that “student-centred learning does not occur in the clinics.” Student respondents commented that “attitudes from classroom and clinical teachers regarding ‘new’ concepts guide their professional behaviours after graduation,” thus the updating of knowledge to include evidence-based research both in class and clinics is imperative and has been notably absent.

Students responded explicitly to questions on minimum clinical requirements: Several students said that “if a procedure is not a requirement” or “you don’t need to do it, students will ignore it.” Students did not consider the financial implications and or/ benefits for a patient when contemplating extending a SDA with a RPD. When they were made aware of this, however, they regarded this as “good ethical and moral clinical practice.” The guidance received by students from clinical teachers can either encourage or discourage them from

implementing new procedures that are not a requirement. Any new concept that can be clinically implemented by students should preferably be included as a clinical requirement for that module. The students' clinical requirements should thus also be reviewed regularly to include new researched information.

(b) Emergent themes

With the analytical abstraction method, the coding process also highlighted several themes that added considerable value to the teaching and learning experiences important to student respondents. These themes are outlined below:

➤ *Clinical outcomes*

Even though students are guided clinically by minimum clinical requirements, the absence of clinical outcomes as in module learning outcomes (prescribed by the curriculum and provided to students) is evident. The use of clinical outcomes would serve as a guide to both students and clinical teachers, ensuring the updating and alignment of clinical teachings.

➤ *Inter-Professional Education (IPE)*

Defined as occasions when two or more professions learn from and about each other to improve collaboration and health outcomes. Following the student interviews, the role of dental technicians was highlighted and students regard their role as equally important when wanting to implement new concepts [43]. Their knowledge regarding the SDA concept and their input with regards to laboratory procedures will impact on its implementation and thus needs to be aligned with evidence-based research and dental students' teachings. The lack of knowledge and subsequent practice related to the SDA concept has been duly documented.

➤ *Interviews*

Both group and individual interviews, conducted with these senior dental students simultaneously served as a teaching and learning opportunity for the researcher and the students. What is otherwise assumed or even disregarded were revealed as important items of information in these interviews, namely: the methodologies employed in clinical teaching (or lack thereof) and its impact on student learning, and the role of clinical teachers and the consequence of their input on students' clinical decision-making [44]. In addition, the effect of what teachers do for staff development (research) and the beneficial impact this has on students has been noticed.

(c) Conceptual Analysis

Students commented that they are not inclined to do any extra reading when the impression is created (in class or clinics) that a concept is insignificant. This attitude when presenting students with evidence-based research is as important as the interpretation by students in guiding their clinical decision-making. Thus the approach in the teaching method should ensure this, and this is what Strayhorn (2004) referred to. When specific classroom teaching strategies are employed, the tendency for students to learn the content and then appropriately transfer this knowledge to clinical practice is enhanced [4]. Student respondents also suggested a “*change in the minimum clinical requirements*” (emphasizing module review) and a change in “*health policies*” to include and implement the SDA treatment option. This would make both student and clinical teacher aware of the concept [17]. This attitude of dental practitioners regarding new concepts was observed in a study by Lalloo et al, (1999). This study concluded that the effortlessness related to the utilization of old concepts (e.g. restoring and extending shortened dental arches) could not be altered without shifting the mindset and healthcare policies for professionals and institutions [17].

3.4. Discussion

The aims of this study are viewed as realistic given the defining goals of the institution that emphasize attributes of *citizenship* and *scholarship of learning*, amongst others. Given that these goals are embedded within the stated outcomes of every module in the curriculum, the findings of this study clearly are not in conformity. In particular, the barriers to more meaningful translation of evidence-based concepts that is taught in class and in clinical settings seems to have been identified by the interviewed students. From this, the inclusion of best evidence in the classroom needs to be supported and reinforced during clinical instruction so as not only to improve students’ basic knowledge but also to empower them to apply new procedures appropriately [1-3]. Students would thus more confidently be able to advise and educate patients, to make informed clinical decisions and deliver the most appropriate treatment to their patients. One student expressed the view that that this research had created evidence, which could change the mindset of practitioners and dental students [1-3]. A related matter is that students will be undertaking community service in mostly rural communities post-graduation, and a thorough grasp of the SDA concept would

greatly add to their decision-making skills in the relatively under-served clinical environment they will find themselves in.

Currently at our institution, classroom instruction has moved to one of student-centered learning, in which a range of teaching strategies to achieve conceptual learning is included [2, 11]. Yet, while classroom instruction emphasizes that students adopt a patient-centered and problem-oriented treatment planning approach clinically, responses in the interviews does not confirm that this was taking place [1-3]. Had such a problem-oriented treatment approach been effectively adopted, the prosthetically non-interventional SDA approach would conceivably have been considered. And consequently, students would have obliged to complete clinical procedures beyond their clinical requirements [3, 19-20]. From the patient's perspective, doing "*what is best for the patient*", including their financial and functional circumstances would also encourage ethical and moral clinical practices [3, 14, 19-20].

In terms of the aims of this study, what dental students are formally taught in class regarding the SDA concept did not relate well with clinical implementation of this treatment protocol. Whether this was due to the influence of sessional clinical staff (that is, their lack of knowledge related to classroom instruction on the SDA) is not established, but its existence cannot be overlooked and clearly needs re-consideration [44]. Hence, the limitation of this confounder should be acknowledged and a study that compares outcomes with sessional versus full-time clinical staff is warranted.

Following both the survey and interviews, students now appear to be more familiar with the low-cost SDA treatment option (including the restrictions to specific clinical situations) for the underprivileged majority in SA [29, 34]. They realize that it needs to be presented to patients, permitting them to make decisions regarding their own treatment needs. The ethics of over-treatment or incurring exorbitant costs to patients can be addressed partially in this way. This resonates with the findings of Henzi et al (2006) who was of the opinion that clinical treatment that enforces certain costly procedures is unethical [14].

The SDA concept is not taught as a separate topic, which could be conceived as another flaw in the module. The extensive clinical research available, including the positive attitude of clinicians regarding its benefits, justifies its inclusion in the module [15, 18-34]. Indeed, this only became evident after the completion of the qualitative research, and this might not

have been observed had only quantitative research been conducted. More significantly, this research allowed reflection on the content of the module, on clinical practices and the choice of clinical teachers. The subsequent inclusion of the SDA concept as a separate lecture can be recommended as a step in the right direction. The importance of instilling self-reflection with respect to our teaching practices (classroom and clinical), and which came through in this research, is also encouraged to improve the students' learning environment [2].

3.5. Conclusions

The results of this study indicate students were positive towards the SDA concept as a treatment option for certain partially dentate adult patients. However, their lack of related knowledge and the absence of encouragement in the clinic are perceived as hindrances to its implementation. These were linked to the emphasis on the SDA during classroom instructions and the nature of clinical guidance and/or instruction. In addition to this, the knowledge of the clinical teacher appears not to be aligned with formal classroom instruction. Given the extensive body of evidence on the functional efficacies of a SDA and the widespread need for low-cost prosthetic management strategies in SA, the case for a more purposeful alignment of the theory and its clinical practice would seem justified. Thus the importance of postgraduate training with appropriate ethical standards for clinical teachers cannot be over-emphasized.

3.5.1. Implications for practice

The SDA has been included as a separate lecture in the module that covers advanced removable denture procedures [45]. In addition, the inclusion of this 'qualitative' therapeutic intervention as a minimum clinical requirement and the necessary policy changes within the institution will need to be addressed [45]. Even though evidence is produced by extensive research, the barriers (of which there are many) to translate this knowledge into clinical practice should be dealt with urgently [45].

References

1. Rolfe IE, Sanson-Fisher, RW. Translating learning principles into practice: a new strategy for learning clinical skills. *Med Educ.* 2002; 36: 345-352
2. Biggs J. *Teaching for Quality Learning at University.* 4th Ed, Berkshire, London, UK: Open University Press, 2004.
3. Bensing J. Bridging the gap. The separate worlds of evidence-based medicine and patient-centered medicine. *Patient Educ Counsel* 2000; 39: 17-25.
4. Strayhorn TL. Engaging Schools: Fostering High school Students' Motivation to Learn. *Educ Review* 2004: 1-8.
5. McMillan WJ. Teaching for clinical reasoning-helping students make conceptual links. *Med Teach* 2010; 32: 436- 42.
6. McMillan W. Making the most of teaching at the chairside. *Eur J Dent Educ* 2011; 15: 63-8.
7. Mc Millan WJ. "Then you get a teacher" – Guidelines in excellent teaching. *Med Teach* 2007; 29: 209-18.
8. MacLellan E. Conceptual learning: The priority for higher education. *Br J Educ Stud* 2005; 53:129–47.
9. McMillan W. Finding a Method to Analyze Qualitative Data: Using a Study of Conceptual Learning. *J Dent Educ* 2009; 73: 53-64.
10. Khan, S.B. Effect of active learning techniques on dental student: A South African case study. *SAJHE* 2011; 25(3):
11. Billing D. Teaching for transfer of core/ key skills in higher education: Cognitive skills. *Higher Educ* 2007; 53: 483-516
12. Taber K. The mismatch between Assumed Prior Knowledge and the Learner's Conceptions: a typology of learning impediments. *Educ Stud* 2001; 27: 159-171.
13. Kreuger PM, Neutens J, Bienstock J, Cox S, Erickson S, Goepfert A, et al. To the point: Reviews in medical education teaching techniques. *Am J Obs. Gyn.* 2004; 191: 408-11.
14. Henzi D, Davis E, Jasinevicius R, Hendricson W. North American Dental Students' Perspectives About Their Clinical Education. *J Dent Educ* 2006; 70: 361-77.
15. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NH. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Oral Sci* 2007; 115: 265-74.

16. Hays R. Assessment in medical education: roles for clinical teachers. *Clin Teach* 2008; 5: 23-7.
17. Laloo R, Myburgh NG, Hobdell MH. Dental caries, socio-economic development and national oral health policies. *Int Dent J* 1999; 49:196-202.
18. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981; 8:457-62.
19. Omar R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ* 2004; 59: 228-37.
20. Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent.* 1989; 9: 426-49.
21. Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aus Dent J* 1987; 32(3):178-82.
22. Witter DJ, van Elteren P, Kayser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988; 15:413-20.
23. Witter DJ, de Haan AF, Kayser AF. van Rossum GM. A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 1994; 21:113-25.
24. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996; 23: 481-85.
25. Armellini DB, Von Fraunhofer JA. The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004; 92(6): 531-535.
26. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K. et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008; 21(1): 72-74.
27. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008; 35: 337- 344.
28. Zeng X, Sheiham A, Tsakos G. Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008; 35:37-44.
29. Owen CP. *Appropriatech*: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont.* 2004; 17(2): 261-2.
30. Sarita PT, Kreulen CM, Witter DJ, Creugers NHJ. Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 2003; 16: 265-70.

31. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003; 16: 375-80.
32. Sarita PT, Witter DJ, Kreulen CM, Creugers NHJ. The shortened dental arch concept—attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol* 2003, 31:111-5.
33. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. *Community Dent Oral Epidemiol* 2003; 31:328-34.
34. Khan S, Chikte UME, Omar R. Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa, *SADJ* 2012; 67 (2): 60-68.
35. World Medical Organization. Declaration of Helsinki. *Br Med J* 1996; 313:1448- 1449.
36. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: interviews and focus groups. *Br Dent J* 2008; 204: 291-295.
37. Cohen L, Manion L, Morrison K. *Research Methods in Education*. 5th Ed, Routledge Falmer. London and New York: Taylor and Francis group, 2005:
38. Creswell JW. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. 2nd Ed, Thousand Oaks, California, USA: Sage Publications, 2003:
39. Dawson B, Trapp RG. *Basic and Clinical Biostatistics*. 4th Ed, New York, USA: McGraw-Hill Companies Inc, 2004:
40. [http://cleamc11.vub.ac.be/Heylighen, F.](http://cleamc11.vub.ac.be/Heylighen,F.) "Referencing pages in Principia Cybernetica Web," 2000.
41. Straker D, Rawlinson G. *How to Invent (Almost) Anything*. UK, Spiro Press 2003.
42. Crafford S, Bitzer E. Consumer learning for university students: a case for curriculum. *Higher Educ Res Dev* 2009; 28:443-455.
43. Inter-professional Education Collaborative Expert Panel. *Core competencies for inter-professional collaborative practice: Report of an expert panel*. 2011 Washington, D.C.: Interprofessional Education Collaborative.
44. Fluit CRMG, Bolhuis S, Grol R, Laan R, Wensing M. Assessing the quality of clinical teachers. *J Gen Int Med* 2010; 25 (12): 1337-1345
45. Straus SE, Tetroe MA, Graham I. Defining knowledge translation. *CMAJ* 2009; 181 (3-4): 165-168.

Table 1

Responses of students and clinical teachers regarding the shortened dental arch (SDA)

Survey Questions	Student Survey (n=73)	Teacher Survey (n=16)
1. Where have you heard of the SDA	81% University 11% this Survey	62% University 8% this Survey
2. Read SDA related research	77% No /Definitely No	77% Yes/ Definitely Yes
3. Do you have knowledge of the variants of the SDA	77% No /Definitely No	77% Yes/ Definitely Yes
4. Can the patient function with a SDA	84% Yes/ Definitely Yes	85% Yes/ Definitely Yes
5. Will you present SDA as an alternative option	86% Yes/ Definitely Yes	85% Yes/ Definitely Yes
6. Treatment options you propose to patients with SDA	66% Metal Dentures 53% Plastic Dentures	69% Metal Dentures 38% Implants
7. What prevents you presenting SDA to patient	86% Lack of knowledge	16% loss of income 39% other
8. Not advise patients to replace missing molars	41% Sometimes 33% Rarely	62% Sometimes 31% rarely
9. Suggestions to implement SDA as a treatment option	51% include SDA as a clinical quota	No Suggestion /Other non-committal responses
10. Do you make denture as a quota for the SDA patient	50% Yes/ Definitely Yes 50% No/ Definitely No	

Chapter 4

Differences in Functional Outcomes for Adult Patients with Prostodontically-Treated and -Untreated Shortened Dental Arches: A Systematic Review

Differences in Functional Outcomes for Adult Patients with Prosthodontically -Treated and -Untreated Shortened Dental Arches: A Systematic Review

Chapter 4 reports on the third study, a systematic review (SR) that seeks to identify relevant published work on outcomes for patients with variously-managed SDAs. This would more comprehensively guide the planned new research that is to be a key part of the PhD work. As importantly, undertaking secondary research using methodologies that would critically evaluate primary studies (both clinical and non-clinical) would add more credibility and make the research more reliable. This would enhance the possibilities for translation of the knowledge to occur more readily. Study designs that might assure easier translation into practice include SRs and/or meta-analyses. These are known to form the top end of the pyramid on hierarchical evidence when they comprise randomized controlled trials only.

SUMMARY

A range of secondary types of research methodologies are available, including scoping, mapping, critical and umbrella reviews. For the present SDA research, a SR with its rigorous methodological quality was chosen as it would provide an idea of what primary research was completed globally. In fact, in the present case a SR of clinical trials including all randomized controlled (RCT) as well as non-randomized clinical trials was completed. This, it was felt, would provide more reliable information since other SRs carried out on the SDA topic included different design types, and not confined to RCTs. It was also important to determine how research completed globally could impact on our course of research and of obtaining evidence for a concept that could benefit many communities within South Africa. In addition and in retrospect, maybe even a scoping review could have been performed to identify specific primary research topics and areas where more research was needed. Such an approach could have added more to the body of knowledge related to the SDA.

Conducting high-end quality research ensures reliable results, making implementation of evidence easier, but for this SR some of the studies had to be downgraded due to methodological error. One of the benefits of the present research, however, is the impact on the teaching of the SDA concept both in the classroom and the student clinic, and

followed by successful clinical application thereof. Patients have a right to receive beneficial treatment especially work that culminates from evidence-based research.

PUBLICATION

This paper has been published in PLoS ONE; Publication citation:

Khan, SB. Musekiwa, A. Chikte, UME. Omar, R. (2014). Differences in Functional Outcomes for Adult Patients with Prosthodontically-Treated and –Untreated Shortened Dental Arches: A Systematic Review. PLoS ONE 9 (7); e101143.

The PhD candidate developed the protocol (with input from both supervisors), submitted the protocol for ethics approval, independently conducted the electronic searches, screened the searches, selected the studies for inclusion, and extracted data and assessed the methodological quality of included primary studies. The Review Manager software was used for this study. The author had discussions with co-author, A. Musekiwa during the protocol phase who then contributed to the independent screening of searches, data extraction, assessment of the methodological quality of included studies, and provided input in the Results section.

The manuscript, including all corrections from both supervisors and journal reviewers who provided guidance and critical comments, was completed by the candidate. All authors approved the final manuscript.

Ethics Approval and PRISMA statement are included as Appendices 4.1-4.2.

ABSTRACT

Introduction

This review examined differences in functional outcomes and patient satisfaction when shortened dental arches are left untreated compared to their restoration to complete arch lengths with different prosthodontic interventions.

Methods

A protocol was developed according to the criteria for a systematic review. All relevant databases were searched to identify appropriate clinical trials regardless of language or publication status. Predetermined eligibility criteria were applied, trial quality assessed and data extracted for each study. Relevant outcomes assessed were: functioning ability, patient satisfaction and harmful effects on oral structures.

Results and Discussion

Only 1 non-randomized and 4 randomized controlled trials were included, but outcomes were reported in the retrieved 19 articles. Pre-specified outcomes were reported for the 3 comparison groups, where possible. Results for *functioning*: Budtz-Jorgensen and Isidor (1987) showed no significant difference for patients with satisfactory occlusion, whereas Witter et al (2001) showed significant occlusal contact for anterior teeth and no significant differences for tooth wear between the SDA and CDA subgroups. For *patient satisfaction*: Mc Kenna (2012) reported a non-significant difference in the oral-health related quality of life scores from baseline to 1 month and for the Wolfart et al (2013) study, the median scores for pre-treatment, baseline, 1 and 5 years follow-up showed significant reduction of impacts ($p < 0.05$) after treatment between RPD and SDA groups. However, only Thomason et al (2007) reported on survival and only Mc Kenna (2012) on cost-effectiveness of the SDA, and had these been determined by the other studies, it would have further strengthened the recommendation of the shortened dental arch as a treatment option.

Conclusion

By using only high quality studies it was expected that the results would be more reliable when making conclusions and recommendations, but some of the included studies had to be downgraded due to methodological errors.

4.1. Introduction

Prosthetic treatment planning customarily includes the replacement of all missing teeth with the intention of achieving complete dental arches (CDAs) comprising 28 teeth [1-3]. The rationale for this approach includes impaired oral function with a perceived detrimental impact on chewing ability, occlusal stability and temporomandibular joint (TMJ) function due to the loss of the molar teeth [4]. On the other hand, several studies and reviews have indicated that twenty occluding teeth provide sufficient oral functional ability and the need to replace all missing posterior teeth has been questioned [3-11].

The classic shortened dental arch (SDA) is defined as ten pairs of occluding anterior and premolar teeth [5, 8]. Many patients present with SDAs since molars are the teeth more commonly lost due to caries, resulting in patients having a posteriorly reduced dental arch [12-13]. Variations of the SDA include a partially dentate arch described as an interrupted or discontinuous dental arch where individual anterior, premolar or even molar teeth are lost [7]. A considerable number of studies have been conducted, though mostly in industrialized countries, that confirm a range of benefits and adequate oral functioning with a SDA [4-12, 14-20]. These studies also propose that the aesthetic features of such partially dentate patients are acceptable [5, 8]. Research related to the SDA concept has also been conducted and promoted in some developing countries such as Tanzania and Nigeria [3, 5-12]. The 1982 WHO oral health goal for developing countries was set as the retention of twenty functional, aesthetic natural teeth without resorting to a prosthesis which is in line with the findings of the SDA research [(4-12, 21].

When dentists extend or reconstitute reduced, shortened or discontinuous dental arches and replace missing teeth in either anterior or posterior regions to create a CDA, the following interventions are usually recommended: removable (RPDP) or fixed partial denture prostheses (FPDP), including resin-bonded bridges (RBB) and implant-retained prostheses [9, 22-33]. Anecdotal evidence suggests that the choice is largely intuitively based upon the number of missing teeth, their location in the arch, and economic considerations. Currently, RPDPs, FPDPs and implant procedures evidently operate on the premise of optimal occlusion encompassing the aesthetics, oral function, oral health and comfort created by the occluding teeth [4-5, 33]. This practice appears to have evolved

empirically, with no scientific or clinical evidence to support its widespread acceptance by clinicians [3, 22-33].

Several research reports tend to support the view that the underlying objective of the SDA to preserve a functional dental arch can be realized through a functionally-oriented treatment approach [5, 15-17, 22, 24, 26]. This entails directing the limited resources towards that part of the dentition that can be successfully preserved and in the most cost-effective manner, rather than on the remaining molar teeth that often have a poorer prognosis [5, 7, 31-58]. The minimum number of teeth or shortness of the arch will also depend on the periodontal condition of the remaining teeth, the age of the patient, occlusal activity, food types and adaptive capacity of the patients' temporomandibular joints [3, 7, 9].

Research suggests that this seemingly beneficial SDA concept and its variations can be utilized to improve accessibility and affordability to treatment for socially- and economically-deprived middle-aged and elderly communities [5, 16, 22, 24, 26]. Other associated benefits of the SDA have been enumerated by several researchers [5-8, 10-20, 31-58]. A number of studies have been conducted in Tanzania where the evidence obtained was used to advise the government, medical and dental personnel to include the SDA concept within the prosthodontic management protocols for the country [12, 16, 50-52]. The consequence of the research was that dental institutions reviewed the dental curricula accordingly [12, 16, 50-52].

Following the large body of published research data related to the SDA conducted in different parts of the world, several efforts at collating these data have been made. Thus a number of systematic reviews (SR) focusing on the SDA have been completed [8, 56-58]. A SR conducted by Gotfredsen and Walls (2007) focused on studies that reported on the assessment of normative needs only, although it did not include quality of life studies that considered the perceived oral health needs of partially dentate patients (8). In the SR by Fueki et al (2011), different types of study designs were included, in addition to the randomised controlled trials (RCT) [56]. Faggion (2011) used the GRADE approach to assess the quality of evidence from longitudinal studies related to restorative and non-restorative

approaches to adult patients with SDAs [58]. With this study, even though all the results from the included studies were not reported, it demonstrated how important methodological rigor is and that these need to be reported [58]. In a recent electronic search in the Cochrane database for systematic reviews, Abt, Carr and Worthington (2012) focused on a broad research question to include all different types of interventions for partially dentate patients, including the SDA [57]). No conclusive evidence was found to indicate that any intervention was better for partially dentate patients, irrespective of particular interventions, procedures or materials used [57].

Given that so few RCTs have been conducted and are available, researchers conducting SRs are faced with the ineluctable option of including different types of study designs and systematic reviews [8, 56-58]. These results in the inclusion of lesser strength studies which could affect the quality of the evidence presented [8, 14, 31-37, 40-48, 53-55].

The aim of this systematic review is to identify and analyse existing clinical trials which could compare the functional outcomes of prosthodontic interventions used for treating shortened arches versus un-restored shortened arches in partially dentate adult patients.

4.2. Methods

4.2.1. Protocol Development

A protocol (Registration No: 11/4/39) was developed (not published) to include all aspects of a SR namely: selection criteria, search strategy, selection methods using predetermined eligibility criteria, data collection, data extraction, assessment of risk of bias using the Cochrane tool, the Grading of Recommendations Assessment, Development and Evaluation (GRADE) tool to grade the evidence of each clinical trial and statistical analysis by calculating risk ratios (RR) for dichotomous outcomes and presented at 95% confidence intervals [59-60].

4.2.2. Criteria for considering studies for this review

(i) Types of studies

Only RCTs and Clinical trials (CTs) are included in the systematic review (SR).

(ii) Types of interventions

Interventions included in this study are described as any prosthodontic intervention used to restore and treat the SDA such as FPDPs and RPDPs. The control group for this study included patients with the classic SDA.

(iii) Types of participants

Participants included in the SR were:

1. Adult male and female participants aged 18 years and older
2. Study population included patients with posteriorly reduced or shortened dental arches

(iv) Types of outcome measures

Primary and secondary outcomes were pre-specified for the SR and are listed below. Only studies that researched the outcomes pre-specified for the SR were included:

(a) Primary outcomes

- 1) Functional outcomes (patient- or investigator-reported) as measured by masticatory function, chewing ability, occlusal effects, nutrient intake (using nutritional assessments and haematological markers) and subjective functioning ability.
- 2) Survival of the interventions (fixed or removable partial dentures) used for the extension of SDAs.

(b) Secondary outcomes

- 1) Patient satisfaction and oral health-related quality of life (social interaction; aesthetics and effectiveness) using oral health indicators for example Oral Health Indicator Profile (OHIP) or the Oral Impacts of Daily Performance (OIDP).
- 2) Harmful effects (caries; tooth loss; periodontal status, plaque index (PI), gingival index (GI), temporomandibular joint (TMJ) problems, interdental spacing and overbite).

4.2.3. Inclusion criteria

Studies that presented the following interventions and outcomes were eligible for this SR namely:

Interventions such as FPDPs (including resin-bonded bridges) or RPDPs used to extend SDAs to CDAs, where clinical trials were used as study design and where the outcomes assessed were related to functioning, patient satisfaction and survival of interventions with SDAs.

4.2.4. *Exclusion criteria*

The following study designs: Case-control studies, cross-sectional studies, cohort studies, case-series and case reports, other SRs, analytical and narrative reviews and the different types of animal studies that were not eligible for inclusion, were excluded.

4.2.5. *Search strategy*

All relevant databases were searched: Medline, Cochrane Central Register of Controlled Trials, EMBASE, CINAHL, Science Direct, ProQuest, Science Journals, Scopus, PsycINFO, ClinicalTrials.gov, WHO ICTRP and PACTR. Further hand-searching was conducted including citations from reference lists of retrieved studies (PEARLing searches) for additional references [59]. Where data were missing and full texts unavailable, these unclear reports were clarified by contacting authors or research institutes. Efforts were made to obtain English versions of studies reported in other languages either by requesting English versions from authors or using language experts to translate key findings. Authors were also contacted for unpublished reports or conference proceedings, where it was needed. Where registries were available for on-going studies, these were included as well and experts in the field of research related to the SDA were contacted.

Key terms were combined using Boolean operators and search strategies for each database were developed using the database specific functions [59]. Medical subject headings were applied in databases which allowed this function [59]. Two search strategies were developed to ensure no eligible studies were excluded, and an example of one of these include the following:

(shortened dental arch* OR partially dentate OR complete dental arch* OR "20 teeth") AND (functioning OR functional* abilit* OR patient satisfaction) AND (clinical trial* OR random* OR randomi?ed controlled trial* OR random allocation OR placebo* OR random research OR comparative OR "evaluation stud*" OR follow up OR prospective* OR control*

OR volunteer* OR single mask* OR double mask* OR treble mask* OR tripl* mask* OR single-blind* OR double-blind* OR treble blind* OR tripl* blind*).

4.2.6. *Search limits*

Databases were searched for articles of over a period of three decades from 1980 to June 2013. The limits included in the search strategy were: human studies, adult patients and randomized and non-randomized controlled clinical trials.

4.2.7. *Selection methods*

Two review authors (SK and AM) independently screened titles and abstracts from the electronic searches to select potentially relevant studies using a predetermined eligibility form based on the inclusion criteria [59]. Full text articles of potential studies were then retrieved and re-assessed for eligibility. Each article was scrutinized to ensure that multiple publications from the same study were included only once. Where eligibility was unclear, clarification was sought from the trial authors and the corresponding articles were re-assessed. Differences between the eligibility results were resolved by consulting the other review authors (UMEC and RO). Studies that did not meet the inclusion criteria were excluded and the reasons for exclusion were reported. Data extraction for the selected studies was completed by the principal researcher (SK) using a specially designed pre-piloted data extraction form for this SR [59]. All disagreements regarding this process were resolved through discussion with the other review authors (AM, UMEC and RO).

4.2.8. *Qualitative analysis*

The quality of the studies included for this SR were evaluated for any risk of bias by researchers (SK and AM) using the Cochrane Risk of Bias tool and as described in the Cochrane Handbook for Systematic Reviews of Interventions [59]. The assessment was done across the following six components: random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other bias. Each of these were judged as 'yes', 'no', or 'unclear' corresponding to low, high, or unclear risk of bias respectively. Where information in the articles was insufficient for making the judgements, trial authors were contacted for clarification. Disagreements were resolved through discussion with other review authors. Results of risk of bias were summarised in a risk of

bias table. In addition, GRADE assessments were completed by the researchers (SK and AM) for each clinical trial and these were used to grade the evidence and strength of recommendations for clinical intervention (where possible) using the GRADE Profiler system [60]. These are reported in the summary of findings tables.

4.2.9. Data synthesis and management

Results were reported separately for the following three comparisons: 1) FPDP versus RPDP; 2) RPDP versus no treatment (SDA); 3) SDA versus CDA. No imputation of missing data was carried out and study authors were requested to provide any missing data. Available case analysis was applied where data were missing. Risk ratios with corresponding 95% confidence intervals were calculated for dichotomous outcomes using Review Manager 5 software. Although meta-analysis of outcomes across study results had been anticipated, the included studies reported different outcomes that could not be pooled in a meta-analysis. Consequently, results for individual studies were reported separately.

4.3. Results

The search strategy identified a total of 99 citations (Figure 1): electronic databases yielded seventy nine and 20 were from reference lists of retrieved articles (that is, through PEARLing searches). A total of 32 duplicate records were removed, leaving 67 citations which were assessed for eligibility. After reading titles and abstracts, a total of 41 records were excluded and the full-text of the remaining 26 records was retrieved. A further 7 records were excluded after reading the full-text reports, leaving the remaining 19 records as included studies for the SR (Figure 1). Only four RCTs and one CT were used for this review, but outcomes were reported in the retrieved 19 records. No on-going studies were found and no eligible studies were excluded for failure to report the reviewer's pre-specified outcomes.

4.3.1. Study characteristics

The study characteristics of the four RCTs and 1 CT included in this SR are summarized in Table 1.

The studies were grouped into the following comparisons:

(i) Comparison 1: FPDPs versus RPDPs for SDAs in the lower jaw

Two included studies from the UK and Denmark assessed comparison 1 [31-38].

(ii) Comparison 2: RPDPs versus no treatment (SDA)

Two studies from Germany and Ireland assessed comparison 2 [40-48].

(iii) Comparison 3: SDA versus CDA

Only one study from the Netherlands assessed comparison 3 [14, 53-55].

4.3.2. *Types of selected studies*

Four of the 5 included studies were randomized clinical trials and 1 was a clinical trial [14, 31-38, 40-48, 53-55].

Population characteristics

All 5 studies that were included for this SR provided information about the participants with a total sample of 518 participants that were evaluated (Table 1).

(i) Comparison 1: For the Budtz-Jorgensen and Isidor (1987, 1990) and Moynihan et al (2000) studies, the total number of participants recruited were 53 and 60 respectively (Table 1) [31-38]

(ii) Comparison 2: The total number of participants recruited from a multi-centre trial of 14 universities in Germany was 215 [40-46]. The Mc Kenna (2012) study recruited 44 participants from the University hospital and was allocated to either a RPD or SDA group (Table 1) [47-48].

(iii) Comparison 3: The 146 participants for the Witter et al (2001) clinical trial were patients at the Nijmegen Dental Clinic, Netherlands (Table 1) [14, 53-55].

4.3.3. *Time of study (duration)*

The duration for each of the clinical trials varied substantially. Some participants were followed up after 5 years of treatment, and with other RCTs and the CT a follow-up of one month is reported (Table 1).

4.3.4. *Types of interventions*

The different studies are grouped according to the different interventions (RPDPs, FPDPs or SDAs) used for each clinical trial (Table 1).

4.3.5. Qualitative analysis

Table 2 specifies the quality assessment of the included studies and these are summarized in the 'risk of bias table' and 'risk of bias graph' where judgements are categorized to indicate a low, high, or unclear risk of bias (Figure 2 and Figure 3) following the Cochrane guidelines [59]. Below we give a detailed explanation of these results:

(i) Sequence Generation

Three of the five trials were reported as having been randomised. For sequence generation, two clinical trials used computer-generated numbers and a third trial used randomly permuted block randomisation for generating the allocation sequence, which we judged as having a low risk of bias [34-38, 40-48]. The Witter et al (2001) clinical trial invited subjects to join the department for a study, and no attempt was made to randomise patients, thus it is judged as having a high risk of bias [14, 53-55]. The Budtz-Jorgensen and Isidor (1987) trial did not mention how the sequence was generated and provided insufficient information to enable us to judge whether there was a high or low risk of bias, and we thus rated it as having an unclear risk of bias [31-33].

(ii) Allocation Concealment

The Moynihan et al (2000), Wolfart et al (2005) and Mc Kenna (2012) studies are described as having a low risk of bias for allocation concealment, as they indicated that the clinician was not involved in the allocation and that concealment was warranted following a central randomisation process after patient enrolment (34-38, 40-48). For the Budtz-Jorgensen and Isidor (1987) and Witter et al (2001) studies, there is no indication as to how intervention allocation was concealed and these were judged as having an unclear risk of bias [14, 31-33, 53-55].

(iii) Blinding

The Moynihan et al (2000) study was referred to as a double blinded study with the clinician blinded to allocation of intervention and statistician being blinded to treatment and thus it is judged as having a low risk of bias [34-38]. The Witter et al (2001) study can be considered as a single blinded study because evaluation of outcomes was completed by a calibrated observer at all intervals, but it was not stated as such, thus it is judged as having an unclear

risk of bias [14, 53-55]. Mc Kenna (2012) indicated that the researcher was not involved in the intervention allocation, making it a single-blinded study, thus it is judged as having a low risk of bias [47-48]. The Wolfart et al (2005) study indicated that it was impossible to blind the dentist and patient due to discrepancies of the treatments; thus it was judged as having a high risk of bias, whereas Budtz-Jorgensen and Isidor (1987) provided insufficient information related to blinding and it was regarded as having an unclear risk of bias [31-33, 40-46].

(iv) Incomplete Outcome Data

Analyses for the Moynihan et al (2000), Wolfart et al (2005) and Mc Kenna (2012) studies were conducted on the "intention-to-treat" (ITT) principle; and the studies reported proportionate numbers of losses to follow-up (which were small) and some having no losses between the intervention and control [34-38, 40-48]. Witter et al (2001) indicated that regression models accounted for the subjects lost during the study [53]. Thus, all 4 studies above were judged as having a low risk of bias [34-38, 40-46, 53-55]. On the other hand, Budtz-Jorgensen and Isidor (1987) did not indicate and specify how the analysis was completed, but all pre-specified outcomes were reported, and the number of losses to follow-up was small, thus it was judged as having a low risk of bias [31-33].

(v) Selective Reporting

All studies were registered and approved with their respective Review boards [14, 31-38, 40-48, 53-55]. The protocol for the Wolfart et al (2005) study was published [41]. In the Budtz-Jorgensen and Isidor (1987) and Witter et al (2001) studies all outcomes were reported but outcomes were not pre-specified as primary or secondary outcomes [14, 31-33, 53-55]. Both these studies were thus judged as having a high risk of bias. The three remaining RCTs specified the outcomes as primary and secondary and reported these as such, thus these were judged as having a low risk of bias [34-38, 40-4]. All the included studies except the Wolfart et al (2005) study reported all their pre-specified outcomes in subsequent publications [14, 31-38, 40-48, 53-55].

(vi) Other potential sources of bias

No other sources of bias were detected with four of the five included studies. The Budtz-Jorgensen and Isidor (1987) study was judged as having high risk of bias because there were six patients who did not wear the RPD at all during the study [32-33].

4.3.6. *Effects of interventions*

See: **Summary of findings for the main comparisons** of functional outcomes and patient satisfaction with FPDs compared to RPDs in treating patients with SDAs (Table 3); **Summary of findings** for SDA patients treated with RPDs compared to no treatment (Table 4) [59].

(i) Comparison 1: Fixed Partial Dentures (FPDs) vs Removable Partial Dentures (RPDs):**a) Primary Outcomes**1. Functional outcomes

The only functional outcome reported is occlusion and the results are given below.

Occlusion

Budtz-Jorgensen and Isidor (1987) showed no significant difference in the number of patients with satisfactory occlusion during the 2-year period after treatment between the FPD and RPD groups (RR 1.16, 95%CI: 0.90 to 1.48, 53 participants) [31].

2. Survival

Thomason et al (2007) reported time to survival for the restoration of the shortened dental arch but there was no significant difference between the FPD and RPD groups (Hazard Ratio 0.59, 95%CI: 0.27 to 1.29, 60 participants, results as reported by authors) [37].

b) Secondary Outcomes1. Patient satisfaction

This outcome was only reported by Jepson et al (2003) but there was no significant difference in median satisfaction scores at 1 year after treatment between the FPD and RPD groups ($p=0.092$ as reported by authors, 52 participants: Table 5) [36].

2. Harmful Effects (caries; tooth loss; periodontal status, plaque index, gingival index; TMJ problems; interdental spacing; overbite).

Caries

Jepson et al (2001) found that treatment with FPDs significantly increased the number of patients with no caries experience during the 2-year period of study compared with RPDs (RR 1.89, 95%CI: 1.09 to 3.30, 50 participants) (35). Isidor and Budtz-Jorgensen (1990) observed 22 dental carious lesions in the RPD group compared with only two lesions in the FPD group; however we could not calculate a treatment effect since the respective number of patients was not reported. Our unit of analysis was individual patients and not individual teeth [33].

TMJ dysfunction

Isidor and Budtz-Jorgensen (1990) found no significant difference in the number of patients showing TMJ dysfunction between the FPD and RPD groups (RR 0.64, 95%CI: 0.36 to 1.16, 53 participants) [33].

Tooth Loss

In the Isidor and Budtz-Jorgensen (1990) study, 11 teeth were extracted in the RPD group compared with only one tooth in the FPD group during the five years of observation. However, no treatment effect could be calculated because the respective numbers of patients were not reported [33].

Plaque Index

Isidor and Budtz-Jorgensen (1990) reported the mean plaque index ranging from 0.4 to 0.7 in the FPD group and from 0.7 to 1.0 in the RPD group; the difference between the two groups was significant ($p < 0.05$) during the first two years of examination as reported by study authors [33].

Gingival Index

Isidor and Budtz-Jorgensen (1990) indicated that the mean gingival index was always higher in the RPD than in the FPD group, the difference being significant ($p < 0.05$) at the 12-, 18-, 36- and 48-month examinations [33].

(ii) Comparison 2: Removable Partial Dentures (RPDs) versus no treatment (SDA)

a) Primary Outcomes

1. Functional outcomes

Mini Nutritional Assessment (MNA)

Mc Kenna (2012) reported the change in MNA scores from baseline to final (month 1) for the two treatment groups and these results are summarised in Table 6, where the standard deviations of change for each group were calculated from the reported values [47]. The values in the table were used to calculate a treatment effect which showed no significant difference in the change in MNA score between the RPD and SDA treatment groups (MD - 0.03, 95%CI:-1.35 to 1.29, 42 participants: Table 6). A higher MNA score indicates better nutrition effect.

2. Survival

This outcome was not reported in the two studies assessing this comparison.

b) Secondary Outcomes

1. Patient satisfaction

Oral Health Related Quality of Life (OHRQoL)

Mc Kenna (2012) reported a non-significant difference in the OHRQoL scores from baseline to the end of treatment (month 1) for the two treatment groups and these results are summarised in Table 7 [47]. The author used the oral health impact profile (OHIP-14) to give a score ranging from 0 (minimum) to 56 (maximum). A high score indicated a poor OHRQoL with low scales indicating good OHRQoL. However, no treatment effect could be calculated to compare the change in the OHIP-14 scores between the two treatment groups because standard deviations of change were not given and also because exact p-values were not reported.

For the Wolfart et al study (2012), the median OHIP-49 scores for pre-treatment, baseline, 1 and 5 years follow-up showed significant reduction of impacts ($p < 0.05$). Before treatment, the median OHIP-49 total score was 38.0 for the RPD group and 40.0 for the SDA group. Most significant reductions occurred at baseline (27.0; $p < 0.0001$) and 1 year on (13.0; $p < 0.0002$) for the RPD group. For the SDA group, a significant change in impacts (19.0; $p < 0.05$) were observed only at baseline, no further significant changes were reported [45].

2. Harmful Effects (caries; tooth loss; periodontal status, plaque index, gingival index; TMJ problems; interdental spacing; overbite).

Tooth loss

The Walter et al study (2012) showed no significant difference in the number of patients experiencing first tooth loss within 38 months of observation after treatment between the RPD and SDA groups (RR 1.23, 95%CI: 0.56 to 2.70, 150 participants) [44]. The respective Kaplan-Meier survival rates at 38 months were 0.83 (95%CI: 0.74 to 0.91) in the RPD group and 0.86 (95%CI: 0.78 to 0.95) in the SDA group, the difference is not significant (as reported by study authors) [44].

(iii) Comparison 3: Shortened Dental Arches (SDA) versus Complete Dental Arches (CDA)

a) Primary Outcomes

1. Functional outcomes

Occlusal contact

Witter et al, (2001) reported that a significantly higher percent (73%, 95%CI: 67-80%) of teeth in the anterior region had occlusal contact in intercuspatal position of the SDA group compared with the CDA group (62%, 95%CI: 55-69%) ($p < 0.05$) [53]. No treatment effect could be calculated because the number of patients per group was not specified [53].

Occlusal tooth wear

Witter et al (1994) reported the mean occlusal tooth wear scores using transformed values for subjects of 40 years of age [55]. However, no significant differences between the SDA subgroups [means (SD) ranging from 1.1(0.1) to 1.6(0.1)] and the CDA group [means (SD) of 1.4(0.0) and 1.5(0.0)] were found when comparing the means of the scores for the upper and for the lower anterior regions. Similarly for the premolar regions, no significant differences were found between the SDA subgroups [mean (SD) scores 0.7(0.1) to 1.0(0.1)] and the CDA group [mean (SD) score 0.9(0.1)]. No treatment effect could be calculated because the respective number of patients was not reported.

2. Survival

This outcome was not reported in the one study assessing this comparison.

b) Secondary outcomes**1. Patient satisfaction**

This outcome was not reported in the one study assessing this comparison.

2. Harmful Effects (caries; tooth loss; periodontal status, plaque index, gingival index; TMJ problems; interdental spacing; overbite).

Interdental spacing

Witter et al (1994) described a comparison of the mean scores of interdental spacing per region [55]. According to the authors, the premolar regions of the SDA subgroups had significantly higher means [mean (SD): 0.4(0.1) and 0.5(0.1)] than the CDA group [mean (SD): 0.1(0), $p < 0.01$ as reported by authors]. For the anterior regions, the spacing was not significantly different for SDA [mean (SD) range from 0.2(0.1) to 0.5(0.1)]; CDA group [mean (SD) range from 0.1(0.0) to 0.3(0.1)]. They also reported that spacing remained the same in all regions over time in the SDA group [55]. No treatment effect could be calculated because the results were given per region and also because the respective number of patients were not specified in the results.

Overbite

Witter et al (1994) stated this outcome only for some subgroups but did not compare their results between the SDA and CDA groups [55]. Therefore we could not calculate a treatment effect.

Periodontal support

Witter et al (1994) described the mean relative bone heights using transformed values for subjects of 40 years of age [55]. The authors reported that maxillary premolars and mandibular second premolars in the SDA subgroups showed significantly lower mean bone height scores than those in the CDA group, whereas mandibular first premolars did not differ. The values reported were not sufficient for the calculation of a treatment effect.

TMJ problems

The Witter et al study (2007) indicated that patients with SDAs (65-79%) had similar prevalence, severity and changes in signs and symptoms related to the TMJ as patients with CDAs (70-75%) [54].

4.3.7. Excluded study characteristics

All non-RCTs and reviews were excluded from this SR. Other SRs and summary articles were viewed as potentially included studies, but these were however later not considered for inclusion (Table 8).

4.4. Discussion

The focus of this review was the classic SDA, irrespective of whether it occurred naturally or was created by means of a FPD. An exhaustive and comprehensive search yielded four RCTs and 1 CT that were included [14, 31-38, 40-48, 53-55]:

Jepson et al (2001) is in agreement with the research conducted by Isidor and Budtz-Jorgensen (1987, 1990) regarding an increase in caries incidence as reported 2 and 5 years post treatment [33, 35, 38]. Survival of fixed bridges for this study was similar to other trials (30-32, 37-38). RPD patients chose not to wear RPDs which was similar to other studies [31-32, 37-38]. For patient satisfaction, the small sample size does not allow us to generalize our results to other settings, thus it is advised to conduct these studies amongst different populations.

For the Wolfart et al study (2010): Post hoc power calculations implied that the pilot sample size was too small to generalize results and for comparison to other studies [40-43]. The larger study results are free of bias with a large enough sample due to it being a multi-centre study. While it reduced the bias, it still could not be generalized to patients that are different to the study sample. For the patient satisfaction outcome, the summary scores of the pilot study were similar to another German study (John and Micheelis, 2003, cited in Walter et al (2012) [45]. For temporomandibular disease (TMD) pain scores, the instrument used in other studies was more reliable (Dworkin, 2002, cited in Walter et al (2012) [44]. Tooth loss as a primary outcome is questioned due to extended time periods, thus it was advised to use caries and periodontal attachment loss as outcomes instead [44].

The Mc Kenna study (2012), which is the most recently conducted RCT; the results are similar to other RCTs completed in the past, where small sample sizes would not necessarily show a significant difference between interventions given the follow-up period [47-48]. In this case, follow-up after only one month of treatment was too short to show any difference

between interventions [47-48]. But the cost-effectiveness reported with this RCT is very important as researchers and clinicians are under the impression that the cost for FPDs far outweighs that of RPD treatment [22, 39, 48].

For the Witter et al study (2001), results were similar to other studies with regards to outcomes reported and the effect of outcomes on the dentition in the SDA group (Aukes, 1988; Mohl, 1988; Eliasson, 1997, cited in Witter et al (2001) [53]). At the end of the Budtz-Jorgensen study (1990) (5years post treatment), an increase in failure of FPD was found as reported in other studies (Randow, 1986, cited in Budtz-Jorgensen (1990) [32]). In addition, the increase in caries incidence for the RPD group also concurred with the research of Bergman et al, (1964), cited in Budtz-Jorgensen (1990) [32].

The quality of the evidence is indicative of the integrity of the study and the research conducted. With reference to the quality assessment of the included studies, this has been described in detail above. More importantly, this quality is determined by the study designs. Study designs are graded according to the quality of evidence that they provide. Systematic reviews and RCTs are considered to be designs of the highest quality [59-60]. Within the different design groups, certain concessions can be made for those designs that do not follow the exact guidelines [59-60]. For instance RCTs can be downgraded if their risk of bias is high [59-60].

Only RCTs and CTs were however included in this systematic review which provides stronger evidence and increases the strength of the recommendations [59-60]. After completing the quality assessment (using the GRADE approach) of the included studies, it clearly showed that some of the studies had not followed the exact guidelines for RCTs, but nevertheless had the features thereof [59-60]. These can be regarded as downgraded RCTs (Tables 3-4). These downgraded RCTs did not use randomization, allocation concealment or blinding, and failed to specify the outcomes as primary or secondary. These downgraded RCTs could thus affect the quality of evidence only slightly [59-60]. For example, the Budtz-Jorgensen (1987, 1990) and Witter et al (2001) studies could be regarded as downgraded CTs [14, 31-33, 53-55, 60].

A meta-analysis could not be completed for this SR for the following reasons: Some of the outcomes for the SR (for example survival of intervention) were not reported by all the

included studies; sufficient RCTs were not found related to SDAs; the outcomes were reported in so many different ways for each of the studies that a narrative approach for this review had to be adopted and not all outcomes are reported for the Wolfart et al (2005) study (and no correspondence was received when the authors were contacted). In addition, there was insufficient information reported by studies to allow us to combine continuous data using the mean difference (MD). The outcomes from the studies were thus grouped for this review.

For this SR, a systematic approach to the evaluation of the evidence obtained from the studies was adopted by the researchers and disagreements were resolved by discussion. The researchers highlighted the areas where bias could have been expected (Table 2). Study samples, settings, age categories, interventions and outcomes for the included studies were mostly similar, creating strong evidence (Table 1). Comparison between the groups of the different studies could be systematically recorded in the stipulated groups. And again, for this SR all potential sources were searched and reported. Most studies followed guidelines to protect against bias (some without making reference to the method followed) [14, 31-33, 53-55]. And this was assessed using the Cochrane's risk of bias tool (59). Since all the included studies in this SR were conducted in developed countries, our findings cannot be generalized to patients in all countries because cultural and socio-economic differences that exist between countries and within communities can influence patients' reactions.

Other SRs were also conducted in the past ten years [8, 56-58], where researchers included studies with different study designs and not only RCTs. For the most current SR [57], the research question was so broad that the focus on the SDA was minimal, thus many of the data related specifically to SDAs were not even included in the analysis [57]. For this SR, only the British and German RCTs were mentioned and only the results of the pilot study for the German RCT was reported [57]. The authors concluded citing insufficient evidence to report a difference between RPD and FPDs in the treatment of SDAs [57]. In addition, when evaluating the quality of the evidence of a systematic review, they recommended that the GRADE approach should be used [60]. It is a method of evaluating the quality of evidence and strength of recommendations in healthcare, and thus provides the needed rigor and transparency when making specific recommendations [60].

4.5. Quality of evidence

As stated above, the quality of evidence was assessed using the GRADE methodology for this SR. With the assessment, the small sample sizes seriously affected the imprecision, and the risk of bias was very serious with studies where no blinding and selective reporting was observed. From the combined effects, the overall the quality of the assessment is regarded as being low. This implies that further research (as in conducting more RCTs) is likely to have an important impact on our confidence in the estimate of effect, and may change the estimate.

4.6. Conclusions

The stronger the evidence, the stronger the recommendation for the implementation of the SDA as a treatment option for partially dentate patients. By using only high quality studies such as RCTs and CTs for this SR, it was expected that the results would be more reliable when making conclusions and recommendations. Nevertheless, any conclusion/s from such a SR can still be regarded in a positive light, even though the included studies had to be downgraded due to methodological errors [60]. The results from this SR related to SDAs as a treatment option was encouraging in terms of functioning, patient satisfaction and cost-effectiveness. However, only the Moynihan et al (2000) study reported on the primary outcome of survival of the SDA, and had this been determined by the other studies, it would have strengthened the recommendation of the SDA as a treatment option even further [34].

4.7. Implications for practice

The SDA concept has been researched and used in industrialized countries and this review aimed to highlight its appropriateness and relevance for a developing country such as South Africa. A change in paradigm or thinking should be encouraged, even though results of clinical trials that are conducted in European and /or Nordic countries may not necessarily be generalizable to South African populations. By regarding the research related to SDAs in a positive light, this SR specifies that policy-makers and/or institutions should be encouraged and recommend its teaching and clinical implementation by students and clinicians. These are considered as instances where low-quality evidence can still make a strong recommendation due to the body of available evidence on SDAs.

4.8. Implications for research

Sufficient RCTs related to SDAs were not found, and thus it would be advisable to conduct more randomized clinical trials. The RCTs were also conducted in European and Nordic countries and these results may not be generalizable to other context, due to substantial cross-cultural and socio-economic differences between countries. External validity or generalizability of studies conducted in other countries depends on: settings where studies were conducted; participants' characteristics; interventions researched across studies; relevance of the endpoints achieved with each study; results obtained and their comparison to one another and the indirect/ direct costs when conducting each study.

It is also recommended that when conducting clinical trials, strict protocols need to be prepared and the reporting of the RCT should follow the CONSORT guidelines [61]. This could then be of great benefit to other researchers when critically appraising these clinical trials. More importantly, outcomes for the RCT have to be pre-specified and all should be reported so that future systematic reviews may be conducted with the inclusion of a meta-analysis, instead of a narrative report as needed to be done for this SR. Thus further research (as in conducting clinical trials) should be encouraged and for the different settings and contexts (for example developing countries) to create a comprehensive database related to SDAs.

References

1. Zarb GA, Bolender CL, Carlsson GE. Boucher's Prosthodontics Treatment for edentulous Patients, 1997 11th ed. Missouri, USA: Mosby.
2. Müller F, Naharro M, Carlsson GE. What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe? Clin Oral Impl Res 2007 18(Sup 3): 2-14.
3. Carlsson GE. Some dogmas related to prosthodontics, temporomandibular disorders and occlusion. Acta Odon Scand 2010 68: 313-322
4. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. J Oral Rehabil 1989 16: 27-33.
5. Käyser AF. Shortened dental arches and oral function. J Oral Rehabil 1981 8: 457-462.
6. Witter DJ, van Elteren P, Käyser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. J Oral Rehabil 1988 15: 413-420.
7. Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and

- certain high risk groups. *Int J Perio Rest Dent* 1989 9(6): 426-449.
8. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin Oral Impl Res* 2007 18(Suppl.3):34-45
 9. Creugers NHJ, Witter DJ, Van't Spijker A, Gerritsen AE, Kreulen CM. Occlusion and temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 2010 1-7. [DOI: 10.115/2010/807850]
 10. Gerritsen AE, Witter DJ, Bronkhorst EW, Creugers NHJ. An observational cohort study on shortened dental arches- clinical course during a period of 27-35 years. *Clin Oral Invest* 2012 1-8 [DOI: 10.1007/s00784-012-0765-6]
 11. Zhang Q, Witter DJ, Bronkhorst EM, Creugers NHJ. Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Invest* 2012 1-11.
 12. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NHJ. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Sci* 2007 115(4): 265-274.
 13. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998 25: 649-661.
 14. Witter DJ, de Haan AF, Kayser AF, van Rossum GM. A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 1994 21(2): 113-25.
 15. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996 23: 481-485.
 16. Sarita PT, Witter DJ, Kreulen CM, Creugers NHJ. The shortened dental arch concept and attitudes of dentists in Tanzania. *Comm Dent Oral Epidimiol* 2003 31: 111-115.
 17. Armellini DB, Von Fraunhofer JA. The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004 92(6): 531-535.
 18. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008 35: 337-344.
 19. Zeng X, Sheiham A, Tsakos G. Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008 35: 37-44.
 20. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. Patterns of missing occlusal units and oral health-related quality of life in SDA patients. *J Oral Rehabil* 2008

35: 621-628.

21. World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Geneva: WHO regional office for Europe. WHO Technical Report 1992 Series No. 826: 16-17.
22. Khan S, Omar R, Chikte UME. Perceptions of practitioners regarding shortened dental arch. *SADJ* 2012 67(2): 60-68
23. Ivanhoe JR, Cibirka RM, Parr GR. Treating the modern complete denture patient: A review of the literature. *J Prosthet Dent* 2002 88: 631-635.
24. Omar R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part I. Traditional management strategy. *SADJ* 2004 59(5): 198-202.
25. Carlsson GE, Omar R. The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil* 2010 37: 143-156.
26. Khan S, Chikte UME, Omar R. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014 78(6): 906-913.
27. Creugers NHJ, Käyser AF, vant Hof MA. A seven-and-half-year survival study of resin-bonded bridges. *J Dent Res* 1992 71: 1822-1825.
28. Creugers NHJ, De Kanter RJ, vant Hof MA. Long-term survival data from a clinical trial on resin bonded bridges. *J Dent* 1997 25: 239-242.
29. De Kanter RJ, Creugers NHJ, Verzijden CW, vant Hof MA. A five year multi-practice clinical study on posterior resin-bonded bridges. *J Dent Res* 1998 77: 609-614.
30. Frank RP, Brudvik JS, Le roux B, Milgrom P, Hawkins N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet Dent* 2000 83: 521-7.
31. Budtz-Jorgensen E, Isidor F. Cantilever bridges or removable partial dentures in geriatric patients: a two-year study. *J Oral Rehabil* 1987 14: 239-249
32. Budtz-Jorgensen E, Isidor F. A 5-year longitudinal study of cantilever fixed partial dentures compared with removable partial dentures in a geriatric population. *J Prosthet Dent* 1990 64: 42-47
33. Isidor F, Budtz-Jorgensen E. Periodontal conditions following treatment with distally extending cantilever bridges or removable partial dentures in the elderly patients. A 5-

- year study. *J Periodont* 1990 61: 21-26
34. Moynihan PJ, Butler TJ, Thomason JM, Jepson NJA. Nutrient intake in partially dentate patients: the effect of prosthetic rehabilitation. *J Dent* 2000 28: 557-563
 35. Jepson NJA, Moynihan PJ, Kelly P, Watson GW, Thomason JM. Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. *BDJ* 2001 191(3): 140-144
 36. Jepson NJA, Allen F, Moynihan PJ, Kelly P, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003 16(4): 409-414
 37. Thomason JM, Moynihan PJ, Steen N, Jepson NJA. Time to Survival for the restoration of the Shortened lower Dental Arch. *J Dent Res* 2007 86(7): 646-650
 38. Balevi B. No difference in the 5-year survival rates between the resin-bonded cantilever bridge and removable partial denture for the restoration of the shortened dental arch. *Evid Based Dent* 2008 9(4): 105-106
 39. Abu-Saleh T, Marnewick J. Implant-supported crowns for a shortened dental arch: A Case Report. *J Contemp Dent Prac* 2008 9(5): 114-121
 40. Wolfart S, Heydecke G, Luthardt RG, Marre B, Freesmeyer WB, Stark H, et al. Effects of prosthetic treatment for SDAs on OHRQoL, self-reports of pain and jaw disability: results from pilot-phase of a randomized multicentre trial. *J Oral Rehabil* 2005 32: 815-822
 41. Luthardt RG, Marré B, Heineck A, Gerss J, Aggstaller H, Busche E, et al. The randomized shortened dental arch study (RaSDA): design and protocol. *Trials* 2010 11(15): 1-9
 42. Walter MH, Weber A, Marré B, Gitt I, Gerß J, Hannak W, et al. The randomized Shortened dental arch study: Tooth Loss. *J Dent Res* 2010 89: 818-822
 43. Walter MH, Weber A, Marré B, Gitt I, Gerß J, Hannak W, et al. The randomized shortened dental arch study: 5 year results of the pilot phase. *Deutsch Zahnärztl Zeits* 2012 67: 360-363
 44. Walter MH, Hannak W, Kern M, Mundt T, Gernet W, Weber A, et al. The randomized shortened dental arch study: tooth loss over five years. *Clin Oral Invest* 2012 1-10 [DOI: 10.1007/s00784-012-0761-x]
 45. Wolfart S, Muller, F, Gerß J, Heydecke G, Marré B, Böning K, et al. The randomized shortened dental arch study: oral-health-related quality of life. *Clin Oral Invest*, 2012 DOI: 10.1007/s00784-013-0991-6

46. Wolfart S, Marré B, Wöstmann B, Kern M, Mundt T, Luthardt RG, et al. The randomized shortened dental arch study: 5-year Maintenance. *J Dent Res* 2012 91(1): 65-71
47. McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, Cronin M, et al. Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodont* 2012 29: e883-e890. [DOI: 10.1111/j.1741-2358.2011.00579.x]
48. McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, Cronin M, et al. A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodont* 2012 1-7
49. De Sa e Frias V, Toothaker R, Wright RF. Shortened Dental Arch: A review of current treatment concepts. *J Prosthodont* 2004 13(2): 104-110
50. Sarita PT, Kreulen CM, Witter DJ, Creugers NHJ. Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 2003 16(3): 265-270.
51. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003 16(4): 375-380.
52. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. *Comm Dent Oral Epidimiol* 2003 31(5): 328-334.
53. Witter DJ, Creugers NHJ, Kreulen CM, de Haan AF. Occlusal stability in Shortened Dental Arches. *J Dent Res* 2001 80(2): 432-436
54. Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Signs and symptoms related to temporomandibular disorders- Follow-up of subjects with shortened and complete dental arches. *J Dent* 2007 35: 521-527.
55. Witter DJ, de Haan AF, Käyser AF, van Rossum GM. A 6-year follow-up study of oral function in shortened dental arches. Part II: Craniomandibular dysfunction and oral comfort. *J Oral Rehabil* 1994 21(4): 353-66.
56. Fueki K, Yoshida E, Igarashi Y. A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011 47: 167-174.
57. Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: partially absent dentition. *Cochrane Database of Systematic Reviews* 2012 Issue 2. Art. No: CD003814. DOI: 10.1002/14651858.CD003814.pub2.
58. Faggion CM. The shortened dental arch revisited: from evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 2011 38: 940-949.
59. Higgins JPT, Green S. *Cochrane Handbook for systematic reviews of interventions*. 2009

1st Edition. West Sussex, UK: Wiley-Blackwell.

60. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ, 2008 336:924-926.

61. CONSORT Guidelines. <http://www.consort-statement.org>

Figure 1

Prisma Flow Chart of Study Selection

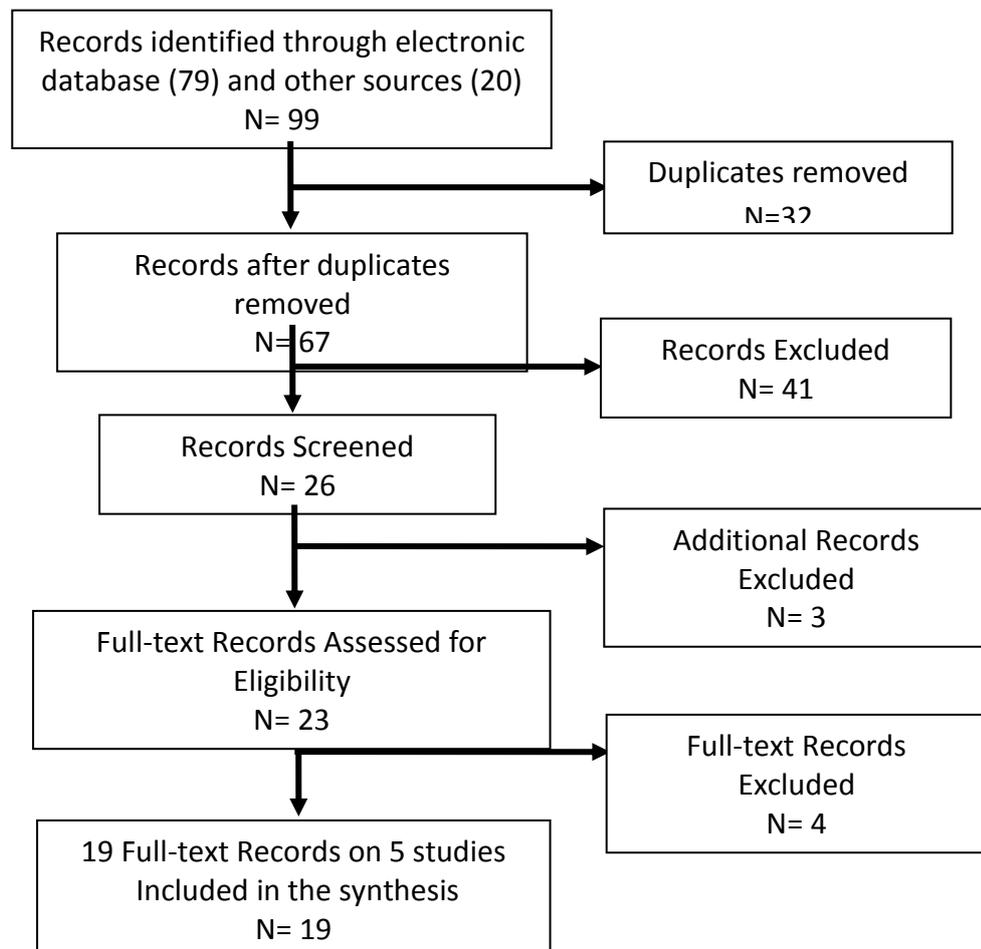


Figure 2

Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Adequate sequence generation?	Allocation concealment?	Blinding?	Incomplete outcome data addressed?	Free of selective reporting?	Free of other bias?
British study (2007)	+	+	+	+	+	+
Danish Study (1990)	?	?	-	+	-	-
Dutch study (2001)	?	?	?	+	-	+
German study (2012)	+	+	-	+	-	+
Irish Study (2012)	+	+	+	+	+	+

Figure 3

Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

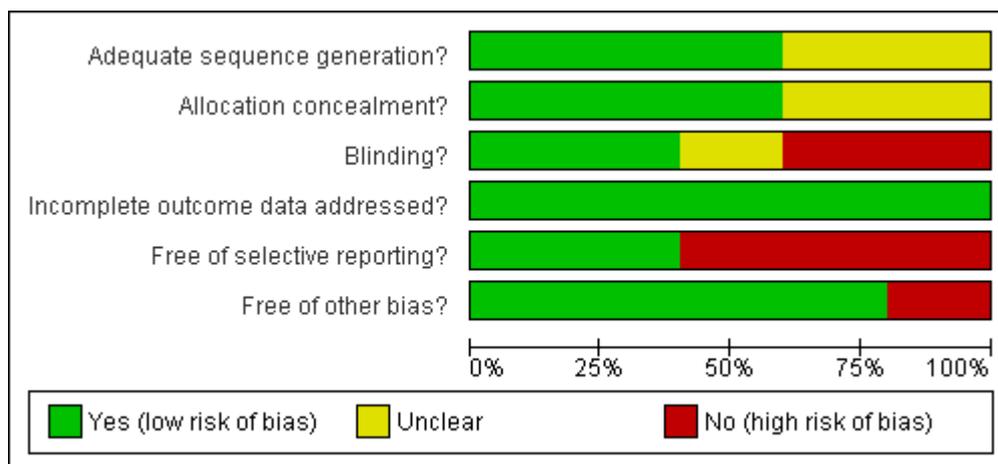


Table 1:

Table of Included Studies

Study Details	Methods	Participants	Interventions	Outcomes	Notes
<p>Author: Budtz-Jorgensen and Isidor, 1990</p> <p>Country: Denmark</p> <p>Study Design: RCT</p>	<p><i>Duration of trial:</i> 5 years</p> <p><i>Assessment periods:</i> 1 and 2 months; 2 and 5 years</p>	<p><i>Sample:</i> Total N= 53 <i>Age:</i> 61-83 yrs (Mean age: 69) <i>Gender:</i> 28 Females; 25 Males</p> <p><i>Country and Setting:</i> Denmark, University hospital</p>	<p><i>Intervention:</i> FPD (N=27)</p> <p><i>Control:</i> RPD (N=26)</p>	<p><i>Outcomes:</i> Caries; Prosthetic condition; periodontal conditions (PI /GI) and masticatory system (TMJ); patient opinion. (Were not divided into primary or secondary outcomes)</p>	<p>Study approval by Ethics Board was not recorded. No verification</p>
<p>Author: Witter, 2001</p> <p>Country: Netherlands</p> <p>Study Design: CT</p>	<p><i>Duration of trial:</i> 9 years</p> <p><i>Assessment periods:</i> Baseline and 3, 6 and 9 years</p>	<p><i>Sample:</i> Total N= 146 <i>Age:</i> Mean -36.2 for CDA Mean - 40.5 for SDA <i>Gender:</i> 82 Females; 64 Males <i>Country and Setting:</i> Netherlands, Nijmegen Dental Clinic</p>	<p><i>Intervention:</i> SDA (N= 74)</p> <p><i>Control:</i> CDA (N= 72)</p>	<p><i>Outcomes:</i> Interdental spacing; occlusal contact; Overbite; occlusal wear; TMJ problems and periodontal support. (Were not divided into primary or secondary outcomes)</p>	<p>Study approved by University Nijmegen Ethics Board. Informed Consent from patients was obtained.</p>
<p>Author: Jepson, 2007</p> <p>Country: United Kingdom (UK)</p> <p>Study Design: RCT</p>	<p><i>Duration of trial:</i> 2 and 5 years</p> <p><i>Assessment periods:</i> 3 months; 1, 2 and 5 years</p>	<p><i>Sample:</i> Total N= 60 <i>Age:</i> 39-81 yrs (Mean age: 67) <i>Gender:</i> 35 Females; 25 Males</p> <p><i>Country and Setting:</i> UK, Newcastle Dental hospital</p>	<p><i>Intervention:</i> FPD (N=30)</p> <p><i>Control:</i> RPD (N=30)</p>	<p><i>Primary:</i> Survival of prosthesis; Influence of diet; nutrient intake</p> <p><i>Secondary:</i> Caries; Periodontal status; patient satisfaction</p>	<p>Power calculations were completed</p> <p>Study approval received from Ethics Board. Informed Consent from patients obtained.</p>
<p>Author: Walters, 2010</p> <p>Country: Germany</p> <p>Study Design: RCT (Multi-centre, 14 Hospitals)</p>	<p><i>Duration of trial:</i> 3 year</p> <p><i>Assessment periods:</i> 4-8 weeks; 6 months and 1, 2, 3, 4 and 5 years</p>	<p><i>Sample:</i> Total N= 215 (pilot sample is included in main study) <i>Age:</i> 35 yrs + (Mean age: 59) <i>Gender:</i> 107 Females; 108 Males <i>Country and Setting:</i> Germany, University hospitals</p>	<p><i>Intervention:</i> SDA (N=106)</p> <p><i>Control:</i> RDP (N=109)</p>	<p><i>Primary:</i> First tooth loss</p> <p><i>Secondary:</i> second tooth loss; caries; survival of treatment; Oral health related quality of life; Tooth mobility; PI; GI; TMJ problems</p>	<p>Power calculations were completed</p> <p>Study approved by Institutional Ethics Review Board</p>

<p>Author: McKenna, 2012</p> <p>Country: Ireland</p> <p>Study Design: RCT</p>	<p><i>Duration of trial:</i> 1year</p> <p><i>Assessment periods:</i> Baseline and 1 month</p>	<p><i>Sample:</i> Total N= 44 <i>Age:</i> 65-82 yrs (Mean age: 68) <i>Gender:</i> 28 Females; 16 Males</p> <p><i>Country and Setting:</i> Ireland, University hospitals</p>	<p><i>Intervention:</i> RPD (N=21)</p> <p><i>Control:</i> RBB/FPD (N=23)</p>	<p><i>Primary:</i> Oral health related quality of Life; Nutritional status</p> <p><i>Secondary:</i> cost-effectiveness of two treatments</p>	<p>Power calculations completed: Estimated that one treatment was not worse than the other. Study approved by Cork University's Ethics Review Board</p>
--	---	---	--	--	---

KEY:

RCT – randomized controlled trial

CT - Clinical Trial

SDA – shortened dental arch

CDA – complete dental arch

FPD – fixed partial denture

RBB – resin-bonded bridge

RPD – removable partial denture

PI – plaque index

GI – gingival index

TMJ – temporomandibular joint

Table 2:

Risk of Bias Table

Study	Budtz-Jorgensen, 1990	Witter, 2001	Jepson, 2007	Walter, 2010	Mc Kenna, 2012
Random Sequence Generation (Selection bias)	Unclear	Unclear	Yes	Yes	Yes
Allocation Concealment (Selection bias)	Unclear	Unclear	Yes	Yes	Yes
Blinding (Detection and Performance bias)	No	Unclear	Yes	No	Yes
Incomplete Outcome Assessment (Attrition bias)	Yes	Yes	Yes	Yes	Yes
Free of Selective Reporting (Reporting bias)	No	No	Yes	No	Yes
Free of Other Bias	No	Yes	Yes	Yes	Yes
“Yes” indicates a low risk of bias, “No” indicates a high risk of bias, and “Unclear” indicates either a lack of information or uncertainty over the potential for bias.					

TABLE 3: FPD versus RPD for Treated and untreated Shortened Dental Arches**Patient or population:** patients with Treated and untreated Shortened Dental Arches**Settings:** Hospital Setting**Intervention:** FPD versus RPD

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk FPD versus RPD				
Number of patients with satisfactory occlusion	Study population		RR 1.16 (0.9 to 1.48)	53 (1 study)	⊕⊕⊕⊕ very low ^{1,2}	
	769 per 1000	892 per 1000 (692 to 1000)				
	Moderate					
Number of patients with no caries experience	Study population		RR 1.89 (1.09 to 3.3)	50 (1 study)	⊕⊕⊕⊕ moderate ²	
	391 per 1000	740 per 1000 (427 to 1000)				
	Moderate					
Number of patients showing TMJ dysfunction	Study population		RR 0.64 (0.36 to 1.16)	53 (1 study)	⊕⊕⊕⊕ very low ^{1,2}	
	577 per 1000	369 per 1000 (208 to 669)				
	Moderate					
Survival of Intervention	Study population		HR 0.59 (0.27 to 1.29)	60 (1 study)	⊕⊕⊕⊕ moderate ²	
	See comment	See comment				
	Moderate					
Patient Satisfaction	Study population		Not estimable ³	52 (1 study)	⊕⊕⊕⊕ moderate ²	
	See comment	See comment				
	Moderate					

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio; HR: Hazard ratio;

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

¹ High risk of bias for blinding, selective reporting bias and other bias;

² Small sample size;

³ No significant difference (p=0.092)

TABLE 4: RPD versus SDA for Treated and untreated Shortened Dental Arches**Patient or population:** patients with Treated and untreated Shortened Dental Arches**Settings:** Hospital setting**Intervention:** RPD versus SDA

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Control	RPD versus SDA				
Change in MNA scores		The mean change in mna scores in the intervention groups was 0.03 lower (1.35 lower to 1.29 higher)		42 (1 study)	⊕⊕⊕⊖ ¹ moderate	
Number of patients with first tooth loss in 38 months	Study population		0.83 (0.74 to 0.91)	150 (1 study)	⊕⊕⊖⊖ low ^{2,3}	
	130 per 1000	108 per 1000 (97 to 119)				
	Moderate					
Patient Satisfaction	Study population		Not estimable ⁴	215 (1 study)	See comment	
	See comment	See comment				
	Moderate					

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

¹ Small sample size

² High risk of bias for blinding and selective reporting bias

³ Wide confidence interval- the 95% CI includes both null effect and appreciable harm

⁴ No significant changes were reported for the Irish study. For the German study: Significant differences were seen at baseline (27.0; p<0.0001) and 1 year on (13.0; p<0.0002) for the RPD group and a significant change in impacts (19.0; p<0.05) were observed only at baseline for the SDA group

Table 5. Summary satisfaction scores for the UK-based study at 1 year
(a lower score indicates more satisfaction)

Group	N	Median (baseline)	Median (1 year)	p-value per group	p-value between groups
FPD (Intervention)	26	18	11	<0.001	0.092
RPD (Control)	26	16.5	13	0.009	

FPD= Fixed partial denture; RPD= Removable partial denture

Table 6. Change in MNA scores for the Irish study

Group	n	Baseline MNA score average	Final MNA score average	p-value per group	Calculated SD of change
RPD	21	23.65	24.75	0.03	2.15
SDA	21	23.24	24.37	0.03	2.21

MNA= Mini nutritional assessment; RPD= Removable partial denture; SDA= Shortened dental arch

Table 7. Change in OHIP-14 scores for the Irish study

Group	n	Baseline OHIP-14 score average	Final OHIP-14 score average	p-value per group
RPD	21	12.4	3.3	< 0.001
SDA	21	11.4	1.8	< 0.001

OHIP= Oral health impact Profile; RPD= Removable partial denture; SDA= Shortened dental arch

Table 8
Table of Excluded studies, with reasons for exclusion

Study	Reasons for exclusion
Abt, Carr, Worthington: 2012	A systematic review focused on treatment options for all types of partially dentate patients did not specifically focus on the interventions for SDAs SDA was considered as only one treatment option
Fueki: 2011	A systematic review completed in Japan Included different study designs All the RCTs included in this review were used for the present review as well. But other RCTs were included for the present SR The analysis for this SR is different to that of the present SR
Faggion: 2011	A systematic review Intention was to include RCTs and CTs, but a prospective study was included All RCTs used for this SR was included in the present review with the inclusion of other RCTs Outcomes that were not reported in this SR has been included in the present review Focus of this paper was the GRADE assessment completed
Emami: 2010	Is a summary of a clinical trial completed on this SDA subject Above RCT has been included in this review
Gotfredsen, Walls: 2007	Is a SR of the literature related to the SDA topic Similar outcomes as addressed in this SR Different study design types were included SR concluded the acceptable level of oral function obtained with 20 natural teeth (which is line with the WHO goal for the year 2000)

KEY:

SDA: shortened dental arch

RCT: randomized controlled trial

CT: clinical trial

SR: systematic review

WHO: World Health Organization

Chapter 5

Impact of removable partial dental prostheses on function and oral health-related quality of life of a South African cohort with varied distributions of missing posterior teeth

Impact of removable partial dental prostheses on function and oral health-related quality of life of a South African cohort with varied distributions of missing posterior teeth

Chapter 5 reports on the fourth study, a cross-sectional study that assesses the impact of RPDPs on satisfying the functioning ability and OHRQoL of a group of partially dentate adult patients, with various distributions of missing posterior teeth according to Kennedy Class I, II and III distributions. It was hypothesized that, in partially dentate patients with a Kennedy Class I and II (posteriorly reduced) or class III (discontinuous and interrupted) dental arch, the use of RPDPs do not influence daily functional ability, satisfaction and OHRQoL.

SUMMARY

The focus of this study was to determine what treatments were completed for patients with varied partially dentate states including shortened dental arches (Kennedy Class I and II) and whether patient-input plays any role in final treatment rendered. It was important to explore the input of patients and how they were guided. This study allowed determining the clinical practices of students after having explored their classroom teachings and opinions. Many quality of life studies using various oral health impact indicators comparing different fixed, removable or a combination of interventions for SDA patients have been conducted globally. While the research outcomes of these studies do not show greatly different results, they may not be generalizable to different contexts or settings due to differences in cultural and/ or socio-economic circumstances. Thus it was decided to conduct a cross-sectional study amongst a South African cohort of patients treated by senior dental students at the University of the Western Cape. What was particularly of interest, in this research, however, was to explore if patients' perceived needs are addressed and met compared to using an approach where normative needs (that is the opinions of professionals) are considered only.

The Oral Impacts on Daily Performance (OIDP) Index that was used had been validated for the SA population. Thus quite a different tool to determine the impact of removable prostheses on patients' quality of life was used, compared to other quality of life studies. Negative oral impacts were reported at the pre-treatment phase, but these were

substantially reduced after patients received their RPDPs. They thus reported an improvement in oral health and satisfaction with no significant differences across the 3 Kennedy groups. Treatment should be evidence-based, and patient-centred treatment is regarded as being more successful. Thus the outdated clinician-centred approach should be reviewed. From the aforementioned, the aims of the study were satisfied with this included convenience sample indicating that all teeth are replaced irrespective of the need for such treatment in especially some Kennedy class I and II set-ups; but the absence of the patient-input in treatment planning were also observed, though this conclusion may not be generalizable to other treatment facilities.

PUBLICATION

This paper has been accepted for publication in the Journal of Prosthodontics; Publication citation: Khan, SB. Chikte, UME. Omar, R. (2017). Impact of dental prostheses on the functional ability and oral health-related quality of life of a South African partially dentate cohort. *J Prosthodont* (Accepted). doi: 10.1111/jopr.12692

The PhD candidate developed the protocol (with input from supervisors), submitted the protocol for ethics approval, independently obtained all information related to research participants including consent, extracted and assessed the data (the statistician assisted with calculating data) and interpreted the data. The manuscript, including all corrections from both supervisors and journal reviewers who provided guidance and critical comments, was completed by the candidate. All authors approved the final manuscript.

The bilingual OIDP Index (2012 version), Consent Form and Ethics Approval are included as Appendices 5.1-5.3.

ABSTRACT

Purpose: To determine the impact of removable partial dental prostheses on satisfying the daily functioning and quality of life of adult patients with different distributions of missing posterior teeth.

Methods: A cross-sectional interventional study was carried out on 80 patients having variously distributed posteriorly shortened and interrupted arches. Treatment comprised provision of partial dentures by senior dental students, and supervised by senior clinical teachers who had knowledge of the potential benefits of the shortened dental arch concept. The Oral Impacts on Daily Performance Index was completed before and 6 months after prosthetic treatment across groups comprising Kennedy Classes I, II and III arches. Analysis included descriptive statistics and associations and comparisons between variables.

Results: Mean age of patients was 57.4 years (SD=13.1), many were retired (72.2%) and a majority were females (60%). Most patients lived in urban areas (95%), and were largely unemployed (63.3%). At pre-treatment, only 31.3 % of patients reported having good dental health and satisfaction with their current oral state, whilst 82.5% said they had a great need for treatment. Frequencies of negative oral impacts that were most commonly experienced were those of eating (67.5%), smiling (50%) and being emotionally disturbed (63.8%). Post-treatment, 76.3 % indicated good oral health and satisfaction with no significant differences between the 3 Kennedy groups. Any further negative impacts were reported mostly for Kennedy Classes I and II.

Conclusions: Overall, significant reductions of negative impacts were observed following treatment with dentures, across the 3 Kennedy groups, with respect to improved function, satisfaction and oral health-related quality of life. The findings confirm the reliance by partially dentate patients in all 3 Kennedy groups on dentures for improved oral health, although it should be noted that the possible benefits of the shortened dental arch concept as an alternative treatment option, was not specifically explored.

5.1. Introduction

Research evidence from several sources recommends that reduced or interrupted dentitions should be categorized according to their ability to ensure satisfactory oral function [1-4]. Studies on oral function suggest that oral health related quality of life (OHRQoL) can be related to the presence of nine or more pairs of anterior and posterior occluding teeth [1-2, 5]; and that anything less than this negatively affects patient satisfaction and OHRQoL [1-2, 5-7]. Generalizability of these results cannot be assumed as contexts differ considerably regarding cultural and socio-economic circumstances, and which in turn have been shown to impact OHRQoL and patient satisfaction [5, 7].

Normative and perceived needs as regards the functional adequacy of partial edentulism, including reduced posterior dentitions, differ [2, 8-9], and thus the assessments for prosthetic replacement vary widely. In general, normative assessments of treatment needs, especially in older, partially dentate adults, exceed the perceived needs of the patients themselves [2, 9]. There is growing evidence that the prosthetic management approach, especially in such an older group of patients, should include treatment options predicated on the maintenance of a functional dentition [3, 10-13]. This differs from the traditional approach of a morphologically intact dentition being considered the determinant of satisfactory function.

The shortened dental arch (SDA) concept, introduced by Käyser in the 1980s, has been proposed as an alternative treatment option for older, partially dentate adults [1, 3-4, 10-13, 14-26]. The concept is functionally-oriented and has been shown to satisfy the functional needs and OHRQoL of such patients in several population groups [11-33]. The classic SDA is defined as having 20 occluding anterior and premolar teeth, although several variations relating to the number of posterior occluding pairs (POPs) of teeth have been described as well [1, 5, 11-13, 17-27]. The benefits of the classic SDA and its many variations have been described in the global contexts [1, 3, 11-12, 17-21, 23-31] and the South African (SA) contexts [22, 32-33].

Gotfredsen and Walls (2007) make reference to the difficulties patients experience when expressing their satisfaction regarding their oral function, and advised that these patients should optimally be guided by clearly defined concepts and validated indicators when their

needs are assessed and treatments recommended [1]. Adopting a problem-orientated and patient-centred treatment approach would increase the possibility of achieving successful treatment outcomes [34].

Several statistically validated OHRQoL indicators are available that would simultaneously determine patients' clinical status, psychological and social dimensions when determining dental needs, that is, combining normative and perceived needs [2, 35-39]. The Oral Impacts on Daily Performance (OIDP) index, described by Adulyanon and Sheiham in 1997, has been used to assess diverse populations' dental needs and for planning dental services [36, 39]. Importantly, the OIDP adequately encompasses the concepts related to basic needs and demands [2, 36, 39].

In studies conducted within the SA context, knowledge related to the SDA amongst dentists in private practice and those teaching at a large dental institution, was not widespread, and not surprisingly it was rarely translated into clinical practice [22, 32]. The commonly-accepted and -applied method of treating such patients is with removable partial dental prostheses (RPDPs). Since patients tend to value and trust the judgements of clinicians without questioning the treatment offered (a clinician-centred approach), the impact and effect of treatment with RPDPs on patients' daily life, in light of alternatives such as the SDA approach, has not been adequately explored. In particular, no studies alluding to the functioning ability and OHRQoL benefits for patients with differing partially dentate scenarios as defined by their Kennedy classification, viz. Class I (which incorporates classic SDAs), II and III, have been conducted in SA.

The aim of this study was to assess the impact of RPDPs on satisfying the functioning ability and OHRQoL of a group of partially dentate adult patients, with various distributions of missing posterior teeth according to Kennedy Class I, II and III.

The null hypothesis was formulated as follows: In partially dentate patients with a Kennedy Class I and II (posteriorly reduced) or class III (discontinuous and interrupted) dental arch, the use of RPDPs do not influence daily functional ability, satisfaction and OHRQoL.

5.2. Material and Methods

Ethical clearance (Registration No. 11/1/50 and S13/04/066) was obtained from the Research and Ethics Committees of the University of the Western Cape (UWC) and the Stellenbosch University. Written informed consent was obtained from the participants according to the Declaration of Helsinki [40]. The study population for this cross-sectional interventional study comprised a convenience sample of partially dentate patients (n=80), presenting to the clinic requesting replacement of missing posterior teeth with cobalt-chrome clasp-retained RPDPs. Patients had to have a Kennedy class I, II (posterior reduced or shortened) or III (discontinuous or interrupted) dental arch and had to be considered suitable for treatment by senior dental students after a thorough screening by academic staff. After being fully informed about the nature and purpose of the study, and agreeing to participate, enrolled patients were interviewed by the principal researcher using the OIDP questionnaire prior to receiving any prosthetic treatment. Subsequent to the prosthetic treatment, and after having worn the prosthesis for 6 months, the principal researcher again completed the OIDP questionnaire with patients so that they served as their own controls. Treatment comprised provision of patients with cobalt-chrome clasp-retained RPDPs to replace all missing teeth by senior dental students' supervised by clinical teachers.

The modified OIDP index (validated for the SA population) was used in this study and administered by the principal researcher [39]. Patients' demographic details (age, gender, economic and employment status) were recorded. Participants were classified into groups according to socio-economic category (middle, low working class, no income) and occupation (professional, skilled, unskilled and unemployed) [39, 41]. In addition, responses to the general and oral health questions were recorded using a 5-point Likert-type scale: for example, responses for rating aspects of dental health ranged from *very poor* (score of 1) to *very good* (score of 5) and for patient satisfaction from *not at all satisfied* (score of 1) to *very satisfied* (score of 5) [40]. With regard to the OIDP assessment, the sections which focused on the OHRQoL required a *yes/no* response for each of the 10 dimensions included, as well as for reasons for patients' particular responses [39]. The corresponding frequency and severity for each dimension was recorded using a 5-point Likert-type scale (*no effect* to *very severe effect*) [39]. Similarly for health behaviours (including dietary intake) and dental care habits, responses were again recorded using a *yes/no* response or a Likert-type scale [39].

Frequencies were calculated for the demographic data and for oral impacts and oral health behaviours at pre- and post-intervention stages and recorded according to the first 3 Kennedy classifications. The associations between qualitative variables (e.g. *dental health* and *need for dental treatment* and oral impacts) were studied by drawing up contingency tables and applying the Chi-square test, or Fisher's exact test where necessary (p -values indicating the significance) at both pre- and post-intervention stages. For comparisons of means, the t -Test or, when appropriate, the paired t -Test was used. Cross tabulations were also completed between pre- and post-intervention responses using McNemar's test to observe statistically significant differences stated by the p -values. The data were analysed using the Epi-Info and R-statistical programmes.

5.3. Results

5.3.1. Demographics

The age range of participants was 28-86 years (mean age=57.4, SD=13.1) with a 60% female majority. Patients were classified according to socio-economic status (low, middle and high income) and occupation (professional, skilled, unskilled, unemployed and/or retired) categories. Most patients lived in *urban areas* (95%), very few were in the upper middle class group (1.3%), and most were largely *retired* (72.2%). The majority of patients were *unemployed* (63.3%), with equal numbers within the other categories at 6.3% in the *skilled* and *unskilled* groups.

The demographic variables that may be considered as confounders were patients' general health, socio-economic status, level of education and residential location. From an assessment of the data, however, no significant results with respect to possible confounders were noted. Notably, post-intervention, whereas complaints or negative impacts were reported amongst patients from different socio-economic and education levels, the only demographic variable showing significant differences was gender. It was also noted that most complaints for the different impacts post-intervention were by males in the Kennedy Class I and III groups, even though females formed the majority of the sample (Table 1).

5.3.2. General Oral Health

For all patients attending the prosthetic clinic for the specific purpose of receiving a RPDP, institutional protocol required that all basic restorative and periodontal procedures had to be completed before these prostheses were provided.

At pre-treatment, 31.3% of the total sample indicated their perceived dental health as good or very good compared to a post-treatment proportion of 76.3% ($p < 0.0001$). Correspondingly, *patient satisfaction* with perceived oral health was recorded as 76.3% ($p < 0.0001$) 6 months after receiving the prostheses. At post-intervention, for both these oral health indicators non-significant differences were recorded across the Kennedy classifications, although the numbers of those reporting being most satisfied was from the Kennedy Class III group (Table 1). Prior to receiving their RPDPs, 82.5% ($p < 0.0001$) of the total sample had felt they were in *great need of dental treatment* whilst this need for further treatment decreased substantially by 80% (with the greatest need noted for the Kennedy Class I group) after provision of the RPDP (Table 1). Cross tabulations completed for the total sample, however, showed highly significant differences between pre- and post-intervention responses as specified by the p -values obtained after applying the McNemar's test. At post-intervention, significant gender differences were observed with more males indicating poor satisfaction and a greater need for more treatment.

5.3.3. Oral Impacts

Total OIDP score measures *prevalence* (proportion of subjects reporting one or more daily oral impact), *extent* (number of daily performances affected) and *severity* (more severe effect in one performance) of oral impacts on daily life. Even though the total OIDP score at pre-intervention stage was recorded to be fairly low (20.7%), signifying good self-rated oral health status, some specific negative oral impacts (*eating, smiling, being emotional and contact with family*) were experienced almost daily. Based on the 5-point scale of responses ('no effect' to 'very severe effect'), the negative impacts were reported to have affected their daily life severely. However, following treatment with a RPDP and after 6 months of usage, the total OIDP score was reduced to 5.9%. The acquisition of a RPDP, which was still worn by this cohort of patients, thus seemingly improved their perceived dental health and subsequently had a positive effect on their quality of life and OHRQoL.

The oral impacts of *speaking, cleaning teeth, physical activity (both light and vigorous), sleeping and relaxing* were unaffected by patients' oral state, and thus are not reported. The oral impacts experienced most frequently by patients with shortened and/or interrupted posterior dental arches were those of *eating, smiling, being emotional* and *contact with family*. Statistically significant reductions in the prevalence of negative impacts were observed for *eating* (20%), *smiling* (11.3%) and *being emotional* (15%) following treatment with clasp-retained RPDPs across all Kennedy groups ($p < 0.0001$).

At post-intervention, the negative oral impacts affecting OHRQoL reported were mostly from males and from the Kennedy I and III groups for *eating, smiling* and *being emotional* (Table 1). Only females reported negative oral impacts in the Kennedy Class II group for *eating* and *being emotional*. Most negative OHRQoL impacts reported were in the following descending order: Kennedy Class I, Class III, and lastly Class II groups, and for those impacts specified above (Table 1). Negative impacts were reported for patients from different age, socio-economic and occupation groups but these were not significant. Only gender differences were significant (as mentioned previously).

5.3.4. Associations between General Oral Health and Oral Impacts

Pre-intervention stage: The association between negative oral impacts (*eating, smiling, being emotional* and *contact with family*) and perceived dental health data were summarized in 5×2 cross tabulation frequency distributions (Table 2). While there was variation between the percentages, the differences between them for *eating* were not statistically significant ($\chi^2 = 4.77$; $df=4$; $p=0.312$) according to the results of a Chi-square test (Table 2). The responses of participants changed for *eating* (recorded as 'no problems with eating') as their perceived dental health status improved (Table 1).

The results for *smiling, being emotional* and *contact with family* versus perceived dental health are also recorded in Table 2. Here, the p -values indicate the significance, or otherwise, of association, and these were confirmed by Fischer's exact tests where needed. Patients' responses for dental health versus *smiling* showed a similar trend to the results for *eating*, but for *smiling* the trend was statistically significant ($\chi^2 = 11.26$; $df=4$; $p=0.024$). Similarly, for patient satisfaction, the trend was comparable to that of perceived dental health, with the percentage of respondents saying 'Yes' (that is 'not satisfied') decreasing

with improved dental health status (Table 2). However, the trend was in the opposite direction with need for treatment versus the reported negative oral impacts (*eating, smiling, being emotional* and *contact with family*), that is the need for treatment was perceived as greater when patients indicated experiencing negative oral impacts (Table 2).

5.4. Discussion

In this study, the oral impacts most noticeably affected pre-operatively were: *eating, smiling, the emotional state of patients* and *contact with family*. Eating was possibly impacted by loss of posterior teeth and their different distributions, while concerns with smiling, given that all anterior teeth were present, may be attributed to missing premolar teeth, especially in patients who have a broad smile.

Following treatment with RPDPs, patients generally expressed satisfaction as well as an improvement in oral impacts, oral functional satisfaction, and more specifically in OHRQoL, although differences across the 3 groups were noted. Overall OIDP scores were lower, indicating that the presence of a clasp-retained cobalt-chrome RPDP improved their self-rated oral health and also the importance that such a denture has for function, and possibly aesthetics, amongst this cohort. Any negative responses that were reported after receiving RPDPs were from the Class I and III groups, and most were reported by the males. It is important to mention that the confounder, viz. provision of basic restorative and periodontal treatment prior to all such interventions, could have influenced the changes in their responses. The fact that the OIDP was completed 6 months after RPDP placement may, however, have reduced this potential effect.

The literature consistently states that the presence or absence of anterior teeth plays a major role in how patients respond to treatment with RPDPs, and thus to questionnaires or oral health indicators that focus on this treatment option [21]. Having excluded such patients from our sample, the responses seem surprising in that a substantial number reported negative responses for smiling. Such a response might have been expected had a Kennedy Class IV group been included as a cohort. At the same time, it is known that that many patients in the community from which our sample was drawn; request to have their anterior extracted as a culturally-driven preference. Since the present focus was on reduced posterior arches, these patients were deliberately excluded. Accordingly, patients were

grouped according to their Kennedy classification, into the first 3 classes only. These three groups facilitated recording specific results reflecting the QoL or OHRQoL with different posteriorly reduced and interrupted arches. The specific number of posterior occluding units was not reported, which is an important aspect that should be explored further, considering the body of evidence related to benefits of a functional dentition [11-33].

The reactions and responses of patients in this study were somewhat at variance with what some of the literature has indicated. Whether this might in some way be on account of patients' lack of knowledge of the potentially negative effects of distal extension clasp-retained RPDPs for Kennedy Class I and II scenarios, including the risk they could pose to the remaining teeth, is difficult to say [24, 34]. Research has shown that patients frequently do not use their distal extension clasp-retained RPDPs [1, 21, 42]. A survey conducted by Jepson et al. (2003) illustrates this point very well, with only 40% of RPDP patients actually wearing their dentures, and do so especially when the anterior components were a priority [21].

Perhaps also related to the observation of improved OIDP score after clasp-retained RPDP provision is the lack of knowledge related to the benefits of the non-interventional rationale of the SDA concept (which has indeed been accepted in South African Oral Health Strategy) among undergraduate students, clinical teachers and general practitioners [22, 32]. It follows that such a lack of awareness on the part of clinicians of the benefits that the SDA concept offers would likely not be conveyed to patients for whom such an option for managing reduced posterior occlusions is both viable and valid [22, 32]. It can also be speculated whether the fact that students' clinical education is premised upon achieving clinical requirements for graduation, and a 'fee-for-service' dental care system, compounds the problem of poor dissemination and uptake of the SDA concept. Thus, while the observed reduction in the total OIDP scores post-treatment indicates patients' satisfaction with prosthetic treatment that addressed their main complaint, whether this was so because it is actual or the perceived norm in clinical practice needs also to be investigated further.

In addition, the general absence among dental professionals of a patient-centred treatment approach has been noted. Gotfredsen and Walls (2007) were explicit about how patients

have difficulties in voicing their opinions regarding oral function and their treatment requirements to practitioners [1]. They suggest that patients be guided by evidence-based concepts when being treated to ensure a more patient-centred approach, and at the same time emphasizing the need for educating patients with regard to all the treatment options, as well applying validated indicators to assess their needs [1]. Knowledge related to the different oral health indicators introduced over time that address diverse aspects of quality of life are thus very important. The OIDP index is a comprehensive indicator that addresses perceived needs of patients based on the daily activities of the individual [26, 36, 39]. The severity of the condition with respect to function can be determined and indeed, the changes following treatment with appropriately-designed RPDPs were very noticeable in the present population. As a follow-up to this research, however, it would be useful to investigate the OHRQoL for patients with a classic SDA, and those with a reduced posterior occlusion but with acceptable numbers of posterior occluding pairs of teeth, while *not having any interrupted arches and with intact anterior teeth*. Such a design might unambiguously indicate whether the need for clasp-retained RPDPs, where cost is a major obstacle for readily obtaining these, is overstated in the SA context.

5.5. Conclusions

In patients presenting with a range of posteriorly reduced, interrupted and/or discontinuous arches, the overall negative oral impacts were greatly reduced after provision of clasp-retained RPDPs. Satisfaction with oral function was increased and OHRQoL was improved across the 3 Kennedy groups. Total OIDP score decreased significantly (from 20% to 5.9%) subsequent to RPDP provision as oral health status and level of satisfaction improved. Whereas the value of RPDPs in this SA cohort, which is at variance with many global studies, was confirmed, the effects of other possible confounders to this apparent outcome need further study.

5.6. Relevance of findings

The findings of this study show the reliance on a clasp-retained RPDP by this cohort of partially dentate SA patients, where application of the SDA concept offering functional benefits could arguably have worked equally successfully. It is also apparent that a clinician-driven treatment approach is still used amongst the population studied, indicating an

absence of patient-centeredness in treatment planning. Clinicians should not offer the RPDP treatment as the only treatment option, especially to patients who come from a low income and education group, when they present for treatment. In light of this, it can only be suggested that the outcomes of the study should be investigated further.

References

1. Gotfredsen K, Walls AWG: What dentition assures oral function? *Clin. Oral Impl. Res* 2007;18: 34-45.doi: 10.1111/j.1600-0501.2007.01436.x.
2. Sheiham A, Tsakos G: Oral health needs assessments. In: Pine CM, Harris R, editors. *Community Oral Health*: Wright Publishers, Oxford, 2004, Chapter 4.
3. Zhang Q, Witter DJ, Bronkhorst EM, et al: Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Invest* 2013; 17:1425-35.
4. Gerritsen AE, Allen FP, Witter DJ, et al: Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010; 8:126-39.
5. Elias EC, Sheiham A: The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998; 25:649-61.
6. Brennan DS, Spencer AJ, Roberts-Thomson KF: Tooth loss, chewing ability and quality of life. *Qual. Life Res* 2008; 17:227-35.
7. Baba K, Igarashi Y, Nishiyama A, et al: The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008;21:72-4.
8. Bradshaw JS: A taxonomy of social need. In McLachlan G, editors. *Problems and Progress in Medical Care*, 7th series, Oxford University Press, 1972; pp.69-82.
9. Narby B, Kronström M, Söderfelt B, et al: Prosthodontics and the patient: Need becoming demand, Demand becoming utilization. *Int J Prosthodont* 2007;20:183-9.
10. Käyser AF, Witter DJ, Spanauf AJ: Overtreatment with removable partial dentures in shortened dental arches. *Aus Dent J* 1987;32:178-82.
11. Käyser AF: The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 1989;9:426-49.
12. Sarita PT, Witter DJ, Kreulen CM, et al: The shortened dental arch concept – attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol* 2003;31:111-5.

13. Witter DJ, van Elteren P, Käyser AF: Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988;15:413-20.
14. Witter DJ, van Elteren P, Käyser AF, et al: Oral comfort in shortened dental arches. *J Oral Rehabil* 1990;17:137-43.
15. Witter DJ, de Haan AF, Käyser AF, et al: A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 1994;21:113-25.
16. Käyser AF: Shortened dental arches and oral function. *J Oral Rehabil* 1981; 8:457-62
17. Kanno T, Carlsson GE: A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil* 2006;33:850-62.
18. Allen PF, Witter DF, Wilson NHF, et al: Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996;23:481-5.
19. Armellini DB, Von Fraunhofer JA: The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004;92:531-5.
20. De Sa e Frias V, Toothaker R, Wright RF: Shortened Dental Arch: A review of current treatment concepts. *J Prosthodont* 2004;13:104-10.
21. Jepson NJA, Allen PF, Moynihan PJ, et al: Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003; 16:409-14.
22. Khan S, Chikte UME, Omar R: From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014;78:906-13.
23. Korduner EK, Söderfelt B, Kronström M, et al: Attitudes toward the shortened dental arch concept among Swedish general dental practitioners. *Int J Prosthodont* 2006; 19:171-6.
24. Owen CP: Appropriatech: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont* 2004;17:261-2.
25. Sarita PT, Witter DJ, Kreulen CM, et al: Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Sciences* 2007;115:265-74.
26. Tan H, Peres KG, Peres MA: Do people with shortened dental arches have worse oral health-related quality of life than those with more natural teeth? A population-based study. *Community Dent Oral Epidemiol* 2014;1-9. Doi:10.1111/cdoe.12124.
27. Zeng X, Sheiham A, Tsakos G: Relationship between clinical dental status and eating

- difficulty in an old Chinese population. *J Oral Rehabil* 2008;35:37-44.
28. Omar R: Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ* 2004;59:228-37.
 29. Allen PF, Witter DF, Wilson NHF: The role of the shortened dental arch concept in the management of reduced dentitions. *Br Dent J* 1995;179:355-7.
 30. Ueno M, Yanagisawa T, Shinada K, et al: Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008;35:337-44.
 31. Fueki K, Yoshida E, Igarashi Y: A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011;47:167-74.
 32. Khan SB, Chikte UME, Omar R: Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa. *SADJ* 2012;67:60-8.
 33. Khan SB, Musekiwa A, Chikte UME, et al: Functional outcomes and relevance of prosthodontic interventions for shortened dental arches in adults: A Systematic Review. *PLOS ONE J* 2014;9: e101143.
 34. Carlsson GE, Omar R: The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil* 2010;37:143-56.
 35. Slade GD, Spencer AJ: Development and evaluation of the Oral Health Impact Profile. *Community Dental Health* 1994;11:3-11.
 36. Adulyanon S, Sheiham A: Oral impacts on daily performances. In Slade, GD, editors. *Measuring Oral Health and Quality of Life*. Chapel Hill, University of North Carolina, 1997; Chapter 14, 151-60.
 37. Strassburger C, Heydecke G, Kerschbaum T. Influence of prosthetic and implant therapy on satisfaction and quality of life: A systematic literature review. Part I– Characteristics of the studies. *Int J Prosthodont* 2004;17:83-93.
 38. Strassburger C, Heydecke G, Kerschbaum T: Influence of implant and conventional prostheses on satisfaction and quality of life: A literature review. Part 2– Qualitative analysis and Evaluation of the studies. *Int J Prosthodont* 2006;19:339-48.
 39. Hobdell M, Tsakos G, Ladrillo TE, et al: Using an oral health-related quality of life measure in three cultural settings. *Int Dent J* 2009;59:381-88.
 40. World Medical Organization. Declaration of Helsinki. *Br Med J* 1996;313:1448-49.
 41. World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe.

Copenhagen: WHO regional office for Europe. WHO Technical Report Series No. 826; 1982, p.16-7.

42. Frank RP, Brudvik JS, Le Roux B, et al: Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. J Prosthet Dent 2008;83:521-7.

Table 1

Demographic distributions and post-intervention patient responses according to Kennedy Classifications

	KENNEDY CLASS I	KENNEDY CLASS II	KENNEDY CLASS III	Total
1. Demographic Data				
Gender: Male	13 (35.1%)	7 (43.7%)	12 (44.4%)	32 (40%)
Female	24 (64.9%)	9 (56.3%)	15 (55.6%)	48 (60%)
Age Category	35-54: N=14	29-54: N=5	28-54: N=12	31 (38.8%)
	55-86: N=23	55-79: N=11	55-83: N=15	49 (61.2%)
Location: Urban	35	16	25	76 (95%)
2. Sample Size (N)	N=37	N=16	N=27	80
POST-INTERVENTION				
3. Oral Health:				
Good Dental Health	27 (72%)	12 (75%)	22 (82%)	76.3%
Patients Satisfied	26 (70%)	12 (75%)	23 (85%)	76.3%
Need Treatment	9 (24.3%)	3 (18.7%)	4 (14.8%)	20 %
4. Negative Oral Impacts:				
Eating	9 (24.3%)	3 (18.8%)	4 (14.8%)	20 %
Smiling	6 (16.2%)	0	3 (11%)	11.25%
Emotional	6 (16.2%)	3 (18.8%)	3 (11%)	15 %
Contact with Family	4 (10.8%)	0	3 (11%)	8.8 %

Table 2

Pre-Intervention Associations between General health and Oral impacts indicating patients

'Yes' responses

Dental Health	1	2	3	4	5	p-value
Eating	100	62.5	68	68.2	33.3	§ 0.312
Smiling	100	62.5	32	45.5	33.3	0.024
Being emotional	100	83.3	52	54.5	0	0.005
Contact with family	100	50	24	36.4	33.3	0.013
Patient Satisfaction	1	2	3	4	5	p-value
Eating	76.5	68.8	54.5	73.7	66.7	§ 0.617
Smiling	100	43.8	50	21.1	16.7	<0.001
Being emotional	82.4	87.5	63.6	42.1	16.7	0.002
Contact with family	76.5	50	31.8	26.3	0	0.003
Need for Dental Treatment	1	2	3	4	5	p-value
Eating		60	66.7	69	67.6	§ 0.997
Smiling		0	33.3	41.4	67.6	0.009
Being emotional		20	33.3	55.2	83.8	0.002
Contact with family		0	33.3	31	56.8	0.034

KEY:

Dental Health:

1= Very Poor
 2= Poor
 3= Fair
 4= Good
 5= Very Good

Patient Satisfaction:

1= Not at all
 2
 3
 4
 5= Very satisfied

Need for Dental Treatment:

1= Not at all
 2
 3
 4
 5= A great deal

§: p-value indicates that the results were not significant

Chapter 6

Outcomes with a posterior Reduced dental arch: A Randomized Controlled Trial

Outcomes with a posterior reduced dental arch: A Randomized Controlled Trial

Chapter 6 reports on the fifth study, a randomized controlled trial related to the SDA concept, and conducted over a period of 3 years. Follow-up of patients will continue after the research objectives have been reported.

The chapter further delves into the challenges presented by the traditional sampling method, and specifically sample size determination, for clinical research. By this method, the required sample size is estimated prior to conducting the research, and doing so in advance reduces the chance of an underpowered study. Frequently the sample size thus calculated, and needed, can be so large as to curtail or preclude conducting the study. This difficulty arose in the early stages of the present RCT and alternatives for estimation of sample size were explored. A fuller description of sequential sampling, an approach to sample size estimation that is rarely used in dentistry, and which was applied in the present RCT, follows below (see Appendix 6.8).

SUMMARY

The overall aim of this RCT was to determine whether the daily functional needs and OHRQoL of young and middle-aged adult patients with a reduced posterior dentition will be satisfied and/or improved without having all their missing teeth replaced with a RPDP, as compared to having the use of such a prosthesis. The RPDP, which has been shown to be a successful treatment option in a previous clinical study (Chapter 5) conducted within the same population group was the treatment selected as a replacement strategy for the treatment group of the RCT. Patients were educated regarding the SDA and on this basis informed consent obtained to be part of this study. The OIDP instrument was the data collection tool of choice as it had been validated for the SA context, and measured the impact on participants' quality of life. In addition, a global visual analogue scale (VAS) to gauge patient satisfaction and oral health-related quality of life was also used.

Sequential sampling (SS) is a non-probability sampling technique where neither the sample size nor the time-frame for data collection is fixed in advance [7-9]. Data are collected and

analysed in sets of patients depending on the stopping rule which formed part of the initial decision. Regarding the stopping rule, using the available variables of sample size, statistical significance and the minimum mean difference set by the researchers, a decision was made to:

- i) Accept either the null or alternative hypothesis and stop sampling if the estimated power was greater than 80%, or
- ii) Continue sampling if the power calculated is below 80%, and then increase the sample size by adding another set of patients [7-9].

Comparing sequential sampling, in which there is an alternative to stop or to continue , sampling, with the traditional type of sampling, where sample size is fixed in advance and the null hypothesis is either accepted or rejected or the alternate hypothesis is accepted, the difference with respect required sample size is evident [5, 7-9].

Patients from the 'no-denture' group were very satisfied with their non-denture status, including functioning without having their teeth replaced with RPDP. Compared to them, patients from the 'denture' group were not satisfied and could not function adequately with a RPDP, which was contrary to the previous study.

PUBLICATION

This paper has been accepted for publication by the Journal of Oral Rehabilitation; Publication citation: Khan, SB. Chikte, UME. Omar, R. (2017). Outcomes of interventions with a posterior reduced dental arch: A Randomized Controlled Trial. J Oral Rehabil (*Accepted*); doi: 10.1111/joor.12549

The PhD candidate developed the protocol and submitted it for ethics approval to the 2 institutions, independently obtained all information related to research participants (including consent) and extracted basic demographic data. The basic restorative and preventive procedures were completed by the service-rendering department of the University of the Western Cape, the allocation of intervention was completed by a research assistant and clinical prosthodontic procedures were completed by a dentist who also teaches in the academic setting. The PhD candidate then completed the questionnaires (VAS and OIDP) 3 months after receiving the interventions, extracted, assessed and interpreted the data (the statistician assisted with calculating the data). The manuscript (including all

corrections from both supervisors and journal reviewers who provided guidance and critical comments) was completed by the PhD candidate. All authors approved the final manuscript. Information Letter, Demographic Details form, Global VAS, Consent Form, Ethics Approval, RCT registration with clinicaltrials.gov, the CONSORT statement and Description of Sequential Sampling are included as Appendices 6.1-6.8.

ABSTRACT

Objective: To compare function, patient satisfaction and quality of life of patients with a posterior reduced mandibular arch with those who had all missing teeth replaced with removable partial dentures.

Methods: Patients with at least 3 and not more than 6 posterior occluding pairs of teeth were enrolled sequentially and randomized into one of two treatment groups: a denture and no denture group. A research assistant allocated interventions; concealment was ensured using opaque-sealed envelopes. Analysis of data was performed in stages, adding samples of 10 incrementally, and stopping when the relevant statistical tests indicated a clear conclusion as judged by the power set at 80% or above. Study outcomes included patient satisfaction, function and survival of remaining teeth at 3 and 12 months post-intervention, using a visual analogue scale and the Oral Impacts on Daily Performance) Statistical analysis was performed by the 'intention-to-treat' principle.

Results: Age range of included patients was 23-55 years (mean=42.3; SD=9.2), with 78% being females. Most patients (70%) belonged to the low- or no-income group. Nine patients left the study, for different reasons. Primary outcomes for the denture group: 10% of the patients were not satisfied and 20% were unhappy with their function; for the no-denture group: 85% of the patients (with 15% having left the study) were satisfied with both their function and their non-denture status.

Conclusion: Patients with posterior reduced mandibular dental arches reported greater perceived satisfaction, function and quality of life compared to those who had received a cobalt-chrome clasp-retained partial removable prosthesis.

Registered at [Clinicaltrials.gov](https://clinicaltrials.gov); Identifier: NCT01597206

6.1. Introduction

Research data increasingly support a functional approach in treatment planning. In prosthodontic clinical decision-making for older patients, such an approach not only encourages patient input, but has been shown to achieve improvements in subjective function and quality of life (QoL), thus ensuring overall treatment success [1-3]. A functional approach also addresses the discrepancies that are known to exist between accepted normatively-defined clinical practices and patients' evaluations of their oral functional needs [1, 2-6].

Results from several randomized and non-randomized clinical trials (RCT and CT) related to the shortened dental arch (SDA) concept have indicated its functional effectiveness, and application of the concept in selected patients has received general acceptance [4-5, 7-9, 12]. Examination of these RCTs and CTs, however, highlights their differences, including the interventions used, aspects of study design, and outcomes assessed (Table 1) [4-5, 7-9, 12]. A recent systematic review (SR) on the SDA concluded that the results of the included studies were not always consistent, and that generalizability may only be possible for specific regional and, perhaps cultural contexts [12]. Since tooth loss and oral function are indicators of the oral health status of individuals and communities [13], their impact on the perceived need for replacement of missing teeth is critical [2, 14-15]. Studies have indicated that the loss of teeth and their location significantly affect the oral health-related quality of life (OHRQoL) of patients [2, 6, 15-16]. The evidence for dentitions with fewer teeth, such as an extreme SDA confirms the negative effect on function and OHRQoL [1, 2, 6, 15].

Of the several available instruments for measuring OHRQoL, the oral impact on daily performance (OIDP) tool is a multidimensional instrument that provides information related to oral conditions [4-6, 12-13, 15-16, 17]. When used concurrently with clinical measures, a more comprehensive assessment of patients' oral status may be determined [13, 17]. The OIDP has been validated, and together with a global visual analogue scale (VAS), may be used to assess oral status, patients' satisfaction and OHRQoL [13, 17].

Given the wide variations in missing posterior tooth distributions, the definition of a SDA has evolved [2-3, 15]. A less formulaic, and perhaps more generic, clinical description may thus include a posteriorly reduced dental arch (PRDA) with 3-4 symmetrically- and 5-6

asymmetrically-arranged posterior occluding pairs (POPs) of teeth [1-2]. In some situations, specific occlusal arrangements as in PRDAs which include the classic SDA are considered acceptable and adequate for oral function, occlusal support and stability [2, 15].

South Africa (SA) is a developing country, which by virtue of its wide socioeconomic disparities, affords only a limited range of treatment procedures for the majority of its population at public health clinics (viz. extractions, fillings and preventive procedures); at the same time, the exorbitant costs associated with current prosthodontic treatment options (complete or partial removable, or conventional or implant-retained fixed prostheses) that are provided by private practitioners make these options inaccessible for most. Management approaches such as the SDA or PRDA would seem to be an appropriate primary healthcare measure for the underprivileged majority of the population [18].

The aim of this study was to determine whether the daily functional needs and the quality of life of adult patients with a posterior reduced mandibular dental arch would be satisfied without having all their missing teeth replaced with a mandibular removable partial denture prosthesis (RPDP), as compared to having a prosthesis. The null hypothesis was that, in adult patients with a posterior reduced mandibular arch, there would be no difference in oral functional satisfaction and quality of life with or without the presence of a prosthesis to replace all missing teeth.

6.2. Methods

Ethical clearance was obtained from the Research and Ethics Committees of Stellenbosch University (Registration No: S13/04/066) and University of the Western Cape (UWC) (Registration No: 12/5/14), SA. This single-centre double-blinded RCT was designed according to the guidelines of the International Organization for Standardisation (ISO/EN540) and the Guidelines for Good Clinical Practice (GCP) in SA [19-20]. Informed consent was obtained from all patients prior to commencement according to the Declaration of Helsinki [21]. The results of this study are reported according to the Consolidated Standards of Reporting Trials (CONSORT) statement [19, 22]. The design aspects, study outcomes, data collection, follow-up details can be viewed in a detailed protocol and can be accessed at: clinicaltrials.gov; Identifier: NCT01597206.

6.2.1. Sampling for the study

Initially, the RCT sample recruited at the UWC dental hospital included patients with a classic SDA scheme for the mandible only, and requesting a RPDP. They were randomly allocated into one of two treatment approaches: Group A, with a cobalt-chrome RPDP as intervention; and Group B, with no RPDP (viz. a classic SDA), as control [19]. In both groups, reduced and interrupted dentitions would first have been restored to the classic SDA scheme using fixed partial denture prostheses (FPDPs) [23].

The standard hypothesis testing method to estimate sample size, using the primary outcome of patient satisfaction, indicated that 420 patients (210 per study group) needed to be recruited. But after conducting a pilot study (N=6), patients with these specific clinical criteria were not easily obtainable. Thus, alternative recruitment criteria were set: traditional sampling changed to sequential sampling; sourcing of patients was extended to include public health clinics; eligible mandibular arch types were modified from only classic SDAs to patients with 3, and not more than 6, posterior occluding pairs (POPs) of teeth, and a complete natural maxillary arch or one rendered as complete by provision of either a complete or partial denture [2]. For this double-blinded RCT, healthy young adult patients (21-55 years) having a mandibular PRDA with 3 and not more than 6 POPs formed the final sample (Table 1).

Sampling was thus by necessity sequential and the data were similarly analysed sequentially. Because VAS questions 4 and 5 were related to the intervention (i.e. 'the impact of the intervention on the patients' oral health' and 'quality of life', respectively), they were used as the primary variables upon which the conclusion to stop sampling was based (Table 2) [26-27]. Patients were included as they presented for treatment and the allocation of mandibular intervention was made pairwise into the two study groups A and B. Sample size was not fixed in advance but finalized as data was obtained. For this purpose, a pre-defined stopping rule had to be set:

- a) If the estimated power was greater than 80%, accept either the null or alternative hypothesis and stop sampling, or
- b) Continue sampling and increase the sample size incrementally by 10 patients [26-27].

Assessment of data collected was performed sequentially on sets of N=10 patients, using a two-sample *t*-Test to determine the power of the study which was set at 80% and above. The first set of N=10 patients was thus Stage 1 of the sequential process, and N=20 was Stage 2, and so on. For this assessment, a mean difference of 20 (which was a figure considered by the researchers to indicate the smallest difference that may be considered clinically important) between the 2 groups for variables VAS4 and VAS5 and a statistical significance of 0.05 was set ([5]. The decision to continue sampling was based on the power determined at each N=10 increment; further sampling and analysis, which would similarly be completed sequentially, stopped as significant results were obtained [26-27].

All basic restorative and preventive procedures were completed by the UWC service-rendering department and the maxillary RPDP or complete denture and mandibular FPDPs were constructed by a clinical assistant according to standard clinical protocols [23]. Patients were enrolled sequentially and randomized into the study; interventions were allocated by a research assistant using sealed opaque envelopes into: Group A to replace all missing mandibular posterior teeth with a cobalt-chrome clasp-retained RPDP following standard prosthodontic design principles and constructed by the clinical assistant; or Group B with a mandibular PRDA (Figure 1) [17, 23]. The principle researcher and statistician were blinded to the treatment allocation and clinical treatment procedures and data identified by numbers were thus submitted anonymously.

6.2.2. Outcomes

The following subjective and objective outcomes with the mandibular intervention were determined:

- (i) Primary outcomes: patient satisfaction, oral function and OHRQoL; and
- (ii) Secondary outcomes: clinical performance, survival of remaining teeth and mandibular RPDP (caries, periodontal problems, loss of teeth, or inability to wear the RPDP), or a change in treatment allocated.

Evaluation of the outcomes was performed by the principal researcher 3 and 12 months after receiving the intervention, as applicable, using the global VAS and OIDP [13, 17, 24]. The global VAS is a 100 mm scale comprising 5 questions which focused on patient

satisfaction, need for treatment and quality of life regarding the current state of their teeth and the intervention provided. Questions 1-3 were completed at baseline and prior to provision of the intervention, and questions 4-5 were completed 3 months after receiving the intervention [17]. The specific oral impacts questions in the OIDP relating to OHRQoL measures include oral function, oro-facial appearance and psychological impact [13]. The OIDP gave an overall rating of patients' satisfaction as well as oral health, QoL and OHRQoL.

Statistical analysis of data was completed by the 'intention-to-treat' principle and patients' personal details were omitted for this phase [25]. Analysis included finalizing the sample size, frequency calculations of demographic data, oral impacts and VAS scores, calculation of correlation coefficient and comparisons using the two sample *t*-test [25].

6.3. Results

At Stage 1 (N=10) and Stage 2 (N=20), the power determined was below 80% and thus unacceptable; recruitment of further sets of patients thus continued (Table 2). At Stage 3, the sample size was acceptable (N=30) on the basis that the power of the study was calculated as 80% and above (Table 2) [26-27]. At this stage, further recruitment of patients could have been stopped, but we wanted to see the effects on outcomes with additional groups of ten participants (N=40 and N=50) (Table 2).

6.3.1. Demographic data obtained at baseline

Fifty patients were included in the RCT, with ages ranging from 23-55 years (mean= 42.3; SD=9.2), and with a bias towards the female gender at 39 (78%) (Table 3). Education level of patients indicated that 41 (82%) had been to school. Many worked in the public sector, 19 (38%) in all, or were unemployed, 26 (52%). Seventy percent were in the 'low' or 'no income' category. The periodontal status of the group at baseline was acceptable (a requirement to be enrolled into the study) with acceptable oral hygiene practices, with 38 (76%) brushing teeth twice a day).

6.3.2. Patient satisfaction, QoL and OHRQoL

At baseline, using the global VAS (0-100 mm scale): 41 (82%) had a score of below 50 mm and rated the state of their mouth or teeth poorly, while 42 (84%), with a score of 50 mm or

less, were not satisfied with their current oral status. Forty nine (98%) of included patients, with scores ranging from 50-100 mm, felt that they were in need of treatment (Table 3). Three months after receiving the intervention (mandibular denture or no denture), with reference to the OIDP questions 8-10: 40 (80%) of all patients indicated an acceptable dental health, and 36 (72%) an acceptable patient satisfaction rating (Table 3). The OIDP questions were completed after all basic restorative or preventive procedures were completed. Three months after receiving the mandibular intervention, only participants in the 'denture group' rated the effect of the RPDP on their oral health and quality of life negatively, relating to questions 4 and 5 on the global VAS (Table 3).

6.3.3. Correlation between VAS and OIDP results

For satisfaction, the VAS1 question (84% not satisfied with their oral state) was completed prior to treatment, while the related OIDP question (76% satisfied and very satisfied with their oral state) was completed 3 months post mandibular intervention (Figure 2, Table 4). As the VAS4 score (50 mm and above) for 'rating the effect of the intervention on oral health' increased, patient satisfaction also increased ($p=0.05$). Similarly, 'rating the effect of the intervention on quality of life' increased (as reflected in VAS5 scores of 50 mm or more), thus increasing patient satisfaction ($p=0.05$). Both VAS4 and VAS5 scores (i.e. 'the impact of the intervention on the patients' oral health' and 'quality of life', respectively) indicated a negative correlation (viz. a decrease) with the need for treatment (Table 4).

6.3.4. Oral Impacts

Oral impacts for measures relating to oral function, oro-facial appearance and psychological impact, and an overall health rating were fully explored to the extent that OIDP permitted, but only significant results are reported. Total OIDP score measures prevalence (proportion of subjects reporting one or more oral impact), extent (number of daily performances impacted), and severity (more severe effect in one performance) of oral impacts on daily life using a 5-point Likert scale [13].

Total OIDP score (2.98%) recorded after receiving the mandibular intervention was very low, signifying a good self-rated health status. Only 1 patient reported all oral impacts as negative, with 6 patients having problems with the oral impacts of eating, and 3 having

negative feelings of being emotional. These were experienced daily for the one patient, and once a month for the others with similar effects on their daily life.

6.3.5. Outcomes reporting

From a sample of 50, nine patients left the study: 4 from the 'no denture' and 5 from the 'denture' group (Figure 2). Reasons for leaving included: unhappy with being allocated to the 'no denture' group, losing teeth, moving cities, and work commitments. Only two of these patients continued with a change in treatment (Figure 1).

Data related to the primary outcomes obtained 3 months after receiving the mandibular intervention indicated that, for the 'denture group', 4% were not satisfied, 12% were unhappy with their function, each of which negatively affected the success with the allocated intervention (Figure 2). In comparison, for the 'no denture group', all of those who remained in the study were satisfied with their non-denture status and content with their function.

Regarding clinical performance, 2 patients complained about adapting to the mandibular RPDP and another mentioned the instability of the lower free-end saddle. No other negative secondary outcomes were reported by either group at this stage (Figure 2).

One year after treatment, no negative reports were received regarding patients' PRDA status or any other secondary outcomes. However, reports of adaptation to RPDPs (both upper and lower), the need for a restoration in the maxillary arch and the usual check-ups were recorded.

6.4. Discussion

The main finding in this RCT was that patients with a PRDA on the mandible reported greater satisfaction, and perceived success of treatment relating to function and OHRQoL without a RPDP compared to those who had had their missing teeth replaced with a cobalt-chrome clasp-retained mandibular RPDP. This was encouraging given the known constraints on access to conventional prosthodontic treatment for a large proportion of partially dentate patients, especially in developing countries. A functional approach to treatment planning that the present findings would appear to support also addresses the differences that are known to exist between normatively-defined clinical practices and patients' evaluations of their oral functional needs [1, 2-6]. Furthermore, none of the present PRDA

patients not provided with a RPDP expressed the need to have their missing mandibular teeth replaced 12 months post treatment. Clinically, the significance of these results cannot be overstated especially coming from a resource-constrained setting such as SA.

A not infrequent concern of patients allocated to the 'denture group' was regarding the use of distal extension mandibular dentures, which has also been reported in the literature [1-4, 14, 28-29]. These concerns typically relate to 'adapting to dentures' and the 'high expectations' patients have with RPDPs [3, 10, 23, 28-29]. Equally, the positive responses from the 'no denture group' that imply acceptable function, satisfaction and OHRQoL with a PRDA concur with extensive literature elsewhere, albeit whose context was not identical with the present study [1-10, 15-16, 18, 29-30].

The sequential sampling used in the present study made it possible to purposefully limit the sample size. Thus, patients' responses were statistically validated when the analysis indicated no difference in their responses, from one staged point to the next, when comparing denture wearing to non-denture wearing patients as regards function, comfort, aesthetics, patient satisfaction and OHRQoL. Moreover, several primary and secondary research studies have concluded that the SDA treatment option is justified on the basis of reduced costs, patient satisfaction and temporomandibular concerns [1-10, 15-16, 18, 29-30]. Lastly, problems experienced by patients with mandibular RPDP usage were comparable with those previously reported as it relates to function, comfort, aesthetics, limitations of denture-wearing, increase in root caries formation and costs of RPDPs [1-12, 14-16, 18, 28-30].

The clinical implications of these results emphasize the need for evidence-based practices. Patients are receptive to such alternative treatments, especially when the clinician has adequately educated and guided them to practices that would be beneficial to them. Approaches such as the SDA or PRDA may be considered primary healthcare measures and may address the widespread socio-economic constraints.

A RCT study design is by its very nature challenging. Making changes to what is already a complicated design may present with even more difficulties. The sampling method adopted in this RCT is fairly novel and has rarely been used in clinical dental research, so that its implementation may be regarded as a limitation. While a small sample size may be

construed as a limitation, an explanation following statistical validation has been provided with the power calculated to be above 80% (and minimizing sampling error). Nevertheless, some researchers may disagree about the generalizability of the results to the population at large given the small sample size. Gender bias may also be considered a limitation, but the random inclusion of patients was from the general population who were in need of denture treatment and who visited the University and general public hospitals. No stratification for age or medical conditions was conducted and this may also be regarded as a limitation. Moreover, the exclusion of patients treated with FPDPs or implant-retained prostheses, and the use of one examiner for recalls may also be considered as limitations.

6.5. Conclusion

Patients with a mandibular PRDA reported greater satisfaction, perceived success of treatment relating to function and OHRQoL without a RPDP compared to those with a complete dental arch that was extended with a cobalt-chrome clasp-retained RPDP.

References

1. Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 1989 9(6):426-49.
2. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin. Oral Impl. Res* 2007 18 (Supp 3):34-45. DOI:10.1111/j.1600-0501.2007.01436.x.
3. Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all—and for life? The oral healthcare system needs revision. *J Oral Rehabil* 2013 40:707-22. DOI:10.1111/joor.12082.
4. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003 16(4):409-14.
5. Wolfart S, Muller F, Gerß J, Heydecke G, Marre B, Böning K, et al. The randomized shortened dental arch study: oral-health-related quality of life. *Clin Oral Invest* 2014 18(2):525-33. DOI: 10.1007/s00784-013-0991-6.
6. Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health Quality Life Outcomes* 2010 8: 126-39.

7. Walter MH, Hannak W, Kern M, Mundt T, Gernet W, Weber A, et al. The randomized shortened dental arch study: tooth loss over five years. *Clin Oral Invest* 2010 17(3):877-86. DOI: 10.1007/s00784-012-0761-x.
8. McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, Cronin M et al.. Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodont* 2012 29(2): e883–e890. DOI:10.1111/j.1741-2358.2011.00579.x.
9. McKenna G, Allen PF, Woods N, O'Mahony D, DaMata C, Cronin M et al. A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodont* 2012 30(3):207-13. DOI: 10.1111/j.1741-2358.2012.00665.x.
10. Budtz-Jørgensen E, Isidor, F. 5-year longitudinal study of cantilever fixed partial dentures compared with a removable partial denture in a geriatric population. *J Prosthet Dent* 1990 64(1):42-7.
11. Isidor F, Budtz-Jørgensen E. Periodontal conditions following treatment with a distally extending cantilever bridge with removable partial dentures in elderly patients: A 5-year study. *J Periodontol* 1990 61(1):21-6.
12. Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated Shortened Dental Arches: A Systematic Review. *PLOS 1* 2014 9(7):e101143. DOI:10.1371/journal.pone.0101143.
13. Hobdell M, Tsakos G, Ladrillo TE, Ross MW, Myburgh N, Gordon N, et al. Using an oral health-related quality of life measure in three cultural settings. *Int Dent J* 2009 59(6):381-88.
14. Cruegers NHJ, Witter DJ, Van't Spijker A, Gerritsen AE, Kreulen CM. Occlusion and Temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 2010 1-7. DOI:10.1155/2010/807850.
15. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1989 25:649-61.
16. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008 21(1):72-74.
17. Lamb DJ, Ellis B. Comparison of patient self-assessment of complete mandibular denture security. *Int J Prosthodont* 1996 9(4):309-14.
18. Owen CP. Appropriatech: Prosthodontics for the Many, Not Just for the Few. *Int J*

- Prosthodont 2004 17(2):261-2.
19. Webb P, Bain C, Pirozzo S. Essential epidemiology: An introduction for students and health professionals. 2005 Cambridge, UK; New York: Cambridge University Press.
 20. International Organization for Standardization/ European Standard (ISO/EN 540), Clinical Investigation of Medical Devices for Human Subjects, Berlin Germany.
 21. World Medical Organization. Declaration of Helsinki. Br Med J 1996 313(7070):1448-9.
 22. Moher D, Schulz KF, Altman DG. CONSORT Group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. The Lancet 2001 357(9263):1191-4.
 23. Zarb GA, Bolender CL, Carlsson GE, Boucher CO. Boucher's prosthodontic treatment for edentulous patient. 2004 London: McGraw-Hill.
 24. Sutton AF, Worthington HV, Mc Cord JF. RCT comparing posterior occlusal forms for complete dentures. J Dent Res 2007 86(7):651-5.
 25. Dawson B, Trapp RG. Basic and Clinical Biostatistics. 2004 4th Ed, Lange Medical Books/McGraw-Hill Publishing Division, New York, USA.
 26. Armitage P. Sequential Methods in Clinical Trials. Am J Public Health 1958 48(10):1995-2002.
 27. Donaldson AN, Whitehead J, Stephens R, Machin D. A simulated sequential analysis based on data from two MRC trials. Br J Cancer 1993 68(6):1171-78.
 28. Frank RP, Brudvik JS, Le Roux B, Milgrom P, Hawkins N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. J Prosthet Dent 2008 83(5):521-7.
 29. Witter DJ, van Elteren P, Kayser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. J Oral Rehabil 1989 16(1):27-33.
 30. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. Community Dent Oral Epidemiol 2003 31(5):328-34.

Figure 1

Prisma Flow Diagram

Figure 1

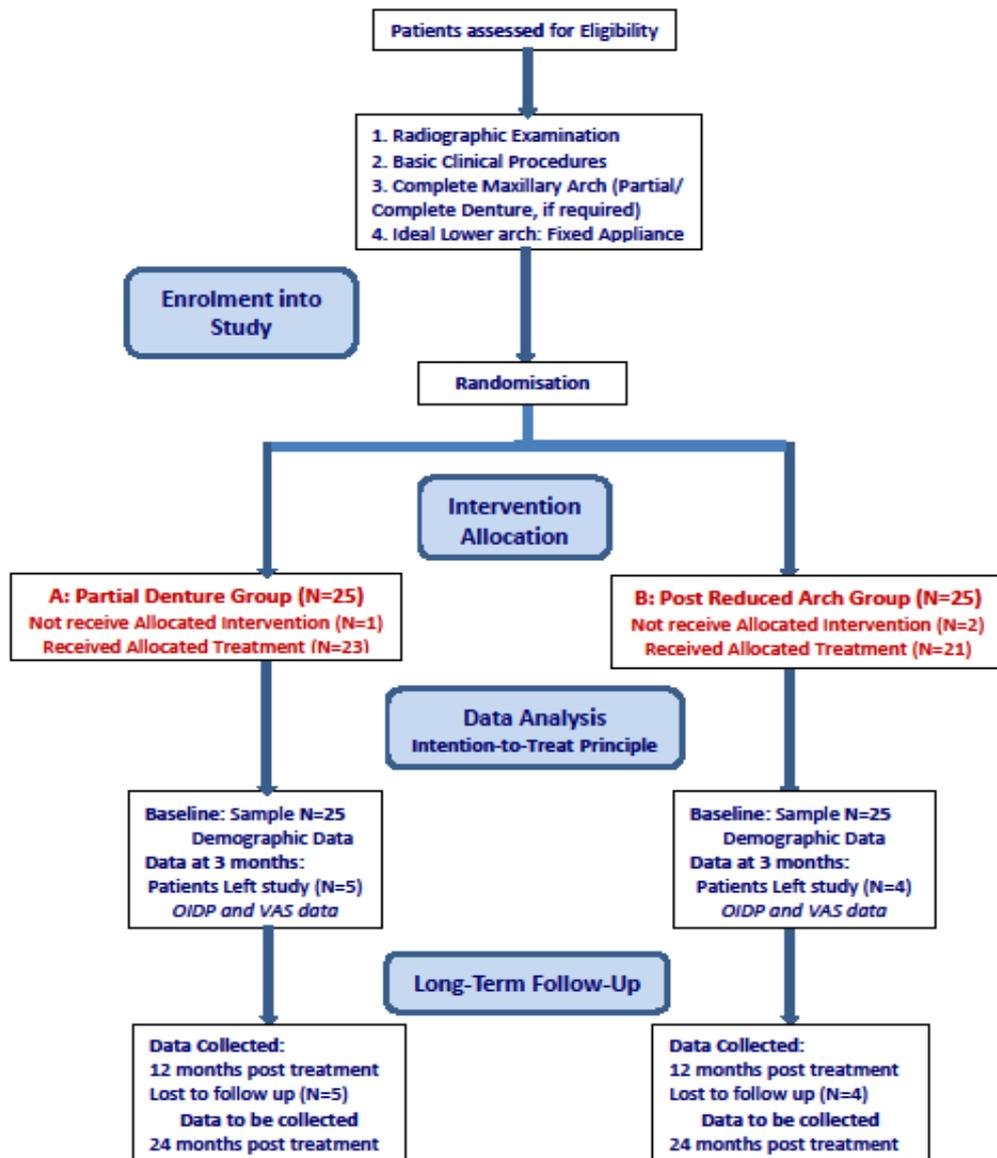
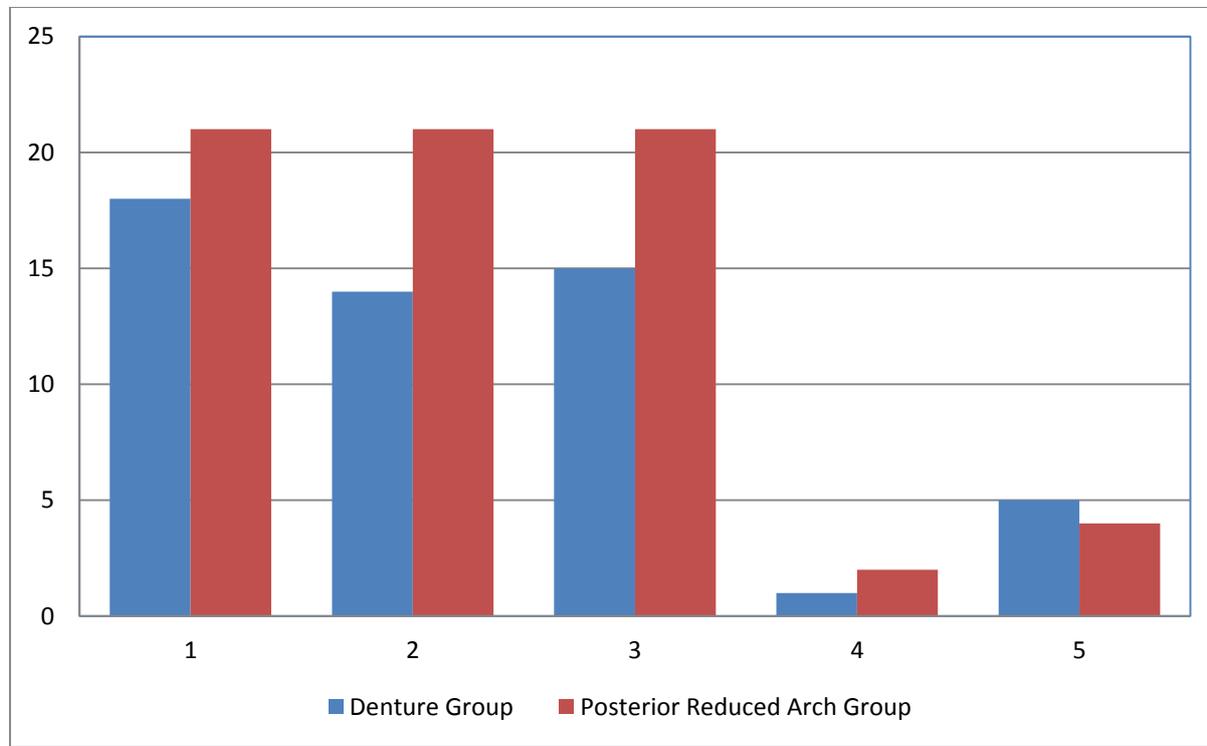


Figure 2

Primary and Secondary Outcomes reported with the interventions in the Mandibular Arch:
 'Denture' or 'Posterior Reduced Dental Arch' (viz. 'No Denture')



KEY of Important Study Outcomes:

Primary Outcomes

1. Patient Satisfaction with Intervention
2. Function with Intervention

Secondary Outcomes

3. Intervention is a Success
4. Treatment Changed
5. Number of Patients Left Study

Table 1

Comparison of Randomized Controlled Trials related to the Shortened Dental Arch

	BRITISH Jepson et al 2003	GERMAN Wolfart et al 2014	IRISH Mc Kenna et al 2012	SOUTH AFRICAN Khan et al
Sequence Generation	Computer Generated Numbers	Randomly Permuted Blocks	Computer Generated Schedule	Randomly Allocated Pairwise
Allocation Concealment	Clinician not involved in process No indication how it was done Patients stratified for Age/ Sex	Warranted; Randomization occurred centrally Patients stratified for Treatment Centre/ Age	Allocation concealed and Randomization (Assistant) Patients stratified for Age/ Gender	Opaque Sealed Envelopes (Assistant)
Blinding	Double Blinded: 1. Clinician to Allocation process 2. Statistician	No Blinding: Not possible to blind clinician as treatments differed	Single Blinded: Clinician to Allocation	Double Blinded: 1. Researcher to Allocation 2. Statistician
Sample Size (N)	N=60 Bridge Group = 30 RPDP Group = 30 Sample size: Hypothesis Testing using Power calculations set at 80% on Survival data/	N=215 RPDP Group = 109 SDA Group = 106 Sample size: Hypothesis Testing using Power calculations (75%) on tooth loss. Multi-Centre Analysis Method of O'Brien/ Fleming;	N=44 RPDP Group = 21 SDA Group = 23 Sample size: Hypothesis Testing using Power calculations (80%) on SDA patients not worst off than RPDP group	N= 50 RPDP Group = 25 PRDA Group = 25 <i>Sequential Sampling & Analysis</i> (Power at 80%; Min. Mean difference=20) on the effect of RPDP/ PRDA on Quality of Life Predetermined Stopping Rule
Clinical Set Up	A Dental Hospital Requests for RPDP Max 8 lower teeth Ant teeth replaced: FPDP/ RPDP; No Maxillary molars	14 Dental Hospital Centres Anterior teeth replaced: FPDP Classic SDA	Patients recruited from 2 Hospital Settings; Min of 6 teeth SDA restored with RBB (10 contacts)	University Dental Hospital Requests for RPDP Anterior teeth Man POPs: 3-5 Maxilla: Complete/ RPDP
Gender	M = 25 F = 35	M = 68 F = 82	M = 16 F = 28	M = 11 F = 39
Age Category	39-81 years Median Age: 67	35 years and over Median Age: 59.6	65 years and over Median Age: 68.2	23-55 years only Median Age: 42.3 (SD=9.2)
Intervention	Group 1: Cantilever RBB Group 2: Cobalt-Chrome RPDP	Group 1: RPDP molars (precision-attachments) Group 2: Classic SDA	Group 1: RPDP Group 2: RBB/ FPDP	Group 1: RPDP (Cobalt-Chrome) Group 2: No RPDP/ PRDA

Table 1

Comparison of Randomized Controlled Trials related to the Shortened Dental Arch
(Continued)

	BRITISH Jepson et al 2003	GERMAN Wolfart et al 2014	IRISH Mc Kenna et al 2012	SOUTH AFRICAN Khan et al
Outcomes:				
Primary	1. Survival of RPDP/FPDP; Dietary Nutrient Intake	1. First Tooth Loss	1. OHRQoL; Mini-Nutrient Assessment;	1. Satisfaction; OHRQoL; Function
Secondary	2. Caries incidence; Satisfaction; periodontal status	2. OHRQoL; Second Tooth Loss; Caries; Periodontal lesions; TMJ; Dysfunction; RPDP problems	2. Survival; Nutritional status; Cost Effectiveness	2. Intervention Success; Caries; Periodontal status; Tooth loss; Change
Instruments/ Tools	Self-designed questionnaire 2-3/day Food Record	OHIP-49 (German version)	OHIP-14 Caries Assessment system;	OIDP Global Visual Analogue Scale

KEY:

SDA: Shortened Dental Arch

RCT: Randomized Controlled Trial

OHRQoL: Oral Health-related Quality of Life

RPDP: Removable partial denture prosthesis

FPDP: Fixed partial denture prosthesis

TMJ: Temporomandibular joint

RBB: Resin Bonded Bridge

OHIP: Oral Health Impact Profile

OIDP: Oral Impact on Daily Performance

Table 2

Sequential Sampling: Calculations using a Two-Sample t-Test

			Minimum Mean Difference	Standard Deviation (SD)	Statistical Significance	Power %
Sample Size (N) per stage	VAS Question	Sample Size for Analysis				
N=10	4	5	*20	20.28	0.05	27.9%
	5	5	20	22.86	0.05	23%
N=20	4	10	20	15.40	0.05	78.4%
	5	10	20	17.11	0.05	69.5%
N=30	4	13	20	13.92	0.05	93.9%
	5	13	20	16.43	0.05	84%
N=40	4	17	20	12.39	0.05	99.4%
	5	17	20	14.61	0.05	97.4%
N=50	4	20	20	18.36	0.05	# 91.9%
	5	20	20	19.15	0.05	# 90.2%

KEY:

VAS: Visual Analogue Scale (100mm ruler)

VAS Question 4: How would you rate the effect of the intervention on your mouth/ oral health? (Responses: Very Bad to Excellent)

VAS Question 5: How would you rate the effect of the intervention on your quality of life? (Responses: Very Bad to Excellent)

* Minimum Mean difference for VAS4 and VAS5 which are considered clinically important and are important in determining the Power of the T-tests

The power calculated decreased as the data included an unexpected extreme response (an OUTLIER).

Table 3

Detailed comparison between two intervention groups

		POSTERIOR REDUCED DENTAL ARCH GROUP	DENTURE GROUP
Pre-Intervention			
Baseline data:	Sample (N) recruited	25	25
	Gender (Females)	21	18
	Full Maxillary Denture	5	7
	VAS 1 (<50mm)	22	19
	VAS 2 (<50mm)	21	21
	VAS 3 (50-100mm)	25	24
Post- Intervention			
3 Months:	VAS 4 (65-100mm)	21 (p=0.05)	18
	VAS 5 (58-100mm)	21 (p=0.05)	18
	OIDP 8: Good	21	19
	OIDP 9: Satisfied	19 (p=0.05)	17
	OIDP 10: No Treatment	20 (p=0.05)	18
	OIDP: 13a (eating)	1	4
	13b (speaking)	0	2
	13i (emotional)	1	2
Primary Outcomes:	Patient Satisfaction	21 (p=0.05)	18
	Function	21 (p=0.05)	14 (p=0.05)
Secondary Outcomes:	Success of Treatment	21 (p=0.05)	15
	Treatment Change	2	2
	Patient Loss	4	5

KEY:

VAS: Visual Analogue Scale

OIDP: Oral Impact on Daily Performance

Table 4

Correlation coefficients for VAS questions versus OIDP questions rating oral health, patient satisfaction and need for dental treatment

VAS Questions	Oral Impacts on Daily Performance Questions		
	Dental Health	Patient Satisfaction	Need for Treatment
State of Mouth	-0.003	0.109	-0.261
Satisfaction	-0.018	0.014	-0.256
Need Treatment	-0.042	-0.130	0.225
Intervention on Mouth	0.566	§ 0.628 (p=0.05)	§ -0.536 (p=0.05)
Intervention on Quality of Life	0.465	§ 0.648 (p=0.05)	-0.452

KEY:**VAS:** Visual Analogue ScalePRE-INTERVENTION (Baseline):

Questions VAS1, VAS2 and VAS 3

OIDP: Oral Impacts on Daily PerformancePOST-INTERVENTION (3 months Post Intervention):

Questions VAS4, VAS5, OIDP8, OIDP9 and OIDP10

§: Indicate Significant Correlations

Chapter 7

Synthesis of SDA Research

An Overview of Systematic Reviews Related to aspects of the Shortened Dental Arch and its Variants in Adults

An Overview of Systematic Reviews Related to Aspects of the Shortened Dental Arch and its Variants in Adults

Chapter 7 reports on the sixth study, an overview of published systematic reviews related to the SDA concept that seeks to critically appraise their scientific merit. An overview forms part of the range of secondary types of research methodologies that are available.

SUMMARY

This overview was performed in order to provide a synthesis of SRs by assessing the rigour with which each of the earlier SRs were conducted across the world, the bias within each study, as well as its novelty. Undertaking secondary research using methodologies that have not previously been applied in relation to SDA research, adds a broader dimension to current knowledge, and makes this work even more unique. In addition, by critically evaluating secondary studies would add credibility, making the outcomes of completed research even more reliable. For the present overview, according to the AMSTAR evaluation 5 of the included studies were recorded as high quality studies and the remaining 4 were of medium quality. The reliability of results of these studies was confirmed. A limitation of the current study important to mention relates to the detailed comparison of the characteristics of included studies for this overview, though a brief analysis of some significant features have been made in Table 2. Disseminating the consolidated information gained makes acceptance by professionals and clinical implementation easier, so ensuring the translation of knowledge more readily. Aside from highlighting the validity and reliability of research related to the SDA, the overview also seeks corroboration of one of the underlying *human rights and academic* perspectives of this dissertation.

PUBLICATION

This paper has been published in the International Journal of Prosthodontics; Publication citation:

Khan, SB. Chikte, UME. Omar, R. (2017). An Overview of Systematic Reviews Related to Aspects of the Shortened Dental Arch and its Variants in Adults. Int J Prosthodont: 30(4):357-366. DOI:10.11607/ijp.5287.

The PhD candidate developed the protocol (with input from both supervisors), submitted the protocol for ethics approval, independently conducted the electronic searches, screened the searches, selected the studies for inclusion, and extracted the data and assessed the methodological quality of included studies using the AMSTAR tool. A research assistant independently assessed the findings, completed data extraction and the AMSTAR checklist for each included systematic review. The PhD candidate interpreted the final data and completed the manuscript, including all corrections from both supervisors and journal reviewers who provided guidance and critical comments. All authors approved the final manuscript.

The AMSTAR Checklist used for this study and Ethics Approval are included as Appendices 7.1 and 7.2.

ABSTRACT

Aim: To conduct an overview of systematic reviews (SRs) related to aspects of the shortened dental arch (SDA) and its variants, and critically appraise the methodological quality of the included SRs using the AMSTAR checklist.

Methods: A comprehensive computerized search and hand-searching of reference lists were conducted for SRs related SDAs to identify publications from 2000-2016. All authors and a research assistant independently screened the results of the electronic searches using an *eligibility form* and extracted information using a specially designed pre-piloted *data extraction form*. An *11-question AMSTAR checklist* was completed for each included SR. Disputes were resolved by discussion between all researchers and results collated and interpreted.

Results: For the period 2007-2016, the search yielded 9 SRs incorporating 228 related articles. The research questions for each SR differed but were related to SDAs, thus the included articles were similar across SRs. Characteristics such as aims/objectives, study outcomes and conclusions of the 9 included SRs were compared. The AMSTAR evaluation indicated that 5 out of 9 studies were of a high quality (used a rigorous methodology) and the remaining 4 were of medium quality. All 9 SRs provided designs and characteristics of included studies. None of the SRs assessed publication bias.

Conclusion: Seven out of the nine SRs drew positive conclusions regarding the SDA concept, finding it functionally sound although some suggested that more high quality primary studies are still needed. The AMSTAR calculation indicated that most included SRs had an acceptable methodological quality, emphasizing the reliability of their results.

Keywords

Shortened dental arches; Systematic reviews; Oral Function; Quality of evidence; AMSTAR checklist

7.1. Introduction

It is well known that translation and clinical implementation of even the most compelling research evidence takes a long time. One example of this presented in the literature is that it took more than 20 years before the documented evidence for using intravenous streptokinase for the management of acute myocardial infection became the norm [1]. Similarly, although ample evidence for the benefits of the shortened dental arch (SDA) approach as a viable treatment option for a number of population groups is available, there has been a noticeable lack of translation into clinical practice in these settings [2-3]. The reasons for this are not fully understood, although undergraduate curricula and syllabi, clinical teachers' educational backgrounds and beliefs, and societal factors play a role [3]. The implementation of the SDA concept may be further compromised as it can be a financial disincentive [2-3]. What cannot be contested regarding the SDA is that much of the primary research has documented its favorable functional efficacy and patient satisfaction.

At about the same time as Käyser's (1981) formulation of the SDA concept, a strategy of 'the retention of 20 functional natural teeth throughout life without resorting to the use of a prosthesis' was adopted by the World Health Organization (WHO) as part of its oral health goals for developing countries [4-6]. Subsequently, this concept has been included in the National Oral Health Policy of South Africa (SA) to ensure optimal oral health for all, however its inclusion and implementation at a practice level has been absent [2-3, 7].

Classically, patients having ten pairs of occluding anterior and premolar teeth are considered as having SDAs [4-5]. The clinical description of the SDA denotes the occluding posterior teeth as occluding units (OU) with one OU equalling two opposing premolars in occlusion and two OU equalling two opposing molars in occlusion [5]. Thus the classic SDA comprises an intact anterior dentition and 4 symmetrically-distributed posterior OUs [4-5]. Other descriptions mentioned in the literature include posterior occluding pairs (POPs) of teeth, with 3-4 POPs symmetrically- and 5-6 POPs asymmetrically-arranged, or a posteriorly reduced dentition [4-5, 8-20]. These occlusal arrangements have been shown to be useful and have been accepted in some of the communities in terms of patients' ability to function, their subjective satisfaction and oral comfort experienced by them with a positive impact on their oral health-related quality of life (OHRQoL) [4-5, 8-20].

Both primary and secondary studies have indicated that the SDA as an alternative treatment approach is scientifically valid and has no harmful effects on the remaining dentition when prescribed appropriately [4-5, 8-10, 12-15, 17, 21-32]. The broad findings of these studies state that:

- a) twenty anterior and posterior occluding teeth (the classic SDA) are adequate for oral function, emphasizing the value of a *functional dentition*,
- b) patient satisfaction increases with a premolar occlusion and adding occluding molars does not improve it any further,
- c) occlusal stability and support is satisfactory with 3-4 POPs of teeth symmetrically- and 5-6 POPs asymmetrically-arranged, and
- d) OHRQoL is directly proportional to 9 or more pairs of anterior and posterior occluding teeth.

Advantages of preserving a functional dentition with 20 teeth, or 4 well-distributed OUs have been reported in the literature [4-5, 16-18]. Such an alternative strategy to the normal 28-teeth when limitations such as cost, patient compliance and/or handicap are a concern produces adequate function. The prosthodontic interventions normally used to have molars replaced include removable or fixed partial denture prostheses (RPDPs or FPDPs) or implant-supported prostheses [19-20]. No difference, however, regarding temporomandibular problems, and no clinically significant differences in OHRQoL of patients who do not have molar teeth are reported [4-5, 16-17]. Indeed, the SDA is regarded as a rehabilitative or reconstructive alternative treatment option, whenever its prescription is possible [19-20]. More specifically, it can be considered as an appropriate and relevant treatment strategy for developing countries, especially in a resource-constrained environment such as SA, for more effective management of the needs of the population [2-3].

Correspondingly, problems related to the use of RPDPs that may mitigate against the extension of shortened arches to 28-teeth include the large number of those who find RPDPs unacceptable and choose not to wear them due to the limitations of retention, support, chewing incapacity and unacceptable aesthetics [4-5, 8, 10, 18, 21-22, 33-34]. Moreover, circumstances where patients would be advised against extension of a shortened arch include: an increase in caries (especially root caries) and periodontal disease of remaining teeth, inconsistent reports of improvement in oral function when using distal-

extension RPDPs, and the improvement in OHRQoL with RPDPs only when aesthetics is a concern but to a lesser extent when chewing ability, speech and comfort are important [4-5, 8, 10, 18, 21-22, 33-34].

It is suggested that a rigorous overview related to the SDA will allow the results from multiple SRs, conducted in different parts of the world, with slightly different inclusion criteria and resulting in different sample sizes but where the findings overlapped, to be synthesized [35-36]. Moreover, this SDA overview would facilitate identification of high quality and reliable SRs on the topic, explore consistency of findings, create more evidence and consequently strengthen the SDA evidence already collected and collated [35-36]. Thus, adopting such a rigorous methodology has advantages in that it allows summarizing of evidence already collected on the SDA, making the process of translating this knowledge related to the SDA to clinical practice easier [35, 37]. This type of critical assessment of SRs related to the SDA concept has not been completed, thus it is a novel approach to doing secondary research [35, 37].

In addition each included SR will be critically appraised using the AMSTAR tool (which assesses the methodological quality of SRs) (Table 1) [37]. The AMSTAR checklist used for this study is an 11-question checklist with 4 responses (Yes/No/Cannot answer/Not applicable) and a score of 1 for each 'Yes' response (Table 1) [37]. The ratings are grouped according to the scores obtained into high (score of 8-11), medium (score of 4-7) and low (0-3 scores) with the responses following a rigorous explanation and interpretation of what constitutes a 'Yes' answer [37].

The aim of this study was to identify high quality SRs related to the SDA concept and its variants, and to explore consistency of findings across reviews with specific reference to function, OHRQoL and the various prosthodontic interventions that may be prescribed for the purpose of arch extension, when deemed appropriate.

7.2. Method

7.2.1. Protocol Development

A protocol (Registration No: 15/2/9) was developed (not published) to include all aspects of an overview of SR namely: selection criteria, search strategy, selection methods using

predetermined eligibility criteria, data collection, data extraction using a preformed data sheet, AMSTAR tool to evaluate the methodological quality of each included SR.

Ethical clearance for the primary studies that were included in each of the SRs used for this overview had to have been obtained from the respective institutions involved at that time. Written informed consent had also been obtained from the participants in the primary studies according to the Declaration of Helsinki [38].

7.2.2. Criteria for considering studies for this Overview

(i) Type of studies: All systematic reviews making reference to SDAs, including those describing different patterns of tooth arrangements and discussing interventions used for SDAs were included.

(ii) Types of participants: Adult male and females aged 18 years and older and having different SDAs and/or posterior reduced dental arches.

(iii) Types of outcome measures: Primary and secondary outcomes were pre-specified and include:

a) Primary outcomes

Subjective- or investigator- or patient-reported outcomes, including outcomes focussing on, for example, function, patient satisfaction and OHRQoL in patients with SDAs or any related tooth arrangements

b) Secondary outcomes

Survival of teeth in patients with SDAs, arrangement and location of teeth (patterns of tooth loss); survival of prosthodontic intervention (RPDPs, FPDPs and implant-retained prostheses) used to treat SDAs.

7.2.3. Inclusion Criteria

SRs conducted related to SDAs (including those describing the location of teeth for SDAs), and studies that discuss prosthodontic interventions used for SDA patients.

7.2.4. Exclusion Criteria

Primary and *secondary* research studies on animals that did not meet the inclusion criteria were excluded from this review.

7.2.5. Search Strategy

A computerized search was conducted for all SRs for the period January 2000 to August 2016 to identify literature related to the SDA, including studies using the SDA as a treatment strategy for partially dentate adult patients within the following databases: Medline, CINAHL, The Cochrane Central Register of Controlled Trials (CENTRAL) of the Cochrane Library, Science Direct, Science Journals, Scopus, Dentistry and Oral Science Source (DOSS), Springerlink and Wiley [35-36]. Further hand-searching was also conducted from reference lists of retrieved studies (PEARLing searches).

Key terms were combined using Boolean operators and search strategies for each database and these were developed using their specific functions. A broad search strategy was used and it focused on types of reviews related to patients with SDAs: (shortened dental arch OR shortened dental arches) AND (literature reviews OR reviews OR systematic review OR meta-analysis OR meta-analyses) AND (2000/01/01-2016/08/31).

Search Limits: Databases were initially searched for SRs published in English for the last 15 years from January 2000 to December 2015. Another search was conducted on August 2016.

The limits included human studies, adult patients and systematic reviews.

7.2.6. Selection Methods

An eligibility form compiled from the inclusion criteria was used by the review authors and a research assistant to independently screen and include potentially relevant studies [35]. Studies that did not meet inclusion criteria were excluded and reasons for inclusion were reported. Full text articles were retrieved and data extraction was completed by the principal researcher and a research assistant on study designs, methods, participants, interventions, outcomes, and conclusions from each SR using a specially-designed pre-piloted *data extraction form* [36]. Disagreements regarding data extraction were resolved by discussion with all reviewers.

Furthermore, the primary author and a research assistant independently completed the *AMSTAR checklist or measurement tool* that critically assesses the methodological quality of SRs (Table 1) [37].

7.2.7. Qualitative Analysis

A qualitative discussion related to the primary and secondary outcomes stipulated for this overview from the data extracted from each SR (Table 2). In addition, the AMSTAR checklist was completed to assess the quality of each included SR and the scores were calculated using the online system where a 'yes' answer equalled a score of 1 and a 0 for all other responses [3]. Results of the AMSTAR evaluation are summarised in the Tables 3 and 4. Observer agreement scores were calculated and disagreements were again resolved by discussion between the research assistant and review authors.

7.2.8. Data Synthesis and management

This process included analysing all Cochrane and non-Cochrane SRs, collating and reporting the results separately for the outcomes, namely, the effects of the SDA on patient satisfaction, function and OHRQoL and arrangement of teeth. In addition, characteristics of each included SR were collated and comparisons between SRs reported using tables and by discussion. The results also include a report on the methodological quality of each included SR according to the AMSTAR checklist and summarised in the Tables.

7.3. Results

A comprehensive search generated a combined total of 45 articles and reviews related to SDAs (Figure 1). Several duplicates (n=21) of SDA articles obtained from the different search engines were excluded, leaving only review articles. The review articles (n=24) included other types of non-systematic reviews and after exclusion, only 5 SRs were left. An additional 4 SRs were found through hand-searching, leaving a final sample size (n=9) of SR as stipulated in the Flow Chart (Figure 1). No SRs were found earlier than 2007, therefore the 9 SRs were for the period 2007-2016 comprising of a total of 228 articles (Table 2) [13, 23-31]. Data collected and the resultant findings of the SRs are described in two sections: *Characteristics of included SRs*, in which a comparison of each SR with respect to the others was carried out, highlighting similarities and differences; and a critical evaluation of the *quality of the evidence* provided by each individual SR according to the AMSTAR criteria [37].

7.3.1. Study Characteristics

The key features of the included SRs are summarized and reported in Table 2.

These are recorded by author, year and location where SR was conducted, aims and/or objectives, outcomes, conclusions and the findings related to the SDA (Table 2). It was interesting to note that while SRs related to SDAs was conducted in eight different countries, each research group tried to answer very different but related aspects of SDA research (Tables 2 and 3).

These characteristics are grouped and their differences further explained:

(i) Design

The 9 included SRs could be broadly grouped according to their included study designs into those where (a) only clinical trials were included and (b) those that included a range of designs.

For group (a) 2 of the SRs by Abt et al. (2012) and Khan et al. (2014) comprised only of RCTs and/or non-randomized controlled clinical trials in their analysis [29-30]. Both these SRs used the Cochrane format to conduct the SR and thus both completed quality assessments of the evidence for any risk of bias using the Cochrane Risk of Bias tool [29-30; 36]. SRs that include only clinical trials are considered to be of a high standard as the primary studies follow a rigorous methodology, and the SRs completed follow an equally strict methodology by including the assessment of the risk of bias of each included study [36].

For group (b) Six of the included SRs by Gerritsen et al. (2010), Faggion (2011), Fueki et al. (2011), Shahmiri and Atieh (2007), Liang et al. (2015) and Zhang et al. (2007) each comprised of a range of designs (cross-sectional, cohort and case reports) in their study and indicated that they did not exclude any studies based upon design [23-28; 31]. The one SR by Gotfredsen and Walls (2007), whilst including a mixed range of designs, nevertheless excluded other study types such as case reports, expert opinions, animal studies and technical descriptions [13].

Thus it can be said that the ideal SR which forms the apex of the pyramid of evidence for effectiveness comprising only of clinical trials as the included primary studies were not strictly followed by several of these SRs included for this Overview [13; 23-31].

(ii) Research Questions

Even though the research questions that the authors of the included SRs attempted to answer differed, they were all still related to the SDA. Importantly, the articles within the included SRs for this Overview were mostly the same. The research questions for the SRs related to interventions used oral function and impact on OHRQoL and location and tooth arrangements with one epidemiological study determining the state of teeth for a specific Chinese community [13, 23-31]. Not surprisingly, the more specific the research question, the fewer articles included in the analysis [23, 26-27, 31]; for example, the Gotfredsen and Walls SR had a broad research question, thus had more articles included for their study (Table 2) [13].

(iii) Outcomes of each SR

Study outcomes should be pre-specified as primary or secondary when conducting a SR. But for the included SRs, outcomes were specified as primary and/or secondary in only three out of the nine SRs [25; 29-30]. Aside from the epidemiological study, for the remaining 8 included SRs, the study outcomes focused mostly on function, aesthetics, patient satisfaction and QoL (Table 2).

When comparing the primary outcomes stipulated for the present Overview to those of the included SRs, the following was noted (Table 2): most of the included SRs (n=8) provided evidence for at least one primary outcome that was also stipulated for this Overview [13; 23, 25-31], with 7 SRs investigating two or more of the primary outcomes common with the present Overview [13; 23; 25; 28-31]. As regards the specific primary outcomes, 7 SRs assessed *oral function* [13; 23; 26-31], 5 SRs assessed *patient satisfaction* [13; 25; 28-30] and *OHRQoL* [13; 25; 28; 30-31].

Regarding secondary outcomes, 4 SRs looked at *tooth loss* [13; 24; 26; 30], and only 4 SRs investigated the outcome of *survival of intervention* [23; 28-30], and 2 SRs looked at *number, arrangement and location of teeth* [24-25].

(iv) Conclusions

The SR by Abt et al. stated that there was not enough evidence to make a definitive conclusion that one intervention is better than the other, thus the research question was

not answered (Table 2) [29]. The Khan et al. SR specified that the SDA as a treatment option was encouraging as regards function, patient satisfaction and cost, even though sufficient RCTs with acceptable rigor have not been conducted (Table 2) [30]. In addition to this, the SRs by Khan et al. and Fueki et al. concluded that the results from certain regions of the world may not be generalizable to the rest of the world due to cultural and/or socio-economic differences (Table 2) [28, 30]. It was also mentioned that primary studies with a rigorous study design were visibly absent and it was thus recommended that more RCTs following a strict protocol should be conducted (Table 2).

With specific reference to the SDA, 7 out of the 9 SRs supported and recommended that the SDA concept be included as a viable treatment option clinically, when appropriate (Table 2).

7.3.2. Quality of Evidence

Quality assessments of studies, be it primary or secondary research, adds reliability to the study and allows the merging of study outcomes, and is thus always recommended [35-37]. The SR conducted by Faggion (2011) also assessed the quality of evidence of the included primary studies using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach as did the Khan et al SR [26-27; 30]. In this way, these studies graded the evidence and strength of recommendations for clinical interventions of each included clinical trial in the respective SR [26-27]. The Khan et al. SR furthermore assessed the quality of the evidence using the risk of bias tool for all included clinical trials, as was mentioned previously [30].

The quality of the evidence for the present Overview of SRs was determined using an AMSTAR checklist by assessing the methodological rigor of each included study. It was interesting to note that the 9 SRs either had a high (n=5) [24-27; 29-30] or a medium (n=4) [13; 23; 28; 31] AMSTAR score (Tables 3 and 4).

Table 4 highlights the responses for each of the 11 AMSTAR questions indicating that all the SRs provided a design and some characteristics of the studies included [13; 23-31; 37]. None of the included SRs, however, assessed publication bias, which is normally indicated by funnel plots or statistical tests such as Egger regression tests; thus a score of zero for this question was recorded (Table 4) [13; 23-31; 36]. The AMSTAR evaluation showed that some of the included SR researchers had not had a quality assessment of the included primary

studies carried out, so drawing definitive conclusions was not possible [37]. As for the 'conflict of interest' statement, only 6 out of the 9 SRs reported this (Table 4), an item that has become mandatory when submitting articles to scientific journals [37].

Disagreements between researchers related to the AMSTAR assessment

The AMSTAR checklist is an 11-question tool and it was completed independently by the primary author and a research assistant (Table 1). On completion, disagreements between the principal author and research assistant were observed and the Pearson correlation coefficient at 0.494 indicated that it was not high and that the differences were not significant (P-value of 0.177). Discussions with regards to disagreements in AMSTAR scores then occurred between them and when consensus could not be reached, the other review authors were brought in to resolve the disagreement.

For the Abt et al and Liang SR, researchers were in total agreement in their AMSTAR scoring [29, 31, 35]. With questions 2, 8 and 9 on the AMSTAR tool (Table 1), differences in scoring were found more often and for two or more of the SRs [13, 24-25, 28, 30, 35]. These could easily be linked to the reporting of how the study was conducted. Other examples worth citing, was with AMSTAR questions 3 and 6 and authors reached a consensus that even if not all characteristics of a study (such as year, databases searched and participant demographics) were included (Table 1), the AMSTAR score the SR would still be recorded as 'Yes' [35].

7.4. Discussion

Although some variances were observed between the different SRs with respect to research questions, outcomes and conclusions, the evidence, once collated and summarized can be regarded as reliable. For overviews, however, results are hampered by the fact that review protocols and outcome measures of the component SRs cannot be assumed to have been consistently similar. For this reason it is recommended that the findings of the present Overview be reported in the form of a narrative [36].

This Overview covered a range of aspects of SDA research in the form of SRs [13, 23-31]. Amongst the studies, overlapping were found but aspects identified related to tooth

arrangements and their impact on QoL and OHRQoL, epidemiological studies determining the patterns of tooth loss amongst older communities, and including the different interventions used to extend SDAs [13, 23-31].

The results of the present Overview showed that a number of different interventions are variously employed for SDA patients ranging from RPDPs, FPDPs, resin-bonded bridges (RBBs), and implant-supported prostheses. It was also found that a SDA with 9-10 occluding units adequately satisfies the oral functional needs of many patients [13, 23-31]. Studies have also indicated the negative impact a RPDP (especially distal extension mandibular dentures) may have on patients [39-40]. The positive outcomes with implant-supported procedures which may be considered ideal, is hardly an option for those in an already resourced-constrained economy of developing countries and disadvantaged communities [23].

These conclusions support the oral functionality of the SDA concept and are in line with other primary and secondary research studies related to function, indicating that restoration of a shortened arch to completeness may, in certain clinical conditions, be considered as overtreatment [4-5, 8-15, 17-20, 22-34]. Additionally, it has been reported that QoL is not negatively impacted by an SDA management approach, although there may be such impacts with an extreme SDA [13, 17, 19-21, 25, 28, 30, 39-42]. The SDA approach further emphasizes how socio-economic constraints and issues of poor access for care experienced by patients can be addressed. Through the appraisal of the included SRs by means of a reliable tool, the evidence gathered indicates support for a more non-interventionist approach in certain cases of reduced posterior occlusions [4-5, 8-13, 15, 17-20, 22-31, 33, 35, 37, 39-42], benefitting underprivileged communities.

7.4.1. Quality of the Evidence

Even though the quality of the evidence, as assessed using the AMSTAR tool, was acceptable (SRs had a medium or high score), the quality of the component primary studies making up the various SRs had not been assessed for most of the clinical trials either by performing Cochrane's risk of bias or using the GRADE analysis [36, 43]. In addition, publication bias was not assessed for any of the included SRs either [36]. This, however, did not affect the quality

of the SRs given the generally high AMSTAR scores [36, 43]. It would be useful though to ensure that quality assessments be completed at primary and secondary research levels.

7.4.2. Implications for Practice

It is recommended that the continuing disjuncture between the evidence for the positive role of the SDA concept and dental clinical education, continuing education and clinical implementation be addressed. Including the SDA concept in undergraduate clinical education would be an important step in adjusting the longstanding clinical paradigm of tooth replacement to a complete 28-tooth arch. Very importantly, the benefit of the SDA approach in disadvantaged communities is highlighted. The next phase of achieving better translation of the SDA concept into clinical practice should be pursued. Barriers known to hinder this critical phase need to be highlighted, implying that the evidence gathered over the last 35 years is shared with decision-makers and clinical teachers by presenting the results to them.

7.4.3. Implications for Research

More importantly, the reasons for the absence of knowledge translation of concepts such as the SDA, which has been extensively researched and corroborated, need to be explored further [44]. Specifically, the acceptance of the SDA amongst communities who have been made aware of its benefits should be researched.

7.5. Conclusions

The research questions, types of studies and study outcomes of each included SR varied, which meant that the conclusions of each were somewhat different from the other. Nevertheless, most of the SRs (n=7) emphasized the importance and significance of the SDA concept as a functionally satisfactory approach to managing certain groups of partially dentate patients. According to the AMSTAR evaluation, the methodologies of the included SRs were of a high standard and most were of good quality, reliance on their results would be acceptable [37, 43].

References

1. White HD, Van de Werf FJJ. Thrombolysis for acute Myocardial Infarction. *Circulation* 1998; 97: 1632-46.
2. Khan S, Chikte UME, Omar R. Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa. *SADJ* 2012; 67(2):60-68
3. Khan S, Chikte UME, Omar R. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014; 78(6):906-913
4. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981; 8:457-62
5. Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Res Dent* 1989; 9(6):426-449.
6. World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Copenhagen: WHO Europe regional office, WHO Technical Report 1982; Series No. 826:16-17
7. Department of National Health and Population Development. National Policy for Oral Health in South Africa. National Policy for Oral Health 1990; Act 116.
8. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996; 23:481-85
9. Witter DJ, van Elteren P, Kayser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988; 15:413-20
10. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 1989; 16:27-33.
11. Carlsson GE. Some dogmas related to prosthodontics, temporomandibular disorders and occlusion. *Acta Odont Scand* 2010; 68:313-322
12. Creugers NHJ, Witter DJ, Van't Spijker A, Gerritsen AE, Kreulen CM. Occlusion and temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 2010; 1-7. [DOI: 10.115/2010/807850]
13. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin Oral Impl Res* 2007; 18(Suppl. 3):34-45
14. Zhang Q, Witter DJ, Bronkhorst EM, Creugers NHJ. Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Invest* 2012; 1-11.

15. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998; 25:649-661
16. Owen CP. *Appropriatech*: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont* 2004; 17(2):261-2
17. Wolfart S, Heydecke G, Luthardt RG, Marre B, Freesmeyer B, Stark H, et al. Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: results from the pilot-phase of a randomized multicentre trial. *J Oral Rehabil* 2005; 32:815-822
18. Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all—and for life? The oral healthcare system needs revision. *J Oral Rehabil* 2013; doi: 10.1111/joor.12082
19. De Sa e Frias V, Toothaker R, Wright RF. Shortened Dental Arch: A review of current treatment concepts. *J Prosthodont* 2004; 13(2):104-110
20. Armellini DB, Von Fraunhofer JA. The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004; 92(6):531-35
21. Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aus Dent J* 1987; 32(3):178-82.
22. Thomason JM, Moynihan PJ, Steen N, Jepson NJA. Time to Survival for the Restoration of the Shortened Lower Dental Arch. *J Dent Res* 2007; 86(7):646-650
23. Shahmiri RA, Atieh MA. Mandibular Kennedy Class I implant-tooth-borne removable partial denture: a Systematic Review. *J Oral Rehabil* 2007; 37:225-234.
24. Zhang Q, Kreulen CM, Witter DJ, Creugers NHJ. Oral Health Status and Prosthodontic Conditions of Chinese Adults: A Systematic Review. *Int J Prosthodont* 2007; 20:567–572.
25. Gerritsen AE, Finbarr Allen P, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *HQoL Outcomes* 2010; 8:126
26. Faggion CM. The shortened dental arch revisited: from evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 2011; 38:940-949
27. Faggion CM, Giannakopoulos NN, Listl S. How strong is the evidence for the need to restore posterior bounded edentulous spaces in adults? Grading the quality of evidence and strength of recommendations. *J Dent* 2011; 39:108-116
28. Fueki K, Yoshida E, Igarashi Y. A systematic review of prosthetic restoration in patients

- with shortened dental arches. *Jap Dent Sci Rev* 2011; 47:167-174
29. Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: partially absent dentition. *Cochrane Database SR* 2012; Issue (2) Art No: CD003814. DOI: 10.1002/14651858.CD003814.pub2
 30. Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated Shortened Dental Arches: A Systematic Review. *PLOS 1* 2014; 9(7): e101143. DOI: 10.1371/journal.pone.0101143
 31. Liang S, Zhang Q, Witter DJ, Wang Y, Creugers NHJ. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: A Systematic Review. *J Dent* 2015; 43:1185-94
 32. Zeng X, Sheiham A, Tsakos G. Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008; 35:37-44
 33. Jepson NJA, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. *Br Dent J* 2001; 191(3):140-144.
 34. Frank RP, Brudvik JS, Le Roux B, Milgrom P, Hawkins N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet D* 2000; 83:521-7.
 35. Cheung C, Weir M, Mayhew A, Kozloff N, Brown K, Grimshaw J. Overview of systematic reviews of the effectiveness of reminders in improving healthcare professional behaviour. *Syst Rev J* 2012; 1(36):1-8
 36. Higgins JPT, Green S. *Cochrane Handbook for systematic reviews of interventions*. 1st Edition. West Sussex, UK: Wiley-Blackwell 2009.
 37. Shea B, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess methodological quality of systematic reviews. *BMC Med Res Methods* 2007; 7:10; doi:10.1186/1471-2288-7-104
 38. World Medical Organization. Declaration of Helsinki. *Br Med J* 1996; 313:1448-49
 39. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003; 16(4):409-14.
 40. Tan H, Peres KG, Peres MA. Do people with shortened dental arches have worse oral health-related quality of life than those with more natural teeth? A population-based

- study. *Com Dent Oral Epi* 2014; 1-9. Doi: 10.1111/cdoe
41. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003; 16(4): 375-380.
 42. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NHJ. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Oral Sci* 2007; 115(4):265-74.
 43. Creugers NHJ, Kreulen CM. Systematic Review of 10 Years of Systematic Reviews in Prosthodontics. *Int J Prosthodont* 2003; 16(2): 123-127.
 44. Straus SE, Tetroe J, Graham I. Defining knowledge translation. *Can Med Ass J* 2009; 181(3-4): 165-168.

Table 1.

A measurement tool to Assess the Methodological quality of Systematic Reviews (AMSTAR)

AMSTAR: A measurement tool to assess the methodological quality of SR.**1. Was an 'a priori' design provided?**

The research question and inclusion criteria should be established before the conduct of the review.

- Yes
 No
 Can't answer
 Not applicable

Note: Need to refer to a protocol, ethics approval, or pre-determined/a priori published research objectives to score a "yes."

2. Was there duplicate study selection and data extraction?

There should be at least two independent data extractors and a consensus procedure for disagreements should be in place.

- Yes
 No
 Can't answer
 Not applicable

3. Was a comprehensive literature search performed?

At least two electronic sources should be searched. The report must include years and databases used (e.g., Central, EMBASE, and MEDLINE). Key words and/or MESH terms must be stated and where feasible the search strategy should be provided. All searches should be supplemented by consulting current contents, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.

- Yes
 No
 Can't answer
 Not applicable

4. Was the status of publication (i.e. grey literature) used as an inclusion criterion?

The authors should state that they searched for reports regardless of their publication type. The authors should state whether or not they excluded any reports (from the systematic review), based on their publication status, language etc.

- Yes
 No
 Can't answer
 Not applicable

5. Was a list of studies (included and excluded) provided?

A list of included and excluded studies should be provided.

- Yes
 No
 Can't answer
 Not applicable

6. Were the characteristics of the included studies provided?

In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions and outcomes. The ranges of characteristics in all the studies analyzed e.g., age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases should be reported.

- Yes
 No
 Can't answer
 Not applicable

7. Was the scientific quality of the included studies assessed and documented?

'A priori' methods of assessment should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.

- Yes
 No
 Can't answer
 Not applicable

8. Was the scientific quality of the included studies used appropriately in formulating conclusions?

The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review, and explicitly stated in formulating recommendations.

- Yes
 No
 Can't answer
 Not applicable

9. Were the methods used to combine the findings of studies appropriate?

For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (i.e., Chi-squared test for homogeneity, I^2). If heterogeneity exists a random effects model should be used and/or the clinical appropriateness of combining should be taken into consideration (i.e., is it sensible to combine?).

- Yes
 No
 Can't answer
 Not applicable

10. Was the likelihood of publication bias assessed?

An assessment of publication bias should include a combination of graphical aids (e.g., funnel plot, other available tests) and/or statistical tests (e.g., Egger regression test, Hedges-Olken).

- Yes
 No
 Can't answer
 Not applicable

11. Was the conflict of interest included?

Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.

- Yes
 No
 Can't answer
 Not applicable

Table 2.

Characteristics of included systematic reviews

AUTHOR/S	N	AIM and / OBJECTIVE/S	OUTCOMES	CONCLUSION/s	SDA
Abt, Carr, Worthington (2012) USA	21	Assess effects of different prostheses for a partially absent dentition	<i>Primary:</i> Long term success <i>Secondary:</i> Function; Morbidity; Patient Satisfaction (PS)	Insufficient evidence to say one intervention better than other. Not all outcomes were reported.	
Faggion (2011) GERMANY	9	1. Systematically assess outcomes from non-treatment and treatment approaches for SDA cases; 2. Assess effectiveness of restorative approaches for SDAs; 3. Assess quality of retrieved evidence (using GRADE)	<i>Qualitative:</i> Quality of Life (QoL); Function; Aesthetics <i>Quantitative:</i> Temporomandibular disorder Occlusal Problems; Tooth Loss (TL)	1. No difference between the 2 approaches. 2. Two studies showed treatment of SDAs with FPDPs greater benefit compared to RPDP.	Positive
Fueki, Yoshida, Igarashi (2011) JAPAN	21	To review literature for effect of prosthetic restorations on SDA patients 1.If RPDPs for distal extensions increases function/ PS/ OHRQoL versus FPDPs 2. Dis- and advantages treatment with RPDP over FPDP and/ SDA	<i>Outcomes:</i> Chewing; PS; QoL; Function; Periodontal problems; Survival of treatment	RCTS conducted in Europe not generalizable to Japan due to socio-economic and/ or Healthcare system differences.	Positive

Gerritsen et al (2010) NETHERLANDS	35	Analyse relationship between Number / Location of missing teeth & OHRQoL 1. Is TL associated with impaired OHRQoL 2. What is the role of location and distribution of Tooth location	<i>Primary:</i> TL associated with impairment of Oral health-related QoL (OHRQoL) <i>Secondary:</i> Location and Distribution of teeth affect OHRQoL	Strong evidence that TL is associated with impairment of OHRQoL and location of TL affects severity.	Positive
Gotfredsen, Walls (2007) DENMARK	83	Evaluate relationship between dentition and oral function	<i>Outcomes:</i> 1. Masticatory function; 2. Aesthetics; PS; 3. Occlusal Support/Stability; 4. Other Functions (tactile/ phonetics /taste)	Few studies with high level of evidence. Low Evidence: masticatory efficiency decrease with TL but 9-10 occluding units (OU) assures functioning/ stability. Dietary intake and OHRQoL unchanged with 9-10 OU.	Positive
Khan, Musekiwa, Chikte, Omar (2014) SOUTH AFRICA	21	1. Compare SDA versus CDA 2. Compare differences between interventions (FPDs/ RPDs) used to extend SDAs 3. Determine PS with these interventions 4. Determine functional outcomes with different interventions	<i>Primary:</i> Functional outcomes; Survival of Intervention <i>Secondary:</i> PS; negative effects	SDA as a treatment option is encouraging (function/ PS/ Costs). Not Sufficient RCTS; RCTS conducted in Europe not generalizable to South Africa due to cultural differences.	Positive
Shahmiri, Atieh (2007) NEW ZEALAND	9	To evaluate the use of implant-tooth-borne RPDs in prosthetic rehab of Kennedy Class I partially edentulous arches Evaluate existing evidence whether implant-supported RPDs provided better performance compared to other treatments	<i>Outcomes:</i> PS, masticatory efficiency, bone loss, prosthetic maintenance, Soft and hard tissue response	Improvement in function, aesthetics and stability has been demonstrated in all studies with minimal prosthetic care. But RCTs are needed to provide evidence that will validate use of these treatment modalities.	Positive

Liang, Zhang, Witter, Creugers (2015) NETHERLANDS	8	To synthesize available knowledge about effects of distal extension RPDPs on masticatory performance of subjects with moderate or extreme SDA	<i>Outcomes:</i> Comminuting ; Chewing; Mixing ability; Occlusal Force	1. Patients with Extreme SDA had 30-40% reduction in masticatory performance. 2. Distal Extension RPDP partially compensated for performance (50%). 3. More false teeth on RPDP resulted in better performance.	Positive towards SDA, not the Extreme SDA
Zhang, Witter Kreulen, Creugers (2007) CHINA	21	To assess oral health & prosthodontic conditions of Chinese adults over time 1. Review DMFT and number and location of teeth in adults 2. Consider need for prosthodontic appliances	<i>Outcomes:</i> Mean DMFT values; Components of DMFT, No of Teeth/ roots/ occluding teeth	Not sufficient information to answer objectives as outcomes was conflicting.	

KEY:

SDA: shortened dental arch

CDA: complete dental arch

RCT: randomized controlled trial

GRADE: Grading of Recommendations Assessment, Development and Evaluation system

QoL: Quality of life

OHRQoL: oral health-related quality of life

RPDP: removable partial denture prosthesis

FPDP: fixed partial dental prosthesis

DMFT: decayed, missing, filled tooth

Table 3.

AMSTAR Scores for included systematic reviews

AUTHOR	EAR	COUNTRY	AMSTAR TOTAL / 11	GRADE
ABT, CARR, WORTHINGTON	2012	USA	10	H
FAGGION	2011	GERMANY	8	H
FUEKI et al	2011	JAPAN	5	M
GERRITSEN et al	2010	NETHERLANDS	8	H
GOTFREDSSEN, WALLS	2007	DENMARK	6	M
KHAN, MUSEKIWA, CHIKTE, OMAR	2014	SOUTH AFRICA	9	H
SHAHMIRI, ATIEH	2007	NEW ZEALAND	8	H
LIANG et al	2015	NETHERLANDS	6	M
ZHANG et al	2007	CHINA	5	M

KEY for AMSTAR SCORES:

H: High Score: 8-11

M: Medium Score: 4-7

L: Low Score: 0-3

Table 4.
Responses of systematic reviews to the AMSTAR questions

		SYSTEMATIC REVIEW RESEARCHERS									
AMSTAR ITEM	No. of Reviews meeting criteria	<i>Abt et al.</i> 2012	<i>Faggion</i> 2011	<i>Fueki et al.</i> 2011	<i>Gerritsen et al.</i> 2010	<i>Godfredsen</i> Walls 2007	<i>Khan et al.</i> 2014	<i>Liang et al.</i> 2015	<i>Shahmiri, Atieh</i> 2007	<i>Zhang et al.</i> 2007	
1	Was an 'a priori' design provided?	9	Y	Y	Y	Y	Y	Y	Y	Y	
2	Was there duplicate study selection and data extraction?	7	Y	N	Y	Y	N	Y	Y	Y	
3	Was a comprehensive literature search performed?	8	Y	Y	Y	Y	Y	Y	Y	N	
4	Was the status of publication used as inclusion criteria?	6	Y	Y	N	Y	N	Y	N	Y	
5	Was a list of included and excluded studies provided?	8	Y	Y	N	Y	Y	Y	Y	Y	
6	Were the characteristics of included studies provided?	9	Y	Y	Y	Y	Y	Y	Y	Y	
7	Was scientific quality of included studies assessed and reported?	5	Y	Y	N	N	Y	Y	N	Y	
8	Was scientific quality of studies used appropriately in formulating conclusions?	5	Y	Y	N	N	Y	Y	N	Y	
9	Were the methods used to combine findings appropriate?	2	Y	N	N	Y	N	N	N	N	
10	Was the likelihood of publication bias assessed?	0	N	N	N	N	N	N	N	N	
11	Was the 'conflict of interest' included?	6	Y	Y	Y	Y	N	Y	Y	N	
AMSTAR SCORE		10	8	5	8	6	9	6	8	5	

KEY:

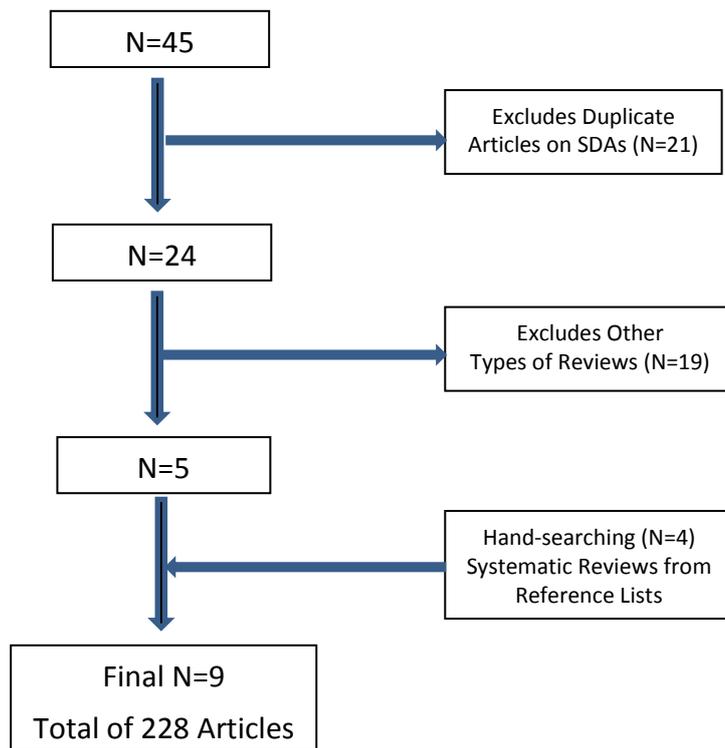
Y=Yes (Equals score of 1 out of 11)

N=No (Equals score of 0)

Legend

Flow Chart of Included Systematic Reviews (Electronic and PEARLing Searches)

Figure 1.



Chapter 8

Discussion and Conclusions

8.1. Summative Comment

It is fair to say that the SDA or PRDA concepts can be seen as ones that challenge existing prosthodontic management paradigms, and which is by-and-large still taught, whereby dental arches are normally rehabilitated to a complete dentition. This is not to suggest, be it in the global or the specific SA contexts, that the findings about the SDA and PRDA research should substitute the replacement of academic teaching with respect to complete dental arch rehabilitation. Equally, it is acknowledged that the SDA or PRDA approach cannot be clinically implemented in all instances. Rather, the findings from this dissertation supports the SDA and PRDA management approaches as alternative treatment options for particular clinical scenarios and especially in communities where they may be cost-effective to apply [1-6]. The SDA concept ('20-teeth for young adults') as a goal, is in line with the WHO and African Regional strategies, and was incorporated into the National Oral Health Strategy 2030 of South Africa (an amended version to the national oral health policy since 1994), albeit without any contextual evidence [7-8]. This research goes some way to providing contextual evidence for implementation of the SDA as a prosthodontic management option in the South African context.

A wide range of aspects relating to the SDA concept, spanning over 35 years, have attempted to show that the treatment approach may be considered as an acceptable evidence-based prosthodontic modality for partially dentate adult patients [9-49]. However, the context for this published research, as well as the quality of the evidence produced permitted extensive scrutiny of several studies, which in turn highlighted their limitations.

The research for this PhD sought to contextualize the existing body of SDA knowledge within a specific stratum of the SA population, including engaging professionals and patients presenting in a university hospital setting. The research was designed to broaden their understanding of key SDA-related areas, including knowledge of professionals and patients, oral functional level, and patient satisfaction and OHRQoL of patients managed using high-end clinical and synthesis research. Significant stakeholders who are relevant for the proper structuring and implementation of the various research studies were included, namely the educators (both classroom and clinical), dental students, clinicians and patients with partially dentate distributions for whom this minimalist prosthodontic approach is relevant

[9-32, 33-40, 42-49]. A number of these researched areas were covered in the preliminary studies exploring the knowledge and attitudes of different groups of clinicians related to the SDA concept, and the existing position of the concept in the dental education program, as well as the implications and potential benefits of introducing curricular changes pertaining to correcting perceived shortcomings. Furthermore, clinical scenarios in which the SDA or PRDA approaches could be implementable, as well as those situations where it should be avoided were also highlighted in the clinical research studies performed, and these outcomes were measured against some of the more robust global evidence in the form of secondary research exercises.

Before critically discussing the details of the collected data and how this research addressed the stated objectives, it is useful to highlight how specific relational aspects of the present SDA studies, performed in a WC Province population within the SA context, contributes to current knowledge and perhaps adding a socio-political dimension to it [1-6].

8.1.1. Human Rights perspective

For all OHC professionals, amongst the many considerations that should be part of clinical decision-making is the importance of being mindful of patients' right of access to appropriate quality care. In turn, access to healthcare requires the appropriate use of research that could benefit communities and ensure the appropriate use of available resources [50-51]. An underlying guiding principle of this dissertation has therefore been the human rights perspective which is specifically referred to, given that they underpin the health and oral health policies for SA [8, 50]. Moreover, the work presented here aimed to determine patients' perceived needs and the confluence of such needs with any proposed management concept or interventional approach, thus highlighting the role of patients in decision-making be taken into account [4-5]. Such an approach, promotes a more patient-centred treatment approach clinically, and very importantly, respects patients' basic human rights.

8.1.2. Economic Perspective

Another key underlying principle of this dissertation was the question of how the evidence gathered related to the SDA can be used to make a difference to society, and/or specifically to the economically deprived communities that form a large percentage of SA populations

[1-6]. In addition, there is the problem of physical access to public OH centres where the required treatment is provided; large sectors of these communities are based in rural areas making it difficult to come to OH centres, incurring even more costs to already poor communities [1-6]. From these perspectives, the SDA or PRDA is considered an alternative for specific cases of patients wherever possible to implement. Moreover, the previously mentioned oral health strategy not only has as its goal the retention of 20-teeth for function, it makes reference to including concepts within a primary healthcare framework [8]. It also states that alternative measures be sought, specifically evidence-based concepts, to ensure policies are 'scientifically justified' making it easily implementable [8]. Evidence-based research is also required by OHC providers and health-insurers when reviewing the costs associated with current dental procedures.

8.1.3. Academic perspective

One of the key benefits of evidence-based dentistry is the greater likelihood of adopting beneficial clinical practices (the absence of which was highlighted with the current research), while eliminating harmful ones [52-54]. Strong and convincing evidence gathered can be used to develop and to improve what is currently taught at dental institutions, to update the knowledge of dental practitioners and consequently improve the quality of care provided for patients. More importantly, the evidence gathered speaks directly to the graduate attributes, exit outcomes and goals of dental institutions, and as required by the regulating health body in SA set for students.

From the foregoing brief, inconsistencies can be noted in relation to the SDA or PRDA concept and its role in appropriately utilising resources. By allocating already limited resources towards the maintenance of premolar and anterior teeth (which have a better prognosis and can be more successfully preserved than molar teeth) would imply substantially reducing the costs of dental treatment to poor or economically deprived patients [8, 50]. On these grounds, the present SDA or PRDA research, presently contextualized for the WC Province of SA, supports the more widespread application of this management approach. As in many other countries, a contradiction between the minimalist SDA approach and the traditional one is evident. At the institutional level, the lack of aligning classroom taught content with evidence-based research and the absence of

translation of both the research and the formally-taught material into clinical practice (evidence-based practices) clearly conflicts with the mission of the university.

There is thus a major disconnect between several key OHC role-players and the community with respect to:

- already formulated policies and clinical oral health practices,
- classroom teaching and related clinical practices,
- classroom teaching and institutional policies,
- education of patients related to beneficial policies and treatment options and
- adopting a more functionally-oriented, patient-centred treatment approach.

In effect, when patients are not made aware of important concepts, which are beneficial to them, it can be considered as ultimately violating their rights.

That being said, if the SDA approach which is regarded as a sound functional concept were to be considered for clinical implementation at both an institutional and clinical practice level in SA, it would have to be based on the results of conclusive local or contextual evidence [1-6]. This dissertation that is based on the current reporting on such research confirms the applicability of the SDA concept for the WC community of SA and re-affirms the beneficial policy that is already in place [1-6, 8]. Now that the current research related to perceived oral function, health of the periodontal system, patient satisfaction, and its impact on OHRQoL as well as practitioners' attitudes to the concept has been completed, and seeing that it has previously been accepted into policy for SA already, the next phase would be to address all aspects of implementation [1-6, 8].

The research completed for this dissertation included studies that allowed a critical analysis of both global primary and secondary research performed elsewhere, while primary studies contextualized for a certain SA community were also conducted [1-6]. The primary clinical studies sought to address specific social concerns within specific communities within the local context, where this concept would be of value [1-2, 4-5], as well as to, gauge the findings of some of the global studies' results that were not generalizable and thus questionable for the SA environment [9-35, 39-40, 42-47]. The reasons for these are cultural and/or socio-economic differences between this SA community and other countries in

which these studies were conducted [55-56]. In addition, aside from the lack of evidence of translational practices of the well-researched SDA concept, there are also aspects of SDA research that could further address concerns related to generalizability of findings from elsewhere and further inform the appropriateness of, and the barriers to its use.

The research was shared with colleagues at local, national and international conferences and all of the research has been published [1-6]. It is hoped that this would make those who have not heard of the SDA concept aware, while updating and informing those who have heard of or read some of the many research data already available. Still other attempts at sharing the results from the SA studies were the inclusion of SA dental practitioners at public health clinics in aspects of the research, for example, during the extension of recruitment of patients for the RCT [5].

8.2. Critical Reflection on Data

When critically viewing the data from the primary and secondary research conducted within the SA context, it is evident that the SDA concept constitutes a relevant treatment option for communities in this country. It is unique insofar as this therapeutic approach, when applied appropriately, can be seen as a significant evidence-based primary healthcare treatment option for the underprivileged and under-resourced communities [37]. The finer details of the results of each of these studies are reported within the included articles [1-6], with the results now critically summarized below.

8.2.1. Exploratory Research

(i) Survey among practitioners in the Western Cape Province of SA [1]

A criticism of the study relates to the small response rate of the survey, and thus any related results and conclusions should be considered with caution and cannot be extrapolated to the general population. The conclusions are necessarily restricted to this small sample of participants only. Many participants of the survey indicated a lack of related information about the SDA concept, so that it is clear that their knowledge related to the concept needs to be improved. As it stands, they are unable to advise patients about their treatment options accurately and appropriately. At the same time, it was recognized that continuous professional development (CPD) has not been too effective in the successful translation of

new knowledge to practice or even in helping to improve clinical decision-making. Practitioners are seemingly comfortable with using old practices and find it hard to change and adjust to new developments. A more informed and effective approach might be fostered if efforts are made to change the teaching of the subject, be it from an evidence-based research angle or from the standpoint of prosthodontic treatment rationale, or an approach combining the two. It would be useful, however to conduct a more representative survey of the knowledge attitude and behaviour of dental clinical practitioners in order to provide stronger evidence for these recommendations. Moreover, the general public, health-insurers and policy-makers should also be educated in this regard which could impact on the implementation. Specifically, the concept of knowledge translation should be extensively explored and used to address this lack of clinical implementation [52].

(ii) Mixed-methods research with final year dental students and survey among their clinical teachers at UWC Dental Faculty [2].

The inclusion of qualitative research methods affords exploration of more detailed information related to knowledge, practices, teachings and expectations of students regarding the SDA concept. The aspects included were a survey, as well as, group and individual interviews conducted with a cohort of the UWC final year dental students. The information so obtained pointed to a lack of information and knowledge about the SDA concept, and this prompted the inclusion of a lecture on the subject in the fourth year of study. However, this idea was abandoned for several reasons, including:

- there was still no evidence of translation into clinical practice,
- not having the SDA treatment option included as part of students clinical requirements for the year was perhaps an obstacle to clinical implementation,
- it would be helpful to have follow-up or recall procedures mandated for SDA patients,
- students' limited clinical knowledge and exposure in general was perhaps another obstacle to implementation, and
- it might be seen as an easy way out to not complete other clinical requirements.

As a result, a recommendation that will be now be followed through is to expose students at this particular institution to the SDA concept in their final year so as to further build upon their clinical-decision making skills, before engaging in the wider clinical remit afforded by community service the following year. This will form part of a new module introduced at this level to engage them on all possible evidence-based alternative treatment options that could strengthen and broaden their clinical decision-making skills. The introduction of evidence based healthcare principles throughout the curriculum is also a step in the right direction as students are taught the skills to acquire new evidence. In addition, clinical teachers should be made aware of the subject, and especially in regard to its appropriate use in student clinics. Such an approach would address the disjointedness and the disjuncture between the classroom and the clinic.

Both of the foregoing studies informed the key objectives of the PhD dissertation.

8.2.2. Research addressing specific stated objectives

The research that addressed the key objectives of this dissertation included primary and secondary studies contextualized for a specific community of SA. They were undertaken sequentially such that the one study informed the following one. Some relevant additional research was conducted, and other areas where more research is required were identified.

i) Systematic Review [3]

Not many RCTs related to the SDA have been conducted. Therefore, some of the published SRs included mixed study designs (cross-sectional, randomized and non-randomized clinical trials) in their criteria. Such inclusions of mixed designs risk the results of the SRs becoming downgraded due to bias. Including the risk of bias analysis for each individual RCT and assessing the evidence using the GRADE approach ensured that internal bias related to the evidence from these studies was addressed, strengthening the recommendations.

In addition, meta-analyses could not be performed as all outcomes for individual studies were not reported. With a pooled effect (or meta-analysis) of included studies, the related evidence would have been strengthened and been given superiority in one direction. Completing a meta-analysis with missing or incomplete data would only have introduced bias into the interpretation of the results. However, having more than one researcher assess each included study independently and discussing disagreements with all researchers also

assisted with managing bias. It was recommended that more RCTs (studies with the least bias) contextualized for the specific geographic areas be conducted, which was another objective presented for the current dissertation.

ii) Clinical Research

Following recommendations of previously conducted research related to the SDA concept, it was decided to conduct primary clinical patient-based outcomes research on the subject, including a RCT.

More importantly, an understanding of why QoL studies using specific OHRQoL indicators should be conducted is necessary. Some of the reasons provided by researchers include:

- measuring effectiveness of oral health-related interventions,
- assessing the quality of life of individuals,
- estimating the health needs of a population,
- improving clinical decision-making, and
- understanding the causes and consequences of differences in health needs in different communities [58].

All the above reasons were aligned to the objectives of the included clinical research (cross-sectional study and RCT) to determine patient-based outcomes related to RPDP use and the SDA intervention, the role of patients in decision-making and the impact of these interventions on patients' oral health-related quality of life. For future studies, the use of a different validated instrument may highlight other concerns related to patient care.

(a) Cross-Sectional Quality of life study [4]

The rationale for performing needs assessments in any oral health system is principally to assess the unmet needs of the population, to obtain data that will effect change and to assist with appropriately distributing and using resources within the health system [57].

The quality of life study completed gave an indication of patients' needs and their expectations related to interventions, for example RPDPs. Moreover, it highlights areas whether patients have input in their treatment choices or have even been fully informed of the options in this regard, as based on available best evidence. This clinical study thus identified deficient areas related to patient-input in the clinical decision-making process and patients' knowledge related to the SDA. Also, the dominance of a purely clinician-oriented

treatment approach was apparent, indicating an absence of patient-centeredness in treatment planning.

Furthermore, in patients presenting with a range of posteriorly reduced, interrupted and/or discontinuous arches, their overall negative oral impacts were greatly reduced after provision of clasp-retained RPDPs. Satisfaction with oral function was increased and OHRQoL was improved. Whereas the value of RPDPs in this SA cohort, which was at variance with many global studies, was confirmed, the effects of other possible confounders to this apparent outcome needed further study [4-5, 58-59]. Moreover, the design of the study (being a purposive sample) highlights its own set of limitations, thus extending this to broader communities may present a different view.

(b) Randomized Controlled Trial [5]

As stated earlier, the need to conduct a RCT emerged clearly from the findings of previous studies in this dissertation [4]. Its method with respect to sampling differed greatly from those other published RCTs related to the SDA [9-17]. Results indicated that, at baseline, patients were more accepting of the SDA management approach with more complaints reported by those patients with the RPDP intervention; this is very much in line with global findings [5, 59], and it is concluded that patients in the present population were very positive towards a SDA or PRDA dentition, even 12 months after treatment.

The fact that RCT results differed from those of the cross-sectional quality of life clinical study conducted in SA raises questions around:

- knowledge and education of patients related to replacement of teeth,
- cultural behaviour related to extraction of teeth,
- why extractions are the first choice of treatment for carious teeth and
- the costs of these specific dental treatments.

These could clearly impact on the patterns of tooth loss that emerge, but more importantly, how patients feel about replacing teeth. In addition, the role of several locally prevalent cultural behaviours specific to the Western Cape of SA, namely the extraction of certain teeth give rise to patterns of missing teeth that seems to affect the prevalence of SDAs in the population studied. This should be explored further [55].

8.2.3. Additional Research

A novel research methodology was carried out that critically analysed the evidence gathered across 5 continents in the form of an overview of SRs. This type of study related to the SDA concept has not been used previously in dentistry.

➤ Overview of systematic reviews [6]

The fact that quality assessments of the evidence of primary studies had not been conducted for most of the published SRs included in this overview was a limitation. A more detailed comparison of included characteristics of each included SR, other than the one incorporated, should have been completed.

8.3. Conclusions

The identification of treatments that produce the optimal outcomes for patients while ensuring their autonomy in the decision-making process is central to the goals of healthcare systems. This implies the organization and facilitation of OHC systems effectively to optimize health benefits for communities through informed healthcare policy. For SA, the SDA concept has already been accepted into policy, and these studies add to the evidence base for its effective implementation [7]. Thus the results of the present research contextualized for SA was to more definitively inform institutional and OHC policies as required.

It is concluded that SA OHC practitioners need to consider a repositioning of the prevailing paradigm regarding management goals for partially dentate patient communities. The non-interventionist, or minimally-interventionist approach, such as the SDA or PRDA, need to be included as an alternative treatment option wherever possible. In this regard, the SDA approach (which may be regarded as a 'no-treatment' alternative) can in a more cost-effective way alleviate the functional needs of underprivileged communities. Furthermore, it is suggested that change might best be effected at an institutional level given that CPD programmes are known not to be effective in instituting change [2]. When prosthodontics is viewed within a primary healthcare (PHC) framework (as alluded to in the National Oral Health Strategy), it is reasonable to suggest that a 'low-tech' management strategy such as the SDA or PRDA concept could meet the criterion of '*appropriatech*' [8, 37]. Such an approach would also be aligned with institutional goals [37].

8.4. Limitations of the research

Limitations were identified with each of the research studies completed towards this dissertation. These have even been addressed within the reported studies, but can be summarized as follows:

8.4.1. Exploratory studies

The survey amongst clinical practitioners was conducted in only one of nine provinces in SA, which implies that the results may not be generalizable to the entire SA population, especially the rurally-based communities [1]. The non-response bias (reasons for which were mentioned in the respective chapter), possible confounders, and the lack of a representative sample of the target population of dentists all negatively impacted on the generalizability of results [1].

For the mixed-methods study, the seemingly low emphasis on evidence-based practice was a concern, and it would be worthwhile to explore what other SA dental institutions teach and whether the lack of evidence-based teaching and practice is a concern and can be improved [2]. Triangulation and member-checking were included for this study to ensure validity and reliability of outcomes data [2].

8.4.2. Designs and rigor of each study

Even though it was a conscious effort by the researcher to complete studies from the top end of the evidence pyramid, there are always concerns with regard to how studies are conducted, especially surveys and qualitative research. Detailed protocols should be followed, as any deviation could negatively impact on the outcomes of studies for both primary and secondary research. For primary research studies, elimination of bias is key. Where possible, especially with both primary and secondary types of studies, assessing the quality of evidence by determining the precision (random error) and accuracy (systematic error) as well as the risk of bias of primary clinical research is critical [4]. These will ensure the reliability and external validity of the results obtained.

For the present SDA research, these concerns were largely addressed. However, for the cross-sectional studies that focus on patients requesting treatment, or students from one

particular institution, the limitations incurred were that they are not representative of the patient or student population at large.

8.4.3. Sampling with each study and sampling limited to the Western Cape

Sampling was referred to with respect to the preliminary as well as with the clinical research completed towards the PhD [1-5]. Participants were patients from diverse backgrounds who attended for treatment at the dental institution and were dependent on the public dental services for treatment. For the RCT, patients were also recruited from the patient-pool that attends public health clinics. Patients come from different socio-economic backgrounds that may have different requests and/or needs. It would be interesting to see how data might differ, if at all, when conducting such studies in private practice, in other provinces, or in specific under-resourced and remote and rural communities in SA.

The sampling methods employed for each study, for example, convenience, purposive or random sampling, come with their own sets of limitations, which were touched upon in each study [1-3, 5]. Ideally, to avoid bias, random sampling should be employed. According to some epidemiologists, especially where consent is needed, patients have the right to refuse to participate which in itself may create bias. With sampling, variability should be at a minimum, thus stratifying the random sample or increasing the sample size may reduce sampling error making it more representative of the target population.

Different types of sampling negatively impact on the generalizability of the results, for example, for convenience sampling the focus is on achieving the aims of the study, and this might not be a concern for the outcomes of the study. For purposive sampling, the sample is not expected to be representative of the target population, and it is chosen for convenience and ease as the methods around data extraction are comprehensive and interpretive in nature [2]. Compared to these, the stratified random sampling technique which accurately represents the population at large is advisable, although stratification of the sample was not employed in any of the studies of this PhD.

With stratification of the sample, some confounding variables such as medical conditions, age, gender and race would have been eliminated. Other confounders of concern for the present studies such as periodontal conditions and caries were largely eliminated as

patients received treatment before the interventions were placed [4-5]. However, being part of an interview or from a convenience or purposive sample implies that bias should be expected, as explained above. Here participants are aware of their presence and how their responses would impact on the study, resulting in threats to both internal (as a confounding variable) and external (not being representative of the target population) validity.

8.4.4. Clinical Studies

Referring to the cross-sectional quality of life study in Chapter 5, limitations identified include variations in the different occlusal arrangements in patients, their satisfaction, and their expectations of the RPDPs they were going to receive [4]. The generalizability of the results from this study is a limitation as this was a convenience sample, even if, appropriate for the fulfilment of the study the aims. Attempts to consciously eliminate confounding variables (medical conditions, age and gender) should have been included in the design, or even addressed statistically to improve the internal validity of the study. Still other confounders, such as periodontal conditions and caries were addressed prior to patients receiving interventions as per university dental treatment protocol [4].

For the RCT, the randomization process (where block-randomization could have been used, but was not) and blinding (where patients could not be blinded due to the nature of the intervention) may also be regarded as limitations [5]. Though the researchers tried not to introduce selection bias with the design of the RCT, eliminating random sampling error totally is not possible. Sampling for the RCT, following decisions of what the effect size and precision should be, the results for calculating the power of the study was acceptable for rather smaller sample sizes [5]. This was evident with narrowing of confidence intervals as sample sizes increased. With regards to confounding variables for the clinical studies (as mentioned earlier), most of these were eliminated or reduced as patients were provided with periodontal and restorative treatment prior to receiving the interventions [5]. A limitation with regards to dealing with confounders is not having addressed it statistically using multi-variable regression analysis. Completing this type of analysis would have verified the impact of confounding variables, if any. This discussion centres on the importance of choosing a sample where the results would be more precise, avoiding overestimation of an outcome and eliminating systematic error.

8.4.5. Researcher and Research Team

The effect of one researcher, this research being the focus of her PhD dissertation might of course be construed as her own bias towards the SDA concept, although strict protocols were followed for each of the included studies [1-6]. Having completed questionnaires with the samples across all studies, the researcher would have introduced an element of interviewer bias, which could have been reduced or eliminated if it was a self-administered questionnaire. Performance bias was reduced as all clinical interventions were completed by one practitioner in the RCT, though not for the quality of life study where students were responsible for the RPDPs [4-5]. With synthesis research (SR and Overview), the research assistants had an important role, that of reducing bias where disagreements were resolved by discussion [3, 6].

8.5. Recommendations

The SDA concept is increasingly recognized and broadly accepted as a primary healthcare treatment approach globally, including SA [8, 37]. There remain areas to be researched in order to make it more comprehensive for this SA context [1-6]. A proposal can be developed for the continuation of the present line of SDA research across the different SA communities following the conclusions from research completed over the last 6 years within this specific context.

8.6. Implications for Future Research

Some of these future research areas should include the following clinically-related areas or questions:

- What are the patterns of tooth loss in SA communities (especially in the WC)?
- Determination of chewing in patients with different posterior reduced dental arches (symmetrically/ asymmetrically placed teeth) using a SD Mechatronik Chewing Simulator CS.
- Comparison of the costs of the SDA or PRDA management approach with the accepted prosthodontic methods (fixed, removable or implant retained procedures).
- Determination of functional effectiveness with different PRDA using finite element analysis.

- Developing guidelines and using knowledge-to-action frameworks for the implementation of the SDA or PRDA as a treatment option for partially dentate adults in SA.

High quality and broader areas of research related to the SDA concept would better inform decisions for clinical practice. More importantly, patients should be made aware of any concept that may be beneficial to them, thus the role of social media and the responsible use thereof to educate and inform the respective role players must be explored.

8.7. Implications for Curriculum Development

In addition to new research ideas, development and revision of current teaching practices to include evidence-based research is also recommended [2]. Moreover, alignment of current academic teaching to OHC policies and institutional goals should also be ensured with specific reference to inclusion of SDA or PRDA approaches in classroom teaching and in clinical requirements (since students only undertake procedures when it is a requirement). The SDA concept has now been included in a module discussing alternative treatment procedures, improving students' clinical decision-making skills. Additionally, inclusion of the evidence-based healthcare (EBHC) approach in the curriculum would be one way of ensuring that new concepts are not overlooked, so providing students with skills to assist them in obtaining high-end evidence that could be used clinically.

8.8. Implications for Clinical Practice

It is known that CPD programmes are not successful in ensuring a change in clinical behaviour, and thus alternatives must be explored. A recommendation to change what is taught at institutions would change the clinical approach of undergraduate and postgraduate students, and thus their clinical behaviour once graduated [2, 4-5]. These results can also be shared with OHC policy-makers and medical insurers, and in this way clinical practitioners may be more inclined to implement the SDA approach.

8.9. Anticipated Problems with Clinical Implementation of SDA

The SDA concept may be regarded as one of the key prosthodontic management approaches that has emerged over the past three to four decades. The evidence emphasizing its long-term sustainability and oral functionality is strong. Indeed, the value of

a reduced posterior arch length that lies at the core of the SDA concept is increasingly recognised in the planning of implant-supported prostheses [60-62]. Yet after 40 years of related research, globally and now locally, the question that remains is:

'Why have clinicians been so reluctant to apply this concept in the clinical setting, especially in communities where it would be of benefit?'

Communities with vastly different socio-economic circumstances are prevalent in all countries and these communities are often not able to afford expensive advanced conventional prosthodontic treatments such as implants. With the primary healthcare approach adopted within SA policies advising the use of existing healthcare infrastructure as opposed to expensive technologically advanced procedures, the SDA concept certainly has a place within oral healthcare delivery especially for these communities. Implementing these policies is a challenge and the reasons for this are reflected within the different studies completed towards this PhD.

The unexplored aspects and those not explicitly mentioned include the lack of knowledge of patients about such beneficial concepts and the perceived loss of income that practitioners would face once they implement such a treatment option. This echoes what has been expressed years ago regarding this concept [60]. So, even if practitioners agree that such a concept is acceptable and valid, speculating about the reasons for absence of clinical implementation would include loss of remuneration for practitioners [60].

In order to succeed with positioning of the non-interventionist approach into the clinical domain, now that more clinical research is available, addressing the educational platform must be regarded as an important starting point. Its implementation should also be a priority in this setting as students are then likely to continue with such a position; it is harder to change old teachings and clinical practices.

Moreover, engaging patients in a concept that would directly benefit them (as attempted with the patient-based outcomes studies reported in Chapters 5 and 6) with exposure through the use of social media is also a step in the right direction. Included on this level would be having conversations with health-insurers, addressing appropriate remuneration strategies. This speaks directly to the third aspect of knowledge translation, that of *implementation* beyond writing articles or publishing research for practitioners and

researchers to read, namely to include the creation of an awareness within the population at large that would be affected by the evidence.

References

1. Khan SB, Chikte UME, Omar R. Perceptions of dental practitioners regarding the shortened dental arch. *SADJ* 2012 67(2):60-68.
2. Khan S, Chikte UME, Omar R. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014 78(6):906-13.
3. Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated Shortened Dental Arches: A Systematic Review. *PLOS 1* 2014 9(7): e101143. DOI: 10.1371/journal.pone.0101143.
4. Khan S, Chikte UMEC, Omar R. (2017). Impact of removable denture prostheses on the functional ability and oral health-related quality of life of a South African partially dentate cohort. *J Prosthodont* 2017. DOI: 10.1111/jopr.12692
5. Khan S, Chikte UME, Omar R. Outcomes of interventions for patients with a posterior reduced dental arch: A randomized controlled trial. *J Oral Rehabil* 2017. DOI: 10.1111/joor.12549.
6. Khan S, Chikte UMEC, Omar R. An Overview of Systematic Reviews related to a shortened dental arch in adults. *Int J Prosthodont* 2017 30(4):357-66. DOI: 10.11607/ijp.5287.
7. World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Copenhagen: WHO Europe regional office, WHO Technical Report; 1982 No. 826:16-7.
8. Department of National Health and Population Development. National Oral Health Policy and Strategy for South Africa 2017: 1-30.
9. Jepson NJA, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. *Br Dent J* 2001 191(3):140-44.
10. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003 16(4):409-14.
11. Thomason JM, Moynihan PJ, Steen N, Jepson NJA. Time to Survival for the Restoration of

- the Shortened Lower Dental Arch. *J Dent Res* 2007 86(7):646-50.
12. Luthardt RG, Marre B, Heineck A, Gerss J, Aggstaller H, Busche E, et al. The randomized shortened dental arch study (RaSDA): design and protocol. *Trials* 2010 11(15):1–9.
 13. Walter MH, Weber A, Marre B, Gitt I, Gerß J, Hannak W, et al. The Randomized Shortened Dental Arch Study: Tooth Loss. *J Dent Res* 2010 89(8):818-22.
 14. McKenna G, Allen PF, Flynn A, O’Mahony D, DaMata C, Cronin M, et al. Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodont* 2012 29: e883–e890. DOI:10.1111/j.1741-2358.2011.00579.x.
 15. McKenna G, Allen PF, Flynn A, O’Mahony D, DaMata C, Woods N, et al. A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodont* 2012 1–7.
 16. Budtz-Jørgensen E, Isidor F. 5-year longitudinal study of cantilever fixed partial dentures compared with a removable partial denture in a geriatric population. *J Prosthet Dent* 1990 64:42-7.
 17. Isidor F, Budtz-Jørgensen E. Periodontal conditions following treatment with a distally extending cantilever bridge with removable partial dentures in elderly patients: A 5-year study. *J Periodontol* 1990 61:22-6.
 18. Cruegers NHJ, Witter DJ, Van’t Spijker A, Gerritsen AE, Kreulen CM. Occlusion and Temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 2010 1-7. DOI:10.1155/2010/807850.
 19. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981 8:457-62.
 20. Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 1989 9 (6):426-49.
 21. Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aust Dent J* 1987 32(3):178-82.
 22. Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010 8:126-39.
 23. Witter DJ, van Elteren P, Käyser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988 15:413-20.
 24. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 1989 16:27-33.

25. Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. Oral comfort in shortened dental arches. *J Oral Rehabil* 1990 17:137-43.
26. Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Signs and symptoms related to temporomandibular disorders. Follow-up of subjects with shortened and complete dental arches. *J Dent* 2007 35:521-27.
27. Sarita PT, Kreulen CM, Witter DJ, Creugers NHJ. Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 2003 16(3):265-70.
28. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003 16(4):375-80.
29. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. *Community Dent Oral Epi* 2003 31(5):328-34.
30. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NHJ. Oral health related to the shortened dental arch concept in Tanzania. *Eur J Sci* 2007 115(4):265-74.
31. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008 35:337-44.
32. Korduner EK, Söderfelt B, Kronström M, Nilner K. Attitudes toward the shortened dental arch concept among Swedish dental practitioners. *Int J Prosthodont* 2006 19:171-6.
33. Van Waas MA, Meeuwissen JH, Meeuwissen R, Käyser AF. Oral function in dentate elderly with reduced dentitions. *Gerodontol* 1993 10(1):40-3.
34. Meeuwissen JH, Van Waas MA, Meeuwissen R, Käyser AF, van't Hof MA, Kalk W. Satisfaction with reduced dentitions in elderly people. *J Oral Rehabil* 1995 22(6):397-401.
35. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008 21(1):72-4.
36. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998 25:649-61.
37. Owen CP. Appropriatech: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont* 2004 17(2):261-2.
38. Fejerskov O, Escobar G, Jøssing M, Baelum V. (2013). A functional natural dentition for all—and for life? The oral healthcare system needs revision. *J Oral Rehabil* 2013. DOI: 10.1111/joor.12082.

39. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin. Oral Impl. Res* 2007 18:34-45. DOI: 10.1111/j.1600-0501.2007.01436.x.
40. Shahmiri RA, Atieh MA. Mandibular Kennedy Class I implant-tooth-borne removable partial denture: a Systematic Review. *J Oral Rehabil* 2007 37:225-34.
41. Zhang Q, Kreulen CM, Witter DJ, Creugers NHJ. Oral Health Status and Prosthodontic Conditions of Chinese Adults: A Systematic Review. *Int J Prosthodont* 2007 20:567–72.
42. Gerritsen AE, Finbarr Allen P, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *HQoL Outcomes* 2010 8:126.
43. Faggion CM. The shortened dental arch revisited: from evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 2011 38:940-49.
44. Faggion CM, Giannakopoulos NN, Listl S. How strong is the evidence for the need to restore posterior bounded edentulous spaces in adults? Grading the quality of evidence and strength of recommendations. *J Dent* 2011 39:108-16.
45. Fueki K, Yoshida E, Igarashi Y. A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011 47:167-74.
46. Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: partially absent dentition. *Cochrane Database SR* 2012 Issue (2) Art No: CD003814. DOI: 10.1002/14651858.CD003814.pub2.
47. Liang S, Zhang Q, Witter DJ, Wang Y, Creugers NHJ. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: A Systematic Review. *J Dent* 2015 43:1185-94.
48. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996 23:481-5.
49. De Sa e Frias V, Toothaker R, Wright RF. Shortened Dental Arch: A review of current treatment concepts. *J Prosthodont* 2004 13:104-10.
50. Department of National Health and Population Development. National Health Act of South Africa, 1994; Section 27.
51. Ayo-Yusuf OA, Ayo-Yusuf IJ, Van Wyk PJ. Socio-economic Inequities in dental caries experience of 12-year-old South Africans: Policy Implications for prevention. *SADJ* 2007 62(1):6-11.
52. Akobeng AK. Principles of evidence based medicine. *Arch Dis Child* 2005 90:837-840.

53. Healy D, Lyons K. Evidence-based practise in dentistry. *New Zeal Dent J* 2002 98:32-5.
54. Gillette J. Striving for Excellence with Evidence-Based Dentistry. *J Evid Base Dent Pract* 2009 9: 125-28.
55. Friedling LJ, Morris AG. Pulling teeth for Fashion: Dental modification in modern day Cape Town, South Africa. *SADJ* 2007 62(3): 106-13.
56. Chikte UME. Health and Human Rights in South Africa. *SADJ* 2009 64(1):2.
57. Tsakos G, Marcenes W, Sheiham A. The relationship between clinical dental status and oral impact in an elderly population. *Oral Health Prev Dent* 2004 2(3):211-20.
58. Zitsmann NU, Hagmann E, Weiger R. What is the prevalence of various types of prosthetic dental restorations in Europe? *Clin Oral Impl. Res* 2007 18(Suppl. 3): 20-33.
59. Frank RP, Brudvik JS, Le Roux B, Milgrom P, Hawkins N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet Dent* 2008 83:521-7.
60. Kanno T, Carlsson GE. A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil* 2006 33:850-62.
61. Creugers NHJ, Witter DJ. Shortened Dental Arch Research Conclusions for Edentulous Patient Management. *Int J Prosthodont* 2017 30(2):139-41. DOI: 10.11607/ijp 2017.2.ic
62. Gerritsen AE, Witter DJ, Creugers NHJ. Long-term follow-up indicates unimpaired oral health-related quality of life for people having shortened dental arches. *J Dent* 2017. DOI: 10.1016/j.jdent.2017.06.011.

Appendices

Appendices

- 1.1. Registration for a PhD in Community Health at Stellenbosch University
- 2.1. Survey with Practitioners: Questionnaire
- 2.2. Survey with Practitioners: Informed Consent Form
- 2.3. Survey with Practitioners: Ethics Approval
- 3.1. Mixed-Methods Education Research: Questionnaire
- 3.2. Mixed-Methods Education Research: Individual and Group Interview Questions
- 3.3. Mixed-Methods Education Research: Informed Consent Form
- 3.4. Mixed-Methods Education Research: Ethics Approval
- 4.1. Systematic Review: Ethics Approval
- 4.2. Systematic Review: PRISMA Statement
- 5.1. Cross-Sectional Quality of Life Study: OIDP-2012 Bilingual Questionnaire
- 5.2. Cross-Sectional Quality of Life Study: Informed Consent Form
- 5.3. Cross-Sectional Quality of Life Study: Ethics Approval
- 6.1. Randomized Controlled Trial: Information Letter
- 6.2. Randomized Controlled Trial: Demographic Details
- 6.3. Randomized Controlled Trial: Global Visual Analogue Scale
- 6.4. Randomized Controlled Trial: Informed Consent Form
- 6.5. Randomized Controlled Trial: Ethics Approval
- 6.6. Randomized Controlled Trial: Registration with *clinicaltrials.gov*
- 6.7. Randomized Controlled Trial: CONSORT Statement
- 6.8. Randomized Controlled Trial: Sample Size Estimation
- 7.1. Overview of Systematic Reviews: AMSTAR Checklist
- 7.2. Overview of Systematic Reviews: Ethics Approval
- 8.1. List of Presentations
- 8.2. International Conference Poster Presentations related to the SDA
- 8.3. List of References
- 8.4. Published Articles

1.1. Registration for a PhD in Community Health at Stellenbosch University



UNIVERSITEIT-STELLENBOSCH-UNIVERSITY
jou kennisvenoot - your knowledge partner

Date of issue: 29 Oct 2014

PROOF OF REGISTRATION

This is to certify that

SAADIKA BEGUM KHAN (Née KHAN)

Date of birth : 06/04/1965

Identity no : 6504060203085

Student number: 13263382-1999

is registered as a student at this University for the academic year 2014.

Degree/diploma/certificate programme:

PhD (FULL TIME)
(Community Health)

Date commenced with programme: Jul 2012

Minimum formal duration of programme: 2.0 Years

Date of termination of studies (if applicable): None

This document is issued without alterations of any kind. As far as present students are concerned this only applies until the date of the certificate.

JE Coetzer
FOR THE REGISTRAR



JE Coetzer

(021) 808 9111

Universiteitskantoor Tygerbergkampus • University Office Tygerberg Campus • Iofisi ye Yunivesithi ese Tygerberg

Posbus/P.O. Box/Ibhokisi 19063 • Tygerberg 7505 • Suid-Afrika/South Africa
Tel/foni: +27 21 938 9204 • Faks/Fax/Ifeksi: +27 86 646 5812
E-pos/E-mail: jco@sun.ac.za

2.1. Survey with Practitioners: Questionnaire

**Department of Restorative Dentistry
Faculty of Dentistry & WHO Oral Health Collaborating Centre**

Private Bag X1, Durban 7705
South Africa
Telephone: +27 21 937 5006
E-mail: skhan@sun.ac.za

Private Bag X06, Mitchell's Plain 7785
South Africa
Fax: +27 21 937 5025



SURVEY: DENTAL PRACTITIONERS OF THE WESTERN CAPE

Instructions:

Please fill in your personal details below (including Dental and Specialist degrees).

Your comments will be highly appreciated.

SECTION A:

Age:

Gender:

Qualifications (including Diplomas and / or Specialities):
.....

Year Qualified: BChD -

Postgraduate Diploma -

Postgraduate Degrees (specify) -

Institution/s Qualified:

Employment Details (Complete, where applicable. More than one entry is allowed):

Private Practice: No of Years:

Public Clinic: No of Years:

University:
(Sessions / Full time) No of Years:

Current Employment: No of Years:



UNIVERSITY of the
WESTERN CAPE

A place of quality, a place to grow, from hope to action through knowledge

SECTION B:PLEASE ANSWER ALL QUESTIONS. More than one option is required for certain questions, mark your response with an **X**.

1. Percentages of procedures treated in your practice per week? (To the nearest 10% and adding up to 100%)	Extraction%	Crowns & Bridges%	Fillings%	Ortho%	Dentures%	Other, specify%
2. Age categories of patients seen in your practice? (Mark all applicable ages)	Under 10	10– 18 yrs	18 - 35 yrs	35 -65 yrs	65 yrs or more	
3. Reasons for extracting teeth in your practice are? (Give a % for all options, to the nearest 10%, adding up to 100%).	Caries%	Perio Dis%	Trauma%	Impaction%	Ortho%	Patient Request%
4. Percentages of the different teeth extracted are? (Give a % all options, to the nearest 10%, adding to a 100%)	Upper Incisors%	Premolars%	Lower Molars%	Upper Molars%	Canines%	Lower Incisor%
5. Do your patients demand the extraction of anterior teeth?	Always	Sometimes	Rarely	Never		
6. Do you comply to requests for extraction of patients' anterior teeth?	Definitely Yes	Yes	No	Definitely No		
7. Patients with decayed teeth are advised to save at least their anterior and premolar teeth?	Always	Sometimes	Rarely	Never		
8. What appliance do you commonly use for replacement of missing teeth?	Plastic Dentures	Metal Dentures	Fixed Bridges	Implants	Other, specify	
9. Do you always replace missing molar teeth with distal extension dentures?	Definitely Yes	Yes	No	Definitely No		
10. Do you advise patients not to replace missing molars with bridges or dentures?	Always	Sometimes	Rarely	Never		
11. Where did you first hear about the Shortened Dental Arch (SDA)?	University	Journal	This Survey	Colleague	Other, specify	
12. Have you read any research related to the SDA conducted locally or internationally?	Definitely Yes	Yes	No	Definitely No	Don't Know	

13. Do you agree that patients can function adequately with a SDA?	Definitely Yes	Yes	No	Definitely No	Don't Know	
14. The SDA should be presented to patients as an alternative treatment option?	Definitely Yes	Yes	No	Definitely No	Don't Know	
15. Treatment options that you usually propose to patients with a SDA are? (More than 1 entry is allowed, to the nearest 10% and adding to a 100%)	Plastic Dentures%	Metal Dentures%	Cantilever Bridges%	Implants%	No Treatment%	Other%
16. Would patients benefit from a SDA treatment option?	Definitely Yes	Yes	No	Definitely No	Don't Know	
17. A SDA treatment option must be limited to special cases only, e.g. the handicapped patient?	Definitely Yes	Yes	No	Definitely No	Don't Know	
18. What will prevent you from presenting the SDA as a treatment option?	Loss of income	Lack of knowledge	Limited research	Not viable option	Nothing	Other, specify
19. Patients most often request the replacement of missing molars with?	Plastic Dentures	Metal Dentures	Fixed Bridges	Implants	No Treatment	
20. Not replacing missing molars will affect the patients' Oral-health-related Quality of life.	Definitely Yes	Yes	No	Definitely No		
21. Extracting anterior teeth will negatively impact on patients' Oral-health-related Quality of Life.	Definitely Yes	Yes	No	Definitely No	Don't Know	
COMMENTS:						



2.2. Survey with Practitioners: Informed Consent Form

UWC Faculty of Dentistry & WHO Oral Health Collaborating Centre

INFORMED CONSENT FOR THIS SURVEY: SHORTENED DENTAL ARCH

There are no known risks associated with participating in this Survey. Your personal information will be strictly confidential and your identity will be protected at all times. You also have the option to refuse to participate in this Survey and nothing will be held against you for your choice. If you would like to withdraw from the Research at any future stage, please feel comfortable to inform me as such.

If you have any further queries, comments, suggestions or want any more information about this Research, please contact:

Dr S Khan: Tel (w) 021 9373006, **Fax:** 021 937 3025 or **E-mail** her at: skhan@uwc.ac.za.

Thanking you in anticipation.

Dr S. Khan

IF YOU WANT TO WILLINGLY PARTICIPATE IN THIS RESEARCH,

Please complete and sign the form below and return it in the prepaid envelope enclosed.

Alternatively, e-mail the completed form to the above e-mail address.

I agree to participate in this Research:

Name:

Address:

Tel Number:

Cell Number:

E – Mail:

Fax Number:

Signature:



**UNIVERSITY of the
WESTERN CAPE**

2.3. Survey with Practitioners: Ethics Approval



**Office of the Deputy Dean
Postgraduate Studies and Research**
Faculty of Dentistry & WHO Collaborating Centre for Oral Health



UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 10th February 2010

For Attention: Dr S Khan
Department of Restorative Dentistry

Dear Dr Khan

STUDY PROJECT: Perceptions of dental practitioners about the shortened dental arch as experienced in the Western Cape Province, South Africa (SA)

PROJECT REGISTRATION NUMBER: 10/2/13

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 10th February 2010 the above project was approved. This project is therefore now registered and you can proceed with the work. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Sudeshni Naidoo', written over a horizontal line.

Professor Sudeshni Naidoo

3.1. Mixed-Methods Education Research: Questionnaire

PLEASE ANSWER ALL QUESTIONS. More than one option is required for certain questions; **mark** your response with an **X**.

1. Where did you first hear about the Shortened Dental Arch (SDA)?	University	Journal	Colleagu e	This Survey	Other, specify	
2. Have you read any <i>research related to the SDA</i> conducted locally or internationally?	Definitely Yes	Yes	No	Definitely No		
3. Are you aware of the different forms of the SDA/ its variants?	Definitely Yes	Yes	No	Definitely No		
4. Do you agree that patients can function adequately with a SDA?	Definitely Yes	Yes	No	Definitely No	Don't Know	
5. Do you agree that the SDA should be presented to patients as an <i>alternative treatment option</i> ?	Definitely Yes	Yes	No	Definitely No	Don't Know	
6. Treatment options that you usually propose to patients/students with a SDA are?	Plastic Dentures	Metal Dentures	Cantileve r Bridge	Implants	No Treatment	Other
7. What will <i>prevent</i> you from presenting the SDA as a treatment option?	Quota Requirement	Lack of knowledge	Limited research	Not viable option	Loss of income	Other, specify
8. Do you advise patients/students not to replace missing molars with bridges or dentures?	Always	Sometimes	Rarely	Never		
9. What do you <i>suggest</i> we do to implement the SDA as a treatment option in the system?	Quota Requirement Changes	Allowed to Charge a fee	Health Policy Changes	No Suggestio n	Other, specify	
10. Would you insist on making an appliance for a patient with a SDA for a quota?	Definitely Yes	Yes	No	Definitely No		
COMMENTS:						

3.2. Mixed-Methods Education Research: Individual and Group Interview Questions

Question 1:

Why do you think 8/73 said they only heard about the SDA from this survey/ questionnaire?

Question 2:

Where was it taught – which year and which module

Question 3:

How was it mentioned in the Teachings? Do you recall whether it was said you MUST or CAN use it?

Why do students then not implement it/ use it as a treatment option?

Question 4:

What are your personal views on it?

Have you read any research related to this topic? If not, why not?

Question 5:

What do you think should be done to implement it? Is there any specific target group?

Question 6:

Comment on your lecturer's knowledge related to the SDA.

Comment on your clinical supervisor's knowledge.

Also comment on the way it was taught - method/ areas/ emphasis.

Question 7:

MONEY – as a student cost is not an issue/ important; Feel free to speak about this

You will soon be a practitioner – how will this affect you, is it important

Comment on loss of income; give negatives and positives about the SDA

At this stage – insistence on making a denture for a quota / as income in future

Question 8:

Education in this Institution- do you know what student-centred learning is – is this happening here, comment

Do you know patient –centred treatment is – is that what we are doing here

Question 9:

CPD: Do you know what this is? How can this activity assist with introducing new concepts

Question 10:

Health Policy changes – how do HP affect our behaviour, can new concepts be introduced by changing rules?

An more specifically – the SDA



3.3. Mixed-Methods Education Research: Informed Consent Form

UWC Faculty of Dentistry & WHO Oral Health Collaborating Centre

INFORMED CONSENT FOR THIS SURVEY: SHORTENED DENTAL ARCH

There are no known risks associated with participating in this Survey. Your personal information will be strictly confidential and your identity will be protected at all times. You also have the option to refuse to participate in this Survey and nothing will be held against you for your choice. If you would like to withdraw from the Research at any future stage, please feel comfortable to inform me as such.

If you have any further queries, comments, suggestions or want any more information about this Research, please contact:

Dr S Khan: Tel (w) 021 9373006, **Fax:** 021 937 3025 or **E-mail** her at: skhan@uwc.ac.za.

Thanking you in anticipation.

Dr S. Khan

IF YOU WANT TO WILLINGLY PARTICIPATE IN THIS RESEARCH,

Please complete and sign the form below and return it in the prepaid envelope enclosed.

Alternatively, e-mail the completed form to the above e-mail address.

I agree to participate in this Research:

Name:

Address:

Tel Number:

Cell Number:

E – Mail:

Fax Number:

Signature:



**UNIVERSITY of the
WESTERN CAPE**

3.4. Mixed-Methods Education Research: Ethics Approval



**Office of the Deputy Dean
Postgraduate Studies and Research**
Faculty of Dentistry & WHO Collaborating Centre for Oral Health



UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 04th March 2011

For Attention: Dr S Khan
Department of Restorative Dentistry

Dear Dr Khan

STUDY PROJECT: A survey of the experiences of senior dental students at UWC regarding the treatment protocol for the shortened dental arch

PROJECT REGISTRATION NUMBER: 11/1/51

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 4th February 2011 the above project was approved. This project is therefore now registered and you can proceed with the work. Please quote the above-mentioned project numbers in all further correspondence.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

A handwritten signature in black ink, appearing to read "Sudeshni Naidoo", written over a horizontal line.

Professor Sudeshni Naidoo

4.1. Systematic Review: Ethics Approval



**Office of the Deputy Dean
Postgraduate Studies and Research**
Faculty of Dentistry & WHO Collaborating Centre for Oral Health



UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 10th June 2011

For Attention: Dr S Khan
Department of Restorative Dentistry

Dear Dr Khan

STUDY PROJECT: Functional relevance of prosthodontic interventions for shortened dental arches in adults: A systematic review

PROJECT REGISTRATION NUMBER: 11/4/39

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 6th May 2011 the above project was approved. This project is therefore now registered and you can proceed with the work. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Sudeshni Naidoo', written over a horizontal line.

Professor Sudeshni Naidoo

4.2. Systematic Review: PRISMA Statement.

Moher d, Liberati A, Tetzlaff J, Altman DG. The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement, PLOS Med (6(6): e1000097. www.prisma-statement.org

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7-8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	9
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	9-10
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	10
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	10
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	10

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	11
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	11
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	11
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	11
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	11
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	12
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12-13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13-16
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	16-22
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	13-16
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	24-26
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	27
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	n/a

5.1. Cross-Sectional Quality of Life study: ODP 2012 Bilingual Questionnaire

Measuring Dental Needs: International Collaborative ODP Study**Interviewer Administered Oral Health Survey Questionnaire****Introduction:**

This interview is about your health, about mouth and teeth problems and about dental treatment. There is no right or wrong answer. Please feel free to ask about anything you don't understand.

- 1) Study Record Number
- 2) Date
- 3) *Geslag* /Sex Male Female
- 4) *Hoe oud is jy? (jare)*//Age in years
- 5) Geographic location (CIRCLE ONE) 1 = Urban 2 = Rural/small town
- 6) Estimated S/E category (CIRCLE ONE) 1 = 2 = 3 = 4 =
- 6B) Occupation (CIRCLE ONE) 1 = 2 = 3 = 4 =

General Health Questions

Now, I am going to ask you some broad questions about your general and dental health:

Nou gaan ek 'n paar vrae oor jou algemene gesondheid vra:

7) In general would you say your health is//*My algemene gesondheid is:*

1 _____ 2 _____ 3 _____ 4 _____ 5
 Very Poor Poor Fair Good Very good
Baie sleg Sleg Aanvaarbaar Goed Baie goed

8) In general would you say your dental health is// *My tandheelkundige gesondheid is*

1 _____ 2 _____ 3 _____ 4 _____ 5
 Very Poor Poor Fair Good Very good
Baie sleg Sleg Aanvaarbaar Goed Baie goed

9) How satisfied are you with your oral health? *Hoe tevrede is u met jou tandheelkundige gesondheid?*

1 _____ 2 _____ 3 _____ 4 _____ 5
 Not at all Very satisfied
Baie ontevrede Heeltemaal tevrede

10) How much do you think you need dental treatment? *Hoeveel benodig jy tandheelkundige behandeling?*

1 _____ 2 _____ 3 _____ 4 _____ 5
 Not at all A great deal

- 11) Have you ever received advice on how to care for the health of your mouth?

1 = Yes	2 = No
---------	--------

Het jy ooit advies gekry hoe om jou mond gesond te hou? (Skip to 13)

- 12) If yes, from where did you get this information? (READ CATEGORIES CODE ALL THAT APPLY)
As jy ja beantwoord het, se asseblief waar jy die informasie gekry het?

Family/Friends // <i>Familie of vriende</i>	1
School // <i>Skool</i>	2
TV/ radio	3
Dental/Health Personnel // <i>Tandheelkundige personeel</i>	4
Newspapers or Magazines // <i>Koerante of tydskrifte</i>	5
Other// <i>Ander bronne (Specify//Wees spesifiek)</i>	96
Specify...	

OIDP Assessment

Now I would like to ask you if **problems with your mouth, teeth or dentures** have caused you difficulty with any everyday activities in the past 6 months.

Nou wil ek jou vra oor die uitwerking van enige tandheelkundige probleme op jou daaglikse lewe gedurende die laaste ses maande.

(INSERT ANSWERS to QUESTIONS 13-16 IN THE OIDP ASSESSMENT Chart ON NEXT PAGE).

- 13) In the past six months, have you had any of the problems mentioned in the OIDP Chart below.
Gedurende die laaste ses maande, het jy enige van die volgende probleme ervaar?

(CIRCLE EITHER "Y" OR "N" IN THE OIDP CHART)

(If answer is Yes, GO TO QUESTIONS 14-16 WITH THIS DIMENSION)

(If answer is No REPEAT QUESTION 13 WITH NEXT DIMENSION)

- 14) During the past six months how often have you had this problem (INSERT DIMENSION)?
Gedurende die laaste ses maande, hoe gereeld het jy hierdie probleem ervaar?

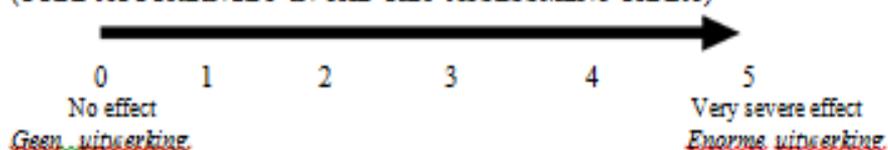
(READ ANSWERS AND CODE IN THE OIDP ASSESSMENT CHART)

<i>Minder as een keer per maand</i> //Less than once a month	1
<i>Een tot twee keer per maand</i> //Once or twice a month	2
<i>Een tot twee keer per week</i> //Once or twice a week	3
<i>Drie tot vier keer per week</i> //Three to four times a week	4
<i>Amper elke dag</i> //Every, or nearly every, day	5

- 15) Using a scale from 0 to 5, where 0 is no effect and 5 is a very severe effect, which number would you say reflects the effect this problem had on your daily life?

Hoe sou jy hierdie probleem op 'n skaal van nil tot vyf tel, as nil beteken geen uitwerking en vyf beteken 'n enorme uitwerking?

(CODE ACCORDINGLY IN THE OIDP ASSESSMENT CHART)



- 16) To which condition(s) do you attribute this impact?
Aan watter rede(s) sou jy hierdie uitwerking toeskryf?

(READ CATEGORIES, CODE ALL THAT APPLY)

Different conditions	Code
<i>Tandpyn</i> //Toothache	1
<i>Sensitiwes tande</i> //Sensitive tooth	2
<i>Tandbederf, 'n gat in jou tand</i> //Tooth decay, hole in a tooth	3
<i>Gebreuke tand</i> //Fractured tooth	4
<i>Verlies van 'n tand(e)</i> //Tooth loss	5
<i>Los tand(e)</i> //Loose tooth.	6
<i>Gekleur van tande</i> //Colour of teeth	7
<i>Rangskikking van jou tande</i> //Position of teeth (crooked, gap)	8
<i>Vorm of grootte van tande</i> //Shape or size of teeth	9
<i>Tandbleis, wat bloei</i> //Bleeding gums	10
<i>Ongesweldde tandbleis of abscess</i> //Swollen gums, gum abscess	11
<i>Ander tandbleis siektes</i> //Receding gums, gum disease, pyorrhoea	12
<i>Tartar of groewes</i> // Calculus,	13
<i>Mondwess</i> //Oral ulcer or sore spot	14
<i>Stink asem</i> //Bad breath	15
<i>Mond mismaaktheid</i> //Deformity of mouth or face (cleft lip, cleft palate)	16
<i>Snaakse geluide by kakabeen lit</i> //Clicking or grating noise in jaw joint	17
<i>Tandstopel verkeerde kleur of afgebreek</i> //Improper filling or crown	18
<i>Tandstelsel los</i> //Loose ill fitting denture or plate	19
<i>Orthodontiese stel</i> //Orthodontic appliance, wires or bands	20
<i>Ander rede</i> //Other (SPECIFY//Wees spesifiek)	96

OIDP Assessment Chart

Dimensions	Questions			
	13 Y/N	14 Frequency	15 Severity	16 Condition
<i>As jy.....</i> //When you are...				
<i>Kos eet</i> //Eating Food	Y/N			
<i>Suiver wil praat</i> //Speaking clearly	Y/N			
<i>Tande skoonmaak</i> //Cleaning your teeth/dentures	Y/N			
<i>Huishoudelike werk</i> //Doing light activities such as household cleaning and maintenance, working on a car, playing games	Y/N			
<i>Kragtige aktiwiteit</i> //Vigorous activities such as running, lifting heavy objects, strenuous sports	Y/N			
<i>Slaap</i> //Sleeping	Y/N			
<i>Ontspan</i> //Relaxing - reading, watching TV, listening to music	Y/N			
<i>Glimlag of lag</i> //Smiling, laughing and showing teeth without embarrassment	Y/N			
<i>Dit laat my meer emosioneel voel</i> //With your emotional state, for example, becoming more easily upset than usual	Y/N			
<i>Gemaklikheid by vriende, and familie</i> //Enjoying the contact of other people, such as relatives, friends or neighbors	Y/N			

1

Gesondheid aktiwiteite/Health Behaviours

Now, I would like us to focus on some basic behaviours that are related to health.
 Nou wil ons ook sekerse gesondheids aktiwiteite praat.

17) Did you clean your **teeth/dentures** yesterday?
 Het jy jou tande/kunstande gister skoongemaak?

1 = Yes	2 = No
(Skip to 20)	

18) How many times did you clean your **teeth/dentures** yesterday?
 Hoeveel keer het jy jou tande gister skoongemaak?
 (READ ANSWERS)

Eenkeer/Once	1
Tweekeer/Twice	2
Meer/More than twice	3



19) Which of the following items did you use to clean your teeth?
 Wat het jy gebruik om jou tande skoon te maak
 (READ ANSWERS, CODE ALL THAT APPLY)

Toothbrush/Borsel	1
Chewing stick/stok	2
Finger/Vinger	3
Fluoride toothpaste	4
Floss	5
Toothpick	6
Mouthrinse/Spoel	7
Other...SPECIFY	96

SPECIFY

20) Which of the following drinks do you have on a typical day and how many times?
 Watter van die volgende (soel of warm) drankte gebruik jy op 'n gewone dag?
 (READ CATEGORIES, SPECIFY NUMBER OF TIMES FOR EACH)

	Code	# Times/Hoeveel keer per dag	
Gewone sodas/colas/Regular fizzy drinks	1		Hoeveel teelepels? → _____
Diet soda (fizzy) drinks	2		
Vrugtesap/Fruit juices	3		
Sport drankte/Sport drinks	4		
Tee/buffie met suiker/Tea/coffee with sugar	5		
Versoete melkdrank/Sweetened flavored milk	6		
Ander versoete drankte/Other sweet drinks	96		

21) How many times do you have a sweet snack on a typical day?
 Hoeveel keer eet jy versoete eetgoedies op 'n gewone dag?
 (E.G. SUGARED GUM, COOKIES/BISCUITS, RAISINS, CAKE, CANDY)

If you use any of the following, please indicate if you use them and how much you use them.
 As jy enige van die volgende gebruik, sê asseblief hoe gereeld jy hulle gebruik.

	Yes/No	Frequency
22) How many alcoholic drinks do you drink in a typical week? Hoe veel alkoholiese drankte gedurende 'n gewone week?	_____	_____drinks/week
23) How many times do you use tobacco (smoke, chew, snuff) on a typical day? Hoe veel keer per dag gebruik jy enige vorm van tabak gedurende 'n gewone week?	_____	_____times/day
24) How many times do you use pan betel nut on a typical day? Hoe veel keer per dag gebruik jy pan betel nut?	_____	_____times/day

The following are behaviour changes that some people might make to improve their dental health. Please indicate your readiness to do the following on a scale from 1-10, where 1="Not at all ready" and 10="Doing this already".

Om mondigesondheid te verbeter, dit is moontlik om een van die volgende persoonlike aksies te neem. Sê asseblief, hoe gereeld jy is om elkeen van die volgende strategies te onderneem op 'n skaal van 1 tot 10 waar 1="Heeltemaal nie gereed om dit te doen" and 10="Alreeds besig om dit te doen"

1	4	6	8	10
<i>Nie gereeld</i> Not at all ready to do this (1-3)	<i>Dink daaroor</i> Thinking about it (4-6)	<i>Bepal om te begin</i> Planning and making a commitment to do this (7-9)	<i>Besig om dit te doen</i> Doing this already (10)	

(ENTER VALUE INTO "NUMERIC READINESS" COLUMN)

<i>Strategie/Behaviour</i>	Numeric Readiness (1-10)	N/A
25) <i>Gebruik van Fluoried tandepaste</i> // Start using fluoride toothpaste		
26) <i>Maak tande daaglik skoon</i> // Clean teeth daily		
27) <i>Verminder suiker gebruik</i> // Reduce sugar intake		
28) <i>Stop alkohol gebruik</i> // Quit drinking alcohol		
29) <i>Stop tabak gebruik</i> // Quit using tobacco		
30) <i>Stop pan/besi nut gebruik</i> // Quit using pan betel nut		

Tandheelkundige Versorg//Dental Care

Finally, I am going to ask you a few questions in relation to the dental care you received.

Uiteindelik wil ons 'n paar vrae vra oor tandheelkundig behandeling wat jy gekry het.

- 31) Have you ever sought dental care? 1=Yes 2=No
(SKIP TO END)
Het jy ooit tandheelkundige behandeling probeer vind?
- 32) If yes, from whom did you seek care? *As jy ja beantwoord het, by wie het jy dienste versorg?*
(READ CATEGORIES, CODE ALL THAT APPLY)

<i>Tandarts//Dentist</i>	1
<i>Therapeut/Dental therapist/assistant</i>	2
<i>Skool kliniek//School clinic</i>	3
<i>Traditionele heiler//healer</i>	4
<i>Hospitaal//Hospital</i>	5
<i>Mediese dokter//Medical practitioner</i>	6
<i>Apteker//Pharmacist</i>	7
<i>Kruiedokter//Herbalist</i>	8
<i>Primêre gesondheid diens//PHC service</i>	9
<i>Ander//Other (SPECIFY)</i>	96
<i>SPECIFY.....</i>	

- 33) How long ago was your last dental visit? *Maande*
//Months
Hoe lank gelede was jou laaste tandheelkundige afspraak of besoek

- 34) In general, how often do you seek dental care?
Oor die algemeen, hoe gereeld soek jy tandheelkundige behandeling?
 (READ ANSWERS, CODE ONLY ONE)

<i>Gereeld</i> //Regularly	1
<i>Soms</i> //Occasionally	2
<i>Net as ma gebeur</i> //Only when in trouble/pain	3

- 35) When you wish to get dental care, what makes it difficult for you to obtain it?
As jy probeer om tandheelkundige behandeling te kry, wat maak dit moeilik?
 (READ ANSWERS, CODE ALL THAT APPLY)



<i>Moeilik om te betaal</i> //Inability to pay/no insurance	1
<i>Vervoer probleme</i> //Transport difficulties	2
<i>Taal/vertolking probleme</i> //Language barriers	3
<i>Lang tye en wagtye</i> //Queues/waiting times	4
<i>Tyd af van die werk te neem</i> //Time off work	5
<i>Moeilik om 'n afspraak te kry</i> //Difficult to get appointment	6
<i>Geen telefoon om afspraak te maak</i> //Lack of telephone to make appointment	7
<i>Kan nie goeie tandarts/kliniek vind nie</i> //Can't find a good dentist clinic	8
<i>Diskriminasie</i> //Discrimination by race/ethnicity, social class, sexual orientation, HIV status	9
<i>Vrees vir tandarts/die behandeling</i> //Fear of dentist dental care procedures	10
<i>Gebrek aan kindersorg</i> //Lack of childcare	11
<i>Ontevrede met die skoonheid van die kliniek</i> //Lack confidence in cleanliness at dental clinic	12
<i>Min vertroue dat behandeling sal help</i> //Lack confidence dental treatment will work	13
<i>Ontevrede met vorige keer se behandeling</i> //Dissatisfaction with previous dental service	14
<i>Beskikbaarheid van die dienste</i> //Availability of services	15
<i>Ander</i> //Other (SPECIFY)	16

SPECIFY _____

- 36) How do you feel when you make a dental visit?
Hoe voel jy gedurende 'n besoek aan die tandarts?
 (READ ANSWERS, CODE ONLY ONE)

<i>Nie seenuoseagtig nie</i> //Not at all nervous	1
<i>A bietjie seenuoseagtig</i> //A little bit nervous	2
<i>Redelik seenuoseagtig</i> //Fairly nervous	3
<i>Baie seenuoseagtig</i> //Really frightened, very nervous	4

- 37) What could be done to make taking care of your mouth easier?
Wat kan gedoen word om die versorg van jou mond makliker to maak?
 (RECORD EXACTLY WHAT PARTICIPANT SAYS)
 SPECIFY _____

5.2. Cross-Sectional Quality of Life study: Informed Consent Form

INFORMATION AND INFORMED CONSENT DOCUMENT:

TITLE OF THE RESEARCH PROJECT:

Level of occlusion satisfying oral functional needs and oral health-related quality of life of partially dentate patients

REFERENCE NUMBER _____

PRINCIPAL INVESTIGATOR: Dr Saadika Khan

DECLARATION BY/ OR ON BEHALF OF PATIENT/*PARTICIPANT:

I, THE UNDERSIGNED,

_____ (name)
 _____ ID No of the patient/*participant or* in my capacity as
 _____ (address).

A. HEREBY CONFIRM AS FOLLOWS:

1. I/*The patient/*participant was invited to participate in the above mentioned research project which is being undertaken by the Department of Prosthetic Dentistry, Faculty of Dentistry, University of the Western Cape.
2. The following aspects have been explained to me/*the patient/*participant:
 - 2.1 Aim: To determine the level of occlusion that satisfies the oral functional needs and oral health-related quality of life of partially dentate patients
 - 2.2 Procedures: A set of partial - dentures or fixed removable dentures will be made for you as part of your routine treatment. You will be asked a number of questions relating to oral problems that you may have experienced in the last 4 weeks. The aim is to try and establish how these problems have affected your quality of life. You will be requested to respond to a set of standard questions prior to you commencing treatment. Your participation in this study consists of two interviews, i.e. a pre-treatment interview on your first visit and a post treatment interview 6 months later following the receipt of your new prostheses. Each interview should last no longer than 15 minutes. To control for bias, subjects to be recruited for the study are to be assured that the research workers are not involved in their treatment and that their participation in the study would not influence the outcome of their treatment.
 - 2.3 Confidentiality: The information is strictly confidential and although the findings will be reported on at a scientific meeting or in a scientific publication you will not be identified.
 - 2.4 Voluntary participation/refusal/discontinuation: You are completely free to take part in the study, in which case you need to sign the attached consent form. You also have the right to refuse or withdraw from the study at any time without it affecting your future treatment. If you decide against

participating, it will not be held against you and you will still receive treatment as specified in your file

3. The information above was explained to me/*the patient/*participant by

_____ (name of relevant person) in

Afrikaans/*English_____ and I am/*the participant/*patient is in command of this language/*it was satisfactorily translated to me/*him/*her by

_____ 122 (name of translator). I/*The participant/*patient was given the opportunity to ask questions and all these questions were answered satisfactorily.

4. No pressure was exerted on me/*the patient/*participant to consent to participation and I/*the participant/*patient understand(s) that I/*the participant/*patient may withdraw at any stage without any penalization.

5. Participation in this study will not result in any additional costs to myself/*the participant/*patient nor will I be paid.

B. I HEREBY CONSENT VOLUNTARILY TO PARTICIPATE IN THE ABOVEMENTIONED PROJECT/*THAT THE PATIENT/*POTENTIAL PARTICIPANT MAY PARTICIPATE IN THE ABOVEMENTIONED STUDY.

Signed/confirmed at _____ on _____ 20

(place) _____

Signature or right thumb print of patient/*representative of the patient/*participant

Signature of witness

STATEMENT BY OR ON BEHALF OF INVESTIGATOR(S):

I, _____, declare that

• I explained the information given in this document to

_____ (name of the patient/*participant) and/*or his/*her representative

_____ (name of the representative);

• he/*she was encouraged and given ample time to ask me any questions;

• this conversation was conducted in Afrikaans/*English/*Xhosa/*Other

_____ and no translator was used/*this conversation was translated into _____

(language) by _____ (name).

Signed at _____ on _____ 20__ (date), _____ (place).

Signature of investigator/*investigator's representative

Signature of witness

5.3. Cross-Sectional Quality of Life study: Ethics Approval



**Office of the Deputy Dean
Postgraduate Studies and Research**
Faculty of Dentistry & WHO Collaborating Centre for Oral Health



UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 04th March 2011

For Attention: Dr S Khan
Department of Restorative Dentistry

Dear Dr Khan

STUDY PROJECT: The level of occlusion that satisfies function and oral health-related quality of life of partially dentate adult patients

PROJECT REGISTRATION NUMBER: 11/1/50

ETHICS: **Approved**

At a meeting of the Senate Research Committee held on Friday 4th February 2011 the above project was approved. This project is therefore now registered and you can proceed with the work. Please quote the above-mentioned project numbers in all further correspondence.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Sudeshni Naidoo', written over a horizontal line.

Professor Sudeshni Naidoo

6.1. Randomized Controlled Trial: Information Letter



UWC Faculty of Dentistry & WHO Oral Health Collaborating Centre

RESEARCH RELATED TO THE SHORTENED DENTAL ARCH (SDA)

This Research is conducted by Dr S Khan of the University of the Western Cape Dental Faculty. The aim is to conduct a Clinical Trial to assess the outcomes of treatments (using a removable partial denture or not) for patients with a classic SDA. The researcher also wants to determine patient satisfaction regarding these treatments. It is well-known that prosthetic practices are constantly evolving (incl. procedures and materials). But it is less certain whether the teachings are reaching dentists (who need to change their clinical practices) and patients (who could benefit from these clinical procedures).

The classic **SDA** is described as having only 20 occluding anterior and premolar teeth, thus preserving a functional dental arch. The SDA has been researched widely and can be regarded as a viable alternative for the partially dentate patients. Benefits of the SDA include: better **patient compliance** with OH; **cost reduction** due to more effective resource allocation to teeth with a **favourable prognosis** (viz. anterior and premolars) and less expenditure on molars which are at greater risk of caries and periodontal disease and application to the needs of special groups such as **handicapped** and some younger **high-risk** patients (Käyser, 1981; Omar, 2004).

Participation in this clinical trial can assist us in presenting all the latest research to you and in teaching students *workable* new concepts. Your invaluable input will make a tremendous contribution in this regard. This research involves: (i) giving and filling-out the consent form; (ii) screening of patients with basic treatment preparations; (iii) clinical procedures to prepare for the clinical trial (if needed); and (iv) participation in the trial until completion of study. *If after completion of the trial, you still feel the need for a prosthesis one will be provided without any additional costs to you.* Results of the clinical trial will be shared in relevant Journal Articles.

Thanking you in anticipation for your time and effort.

Dr S. Khan



UNIVERSITY of the
WESTERN CAPE

A place of quality, a place to grow, from hope to action through knowledge

6.2. Randomized Controlled Trial: Demographics Details



Department of Restorative Dentistry Faculty of Dentistry & WHO Oral Health Collaborating Centre

Private Bag X1, ~~Stellenbosch~~ 7705 Private Bag X05, Mitchell's Plain 7785
South Africa South Africa
Telephone: 427 21 957 5006 Telephone: 427 21 970 4414
Email: skhan@uwc.ac.za

PATIENT PERSONAL DETAILS

Record Number:

Instructions:

Please fill in your personal details below.

Name:

Contact Tel Number/s:

Age: Gender:

Marital Status:

Level School/Tertiary Qualifications:
.....

Income Category:
Low (R0 – R 2000):
Middle (R 2000-R 10 000):
High (R 10 000-above):

Current Employment Details (More than one entry is allowed):

Self employed: No of Years:

Public Service: No of Years:

Profession: No of Years:

Unemployed: No of Years:



UNIVERSITY of the
WESTERN CAPE

A place of quality, a place to grow, from hope to action through knowledge

6.4. Randomized Controlled Trial: Informed Consent Form



UWC Faculty of Dentistry & WHO Oral Health Collaborating Centre

INFORMED CONSENT FOR THIS SHORTENED DENTAL ARCH STUDY

I would appreciate your participation in this research study as explained to you at the initial clinical visit. There are no known risks associated with participating in this Study. Your personal information will be strictly confidential and your identity will be protected at all times. You also have the option to refuse to participate in this Clinical Trial and nothing will be held against you for your choice. If you would like to withdraw from the Research at any future stage, please feel comfortable to inform me as such.

If you have any further queries, comments, suggestions or want any more information about this Research, please contact:

Dr S Khan: Tel (w) 021 9373006, Fax: 021 937 3025 or E-mail her at: skhan@uwc.ac.za.

Thanking you in anticipation.

Dr S. Khan

IF YOU WANT TO WILLINGLY PARTICIPATE IN THIS RESEARCH,

Please complete and sign the form below and return to the Researcher.

Alternatively, e-mail the completed form to the above e-mail address.

I agree to participate in this Research:

Name: _____

Address: _____

Tel Number: _____

Cell Number: _____

E – Mail: _____

Fax Number: _____

Signature: _____



**UNIVERSITY of the
WESTERN CAPE**

A place of quality, a place to grow, from hope to action through knowledge

6.5. Randomized Controlled Trial: Ethics Approval from UWC



**Office of the Deputy Dean
Postgraduate Studies and Research**
Faculty of Dentistry & WHO Collaborating Centre for Oral Health



UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 20th July 2012

For Attention: Dr S Khan
Restorative Dentistry

Dear Dr Khan

STUDY PROJECT: Outcomes of interventions for patients with a classic shortened dental arch: a randomized control trial

PROJECT REGISTRATION NUMBER: 12/5/4

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 8th June 2012 the above project was approved. This project is therefore now registered and you can proceed with the study. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

Professor Sudeshni Naidoo

Randomized Controlled Trial: Ethics Approval from Stellenbosch University



UNIVERSITEIT-STELLENBOSCH-UNIVERSITY
jou kennisvermoogen - your knowledge partner

Approved with Stipulations New Application

12-Nov-2013
Khan, Sadika S
Stellenbosch, WC

Ethics Reference #: S13/04/066

Title: Outcomes of interventions for patients with a classic shortened dental arch A randomized Controlled trail

Dear Dr Sadika Khan,

The New Application received on 17-Apr-2013, was reviewed by Health Research Ethics Committee 1 via Committee Review procedures on 06-Nov-2013.

Please note the following information about your approved research protocol:

Protocol Approval Period: 06-Nov-2013 -06-Nov-2014

Present Committee Members:

WELZEL, Tyson B
Barsdorf, Nicola
Whitelaw, David DA
Seedat, Sornya S
Theunissen, Marie ME
Kearns, E
Weber, Franklin CFS
Unger, Marianne M
Nel, Etienne EDLR
Sprenkels, Marie-Louise MHE
Els, Petrus PJJ
Potgieter, Sunita S
Mukinda, Fidele FK
Ferris, William WF
Burgess, Lesley

The Stipulations of your ethics approval are as follows:
Minor modifications to consent document required.

Please remember to use your protocol number (S13/04/066) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note a template of the progress report is obtainable on www.sun.ac.za/rdc and should be submitted to the Committee before the year has expired.

The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research

that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/hrs

If you have any questions or need further assistance, please contact the HREC office at 0219389657.

Included Documents:

CV CHIKTE
DEC LETTER KHAN
CHECKLIST
PATIENT FORM
RCT Protocol
Revised Protocol
PROTOCOL
CV KHAN
COV LETTER
BUDGET
PATIENTS DETAILS
PHD One Pager
COURSE REG FORM
IC FORM
VISUAL SCALE
APPLIC FORM
SYNOPSIS
QUEST
DEC LETTER CHIKTE

Sincerely,



Franklin Weber
HREC Coordinator
Health Research Ethics Committee 1

6.6. Randomized Controlled Trial: Registration with *clinicaltrials.gov*

ClinicalTrials.gov PRS
Protocol Registration and Results System

ClinicalTrials.gov Protocol and Results Registration System (PRS) Receipt
 Release Date: 01/14/2016

ClinicalTrials.gov ID: NCT01597206

Study Identification

Unique Protocol ID: SDA Clinical Trial
 Brief Title: Interventions for Patients With a Shortened Dental Arch (SDA-RCT)
 Official Title: Outcomes of Interventions for Patients With a Reduced Posterior Dental Arch: A Randomized Controlled Trial
 Secondary IDs: SDA South African RCT [UWC- SA]

Study Status

Record Verification: January 2016
 Overall Status: Recruiting
 Study Start: January 2014
 Primary Completion: December 2016 [Anticipated]
 Study Completion: December 2017 [Anticipated]

Sponsor/Collaborators

Sponsor: University of the Western Cape
 Responsible Party: Principal Investigator
 Investigator: Dr Saadika Khan [skhan]
 Official Title: Dr
 Affiliation: University of the Western Cape
 Collaborators: University of the Western Cape

Oversight

FDA Regulated?: No
 IND/IDE Protocol?: No
 Review Board: Approval Status: Approved
 Approval Number: 12/5/4
 Board Name: University of Western Cape Research Committee
 Board Affiliation: Staff Member
 Phone: 021 9592911
 Email: rchristie@uwc.ac.za
 Data Monitoring?: Yes
 Plan to Share Data?: Yes
 By publishing the results in a reputable (peer reviewed and accredited) journal

6.7. Randomized Controlled Trial: CONSORT Statement


CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	2
Introduction			
Background and objectives			
	2a	Scientific background and explanation of rationale	3-4
	2b	Specific objectives or hypotheses	4
Methods			
Trial design			
	3a	Description of trial design (such as parallel, factorial) including allocation ratio	4-5
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	5
Participants			
	4a	Eligibility criteria for participants	5
	4b	Settings and locations where the data were collected	5
Interventions			
	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	5-6
Outcomes			
	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	6
	6b	Any changes to trial outcomes after the trial commenced, with reasons	5-6
Sample size			
	7a	How sample size was determined	5-7
	7b	When applicable, explanation of any interim analyses and stopping guidelines	6-7
Randomisation:			
Sequence generation			
	8a	Method used to generate the random allocation sequence	5-6
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	5-6
Allocation concealment mechanism			
	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	5-6
Implementation			
	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	5-6
Blinding			
	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	5-6

		assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	6
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	6
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	N/A
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	8
	13b	For each group, losses and exclusions after randomisation, together with reasons	8
Recruitment	14a	Dates defining the periods of recruitment and follow-up	6-7
	14b	Why the trial ended or was stopped	7
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	7.. YES
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	7-8..YES
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	8
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	11
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	10-11
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	10-11
Other information			
Registration	23	Registration number and name of trial registry	ClinicalTrials.gov Identifier: NCT01597206
Protocol	24	Where the full trial protocol can be accessed, if available	ClinicalTrials.gov
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Institutional

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

6.8. Randomized Controlled Trial: Sample Size Estimation

The importance of conducting clinical research in dentistry cannot be over-emphasized as no amount of non-clinical evidence can define the effectiveness, relevance or significance of procedures or materials without determining their clinical impact. Clinical research, however, is more often than not avoided, and this is mainly due to the extensive list of generic problems experienced with conducting this type of research. Some of the problems more commonly experienced with clinical research are [1-5]:

(i) patient-related: estimating statistically validated samples from the population and determining sample size prior to conducting the study by power calculations, ethical considerations and obtaining informed consent from study subjects, vigorous recruitment of appropriate patients that ensures generalizability of results, timing of the study, daily-life issues in retaining patients in the study and controlling the drop-out rate, compensating patients to be part of the study and the costs incurred to them;

(ii) procedure- or material-related: ethics of using certain procedures or materials on patients, errors when designing the study (methodology), extended time-periods over which the study is conducted, excessive costs of related clinical procedures and materials, validity and reliability and the methods proposed when conducting the research, and

(iii) co-researchers-related: buy-in from faculty, other collaborators and research teams that are required to successfully complete a study and the obligatory involvement of all in controlling study bias. All of these problems have to be circumvented before any meaningful and reliable data can be obtained [1-3].

As regards the RCT conducted as part of the present SDA research, specific problems related to sample size and suitable participants were encountered [6]. An RCT design was chosen for the strength of evidence obtainable based on the internal validity and unbiased estimates of effectiveness of the interventions under investigation [4]. The sample size that was estimated by the traditional process, and was thus needed, was so large that it would have restricted or even eliminated the possibility of conducting the study [5]. Moreover, the researcher experienced difficulties in recruiting the particular patients required for the study [6]. Given these restrictions, alternatives for estimation of sample size were explored.

Sequential sampling (SS) is a non-probability sampling technique where neither the sample size nor the timeframe for data collection is fixed in advance [7-9]. Data are collected and analysed in sets of patients depending on the stopping rule which formed part of the initial decision. Regarding the stopping rule, using the available variables of sample size, statistical significance and the minimum mean difference set by the researchers, a decision was made to:

- a) Accept either the null or alternative hypothesis and stop sampling if the estimated power was greater than 80%, or
- b) Continue sampling if the power calculated is below 80%, and then increase the sample size by adding another set of patients [7-9].

Comparing sequential sampling, in which there is an alternative to stop or to continue , sampling, with the traditional type of sampling, where sample size is fixed in advance and the null hypothesis is either accepted or rejected or the alternate hypothesis is accepted, the difference with respect required sample size is evident [5, 7-9].

Difficulties that may be addressed and resolved with sequential sampling include:

- statistical validation of the sample obtained from the population,
- recruitment of appropriate numbers and types of patients,
- generalizability of study outcomes to the population, and
- reduction in the time-period over which the study is to be conducted.

Thus the generic problems noted with clinical research, and more particularly with RCTs, which include recruitment of appropriate patients, sampling, clinical scenarios, setting or location, funding and costs involved and patient loss due to the time-taken for the study, may be reduced with this type of alternative study technique.

Several other advantages were also noted using this type of sampling technique which include:

- reduced recruitment time for study subjects,
- reduced time of involvement of patients in the study,
- no overestimation of the study subject numbers,
- decreased exposure to risks for study patients,
- a smaller chance of unethical practices, and

- conclusions that may be reached earlier than had researchers followed the traditional sampling and testing methods.

For all the foregoing reasons, there was an overall reduction in costs, time and effort in conducting the RCT with the SS technique [7-9].

References

1. Clark GT, Mulligan R. (2011). Fifteen common mistakes encountered in clinical research. *J Prosthodont Res* 55:1-6.
2. Whitham D, Silcocks P, Whitehouse W, Hodgson S, Sammons H. (2009). An example of problems that arise from clinical trials and how to avoid them. *The Pharm J* 283:129.
3. Fleming PS, Lynch CD, Pandis N. (2014). Randomized controlled trials in dentistry: Common pitfalls and how to avoid to them. *J Dent* 42:908-914.
4. Webb P, Bain C, Pirozzo S. (2005). Essential epidemiology: An introduction for students and health professionals. Cambridge University Press, UK.
5. Dawson B, Trapp RG. (2004). Basic and Clinical Biostatistics. 4th Ed, Lange Medical Books/McGraw-Hill Publishing Division, New York, USA.
6. Khan SB, Chikte UME, Omar R. (2017). Outcomes with a Posterior Reduced Dental Arch: A Randomized Controlled Trial. *J Oral Rehabil* DOI: 10.1111/joor.12549.
7. Armitage P. (1958). Sequential Methods in Clinical Trials. *Am J Public Health* 48(10):1995-2002.
8. Donaldson AN, Whitehead J, Stephens R, Machin D. (1993). A simulated sequential analysis based on data from two MRC trials. *Br J Cancer* 68(6):1171-78.
9. NIST/SEMATECH e-Handbook of Statistical Methods, <http://www.itl.nist.gov/div898/handbook/chapter6/2012>.

7.1. Overview of Systematic Reviews: AMSTAR Checklist

AMSTAR: A measurement tool to assess the methodological quality of systematic reviews.

1. Was an 'a priori' design provided?

The research question and inclusion criteria should be established before the conduct of the review.

- Yes
- No
- Can't answer
- Not applicable

Note: Need to refer to a protocol, ethics approval, or pre-determined/a priori published research objectives to score a "yes."

2. Was there duplicate study selection and data extraction?

There should be at least two independent data extractors and a consensus procedure for disagreements should be in place.

- Yes
- No
- Can't answer
- Not applicable

Note: 2 people do study selection, 2 people do data extraction, consensus process or one person checks the other's work.

3. Was a comprehensive literature search performed?

At least two electronic sources should be searched. The report must include years and databases used (e.g., Central, EMBASE, and MEDLINE). Key words and/or MESH terms must be stated and where feasible the search strategy should be provided. All searches should be supplemented by consulting current contents, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.

- Yes
- No
- Can't answer
- Not applicable

Note: If at least 2 sources + one supplementary strategy used, select "yes" (Cochrane register/Central counts as 2 sources; a grey literature search counts as supplementary).

4. Was the status of publication (i.e. grey literature) used as an inclusion criterion?

The authors should state that they searched for reports regardless of their publication type. The authors should state whether or not they excluded any reports (from the systematic review), based on their publication status, language etc.

- Yes
- No
- Can't answer
- Not applicable

Note: If review indicates that there was a search for "grey literature" or "unpublished literature," indicate "yes." SIGLE database, dissertations, conference proceedings, and trial registries are all considered grey for this purpose. If searching a source that contains both grey and non-grey, must specify that they were searching for grey/unpublished lit.

5. Was a list of studies (included and excluded) provided?

A list of included and excluded studies should be provided.

- Yes
- No
- Can't answer
- Not applicable

Note: Acceptable if the excluded studies are referenced. If there is an electronic link to the list but the link is dead, select "no."

6. Were the characteristics of the included studies provided?

In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions and outcomes. The ranges of characteristics in all the studies analyzed e.g., age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases should be reported.

- Yes
- No
- Can't answer
- Not applicable

Note: Acceptable if not in table format as long as they are described as above.

7. Was the scientific quality of the included studies assessed and documented?

'A priori' methods of assessment should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.

- Yes
 No
 Can't answer
 Not applicable

Note: Can include use of a quality scoring tool or checklist, e.g., Jadad scale, risk of bias, sensitivity analysis, etc., or a description of quality items, with some kind of result for EACH study ("low" or "high" is fine, as long as it is clear which studies scored "low" and which scored "high"; a summary score/range for all studies is not acceptable).

8. Was the scientific quality of the included studies used appropriately in formulating conclusions?

The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review, and explicitly stated in formulating recommendations.

- Yes
 No
 Can't answer
 Not applicable

Note: Might say something such as "the results should be interpreted with caution due to poor quality of included studies." Cannot score "yes" for this question if scored "no" for question 7.

9. Were the methods used to combine the findings of studies appropriate?

For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (i.e., Chi-squared test for homogeneity, I^2). If heterogeneity exists a random effects model should be used and/or the clinical appropriateness of combining should be taken into consideration (i.e., is it sensible to combine?).

- Yes
 No
 Can't answer
 Not applicable

Note: Indicate "yes" if they mention or describe heterogeneity, i.e., if they explain that they cannot pool because of heterogeneity/variability between interventions.

10. Was the likelihood of publication bias assessed?

An assessment of publication bias should include a combination of graphical aids (e.g., funnel plot, other available tests) and/or statistical tests (e.g., Egger regression test, Hedges-Olkin).

- Yes
 No
 Can't answer
 Not applicable

Note: If no test values or funnel plot included, score "no". Score "yes" if mentions that publication bias could not be assessed because there were fewer than 10 included studies.

11. Was the conflict of interest included?

Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.

- Yes
 No
 Can't answer
 Not applicable

Note: To get a "yes," must indicate source of funding or support for the systematic review AND for each of the included studies.

Shea et al. *BMC Medical Research Methodology* 2007 7:10 doi:[10.1186/1471-2288-7-10](https://doi.org/10.1186/1471-2288-7-10)

Additional notes (in italics) made by Michelle Weir, Julia Worrick, and Carolyn Wayne based on conversations with Bev Shea and/or Jeremy Grimshaw in June and October 2008 and July and September 2010.

7.2. Overview of Systematic Reviews: Ethics Approval



**Office of the Deputy Dean
Postgraduate Studies and Research**
Faculty of Dentistry & WHO Collaborating Centre for Oral Health



UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 16th March 2015

For Attention: Dr S Khan
Faculty of Dentistry
Tygerberg Campus

Dear Dr Khan

STUDY PROJECT: Overview of systematic reviews related to interventions used for treating adult patients with a shortened dental arch

PROJECT REGISTRATION NUMBER: 15/2/9

ETHICS: **Approved**

At a meeting of the Senate Research Committee held on Friday 6th March 2015 the above-mentioned project was approved. This project is therefore now registered and you can proceed with the study. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

A handwritten signature in black ink, appearing to read 'S. Naidoo', written over a horizontal line.

Professor Sudeshni Naidoo

8.1. Presentations of SDA Research at National, International Conferences and Workshops

1. Survey conducted with General Practitioners

Perceptions regarding the shortened dental arch amongst practitioners in the Western Cape

International Association for Dental Research (IADR)-South Africa (SA) 2010: **Oral Presentation**

2. Mixed Method Education Research

A survey of the experiences of senior dental students regarding shortened dental arch

Conference of the European Prosthodontic Association (EPA)-2011; Berne, Switzerland: **Poster Presentation**

Education Colloquium on 4 June 2012, University of the Western Cape: **Oral Presentation**

HELTASA Conference 2013, Stellenbosch, South Africa: **Oral Presentation**

3. Systematic Review related to shortened dental arch

a) Differences in functional outcomes for adult patients with treated and untreated Shortened Dental Arches: A Systematic Review

IADR-SA 2012: **Oral Presentation**

Stellenbosch University Academic Day, Cape Town: **Poster Presentation**

b) Quality Assessments of Systematic Review

Global Session of the IADR 2014, Cape Town, South Africa: **Poster Presentation**

4. Cross-sectional study on Quality of Life

Impact of removable denture prostheses on the functional ability and oral health-related quality of life of a South African partially dentate cohort

EPA-2012, Rotterdam, Netherlands: **Poster Presentation**

5. Randomized Controlled Trial

Outcomes of interventions for patients with a reduced posterior dental arch: A Randomized Controlled Trial

International Congress of Prosthodontists (ICP)-2015, Seoul, South Korea: **Poster Presentation**

6. Overview of Systematic Review

Overview of systematic reviews related to a shortened dental arch

IADR-2015, Pretoria, South Africa: **Oral Presentation**

7. Sequential Sample Size Estimation Technique in Clinical Dental Research

Sequential Sampling Technique: Overcoming concerns of Sample size in Clinical Research in Dentistry; A SDA-RCT case study

IADR-2016, Cape Town, South Africa: **Oral Presentation**

8. Contextual evidence related to the shortened dental arch according to the evidence pyramid

Evidence supporting the shortened dental arch concept for underprivileged South Africans

Global Evidence Summit- September 2017, Cape Town, South Africa: **Poster Presentation**

8.2. POSTERS presented at International Conferences

8.2.1. Mixed-Methods Research presented: European Prosthodontic Association in 2011



Shortened Dental Arch: Survey of the experiences of senior dental students

KHAN SB,* OMAR R, CHIKTE UME
University of the Western Cape (UWC),
South Africa



GOAL
To determine the level of understanding and factors affecting recommendation and implementation of the shortened dental arch (SDA) concept among senior dental students at UWC.

METHOD
A combination of survey, and individual and group interviews were conducted for this research. The cohort included senior students (n=73) and their clinical teachers (n=13). Participants were questioned regarding their understanding of the SDA concept, its application and problems related to its teaching in the undergraduate program. A mixed-method analysis was employed. Quantitative data analyses include frequency distributions, Spearman rank correlations and Chi-squared statistics, while qualitative data were analyzed by the analytical abstraction method and are reported in themes.

RESULTS
The quantitative and qualitative results are presented below:

SURVEY QUESTIONS	STUDENT SURVEY (100% response rate)	TEACHER SURVEY (87% response rate)	QUALITATIVE DATA ANALYSIS	GROUP INTERVIEW (90% response rate)	INDIVIDUAL INTERVIEWS (70% response rate)
Where did they first hear of the SDA	81% University 11% Survey	62% University 8% Survey *	Themes:		
Have they read research related to SDA	77% not read research	77% read research 23% not read research *		New Concepts	'Not know term SDA'; 'SDA is an optional alternative'; 'students show disinterest in SDA'
Do they know the variants of the SDA	77% not know SDA variants	77% know of the variants (Spearman Correlation) *	Classroom and Clinical Teachings	'No emphasis on SDA in class'; teachers not suggest students implement clinically'	'no formal lecture on SDA'; 'teachers not know about SDA'; 'Empower students - share SDA'
Do they agree that patients can function with SDA	84% can function with SDA	85% function with SDA	Minimum clinical requirements or Clinical quotas	'SDA not a quota' therefore 'students not do it' and 'students ignore mentioning the SDA'	'students obsess about quotas'; 'add SDA to quotas, they will do it'; 'Change quota and Health policy'
Will they present the SDA as a treatment option	86% present SDA to patients	85% present SDA to patients	Emergent Themes:		
What prevents them from presenting SDA to patients	86% said having 'no knowledge regarding the SDA'	16% loss income 39% said 'other' (Nothing; Patient preference; Esthetics) *	Transference of theoretical concepts	Student-centred-Learning occurs in class, not in the Clinics	No alignment between classroom and clinical teachings and there are no clinical outcomes
Suggest ions to implement the SDA as a treatment option	51% include as a clinical quota	No Suggestion / Other (Rx-low cost; Education; Research) * Non-committal responses	Evidence-based teachings	is lacking, extensive research is not shared with students	Research conducted locally can assist with implementing the SDA
Do they replace molars in patients with a SDA	45% Yes, (95% Metal /Acrylic D) 19% No; Chi-squared=7.3 *	92% Yes – even though they read research	Problem-oriented treatment	If occurs, SDA should be mentioned, but this does not happen	Students guided by clinical quotas 'unethical' and 'Immoral'
Will they make a denture for a Quota for the SDA patient	50% Yes and 50% No Quota Ch: Chi-squared =9.95 *		Conceptual Analysis:	Students research topics if they deem it important, depends on emphasis by teachers	Empower students using evidence-based teachings

CONCLUSIONS
Students were positive towards the SDA as a treatment option, but not having any related knowledge or encouragement in the clinic is a hindrance in its implementation. Clinical instructions and clinical teacher knowledge appear not to be aligned to classroom teachings.

References are available on request

Acknowledgement: Dr Kotze for his assistance with the data analysis.

8.2.2. Cross-Sectional Quality of Life study related to the SDA presented at the European Prosthodontic Association in 2012, Netherlands



Effect of restoring posterior occlusion on the oral health-related quality of life of partially dentate patients

KHAN SB,* CHIKTE UME, OMAR R

University of the Western Cape (UWC)
Cape Town, South Africa (SA)



OBJECTIVES
To (i) establish patient satisfaction related to oral functioning ability, and (ii) to investigate the relationship between level of occlusion and oral health-related quality of life amongst patients with shortened, discontinuous and interrupted dental arches.

METHOD
A cohort study was conducted amongst partially dentate adult patients (N=56) at the Faculty of Dentistry, UWC, SA. Patients with classic shortened, discontinuous or interrupted dental arches, and requesting removable partial dentures (RPDs), completed the Oral Impacts on Daily Performance (OIDP) questionnaire before and after dental treatment. The data were analysed with the K-Stats and Epi-Info statistical programmes by way of frequency calculations, paired comparisons and Chi-squared statistics to reflect the significance of each statement. Patient informed consent and ethical clearance (No:11/1/50) was obtained.

RESULTS

- ❖ Age range of participants was 28-86 years (mean=58.11).
- ❖ Most patients were female (62.5%), lived in urban areas (92.9%), and were largely unemployed or retired (73.2%).
- ❖ Similar numbers of respondents (35.7%) rated dental health as very good or very poor.
- ❖ 41% were not satisfied with the state of their oral health.
- ❖ 53% felt they were in great need of treatment.
- ❖ Patients received oral care advice mostly from dentists (86%).
- ❖ Frequency of oral impacts experienced by patients with shortened arches were **eating** (71.4%), **smiling** (51.8%) and being **emotional** because of missing teeth (69.6%).
- ❖ A statistically significant ($p < 0.0001$) reduction of negative impacts was observed following treatment with RPDs as observed with the Pearson's correlation tests as well: **Figure 1: Eating** ($\chi^2 = 17.77$; $df=4$, $p=0.001$) and **smiling** ($\chi^2 = 17.81$; $df=4$, $p=0.001$) versus dental health and;
- Figure 2: Eating** ($\chi^2 = 22.53$; $df=4$, $p=0.001$) and **contact with family** ($\chi^2 = 22.15$; $df=4$, $p=0.001$) versus need for dental treatment.

Figure 1: Association between Daily Impacts and state of Dental health

Figure 2: Association between Daily Impacts and need for dental treatment

CONCLUSIONS
In patients presenting with a range of posteriorly reduced, interrupted and discontinuous dental arches, negative oral impacts were greatly reduced after treatment with placement of RPDs, increasing their satisfaction with oral function and improvement in their oral health-related quality of life. Provision of RPDs, even for patients with classic shortened arches, increase the oral health-related quality of life for patients in SA.

References are available on request

8.2.3. Systematic Review: Quality Assessments presented at the Global Session of the International Association Dental Research (IADR) in 2014; Cape Town, South Africa



QUALITY ASSESSMENT OF CLINICAL TRIALS RELATED TO THE SHORTENED DENTAL ARCH

Saadika Khan*

A Musekiwa, UME Chikte, R Omar



Abstract No: 187490

OBJECTIVES

To assess the quality of clinical trials comparing different interventions for shortened dental arches versus restoring complete dental arches in partially dentate adults

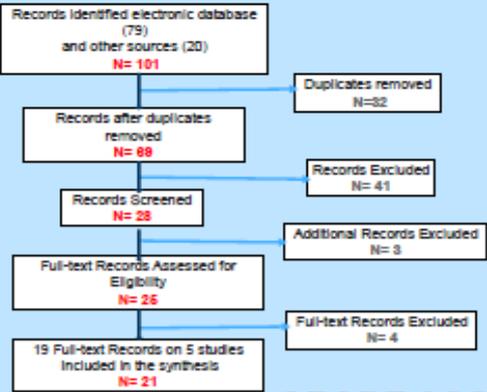
METHODOLOGY

All relevant databases (Medline, Cochrane Central Register of Controlled Trials, EMBASE, CINAHL, Science Direct, ProQuest, Science Journals, Scopus, PsycINFO, WHO ICTRP, ClinicalTrials.gov and PACTR) were searched to identify appropriate randomized and non-randomized clinical trials. Outcomes pre-specified for the study were: *Primary outcomes* - functioning, patient satisfaction and *Secondary outcomes* - survival of intervention and negative effects on oral structures. Trial quality was assessed independently by authors using the Cochrane's risk of bias tool and the Grading of Recommendations Assessment Development and Evaluation (GRADE) approach to grade the evidence and strength of recommendations.

RESULTS

Clinical trials that met the eligibility criteria were included (*PRISMA Flow Diagram*). From the *Risk of Bias Table*, only 2 studies (British and Irish) had a low risk of bias for the entire assessment. After completing the *GRADE assessments*, it was observed that some studies had not followed the exact guidelines for randomized controlled trials but had the features thereof. These were downgraded because they did not use randomization, allocation concealment or blinding, and failed to specify the outcomes as primary or secondary. The small sample sizes seriously affected the imprecision, and the risk of bias was very serious with studies where no blinding and selective reporting was observed. From the combined effects, the overall quality of the clinical trials was assessed as being low. This implies that further studies are likely to have an important impact on our confidence in the estimate of effect, and may change the estimate.

PRISMA FLOW DIAGRAM



COCHRANE'S RISK of BIAS

KEY:
● Low Risk of Bias
● High Risk of Bias
● Unclear Risk of Bias

	Adequate sequence generation?	Allocation concealment?	Blinding?	Incomplete outcome data addressed?	Free of selective reporting?	Free of other bias?
British study (2007)	●	●	●	●	●	●
Danish Study (1990)	●	●	●	●	●	●
Dutch study (2001)	●	●	●	●	●	●
German study (2012)	●	●	●	●	●	●
Irish Study (2012)	●	●	●	●	●	●

GRADE ASSESSMENTS

Some studies have not followed the exact guidelines for conducting randomized controlled trials, but had some features thereof. These were assessed accordingly:

Downgraded - not use randomization, allocation concealment or blinding, and failed to specify the outcomes as primary or secondary, were graded as having moderate quality of evidence.

Imprecision - the small sample sizes seriously affected the imprecision, and the risk of bias was very serious with studies where no blinding and selective reporting was observed graded as having low quality.

Combined effects - the overall quality of the clinical trials was assessed as being low.

This implies that further studies are likely to have an important impact on our confidence in the estimate of effect, and may change the estimate.

CONCLUSIONS

SDAs as a treatment option was encouraging for functioning and patient satisfaction. Clinical trials assessing interventions for treating shortened dental arches were of low quality. Higher quality randomized controlled clinical trials assessing this comparison are urgently required to supply the evidence regarding their effectiveness.

8.2.4. RCT: Presented at the International College of Prosthodontists in 2015; Seoul, South Korea



Ethics No: 12/5/14

INTERVENTIONS TO RESTORE A REDUCED POSTERIOR DENTAL ARCH

KHAN SB,* CHIKTE UME,# OMAR R
 * University of the Western Cape (UWC)
 # Stellenbosch University (SU), South Africa (SA)
(016246161.gov ID#0766: SC702597206)



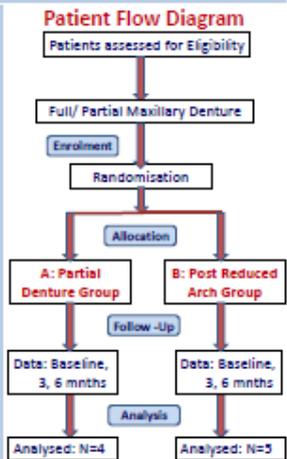
Ethics No: S13/04/066

PURPOSE
 To determine the daily *functional ability*, *patient satisfaction* and *quality of life* of partially dentate adult patients with a reduced posterior dental arch. Outcomes are compared where all missing teeth are replaced with a removable partial denture prosthesis (RPDP) for one group, and no teeth are replaced for the second group.

METHOD

- ❖ A two-arm randomized clinical trial design is employed: Patients with 3-5 occluding units or a 'restored-to-3 occluding unit' status are randomized into either a group with a RPDP (Group A) or no RPDP/ Posterior Reduced Arch (Group B).
- ❖ Allocation concealment is ensured using opaque sealed envelopes for each intervention and is administered by a research assistant.
- ❖ The study sample will be finalized by *sequential sampling* and data analysis will be completed in stages until saturation.
- ❖ Subjective and objective outcomes, function, survival of teeth and prostheses is evaluated at 3 months post intervention. Oral functional satisfaction is determined using the *Oral Impacts of Daily Performance (OIDP)*. A global *Visual Analogue Scale (VAS)* focusing on state of mouth/ need for treatment and intervention pre- and post-treatment is completed to correlate the results to that of the OIDP. Statistical analysis is completed by the '*intention-to-treat*' principle, and includes primary and secondary outcomes reporting and that of excluded/ withdrawn data.

Patient Flow Diagram



RESULTS

Preliminary results of an ongoing trial showed:

- ❖ *Age range* of participants as 28-55 years (mean=39.4, SD=9.2) with an equal *gender* spread.
- ❖ 70% of patients had left *school* early and only 30% had a tertiary education.
- ❖ *Income level*: 50% in the low/ middle category.
- ❖ 80% *worked* in the public sector.

OIDP:

- ❖ Majority (80%) did not report negative *oral impacts*.
- ❖ One patient (dissatisfied with functioning) reported negatively on *eating* and *being emotional* with wearing the denture.
- ❖ 80% of the patients indicated their interventions of Denture/ No Denture as successful.

VISUAL ANALOGUE SCALE (VAS)	ORAL IMPACTS OF DAILY PERFORMANCE (OIDP)		
	Dental Health	Satisfaction with Oral Health	Need for Treatment
1. State of Mouth/Teeth	0.261	0.284	-0.798 (p=0.05)
2. Satisfaction with Mouth/Teeth	0.443	0.502	-0.470
3. Need for Treatment	0.293	-0.172	0.532
4. Intervention on Mouth/Teeth	0.430	0.574	-0.048
5. Intervention on Quality of Life (03-3 Pre Intervention) (04-5 Post Intervention)	0.368	0.670 (p=0.05)	-0.129

Table: Correlation between VAS and OIDP:
 As the VAS1 score increased, the *need for treatment* decreased (p=0.05). The effect of the intervention (Denture/ No denture) on the *quality of life* increased (VAS5 score), increasing patient satisfaction (p=0.05) and reducing the need for more treatment.

CONCLUSION: Patients with a reduced posterior dental arch reported greater satisfaction without treatment compared to those with a complete dental arch extended with a chrome cobalt removable prosthesis. The results may not be generalized to all patients, the current sample needs to be increased.

References are available on request

8.2.5. Contextual evidence related to the shortened dental arch according to the evidence pyramid: To be Presented at the Global Evidence Summit- 2017, Cape Town South Africa.



EVIDENCE SUPPORTING THE SHORTENED DENTAL ARCH CONCEPT

KHAN SB,¹ CHIKTE UME,² OMAR R.³
¹University of the Western Cape
²Stellenbosch University, South Africa; ³Kuwait University, Kuwait.



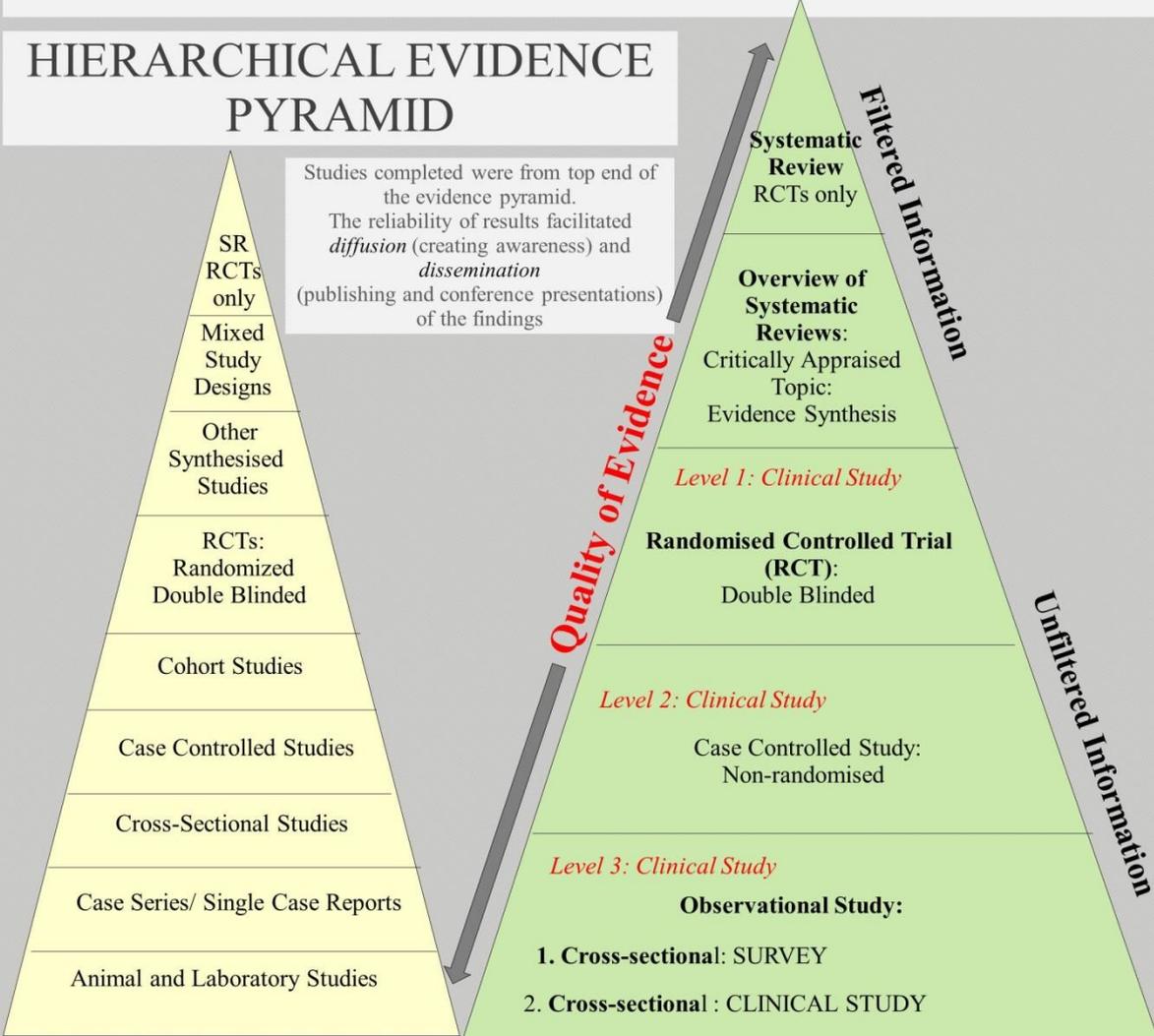
Objectives

To provide evidence to support the preservation of a functional dentition represented by a shortened dental arch (SDA) or posteriorly reduced dental arch (PRDA), minimising mechanical prosthodontic interventions for partially dentate adult patients in South Africa (SA).

Methods

A stepwise approach was adopted for studies conducted amongst a South African cohort. Initially, a *systematic review* was completed to guide us with the literature; then an *overview of systematic reviews* was completed to emphasize the evidence. Thereafter, *cross-sectional questionnaires* and a *cross-sectional study* were completed with general dental practitioners, clinical teachers and dental students to determine what was currently taught and clinically practised. A *randomized controlled trial* was subsequently conducted to determine patient satisfaction and quality of life with a SDA or PRDA.

HIERARCHICAL EVIDENCE PYRAMID



Studies completed were from top end of the evidence pyramid.
The reliability of results facilitated *diffusion* (creating awareness) and *dissemination* (publishing and conference presentations) of the findings

Quality of Evidence

Conclusions

This stepwise approach highlighted the absence of knowledge translation, and more particularly the *implementation* to clinical practice within the SA context, of a concept which could positively impact underprivileged patients' treatment costs, satisfaction and oral health-related quality of life.

8.3. PhD References

Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: partially absent dentition. Cochrane Database SR 2012 Issue (2) Art No: CD003814. DOI: 10.1002/14651858.CD003814.pub2.

Abu-Saleh T, Marnewick J. Implant-supported crowns for a shortened dental arch: A Case Report. *J Contemp Dent Pract* 2008 9(5):114-121.

Adulyanon S, Sheiham A. Oral impacts on daily performances. In Slade, GD, editors. *Measuring Oral Health and Quality of Life*. Chapel Hill, University of North Carolina, 1997 Chapter 14, 151-60.

Akobeng AK. Principles of evidence based medicine. *Arch Dis Child* 2005 90: 837-40.

Akobeng AK. Evidence in practice. *Arch Dis Child*; 2005 90: 849-52

Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996 23:481-5.

Allen PF, Witter DF, Wilson NHF. The role of the shortened dental arch concept in the management of reduced dentitions. *Br Dent J* 1995 179:355-7.

Armellini DB, Von Fraunhofer JA. The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004 92:531-5.

Armitage P. Sequential Methods in Clinical Trials. *Am J Public Health* 1958 48(10):1995-2002.

Ayo-Yusuf OA, Ayo-Yusuf IJ, Van Wyk PJ. Socio-economic Inequities in dental caries experience of 12-year-old South Africans: Policy Implications for prevention. *SADJ* 2007 62(1):6-11.

Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008 21(1):72-4.

Balevi B. No difference in the 5-year survival rates between the resin-bonded cantilever bridge and the removable partial denture for the restoration of the shortened dental arch. *Evid Based Dent* 2008 9(4):105-6.

Bensing J. Bridging the gap. The separate worlds of evidence-based medicine and patient-centered medicine. *Patient Educ Counsel* 2000 39: 17-25.

Biggs J. *Teaching for quality learning at university*. 2004 4thed. London: Open University Press.

- Billing D. Teaching for transfer of core/ key skills in higher education: Cognitive skills. *Higher Educ* 2007 53: 483-516
- Bradshaw JS. A taxonomy of social need. In McLachlan G, editors. *Problems and Progress in Medical Care*. 1972 7th series, Oxford University Press; pp.69-82.
- Broden P, Bennet I, Appleton J, Bonta Y, Feher E, Fiehn NE, et al. Ensuring research productivity in the future faculty. *Eur J Dent Education* 2002 6 (Suppl 3):97-106.
- Brennan DS, Spencer AJ, Roberts-Thomson KF. Tooth loss, chewing ability and quality of life. *Qual. Life Res* 2008 17:227-35.
- Budtz-Jørgensen E, Isidor F. 5-year longitudinal study of cantilever fixed partial dentures compared with a removable partial denture in a geriatric population. *J Prosthet Dent* 1990 64:42-7.
- Carlsson GE, Omar R. The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil* 2010 37:143-56.
- Chikte UME. Health and Human Rights in South Africa. *SADJ* 2009 64(1):2.
- Cohen L, Manion L, Morrison K. *Research Methods in Education*. 2005 5th Ed, Routledge Falmer. London and New York: Taylor and Francis group.
- Crafford S, Bitzer E. Consumer learning for university students: a case for curriculum. *Higher Educ Res Dev* 2009 28:443- 455.
- Creswell JW. *Research Design. Qualitative, Quantitative and Mixed Methods Approaches*. 2003 2nd Ed, Thousand Oaks, California, USA: Sage Publications.
- Creugers NHJ, Witter DJ, Van't Spijker A, Gerritsen AE, Kreulen CM. Occlusion and Temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 2010 1-7. DOI:10.1155/2010/807850.
- Creugers NHJ, Van't Spijker A. Tooth wear and occlusion. Friend or foes? *Int J Prosthodont*, 2007 20:348-50.
- Das K, Malick S, Khan KS. Tips for teaching evidence-based medicine in a clinical setting: lessons from adult learning theory. Part One. *J R Soc Med* 2008 101(10):493-500.
- Dawson B, Trapp RG. *Basic and Clinical Biostatistics*. 2004 4th Ed, Lange Medical Books/McGraw-Hill Publishing Division, New York, USA.
- Department of National Health and Population Development. *National Policy for Oral Health in South Africa*. National Policy for Oral Health 1990; Act 116.

Department of National Health and Population Development. National Oral Health Policy and Strategy for South Africa 2017: 1-30.

Department of National Health and Population Development. National Oral Health Policy and Strategy for South Africa 2017: 1-30.

De Sa e Frias V, Toothaker R, Wright RF. Shortened Dental Arch: A review of current treatment concepts. *J Prosthodont* 2004 13:104-10.

Donaldson AN, Whitehead J, Stephens R, Machin D. A simulated sequential analysis based on data from two MRC trials. *Br J Cancer* 1993 68(6):1171-78.

Eckert S. The True Goal of Evidence-Based Dentistry. *Int J Prosthodont* 2006 19(2):128-9.

Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998 25:649-61.

Faggion CM. The shortened dental arch revisited: from evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 2011 38:940-9.

Faggion CM, Giannakopoulos NN, Listl S. How strong is the evidence for the need to restore posterior bounded edentulous spaces in adults? Grading the quality of evidence and strength of recommendations. *J Dent* 2011 39:108-16.

Fejerskov O, Escobar G, JØssing M, Baelum V. A functional natural dentition for all—and for life? The oral healthcare system needs revision. *J Oral Rehabil* 2013. DOI: 10.1111/joor.12082.

Frank RP, Brudvik JS, Le Roux B, Milgrom, P. Hawkins, N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet Dent* 2008 83:521-7.

Friedling LJ, Morris AG. Pulling teeth for Fashion: Dental modification in modern day Cape Town, South Africa. *SADJ* 2007 62(3): 106-13.

Fueki K, Yoshida E, Igarashi Y. A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011 47:167-74.

Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010 8:126-39.

Gerritsen AE, Sarita P, Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Esthetic perception of missing teeth among a group of Tanzanian adults. *Int J Prosthodont* 2008 21:169-173.

- Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: interviews and focus groups. *Br Dent J* 2008 204 (6): 291-95.
- Gillette J. Striving for Excellence with Evidence-Based Dentistry. *J Evid Base Dent Pract* 2009 9:125-8.
- Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin. Oral Impl. Res* 2007 18:34-45. DOI: 10.1111/j.1600-0501.2007.01436.x.
- Greenhalgh T. How to implement evidence-based healthcare. 2017 Oxford, UK; Wiley Blackwell.
- Grimshaw JM, Eccles MP, Lavis JN, Hill SJ, Squires JE. Knowledge translation of research findings. *Implementation Science* 2012 7:50.
- Grol R. Successes and failures in the implementation of evidence based guidelines for clinical practice. *Med Care* 2001 39 (Suppl. 2): II46-II54.
- Haynes B, Haynes GA. What does it take to put an ugly face through the heart of a beautiful hypothesis? (Editorial). *Ann Intern Med.* 2009 17 150: JC3-2, JC3-3.
- Healy D, Lyons K. Evidence-based practise in dentistry. *New Zealand Dent J* 2002 98:32-5.
- Helminen SE, Vehkalati M, Murtomaa H: Dentists' perception of their treatment practices versus documented evidence. *Int Den J* 2002 52:71-74
- Henzi D, Davis E, Jasinevicius R, Hendricson W. North American Dental Students' Perspectives About Their Clinical Education. *J Dent Educ*, 2006 70(4): 361-377.
- Higgins JPT, Green S. *Cochrane Handbook for systematic reviews of interventions*. 2009 1st Edition. West Sussex, UK: Wiley-Blackwell.
- Hobdell M, Tsakos G, Ladrillo TE, Ross MW, Myburgh N, Gordon N, et al. Using an oral health-related quality of life measure in three cultural settings. *Int Dent J* 2009 59:381-8.
- Inglehart MR, Bagramian RA. Oral Health-Related quality of Life. In: Inglehart MR, Bagramian RA eds. *Oral Health-related Quality of Life*. Carol Stream: Quintessence, 2002:1-6.
- International Organization for Standardization/ European Standard (ISO/EN 540), *Clinical Investigation of Medical Devices for Human Subjects*, Berlin Germany.
- Ismail AI, Bader JD. Evidence-based dentistry in clinical practice. *JADA* 2004 135:78-83.
- Isidor F, Budtz-Jørgensen E. Periodontal conditions following treatment with a distally extending cantilever bridge with removable partial dentures in elderly patients: A 5-year study. *J Periodontol* 1990 61:22-6.

- Ivanhoe JR, Cibirka RM, Parr GR. Treating the modern complete denture patient: A review of the literature. *J Prosthet Dent* 2002 88:631-5.
- Jepson NJA, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. *Br Dent J* 2001 191(3):140-44.
- Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003 16(4):409-14.
- Kanno T, Carlsson GE. A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil* 2006 33:850-62.
- Kay EJ, Blinkhorn AS. A qualitative investigation of factors governing dentists' treatment philosophies. *Br Dent J* 1996 180: 171-176.
- Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981 8:457-462.
- Käyser AF. The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 1989 9(6):426-49.
- Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aust Dent J* 1987 32(3):178-82.
- Kitson A, Straus SE. The knowledge-to-action cycle: identifying the gaps. *CMAJ* 2010 18 (2).
- Khan SB, Chikte UME, Omar R. Perceptions of dental practitioners regarding the shortened dental arch. *SADJ* 2012 67(2):60-8.
- Khan S, Chikte UME, Omar R. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014 78(6):906-13.
- Khan S, Chikte UME, Omar R. Outcomes of interventions for patients with a posterior reduced dental arch: A randomized controlled trial. *J Oral Rehab* 2017 (Accepted). DOI: 10.1111/joor.12549.
- Khan S, Chikte UME, Omar R. Impact of removable partial dental prostheses on the function and oral health-related quality of life of a South African cohort with varied distributions of missing posterior teeth. *J Prosthodont* 2017. DOI: 10.1111/jopr.12692
- Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated Shortened Dental Arches: A Systematic Review. *PLOS 1* 2014 9(7):e101143. DOI: 10.1371/journal.pone.0101143.

- Khan S, Chikte UME, Omar R. An Overview of Systematic Reviews related to a shortened dental arch in adults. *Int J Prosthodont* 2017. DOI:10.11607/ijp.5287.
- Korduner EK, Söderfelt B, Kronström M, Nilner K. Attitudes toward the shortened dental arch concept among Swedish general dental practitioners. *Int J Prosthodont* 2006 19:171-6.
- Körduner EK, Söderfelt B, Kronström M, Nilner K. Decision making among Swedish general dental practitioners concerning prosthodontic treatment planning in a shortened dental arch. *Eur J Prosthodont Rest Dent* 2010 18:43-47.
- Kreuger PM, Neutens J, Bienstock J, Cox S, Erickson S, Geonfert A, et al. To the point: reviews in medical education teaching techniques. *Am J Obstet Gynecol* 2004 191:408-11.
- Laloo R, Myburgh NG, Hobdell MH. Dental caries, socio-economic development and national oral health policies. *Int Dent J* 1999 49:196-202.
- Lamb DJ, Ellis B. Comparison of patient self-assessment of complete mandibular denture security. *Int J Prosthodont* 1996 9(4):309-14.
- Liang S, Zhang Q, Witter DJ, Wang Y, Creugers NHJ. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: A Systematic Review. *J Dent* 2015 43:1185-94.
- Luthardt RG, Marre B, Heineck A, Gerß J, Aggstaller H, Busche E, et al. The randomized shortened dental arch study (RaSDA): design and protocol. *Trials* 2010 11(15):1-9.
- McAvoy BR, Kaner EFS. General practice surveys: a questionnaire too far? *BMJ* 1996 313: 732-33
- McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, Cronin M, et al. Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodontology* 2012 29:e883-e890. DOI:10.1111/j.1741-2358.2011.00579.x.
- McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, Woods N, et al. A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodontology* 2012 28:1-7.
- McMillan AS, Wong MC. Emotional effects of tooth loss in community-dwelling elderly people in Hong Kong. *Int J Prosthodont* 2004 17(2):172-6.
- McMillan WJ. Teaching for clinical reasoning- helping students make conceptual links. *Med Teacher* 2010 32: 436-442.
- McMillan W. Making the most of teaching at the chairside. *Eur J Dent Educ* 2011 15: 63-68.

- McMillan W. Finding a Method to Analyze Qualitative Data: Using a Study of Conceptual Learning. *J Dent Educ* 2009 73: 53-64.
- Meeuwissen JH, Van Waas MA, Meeuwissen R, Käyser AF, van't Hof MA, Kalk W. Satisfaction with reduced dentitions in elderly people. *J Oral Rehabil* 1995 22(6):397- 401.
- Moher D, Schulz KF, Altman DG. CONSORT Group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. *The Lancet* 2001 357(9263):1191-4.
- Müller F, Naharro M, Carlsson GE. What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe? *Clin Oral Impl Res* 2007 18(Suppl. 3):2-14.
- Naidoo S, Chikte UME, Moola H, Steyn K. Perceptions of oral health: The South African Demographic and Health Survey of 1998. *SADJ* 2001 56(11):505-10.
- Narby B, Kronström M, Söderfelt B, Palmqvist S. Prosthodontics and the patient: What is oral rehabilitation need? Conceptual analysis of need and demand for prosthodontic treatment. Part I: A conceptual analysis. *Int J Prosthodont* 2005 18: 75-9.
- Narby B, Kronström M, Söderfelt B, Palmqvist S. Prosthodontics and the patient: Need becoming demand, Demand becoming utilization. *Int J Prosthodont* 2007 20:183-9.
- National Centre for the Dissemination of Disability Research. What is Knowledge Translation? Technical Brief 2005 10:1-4.
- National Oral Health Survey of South Africa (1988/89). A report: Department of Health. Pages: 24-31; 57-60; 62; 93-100.
- Omar R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ* 2004 59(6):228-37.
- Owen CP. Appropriatech: Prosthodontics for the Many, Not Just for the Few. *Int J Prosthodont* 2004 17(2):261-2.
- Rolfe SE, Sanson-Fisher RW. Translating learning principles into practice: a new strategy for learning clinical skills. *Med Educ* 2002 36:345-52.
- Sackett DL, Rosenberg WM, Gray JA, Haynes R, Richardson W. Evidence-based medicine: what it is and what it isn't. *BMJ* 1996 312:71-2.
- Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. *Community Dent Oral Epidemiol* 2003 31(5):328-34.
- Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NHJ. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Sci* 2007 115(4):265-74.

- Sarita PT, Kreulen CM, Witter DJ, Creugers NHJ. Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 2003 16(3):265-70.
- Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003 16(4):375-80.
- Sarita PT, Witter DJ, Kreulen CM, Creugers NHJ. The shortened dental arch concept – attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol*, 2003 31:111-5.
- Shahmiri RA, Atieh MA. Mandibular Kennedy Class I implant-tooth-borne removable partial denture: a Systematic Review. *J Oral Rehabil* 2007 37:225-34.
- Sheiham A, Tsakos G. Oral health needs assessments. In: Pine CM, Harris R, editors. *Community Oral Health*: Wright Publishers, Oxford, 2004, Chapter 4.
- Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. *Community Dental Health* 1994 11:3-11.
- Steele JG, Walls AW. Strategies to improve the quality of oral health care for frail and dependent older people. *Qual Health Care*. 1997 6: 165-169.
- Strassburger C, Heydecke G, Kerschbaum T. Influence of prosthetic and implant therapy on satisfaction and quality of life: A systematic literature review. Part I– Characteristics of the studies. *Int J Prosthodont* 2004 17:83-93.
- Strassburger C, Heydecke G, Kerschbaum T. Influence of implant and conventional prostheses on satisfaction and quality of life: A literature review. Part 2– Qualitative analysis and Evaluation of the studies. *Int J Prosthodont* 2006 19:339-48.
- Straus SE, Tetroe J, Graham I. Defining knowledge translation. *Can Med Ass J* 2009 181(34):165-8.
- Strayhorn TL. Engaging Schools: Fostering High school Students' Motivation to Learn. *Education Review* 2004 1-8.
- Sutton AF, Worthington HV, Mc Cord JF. RCT comparing posterior occlusal forms for complete dentures. *J Dent Res* 2007 86(7):651-5.
- Taber K. The mismatch between Assumed Prior Knowledge and the Learner's Conceptions: a typology of learning impediments. *Educ Stud* 2001 27: 159-171.
- Tan H, Peres KG, Peres MA. Do people with shortened dental arches have worse oral health-related quality of life than those with more natural teeth? A population-based study. *Community Dent Oral Epidemiol* 2014:1-9. Doi:10.1111/cdoe.12124.

- Thomason JM, Moynihan PJ, Steen N, Jepson NJA. Time to Survival for the Restoration of the Shortened Lower Dental Arch. *J Dent Res* 2007 86(7):646-50.
- Tsakos G, Marcenes W, Sheiham A. The relationship between clinical dental status and oral impact in an elderly population. *Oral Health Prev Dent* 2004 2(3):211-20.
- Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008 35:337-44.
- Van der Sanden WJM, Mettes DG, Plasschaert AJM, Grol RPTM, Mulder J, Verdonschot EH. Effectiveness of clinical practice guideline implementation on lower third molar management in improving clinical decision-making: a randomized controlled trial. *Eur J Oral Sci.* 2005 113:349-354.
- Van Waas MA, Meeuwissen JH, Meeuwissen R, Käyser AF. Oral function in dentate elderly with reduced dentitions. *Gerodontol* 1993 10(1):40 -3.
- Walter MH, Weber A, Marre B, Gitt I, Gerß J, Hannak W, et al. The Randomized Shortened Dental Arch Study: Tooth Loss. *J Dent Res* 2010 89(8):818-22.
- Walter MH, Hannak W, Kern M, Mundt T, Gernet W, Weber A, et al. The randomized shortened dental arch study: tooth loss over five years. *Clin Oral Invest* 2012 17(3):877-86. DOI: 10.1007/s00784-012-0761-x.
- Webb P, Bain C, Pirozzo S. *Essential epidemiology: An introduction for students and health professionals.* 2005 Cambridge, UK; New York: Cambridge University Press.
- White HD, Van de Werf FJJ. Thrombolysis for acute Myocardial Infarction. *Circulation* 1998; 97: 1632-46.
- Witter DF, Allen PF, Wilson NHF, Kayser AF. Dentists' attitude to the shortened dental arch concept. *J Oral Rehabil* 1997 24: 143-147.
- Witter DJ, van Elteren P, Käyser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988 15:413-420.
- Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 1989 16:27-33.
- Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM. Oral comfort in shortened dental arches. *J Oral Rehabil* 1990 17:137-143.
- Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Signs and symptoms related to temporomandibular disorders- Follow-up of subjects with shortened and complete dental arches. *J Dent* 2007 35:521-527.

- Witter DJ, de Haan AF, Käyser AF, van Rossum GM. A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 1994 21:113-25.
- Wolfart S, Heydecke G, Luthardt RG, Marre B, Freesmeyer B, Stark S et al. Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: results from the pilot-phase of a randomized multicentre trial. *J of Oral Rehabil* 2005 32:815-822.
- Wolfart S, Muller F, Gerß J, Heydecke G, Marre B, Böning K, et al. The randomized shortened dental arch study: oral-health-related quality of life. *Clin Oral Invest* 2014 18(2):525-33. DOI: 10.1007/s00784-013-0991-6.
- Wong MC, McMillan AS. Tooth loss, denture wearing and oral health-related quality of life in elderly Chinese people. *Community Dent Health* 2005 22(3):156-61.
- World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Copenhagen: WHO Europe regional office, WHO Technical Report; 1982 Series No. 826:16-7.
- World Medical Organization. Declaration of Helsinki. *Br Med J* 1996 313:1448-49.
- Zarb GA, Bolender CL, Carlsson GE, Boucher CO. Boucher's prosthodontic treatment for edentulous patients. 2004 London: McGraw-Hill.
- Zeng X, Sheiham A, Tsakos G: Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008 35:37-44.
- Zhang Q, Kreulen CM, Witter DJ, Creugers NHJ. Oral Health Status and Prosthodontic Conditions of Chinese Adults: A Systematic Review. *Int J Prosthodont* 2007 20:567-72.
- Zhang Q, Witter DJ, Bronkhorst EM, Creugers NHJ. Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Invest* 2013; 17:1425-35.
- Zitsmann NU, Hagmann E, Weiger R. What is the prevalence of various types of prosthetic dental restorations in Europe? *Clin Oral Impl. Res* 2007 18(Suppl. 3): 20-33.

Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa

SADJ March 2012, Vol 67 no 2 p60 - p68

S B Khan: Faculty of Dentistry, University of the Western Cape, South Africa.

R Omar: Faculty of Dentistry, Kuwait University, Kuwait.

UME Chikte: Faculty of Health Sciences, University of Stellenbosch, South Africa.

Correspondence author

S B Khan: Department of Restorative Dentistry, University of the Western Cape, Private Bag X01, Tygerberg 7505; Tel: 021 937 3006, Fax: 021 931 2287, E-mail: skhan@uwc.ac.za.

Aim and objectives: This survey was conducted to determine the knowledge of and opinions related to the shortened dental arch (SDA), among dentists in the Western Cape Province, South Africa.

Methods: The study sample included two consecutive groups, drawn by a process of randomisation from the registered dentist population that included general dentists, specialists, those who had emigrated and retired dentists. A self-administered questionnaire was mailed, e-mailed and/or faxed to those selected. Reminders were either e-mailed or made by telephone over a period of six months.

Results: A final sample of 84 respondents with a mean age of 43 years (SD=11.9) was obtained. This represented a response rate of 23% (n= 84) from the final working sample (n=368), derived from the target group (n=618) originally contacted. All participants completed an informed consent form in which confidentiality was assured. Several respondents (40%) said they had heard about the SDA while at university, which would be in line with the age range of respondents in relation to introduction of the concept into dental curricula. As many as 62% had never read any research articles related to the concept which could partly account for the low response rate. The majority (86%) felt that patients can function with a SDA and that they would recommend acceptance to their patients.

Conclusion: Respondents know of the potential benefit that the SDA may have for their patients and see it as a viable alternative treatment option for the partially dentate patient, even though their level of current knowledge of the subject must be considered questionable.

Keywords: Tooth loss; shortened dental arch; attitudes; perceptions; knowledge; quality of life

INTRODUCTION

The treatment objective of the complete restoration of dental arches lacks compelling scientific and clinical research

support, yet steadfastly remains the therapeutic standard of care amongst practitioners.^{1,2} Whereas tooth loss in general is perceived negatively by most people,³ the loss of anterior teeth is more profoundly felt.⁴ There is also an increasing recognition that a patient's occlusal functional need cannot be defined solely by professionals.⁵ Specifically, the need for full restoration of missing posterior segments is increasingly being questioned and the functional satisfaction that may be derived from less than a complete dentition in some patients, particularly in older adults, is both recognised and documented.^{4, 6-14}

As originally defined, the classic shortened dental arch (SDA) consisting of twenty occluding anterior and premolar teeth, 6 was initially proposed as a treatment strategy for the older, partially dentate patient.^{6,15} Several variations to the classic SDA occlusal pattern, including discontinuous or interrupted arches, were proposed and the reduced posterior arches have been described in terms of the number of occluding units that can ensure adequate chewing function.^{6,7,11,12} The SDA concept is a cost-effective treatment option that has been extensively studied and has been advocated as being viable for many industrialised as well as developing countries.^{9,12-22} The SDA and its variations improve the accessibility of treatment for large sectors of the population, especially the socially- and economically-deprived middle-aged and elderly communities. It follows that disparities related to oral health that exists within and between populations, as in South Africa, can be addressed utilising the SDA concept as an appropriate treatment strategy.^{2,16}

Effecting improvement and/or change in an oral healthcare system depends upon appropriately distributing and using available resources for better health outcomes. An inability to meet the needs and demands of partially dentate patients causes oral healthcare providers, healthcare policy-makers, and third party funders to call for more evidence-based practices in dentistry.^{2-5, 14, 15} The literature reports several clinical trials and other research studies where the success of treatment using the SDA concept has been

demonstrated.^{3,6-8,10-5} The assertion that this will provide effective treatment, reduce costs and allow equitable distribution of resources seems reasonable. For a country such as South Africa, contemporary treatment planning strategies, such as those based on the SDA concept, need to be considered and should be researched locally for relevance amongst the local population. The results may be able to support a proposal for implementation. Healthcare providers, however, will be at the front line in delivering such a management strategy to patients, and it is thus important that their understanding of, and attitudes towards, such a 'novel' treatment concept be gauged.

Studies have been conducted globally to determine the opinions and practices of dental clinicians regarding the SDA, but

differences in sampling have been noted and considered before undertaking the current research.^{8,10,16,26} The convenience of samples drawn from consultants and departmental staff ensured a high response rate in some studies.^{8,10,16,26}

For this questionnaire-based study, a survey was conducted amongst registered dentists practicing in the Western Cape Province, South Africa, with the objective of assessing their knowledge and current practices related to the SDA as an appropriate management approach in the partially dentate adult patient.

MATERIALS AND METHODS

Ethical clearance for the research project (No. 10/2/13) was obtained from the Research and Ethics Committee of the

Survey: Dental practitioners of the Western Cape						
Please answer all questions. More than one option is required for certain questions, mark your response with an X						
1. Percentages of procedures treated in your practice per week? (To the nearest 10% and adding up to 100%)	Extraction%	Crowns & Bridges%	Fillings%	Ortho%	Dentures%	Other, specify%
2. Age categories of patients seen in your practice? (Mark all applicable ages)	Under 10	10– 18 yrs	18 - 35 yrs	35 -65 yrs	65 yrs or more	
3. Reasons for extracting teeth in your practice are? (Give a % for all options, to the nearest 10%, adding up to 100%).	Caries%	Perio Dis%	Trauma%	Impaction%	Ortho%	Patient request%
4. Percentages of the different teeth extracted are? (Give a % all options, to the nearest 10%, adding to a 100%)	Upper incisors%	Premolars%	Lower molars%	Upper molars%	Canines%	Lower Incisor%
5. Do your patients demand the extraction of anterior teeth?	Always	Sometimes	Rarely	Never		
6. Do you comply to requests for extraction of patients' anterior teeth?	Definitely yes	Yes	No	Definitely no		
7. Patients with decayed teeth are advised to save at least their anterior and premolar teeth?	Always	Sometimes	Rarely	Never		
8. What appliance do you commonly use for replacement of missing teeth?	Plastic dentures	Metal dentures	Fixed bridges	Implants	Other, specify	
9. Do you always replace missing molar teeth with distal extension dentures?	Definitely yes	Yes	No	Definitely no		
10. Do you advise patients not to replace missing molars with bridges or dentures?	Always	Sometimes	Rarely	Never		
11. Where did you first hear about the Shortened Dental Arch (SDA)?	University	Journal	This survey	Colleague	Other, specify	
12. Have you read any research related to the SDA conducted locally or internationally?	Definitely yes	Yes	No	Definitely no	Don't know	
13. Do you agree that patients can function adequately with a SDA?	Definitely yes	Yes	No	Definitely no	Don't know	
14. The SDA should be presented to patients as an alternative treatment option?	Definitely yes	Yes	No	Definitely no	Don't know	
15. Treatment options that you usually propose to patients with a SDA are? (More than 1 entry is allowed, to the nearest 10% and adding to 100%)	Plastic dentures%	Metal dentures%	Cantilever bridges%	Implants%	No treatment%	Other%
16. Would patients benefit from an SDA treatment option?	Definitely yes	Yes	No	Definitely no	Don't know	
17. An SDA treatment option must be limited to special cases only, e.g. the handicapped patient?	Definitely yes	Yes	No	Definitely no	Don't know	
18. What will prevent you from presenting the SDA as a treatment option?	Loss of income	Lack of knowledge	Limited research	Not viable option	Nothing	Other, specify
19. Patients most often request the replacement of missing molars with?	Plastic dentures	Metal dentures	Fixed bridges	Implants	No treatment	
20. Not replacing missing molars will affect the patients' Oral-health- related Quality of life.	Definitely yes	Yes	No	Definitely no		
21. Extracting anterior teeth will negatively impact on patients' Oral- health- related Quality of Life.	Definitely yes	Yes	No	Definitely no	Don't know	

Table 1: Demographic details of respondents

Age range	24 – 35yrs	36 – 45yrs	46 – 59yrs	60+ yrs
	28	24	24	8
Gender	Female	Male	Not Recorded	
	31	52	1	
Institutions attended (could be more than one)	University of the Western Cape	Stellenbosch University	Other South African Universities	International Universities
	24	40	13	4
Qualifications	BChD	PDD	MChD	BSc/MSc/ PhD
	84	35	10	25
Employment details (dual appointments included)	Private/ Public Health		Academic Institution	
	73		31	

University of the Western Cape (WC), South Africa. The first cycle of data collection was conducted as a pilot study amongst the staff (n=15) in the Department of Restorative Dentistry in the latter part of August 2009. The initial questionnaire was distributed amongst them to solicit their input and expertise so that ambiguities in the questions could be eliminated. The final self-administered questionnaire (Figure 1), cover letter and consent form were then distributed by post, fax and/or e-mail to randomly selected dentists practicing in the public and private sectors of the WC Province. The design of the questionnaire assessed respondents' opinions, knowledge, understanding and current clinical practices regarding the SDA concept. It also included questions designed to obtain the demographic profile of practitioners, the types of practices dentists worked in and the diversity of patients treated.

The population of dentists in the Western Cape included in this study was all registered practitioners and included general dentists in the public and private domains, as well as retired dentists and specialists in the fields of prosthodontics, periodontics and orthodontics. Excluded from the study were dentists whose interests do not especially include treatment of the partially dentate state, such as maxillofacial and oral surgeons, oral pathologists and community-dentistry specialists.

Through a compilation of records obtained from the Health Professions Council of South Africa (HPCSA), South African Dental Association, Public Health Clinics and Messrs Wright-Milner's Dental (the largest dental supplier in the region), it was recognised that the list of dentists and specialists registered with the HPCSA from the WC Province included many who had retired, specialised, emigrated or are no longer in practice. We used randomisation (accomplished through computer-generated numbers) for the second and third cycles to obtain a final sample of 652 active practitioners. For the third cycle, the information sheet was modified to indicate that an incentive would be received on completion of the questionnaire. This was decided upon after discussions with the statistician, to improve the response rate. After taking statistical advice, the pilot study sample (n=15) was included in the final study sample as these practitioners were all on the registered lists of dentists. In addition, several of these (academic) dental practitioners either have their own dental practices or work for other private practitioners.

Practical difficulties experienced included a large number of non-responders, outdated registered contact details, a

Table 2: Anterior extractions: patient demand and dentist reaction

Perceived demand for anterior extractions	Compliance by dentists with patient demand for anterior extractions			
	Definitely No	No	Yes	Total
Never	21	6		27
Rarely	14	14	5	33
Sometimes	7	7	8	22
Total	42	27	13	82

(Chi-squared test = 17.81, df. = 4, p-value < 0.005)

Table 3: Summary of results related to questions focusing on the shortened dental arch

	Definitely yes and Yes	Definitely no and No	Don't know
Read research	38%	62%	
Agree can function	86%		11%
As treatment option	83%		10%
Benefit to patients	82%		8%
Limit to special cases only	25%	67%	
Absent molars – affect OHRQoL	46%	43%	

number of disinterested practitioners including some retired practitioners; thus the period for obtaining completed questionnaires from the three cycles was extended to six months (from late August 2009 to January 2010). A research assistant followed up the non-responders who did not return the questionnaires, with participants receiving monthly reminders for at least two months via telephone, fax and e-mail in an effort to obtain as representative a sample as possible. The final collection and recording of data was completed by the researcher (SK).

Sample size, randomisation of sample, questionnaire format, type of study and the statistical analysis of data (type of tests) were initially discussed with the statistician. Data extracted from completed questionnaires were analysed using the Excel Statistical package. The categorical data were analysed by means of residuals based on observed and expected values. The data consisted of categorical and ordinal observations, as well

as paired comparisons. A lexicographical analysis was also included for question 18 (which states 'What would prevent respondents from implementing the SDA as a treatment option?') and it involves determining the specific responses for each given response option in a systematic sequence.²⁷

RESULTS

From the three cycles, the final working sample (n= 368) included registered and willing participants and excluded all the practitioners who were registered but had emigrated, were not practicing, some who had retired, those who had obtained a specialisation which was excluded, those who declined to participate and those whose current contact details were unavailable.

Of the 15 questionnaires distributed amongst the staff for the pilot study, 13 were completed. Together with those obtained in the second and third cycles, the final sample resulted in 84 completed questionnaires (23%). The demographic details are included in Table 1. The ages of respondents ranged from 24 to 75 years, with a mean age of 43 years (SD=11.9) and with most respondents being males at 62%. Many retired dentists, who were intentionally included so that the changes in teaching and practice over the years might be determined, did not participate. Respondents were from diverse academic backgrounds with dental qualifications having been obtained locally and/or internationally (Table 1).

Almost three-quarters (74%) of respondents (n= 62/84) reported that their practices were mainly restorative in nature. One-fifth of respondents (20%) further indicated that fixed prostheses and removable partial dentures were their treatments of choice in the management of partially dentate patients. Patients treated ranged from under 10-to-65 year-olds, with only three respondents indicating that they do not treat adult patients.

The unusual practice of anterior-tooth extractions, a cultural habit observed in the WC Province, necessitated that the questionnaire contain questions specific to the practice. Only 25% (n= 21/84) of respondents stated that requests for such extractions were not made. The majority of the responding dentists had been asked to extract anterior teeth and even though 82% of respondents said they did not accede to these requests, almost 20% said that they do extract these teeth to satisfy patients' requests. To see whether any relationship existed between requests by patients for anterior extractions and the subsequent reaction of dentists, a Chi-squared test ($\chi^2 = 17.81$, df. = 4, p-value <0.005) was performed (Table 2). These results suggest that the frequency of demands by patients for anterior extractions is influenced by the compliance of dentists to accede to these requests (i.e. a strong relationship between demand for anterior extractions by patients and compliance by dentists exists, and vice versa). Of all other tooth types extracted in the WC Province, lower molars were the most commonly reported at 67%, which is in line with global studies.

Prostheses provided for replacement of missing posterior teeth, in order of frequency, were acrylic partial dentures, metal-based partial dentures, fixed bridges and implants. Responses to questions relating to the replacement of missing molar teeth would appear to be influenced by knowledge of the SDA concept ($\chi^2 = 6.79$; df. = 1; p-value=0.0092). Even though 48% of respondents (n=40/84) indicated that they had heard about the SDA at university, and 32% in a journal, 21% indicated that they heard about it for the first time from this survey. Those respondents (48%) who had heard about the concept at university were of a mean age of 43 years, which is in line with the likelihood that they would have been taught the concept during the 1990s.

Table 3 refers to the responses to questions related to the SDA and here data imputation was managed by dichotomisation: thus for the answers definitely no and no, these

Table 4: Comparison of the design and results of this study with similar studies conducted globally

Country	UK	Sweden	Tanzania	Netherlands	South Africa
Authors	Allen, 1993	Korduner, 2003	Sarita, 1998	Witter, 1997	Khan, current
Sample (n)	91	189	77	64	84
Reminders	Mail	Mail	Mail	Mail	Fax, telephone and e-mail
Information sheet	Yes	Yes	Yes	Yes	Yes
Sample	Restorative consultants	GPs	GPs, public sector dentists	Department staff	GPs, Department staff, specialists
Comparison of data requested in Questionnaire					
Demographic details	Yes	Yes	Yes	Yes	Yes
Opinions	Yes	Yes	Yes		Yes
Experiences		Yes	Yes	Yes	Yes
Implemented	Yes	Yes	Yes	Yes	Yes
Conclusions	Accepted, but not practiced	Affirmative	Accepted, but uncertain of practice	For contemporary practices	Would benefit South Africans
Comments	Reservation; No premolar occlusion	Few risks	89% use acrylic RPD for SDA	SDA useful if patients accept it	Produces no income; lack of knowledge
Problems	Drifting; age; knowledge	Decreased benefits for GPs	Acceptable for practice	Special needs only; TMJ/ periodontal problems	Non-response

were settled as a no response. As regards their 'having read any research' relating to the SDA concept, as many as 62% of respondents (n=52/84) indicated not having done so. On the other hand, 86% said that 'patients will be able to function adequately' with a SDA, even though most had not read any literature on the subject. A large majority of respondents (83%) said that they would 'present it as a treatment option,' while 82% indicated that it would 'benefit their patients'. Many respondents (67%) believed its application should not be 'limited to patients with physical disabilities' only.

Examining the results of questions referring to the treatment options proposed by practitioners compared with patients' requests for SDA treatment approach revealed distinct differences in responses. From the final sample (n= 84), 83% of dentists suggested the provision of acrylic and metal dentures, but patients requested implant therapy and either acrylic or fixed prostheses (and in that order). A clear difference existed in what patients perceived their needs and desires to be (irrespective of the finances involved) and what practitioners proposed and what was the final administered treatment.

For Question 18, 'what would prevent respondents from suggesting a SDA treatment option', respondents were presented with a range of options and their answers revealed some interesting responses: only 5% of respondents (n=4/84) admitted that 'loss of income' whereas 37% said 'nothing' would prevent them from proposing and implementing the SDA concept as a treatment option. It was then decided to conduct a lexicographical analysis of the responses for this question. This type of systematic analysis is used for data with several variables as responses, where the analysis includes several options or combinations of options.²⁷ For this question with four options, 16 different combinations could be provided. Interestingly, 93% of observations were found in four combinations with 49% of observations sitting in one combination only. This distribution fits the information (or Pareto) principle,²⁸ which states that for most cases in life, 80% of effects come from 20% of the causes.

A description of this combination includes, for example: no income; no knowledge; limited research and not viable versus 'nothing' will prevent the practitioner from suggesting a SDA. And within this combination, 73% (30/41 respondents) said 'nothing' will prevent them from suggesting a SDA. This type of analysis gave very specific responses to these options,²⁷ revealing that the respondents expressed a very positive attitude towards this SDA concept as a treatment option for their partially dentate patients. The benefits of using this concept were obvious to the dentists, even though many of them had indicated not having read any research related to the concept.

DISCUSSION

Questionnaire-based studies are a useful tool in dental research, but can be a mixed blessing. Response rates among general practitioners have been shown to be dropping.²⁹ They also are at risk, if not sufficiently robustly framed, of conveying what respondents state they believe, or would do, and even what they believe the interviewer wishes to hear.³⁰

The present research brought into focus some of these difficulties, in particular the lower than expected overall response rate (n= 84). On the other hand, the response rate in the pilot study (n= 13/15) was very good, but that was conducted in a controlled environment. Data thus derived are at risk of bias. In addition, the very high response rate would likely have been due to the pilot group being colleagues who felt obligated to cooperate. This pleasing effect could also have contributed as a source of bias. Such effects (opinion research and doing research in the same department) have been reported in the literature (Table 4).^{8,10,16,26}

Efforts were made to reduce the risks of bias during the second and third cycles of the study. Reminders were limited to a maximum number of telephone calls, faxes and e-mails and over a short period of time. With the third cycle, it was hoped to improve the response rate and thus increase the sample size by offering an incentive. This was done to improve the internal validity and generalisability of the study and to eliminate any errors that could occur. For this study conducted amongst the registered population of dentists, the final sample size was still relatively small (n= 84) and may not give an accurate estimate for the total practitioner pool. In comparison, other global studies were conducted using convenience samples and within a controlled environment, thus reflecting larger response rates (Table 4).^{8,10,16,26}

The non-response of participants for this study could be attributed to the time-consuming nature of completing a questionnaire; disinterest; lack of knowledge regarding the topic, dentists being retired and/or their refusal to respond, and the South African oral healthcare system operating under a fee-for-service structure which conflicts with the underlying 'non-interventional' concept under study. The final decisions for treatment are guided by the financial constraints of the most requested treatment option (implants) for a SDA. It is a situation that can be easily manipulated either way, in favour of the dentist or the patient. More importantly, it is a setting that should be used to guide and educate patients of the workable cost-effective solutions in the form of the SDA, if only practitioners had adequate knowledge of the SDA concept. It has been shown elsewhere that salaried public sector practitioners (e.g. academics) are more positively inclined towards the SDA concept in their clinical decision-making.³¹ Some of the earlier studies that looked at the attitude of dentists toward the SDA were conducted in a controlled environment, had fewer participants, and in some cases had even longer questionnaires.^{8,10,16,26} Notwithstanding the differences amongst the listed studies, it is evident that the present findings compare well with those found globally (Table 4).^{8,10,16,26}

The condition of not having read any research related to the SDA had obvious bearings on this study. It is possible that a lack of knowledge related to the topic might cause reluctance to complete the questionnaire and so affect the response rate. In addition to this, the uncertainty expressed regarding the relationship between the SDA and oral-health related quality of life by the non-committed responses can also be explained by the respondents' limited knowledge. Oral health-related quality of life (OHRQoL), defined as the impact of the oral cavity and related diseases on the quality of life of an individual, is influenced by the age, number of

teeth, psychological, functional and cultural factors.^{32,33} In the context of tooth loss, the degree to which OHRQoL is impacted is most likely context dependent,²² with location and distribution of missing teeth being important.³ Patients who have lost teeth usually seek treatment, primarily to address their esthetic concerns, and the desire to replace posterior teeth is less and reduces with the passage of time after extraction.^{4,32} Whereas RPDs address and satisfy the esthetic concerns of many patients, research has questioned the efficacy of especially the distal extension denture.^{24,25} Furthermore, these dentures are not regularly worn by up to 50% of patients, and providing them amounts to a considerable waste of resources and time.^{11,15,24,25}

More importantly, the need for a questionnaire survey among South African dentists to gauge their attitudes towards the SDA concept, as was attempted in this study, appears to have been warranted. Notwithstanding the low response rate reported here, and the limitation this places on making the generalisation to all practitioners in SA, some cautious extrapolations from the present findings might reasonably be made. Firstly, the awareness by most respondents of the SDA concept, the belief by most that reduced posterior arch lengths can provide adequate function and indeed benefit certain patients and the readiness by most to offer the SDA option for consideration in the management of suitable partially dentate patients are all positive indicators of a possible shift in prosthodontic treatment planning. A clinical trial to assess the success of treatment using the SDA concept can thus be instituted with such positive feedback from practitioners.

Gauging the epidemiological data of the South African population, from the total of 48 million, approximately 30 million form the adult population of 20-80 year-olds and about five million (10.9%) of the country's population reside in the Western Cape (WC) Province.³⁴ Historically, the population was segregated into four broad groups by legislation, with socio-economic status also closely aligned with these divisions. The prevalence of periodontal disease, dental caries and tooth loss vary across the country, but are recorded to be the highest in adults (and children) in the groups living in the WC Province, concurring with other studies.^{34,35} The WC Province also has the highest prevalence of adult edentulousness (37%) in the country (with farm-workers at 76%), but only 27% of edentulous patients had acquired complete removable dentures. The reasons cited for this are inaccessibility to clinics, high cost of dentures and no transport facilities to clinics.³⁴ It is evident from the foregoing that the oral health status, and pertinently the prosthetic aspects, of the population living in the WC Province fall far short of being acceptable.

According to Owen (2004), the inequities experienced in the South African healthcare system need to be addressed with appropriate primary healthcare measures.³⁶ The SDA can be seen as unique and as a significant evidence-based solution for South Africa. It can, in principle, be seen as an appropriate therapeutic approach for many patients in SA through which major inequities in the healthcare system can be addressed.² In an environment of limited resources, the concept has the potential to overcome barriers of financial access that are associated with conventional interventional options such as complete

and partial removable dentures, fixed prosthodontics or implant-retained procedures.^{2,15,34}

Concerted efforts need to be made to improve the knowledge, and with it, interest in the topic. While Continuing Professional Development is an accepted method of updating knowledge, such direct educational interventions are considered to be not very effective in influencing clinical behaviors. Furthermore, while guidelines may improve the knowledge of dentists, they do not improve clinical decision-making skills.^{37,38} It would seem that an important aspect that needs research attention is the process of the translation of knowledge of available evidence into best practice.³⁹ Such a task may be easier to inculcate at the undergraduate level, hence a survey of this nature completed with senior dental students as respondents would be an excellent indicator of what is being taught and how students translate such teachings into actions.

Equally pertinent, the patient should play a meaningful role in effecting healthcare, in terms of informed inputs into choices and consent. However, the patient is exposed to a surfeit of non-scientific information, imposing upon the dentist the need to enhance communication skills which must be learnt and practiced.⁴⁰ Thus determining the needs of patients and placing less reliance on normative approaches in decision-making, would be prudent in terms of introducing new concepts. It would seem that in the latter regard in particular, clinical decision making that encompasses SDA options would be beneficial.

CONCLUSIONS

The participants in this study felt that patients can benefit from the implementation of the SDA concept. In addition, they alluded to the fact that patients with a SDA will be able to function adequately and that it should thus be presented to them as a treatment option.

The benefit of implementing this questionnaire survey amongst practitioners, whose reading of research on the subject was seen to be limited, has been revealing and points to the urgent need for further such surveys on a larger, more broadly-based and thus a more representative sample. More precise information and continued research are prerequisite for any further consideration of the SDA concept as an appropriate treatment strategy for the country.

Acknowledgements

Grateful thanks are due to Professor Yusuf Osman, Dr Theunis Kotze and Mrs Reneda Basson for their invaluable guidance, support and assistance with this research. Our gratitude is also extended to UWC Ethics and Research Committee and Wrights-Milner's Dental Group for their financial assistance for the completion of this research project.

Declaration: No conflict of interest.

References

1. Müller, F. Naharro, M. Carlsson, G.E. What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe? *Clin Oral Impl Res.* 2007; 18(Suppl. 3): 2-14.
2. Omar, R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ.* 2004; 59(6):228-37.
3. Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a sys-

- tematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010;(8):126
4. Elias, E.C. and Sheiham, A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil.* 1998;(25):649-61.
 5. Narby B, Kronström M, Söderfeldt B, Palmqvist S. Prosthodontics and the patient: What is oral rehabilitation need? Conceptual analysis of need and demand for prosthodontic treatment. Part 1: Conceptual analysis. *Int J Prosthodont.* 2005;(18):75-9.
 6. Käyser, A.F. Shortened dental arches and oral function. *J Oral Rehabil.* 1981;(8):457-62.
 7. Käyser, A.F. The shortened dental arch: A therapeutic concept in reduced dentitions and certain high risk groups. *Int J of Perio and Rest Dent.*1989; 9 (6):426-49.
 8. Allen, P.F. Witter, D.F. Wilson, N.H.F. Käyser, A.F. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil.* 1996;(23):481-5.
 9. Steele, J.G. Walls, A.W. Strategies to improve the quality of oral health care for frail and dependent older people. *Qual Health Care.* 1997;(6):165-9.
 10. Korduner, E. K. Söderfeldt, B. Kronström, M. and Nilner, K. Attitudes toward the shortened dental arch concept among Swedish general dental practitioners. *Int J Prosthodont.*2006;(19):171-6.
 11. De Sa e Frias, V. Toothaker, R. Wright, R.F. Shortened dental arch: A review of current treatment concepts. *Jnl of Prosthodont.* 2004; 13(2):104-10.
 12. Kanno, T. and Carlsson, G.E. A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil.*2006; 33(11):850-62.
 13. Sarita, P.T. Witter, D.J. Kreulen, C.M Matee, M.I. Van't Hof, M.A. and Creugers, N.H. Oral health status related to the shortened dental arch concept in Tanzania. *Europ J of Sciences.*2007; 115(4): 265-74.
 14. Gotfredsen, K. Walls, A.W.G. What dentition assures oral function? *Clin Oral Impl. Res.* 2007; 18(Suppl.3):34-45.
 15. Käyser, A.F. Witter, D.J. and Spanauf, A.J. Overtreatment with removable partial dentures in shortened dental arches. *Aus Dent J.*1987;32(3):178-82.
 16. Sarita, P.T. Witter, D.J. Kreulen, C.M and Creugers, N.H. The shortened dental arch concept – attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol.* 2003;(31): 111-5.
 17. Witter, D.J. van Elteren, P. and Käyser, A.F. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil.* 1988;(15):413-20.
 18. Wolfart, S. Heydecke, G Luthardt, R.G. Marre, B. Freesmeyer, B. Stark, H. *et al.* Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: results from the pilot-phase of a randomized multicentre trial. *J of Oral Rehabil.*2005;(32):815-22.
 19. Witter, D.J. de Haan, A.F. Käyser, A.F. and van Rossum, G.M. A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil.*1994; 21(2): 113-25.
 20. Ueno, M. Yanagisawa, T. Shinada, K. Ohara, S. Kawaguchi, Y. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil.* 2008;(35):337-44.
 21. Zeng, X. Sheiham, A. Tsakos, G. (2008). Relationship between clinical dental status and eating difficulty in an old Chinese population. *J of Oral Rehabil.* (35):37-44.
 22. Baba, K. Igarashi, Y. Nishiyama, A. John, M.T. Akagawa, Y. Ikebe, *et al.* The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont.* 2008; 21(1): 72-4.
 23. Gerritsen, A.E. Sarita, P. Witter, D.J. Kreulen, C.M Mulder, J and Creugers, N.H.J. Esthetic perception of missing teeth among a group of Tanzanian adults. *Int J Prosthodont.* 2008; (21):169-73.
 24. Witter, D.J. van Elteren, P. Käyser, A.F. Van Rossum, M.J.M. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil.* 1989; (16):27-33.
 25. Jepson, N.J.A. Allen, P.F. Moynihan, P.J. Kelly, P.J. and Thomason, J.M. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont.* 2003; 16(4):409-14.
 26. Witter, D.F. Allen, P.F. Wilson, N.H.F. Käyser, A.F. Dentists' attitude to the shortened dental arch concept. *J Oral Rehabil.* 1997; (24): 143-7.
 27. <http://www-math.mit.edu>
 28. <http://en.wikipedia.org/wiki>
 29. McAvooy BR, Kaner EFS. General practice surveys: a questionnaire too far? *BMJ* 1996; (313): 732-3.
 30. Helminen SE, Vehkalati M, Murtomaa H: Dentists' perception of their treatment practices versus documented evidence. *Int Den J* 2002;(52):71-4
 31. Korduner, E. K. Söderfeldt, B. Kronström, M. and Nilner, K. Decision making among Swedish general dental practitioners concerning prosthodontic treatment planning in a shortened dental arch. *Eur J Prosthodont Rest Dent.*2010; (18): 43-7.
 32. Sheiham, A. Tsakos, G. Oral Health Needs Assessments. In: Pine C ed. *Community Oral Health.* Oxford: Wright Publishers, 2004: Chapter 4, pages 1-3; 8; 11.
 33. Inglehart MR, Bagramian RA. Oral Health-Related Quality of Life. In: Inglehart MR, Bagramian RA eds. *Oral Health-related Quality of Life.* Carol Stream: Quintessence, 2002:1-6.
 34. National Oral Health Survey of South Africa. A Report: Department of Health. 1988/89.
 35. Naidoo, S. Chikte, UME.Moola, H. Steyn, K. Perceptions of oral health: The South African Demographic and Health Survey of 1998. *SADJ.*2001; 56(11):505-10.
 36. Owen, C.P. Appropriatech: Prosthodontics for the many, not just for the few. *Int J Prosthodont.* 2004; 17(2): 261-2.
 37. Van der Sanden WJM, Mettes DG, Plasschaert AJM, Grol RPTM, Mulder J, Verdonschot EH. Effectiveness of clinical practice guideline implementation on lower third molar management in improving clinical decision-making: a randomized controlled trial. *Eur J Oral Sci.* 2005;(113):349-54.
 38. Grol R. Successes and failures in the implementation of evidence based guidelines for clinical practice. *Med Care* 2001a; 39 (Suppl. 2): I146-54.
 39. Haynes, B, Haynes GA. What does it take to put an ugly face through the heart of a beautiful hypothesis? (Editorial). *Ann Intern Med.* 2009 17; 150: JC3-2, JC3-3.
 40. Kay EJ, Blinkhorn AS. A qualitative investigation of factors governing dentists' treatment philosophies. *Br Dent J* 1996;(180): 171-6.

Remember to
update your
details if they have
changed on
www.sada.co.za

From Classroom Teaching to Clinical Practice: Experiences of Senior Dental Students Regarding the Shortened Dental Arch Concept

Saadika B. Khan, B.Ch.D., P.D.D., M.Sc.; Usuf M.E. Chikte, B.Ch.D., M.Sc., D.H.S.M., M.Dent., Ph.D.; Ridwaan Omar, B.D.S., LDSRCS, M.Sc., FRACDS, FDSRCSed

Abstract: This study explored the barriers to a meaningful translation of didactic classroom instruction to clinical practice, using the shortened dental arch (SDA) concept as a case study. A combination of survey and individual and group interviews (a mixed-methods approach) was used to collect data related to the SDA. The cohort consisted of senior dental students and their clinical teachers at the University of the Western Cape, South Africa. The response rates were 100 percent for the students (n=73) and 78 percent for the clinical teachers (n=16). Triangulation was employed to eliminate bias and strengthen the reliability of the research. In the quantitative analysis, most students (81 percent) reported having heard about the SDA concept at the university, but their responses revealed an absence of clinical implementation. The students agreed that patients can function adequately with an SDA and agreed with presenting it as a treatment option to patients. In the qualitative analysis, a “change in the clinical requirements,” “being empowered by exposing them to SDA literature,” and “change in health policies” were recommended measures to increase implementation of the SDA approach clinically. The students were positive about the SDA as a treatment option, but the lack of adequate knowledge and encouragement in clinical implementation was a hindrance to its use.

Dr. Khan is Senior Lecturer, Department of Restorative Dentistry, University of the Western Cape, South Africa; Dr. Chikte is Professor, Department of Interdisciplinary Health Sciences, Stellenbosch University, South Africa; and Dr. Omar is Professor, Department of Prosthodontics, Kuwait University, Kuwait. Direct correspondence and requests for reprints to Dr. Saadika B. Khan, Department of Restorative Dentistry, University of the Western Cape, Private Bag X01, Tygerberg 7505, South Africa; skhan@uwc.ac.za.

Keywords: dental education, shortened dental arch, clinical education, clinical diagnostic reasoning, South Africa

Submitted for publication 4/17/13; accepted 9/24/13

Best available evidence is increasingly accepted as an essential guide for best clinical practice.¹ The process begins in the classroom, and the implementation then needs to manifest in the clinical setting. Alongside this, dental schools are adopting a more patient-oriented approach in their clinical educational programs,¹⁻³ which generally assumes there is continuity and coherence in implementing best evidence from classroom teaching to clinical practice.⁴⁻⁶ To what extent this translational learning outcome is realized has long absorbed educators and clinicians.

Among the many theories of learning, the constructivist paradigm is described as one that alludes to the role of students and the teacher in facilitating the learning of concepts.^{2,7,8} Studies have emphasized the significance of a student-centered teaching strategy, which encourages a deep approach to experiential learning and knowledge transfer, resulting in more effective conceptual understanding of content.^{2,4,7-12} Researchers refer to traditional forms of lecturing (which restricts learning largely to passive modes)

as the least effective method of knowledge acquisition.^{2,13} Active learning of concepts occurs in clinical practice, and this needs to be a guided process, placing the focus on the role of clinical teachers to facilitate this deep approach to learning.^{1,10}

Since effective learning of the clinical process, from decision making to implementation, depends on the quality of the clinical teaching,^{5,6,14} the choice of clinical teachers becomes crucial. They must have the ability to mediate the experiential learning of students, appropriately guide them to do what is best for the patient (i.e., adopting a patient-centered approach), and critically assess student performance.^{1-3,5-8,12,14} Kreuger et al. found that students “forget” theoretical information when commencing clinical practice and are subsequently unable to transfer concepts to different contexts.¹³ To ensure that any disjuncture between classroom and clinical practice is minimized or avoided is key.^{5,6}

Assessment in module-based clinical curricula should include students’ performance based on not only their understanding and clinical application of

concepts but also the completion of predetermined clinical procedures.¹⁵ It has been noted that assessment drives learning, an assertion supported by the finding that students in clinical modules are apparently contented with mere completion of the predetermined clinical procedures.^{2,3,16} At the same time, entrenched institutional and traditional practices can impede the inclusion of newer clinical concepts that are based on best evidence. Such a situation can be regarded as ethically questionable.^{3,14,17}

It would therefore seem that the nature of the alignment between two educational outcomes needs exploring: 1) the transfer of concepts from classroom instruction to clinical practice and 2) the clinical competence (i.e., readiness and ability) of dental students to prescribe evidence-based therapeutic solutions. For this study, we decided that the shortened dental arch (SDA) concept lends itself well to exploring these questions. The SDA concept is a clinical management approach that is compatible with the functional needs of many older, partially dentate individuals. With practitioners and institutions seeking clinical solutions for historically disadvantaged South African communities, the SDA seemed to be a logical choice for this study.

In this case study, the SDA approach was used to examine the extent to which the transference of theoretical concepts to clinical practice occurs amongst senior dental students. The classic SDA consists of twenty occluding anterior and premolar teeth and represents a functional approach to managing partially dentate middle-aged and elderly patients and sometimes young, high-risk patients.¹⁸ The reduced posterior arches ensure adequate chewing function, and research has shown the SDA concept to be a clinically beneficial treatment option, albeit within defined clinical conditions.^{1,15,18-29} From a socioeconomic point of view, the SDA approach offers the additional advantage of being a compelling primary health care measure relevant for many underprivileged groups, such as some of South Africa's communities.²⁹

Traditionally, removable partial dentures (RPDs) are used to restore functions deemed essential in partially dentate patients.¹⁸⁻²¹ The necessity for such an approach has long been questioned (more so in the context of limited resources), and evidence is ubiquitous that the profession still resists modifying traditional clinical practice accordingly.^{15,18,29-34} This apparent resistance to implementing the SDA approach in specific conditions can be related to several factors: an indifference towards including

evidence-based findings in teaching and practice, utilizing practices based on tradition and peer input, misplaced confidence in traditional practices, the need to complete a procedure to satisfy patients, profit-based practices, the inadequacy of knowledge transfer to clinical practice, and/or a general disinclination of clinicians to apply new concepts.^{13,17}

Although there have been attempts to change oral health care policies based on clinical research,^{15,18-28,30-33} there is a void on the subject of translation of classroom teaching to clinical implementation. The aim of this study was therefore to determine the relationship between what dental students are formally taught in class regarding the SDA concept for managing partially dentate patients and the extent to which clinical implementation of this treatment protocol actually occurs.

Methods

Ethical clearance (Registration No. 11/1/51) was obtained from the Research and Ethics Committee of the University of the Western Cape (UWC), South Africa. Written informed consent was obtained from the participants according to the Declaration of Helsinki.³⁵ A mixed-methods approach was used in data collection (quantitative and qualitative) and analysis.³⁶⁻³⁸ Triangulation was used to eliminate bias and increase the validity and strengthen the reliability of the research.^{37,38} The study drew on the sequential explanatory strategy in data collection and analysis and for subsequent inclusion of the semi-structured interview phases (qualitative data) following the completion of a survey (quantitative data).³⁶⁻³⁸

For the first phase, a survey was conducted amongst the senior dental students and their clinical teachers at UWC from January to March 2011 (survey is available from the corresponding author). The student sample was chosen because this group had completed the theory and related biomechanical principles of RPDs.^{37,38} Furthermore, their minimum clinical requirements included the completion of acrylic- and metal-based RPDs for patients with shortened, interrupted, or discontinuous arches.

The self-administered questionnaire was distributed and collected from the students and clinical faculty by the principal investigator (SK). The quantitative data (categorical and ordinal observations, as well as paired comparisons) were analyzed by a statistician using the Microsoft Excel statistical package.³⁹ The categorical data were analyzed by

means of residuals based on observed and expected values and using frequency distribution, Spearman rank correlations, and chi-squared statistics.³⁹ The data were managed by dichotomization (definitely yes and yes, to a yes response), and this collapsed table strengthened the pattern of analysis.³⁹

For the second and third phases of the study, qualitative interviews were conducted to supplement the findings from the survey.^{36,38} Smaller samples of students were selected for the semi-structured individual interviews (n=10) and for one semi-structured group interview (n=1, including ten students), both of which were conducted from April to June 2011.³⁶⁻³⁸ These participating students were selected from the class (n=73) via the process of statistical randomization accomplished through computer-generated numbers.³⁷ The interviews permitted a more comprehensive discussion and understanding of why students were not suggesting or implementing the SDA as a treatment option.^{9,38}

The semi-structured individual interviews with the students were of one-hour duration each, and responses were transcribed by the principal investigator (SK).³⁶⁻³⁸ Another group of ten senior dental students was also chosen by randomization for the semi-structured group interview.³⁶⁻³⁸ The Crawford slip-method allowed students to record their responses without any bias and avoid their being influenced by the thinking and responses of the group.^{40,41} The use of this method allowed students to give their own independent opinions when answering the questions, and it ensured maximum participation from all students.

The qualitative data (semi-structured individual and group interviews) were analyzed using the analytical abstraction method (which has a clear, logical step-by-step analysis approach).^{38,42} Themes present in the literature review were used as a guide in the basic coding process.^{37,38,42} These themes include a discussion at the basic level (actual words of respondents) and a higher level (inferences of responses). The recorded text from both interviews used in the analysis ensured an accurate account of student responses, and member-checking was implemented in which students had to check that their responses were transcribed verbatim and were reflected in the subsequent interpretation.³⁸

Furthermore, three emergent themes that became apparent from the basic analysis of the qualitative data were extrapolated; these themes are discussed in the results section.^{37,38,42} A conceptual analysis of the data including an interpretation and

discussion thereof is also presented.^{37,38} These strategies and sampling were included to increase the validity and strengthen the reliability of the research and at the same time reduce any bias encountered by the role of the researcher.^{37,38}

Results

Quantitative Data Analysis

The quantitative data from the student and clinical teacher surveys are shown in Table 1. The response rates were 100 percent for the students (n=73) and 78 percent for the clinical teachers (n=16).

Student survey responses. Eleven percent of the student respondents indicated having heard about the SDA concept from this survey only and ascribed this omission to having missed lectures, not paying attention in class, or the lecturer placing little emphasis on this concept and without encouraging its use clinically. According to the Spearman rank correlation (0.565), a strong relationship existed between students' not having read the research (77 percent) and their lack of knowledge of the SDA variants (77 percent).

Many of the students indicated their proposed treatment for a SDA would include either metal (66 percent) or acrylic (53 percent) dentures or a combination of these with other treatment options such as implants (Table 1). Only 3 percent chose "no treatment" as a suggested treatment alternative for a patient with a SDA, which prompted extensive questioning in the interviews regarding their knowledge, classroom teaching, and clinical use of the SDA. Twelve percent of the respondents indicated "quota requirements" but 86 percent said "not having any knowledge" of the SDA will prevent their clinical use of this approach. More importantly, the students were totally unaware of the financial benefits for patients with the SDA treatment option. To the question of whether they would insist on making a denture for a clinical quota, 50 percent responded no. This response was unexpected as the students' main concern is the completion of minimum clinical requirements.

When we correlated the questions about "making of a denture for a quota" and "suggestions to implement the SDA as a treatment option," the distribution of the suggestions varied significantly ($p < 0.05$): these significant differences were observed with the responses of "no suggestion" versus a "quota change." Nineteen percent of the students responded

Table 1. Responses of students and teachers to survey regarding the shortened dental arch (SDA)

Question	Student Responses (n=73)	Teacher Responses (n=16)
1. Where have you heard of the SDA?	81% university 11% this survey	62% university 8% this survey
2. Do you read SDA-related research?	77% no/definitely no	77% yes/definitely yes
3. Do you have knowledge of the variants of the SDA?	77% no/definitely no	77% yes/definitely yes
4. Can a patient function with an SDA?	84% yes/definitely yes	85% yes/definitely yes
5. Will you present SDA as a treatment option to patients?	86% yes/definitely yes	85% yes/definitely yes
6. Which treatment options will you propose to patients along with SDA?	66% metal dentures 53% plastic dentures	69% metal dentures 38% implants
7. What prevents you from presenting SDA to patients?	86% lack of knowledge	16% loss of income 39% other
8. How often do you advise patients not to replace missing molars?	41% sometimes 33% rarely	62% sometimes 31% rarely
9. How should SDA be implemented as a treatment option in the clinic?	51% include SDA as a clinical quota	No suggestion/other noncommittal responses
10. Do you make dentures as a quota for the SDA patient?	50% yes/definitely yes 50% no/definitely no	

“yes” and 39 percent responded “no” to the question of “no suggestion to the making of a denture for a quota” ($\chi^2=9.9627$; d.f.=4; $p=0.0411$). Fifty-three percent of the students responded “yes” to a quota change (including the SDA) versus 19 percent who said “no” to a quota change.

Clinical teacher survey responses. The clinical teachers’ responses indicated that they had read the research, knew about the SDA variants, and agreed that patients can function with a SDA (Table 1). However, their responses were of some concern as these clinical teachers nevertheless indicated that they would replace molars in all patients with a SDA. The disparity between knowing theoretical concepts and carrying out clinical implementation was obvious. Moreover, it can be assumed, though only speculated from this finding, that their teaching about and implementation of evidence-based findings were also absent.

Qualitative Data Analysis

The qualitative findings explain what happened during lectures and clinical implementation from the students’ point of view. These are reported under three broad categories: basic and higher levels and then conceptual analysis of these two levels. The basic and higher levels are reported in themes—first,

guided by the literature and then, second, those that became apparent after the analysis.

Basic and higher level analysis. The themes guided by the literature include definition of the SDA concept, classroom and clinical instruction, and minimum clinical requirements. Student comments on the SDA concept used in class included “no term SDA” or “a term interchange” and “SDA was not used.” The definition of the SDA given in class (and used for distal extension dentures include teeth up to the first molars) is very different from that cited in the literature, where it is described as a premolar-to-premolar occlusion.¹⁹⁻²¹ In spite of the rather indistinct definition of the SDA concept, the students suggested that this SDA “be used if it is advantageous to” or “benefits patients.” Many students suggested that a separate lecture be given for an alternative treatment option such as the SDA as they were unaware of the extensive research conducted and expressed the need to be informed.

The student respondents commented that the classroom teaching of the SDA included “no explanation when teaching the concept” and “the way it was mentioned we regarded it as insignificant.” Because of this brief mentioning of the SDA, the students clearly considered the concept as unimportant and forgot about it.^{11,12} Thus, its use clinically by students on their own initiative can hardly be expected. In-

stead, the clinical teacher needed to assume the role of reminding them about the appropriate use of the SDA rather than ignoring situations in which its use could have greatly benefited the patient.^{11,12} The students were very conscious of the difference between classroom and clinical teachings and expressed their dissatisfaction that “student-centred learning does not occur in the clinics.” Students commented that “attitudes from classroom and clinical teachers regarding ‘new’ concepts guide their professional behaviours after graduation,” so the updating of knowledge to include evidence-based research both in class and clinics is imperative and has been notably absent.

The students responded explicitly to questions on minimum clinical requirements. Several students said that “if a procedure is not a requirement” or “you don’t need to do it, students will ignore it.” The students did not consider the financial implications and/or benefits for a patient when contemplating extending an SDA with an RPD. When they were made aware of this, however, they regarded it as “good ethical and moral clinical practice.” The guidance received by students from clinical teachers can either encourage or discourage them from implementing new procedures that are not a requirement. Any new concept that can be clinically implemented by students should be included as a clinical requirement for that module. The students’ clinical requirements should thus also be reviewed regularly to include information from new research.

Emergent themes. With the analytical abstraction method, the coding process also highlighted several themes that added considerable value to the teaching and learning experiences important to the student respondents. Regarding the clinical outcomes theme, even though students are guided clinically by minimum clinical requirements, the absence of clinical outcomes as in module learning outcomes (prescribed by the curriculum and provided to students) is evident. The use of clinical outcomes would serve as a guide to both students and clinical teachers, ensuring the updating and alignment of clinical education.

The interprofessional education theme was defined as occasions when two or more professions learn from and about each other to improve collaboration and health outcomes. Following the student interviews, the role of dental technicians was highlighted, and students regard their role as equally important when wanting to implement new concepts.⁴³ Their knowledge of the SDA concept and their input with regards to laboratory procedures will

affect its implementation and thus need to be aligned with evidence-based research and clinical education. The lack of knowledge and subsequent practice related to the SDA concept has been duly documented.

Regarding the theme of interviews, both the group and individual interviews conducted with these senior dental students simultaneously served as a teaching and learning opportunity for the principal investigator and the students. What is otherwise assumed or even disregarded was revealed as important items of information in these interviews—namely, the methodologies employed in clinical teaching (or lack thereof) and their impact on student learning and the role of clinical teachers and the consequence of their input on students’ clinical decision making.⁴⁴ In addition, faculty development and research and their beneficial impact on students became evident.

Regarding the conceptual analysis theme, students commented that they were not inclined to do any extra reading when the impression was created (in class or clinics) that a concept was insignificant. This attitude when presenting students with evidence-based research is as important as interpretation by students in guiding their clinical decision making. Thus, instructors must emphasize the importance of clinical concepts, not merely teach how to implement them, to convince students that such practices should be followed. According to Strayhorn, when specific classroom teaching strategies were employed, the tendency for students to learn the content and then appropriately transfer this knowledge to clinical practice is enhanced.⁴ The students in our study also suggested a change in the minimum clinical requirements (emphasizing module review) and a change in health policies to include and implement the SDA treatment option. Doing so would make both students and clinical teachers more aware of the concept.¹⁷ This attitude of dental practitioners regarding new concepts was observed in a study by Lalloo et al., which concluded that the effortlessness in using old concepts (e.g., restoring and extending shortened dental arches) could not be altered without shifting the mindset and health care policies for professionals and institutions.¹⁷

Discussion

The aims of this study were consistent with the goals of the institution that emphasize attributes of citizenship and scholarship of learning, amongst others. Given that these goals are embedded in the

stated outcomes of every module in the curriculum, the findings of the study suggest that use of the SDA approach is not in conformity. In particular, the barriers to more meaningful translation of evidence-based concepts that are taught in class and clinical settings seem to have been identified by the interviewed students. From this result, it seems the inclusion of best evidence in the classroom needs to be supported and reinforced during clinical instruction so as not only to improve students' basic knowledge but also to empower them to apply new procedures appropriately.¹⁻³ Doing so would help students more confidently advise and educate patients, make informed clinical decisions, and deliver the most appropriate treatment to their patients. One student expressed the view that this research had created evidence, which could change the mindset of practitioners and dental students.¹⁻³ A related matter is that students will be undertaking community service in mostly rural communities after graduation, and a thorough grasp of the SDA concept would add greatly to their decision making skills in those relatively underserved clinical environments.

Currently at our institution, classroom instruction has moved to one of student-centered learning, in which a range of teaching strategies to achieve conceptual learning is included.^{2,11} However, while classroom instruction emphasizes that students adopt a patient-centered and problem-oriented treatment planning approach clinically,¹⁻³ responses in the interviews did not confirm that this was taking place. Had such a problem-oriented treatment approach been effectively adopted, the prosthetically non-interventional SDA approach would conceivably have been considered. Consequently, students would have been obliged to complete clinical procedures beyond their clinical requirements.^{3,19,20} Doing what is best for the patient, including taking into account their financial and functional circumstances, would also encourage ethical and moral clinical practices.^{3,14,19,20}

In terms of the aims of this study, what dental students were formally taught in class regarding the SDA concept did not relate well to clinical implementation of this treatment protocol.⁴⁴ Whether this was due to the influence of sessional clinical staff (that is, their lack of knowledge related to classroom instruction on the SDA) is not established, but its existence cannot be overlooked and clearly needs re-consideration.⁴⁵ Hence, the limitation of this confounder should be acknowledged, and a study that compares outcomes with sessional versus full-time clinical staff is warranted.

Following both the survey and interviews, the students now appear to be more familiar with the low-cost SDA treatment option, including the restrictions to specific clinical situations for the underprivileged majority in South Africa.^{29,34} They realize that it needs to be presented to patients, permitting them to make decisions regarding their own treatment needs. The ethics of overtreatment or incurring exorbitant costs to patients can be addressed partially in this way. This resonates with the findings of Henzi et al., who argued that clinical treatment that enforces certain costly procedures is unethical.¹⁴

The SDA concept is not taught as a separate topic, which could be seen as another flaw in the module. The extensive clinical research available, including the positive attitude of clinicians regarding its benefits, justifies its inclusion in the module.^{15,18-34} Indeed, this finding only became evident after the qualitative research, and it might not have been observed had only quantitative research been conducted. More significantly, this research allowed reflection on the content of the module, clinical practices, and the choice and training of clinical teachers. The subsequent inclusion of the SDA concept as a separate lecture can be recommended as a step in the right direction. The importance of instilling self-reflection with respect to our teaching practices (classroom and clinical), which became evident in our study, is also encouraged to improve the students' learning environment.² Moreover, for this revision to be effective, a change in the protocol for the clinical setting and institutional policies regarding SDA therapy surely needs to be considered.

Conclusion

The results of this study indicate the students were positive towards the SDA concept as a treatment option for certain partially dentate adult patients. However, their lack of related knowledge and the absence of encouragement in the clinic were seen as hindrances to its implementation. These were linked to the emphasis on the SDA during classroom instructions and the nature of clinical guidance and/or instruction. In addition to this, the knowledge of the clinical teachers appears not to be aligned with formal classroom instruction. Given the extensive body of evidence on the functional efficacies of the SDA approach and the widespread need for low-cost prosthetic management strategies in South Africa, the case for a more purposeful alignment of the

theory and its clinical practice would seem justified. Thus, faculty development with appropriate ethical standards for clinical teachers should be expanded.

The SDA has been included as a separate lecture in the module that covers advanced removable denture procedures. The inclusion of this qualitative therapeutic intervention as a minimum clinical requirement and the necessary policy changes within the institution cannot be overemphasized. The barriers (of which there are many) to translate this knowledge into clinical practice should be dealt with urgently. Furthermore, ensuring consistency from didactic classroom instruction to implementation in a clinical setting would certainly standardize the curriculum regarding SDA therapy. This would ensure that students are able to implement this beneficial concept and thus address the needs of many underprivileged communities in their country.

Acknowledgments

Grateful thanks are extended to Prof. Yusuf Osman, Dr. Theunis Kotze, and Miss Shamima Allie for their invaluable guidance, support, and assistance with this research; to the BChD V Class of 2011 for their cooperation, support, and encouragement during this research; and to the UWC Ethics and Research Committee for financial assistance required for completion of this project.

REFERENCES

1. Rolfe IE, Sanson-Fisher RW. Translating learning principles into practice: a new strategy for learning clinical skills. *Med Educ* 2002;36:345-52.
2. Biggs J. *Teaching for quality learning at university*. 4th ed. London: Open University Press, 2004.
3. Bensing J. Bridging the gap: the separate worlds of evidence-based medicine and patient-centered medicine. *Patient Educ Couns* 2000;39:17-25.
4. Strayhorn TL. Engaging schools: fostering high school students' motivation to learn. *Educ Review* 2004;1-8.
5. McMillan WJ. Teaching for clinical reasoning: helping students make conceptual links. *Med Teach* 2010;32:436-42.
6. McMillan W. Making the most of teaching at the chairside. *Eur J Dent Educ* 2011;15:63-8.
7. McMillan WJ. "Then you get a teacher": guidelines in excellent teaching. *Med Teach* 2007;29:209-18.
8. MacLellan E. Conceptual learning: the priority for higher education. *Br J Educ Stud* 2005;53:129-47.
9. McMillan W. Finding a method to analyze qualitative data: using a study of conceptual learning. *J Dent Educ* 2009;73(1):53-64.
10. Khan SB. Effect of active learning techniques on dental students: a South African case study. *S Afr J Higher Educ* 2011;25(3).
11. Billing D. Teaching for transfer of core/key skills in higher education: cognitive skills. *Higher Educ* 2007;53:483-516.
12. Taber K. The mismatch between assumed prior knowledge and the learner's conceptions: a typology of learning impediments. *Educ Stud* 2001;27:159-71.
13. Kreuger PM, Neutens J, Bienstock J, et al. To the point: reviews in medical education teaching techniques. *Am J Obstet Gynecol* 2004;191:408-11.
14. Henzi D, Davis E, Jasinevicius R, Hendricson W. North American dental students' perspectives about their clinical education. *J Dent Educ* 2006;70(3):361-77.
15. Sarita PT, Witter DJ, Kreulen CM, et al. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Oral Sci* 2007;115:265-74.
16. Hays R. Assessment in medical education: roles for clinical teachers. *Clin Teach* 2008;5:23-7.
17. Laloo R, Myburgh NG, Hobdell MH. Dental caries, socioeconomic development, and national oral health policies. *Int Dent J* 1999;49:196-202.
18. Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981;8:457-62.
19. Omar R. Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ* 2004;59:228-37.
20. Käyser AF. The shortened dental arch: a therapeutic concept in reduced dentitions and certain high risk groups. *Int J Periodontics Restorative Dent* 1989;9:426-49.
21. Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aust Dent J* 1987;32(3):178-82.
22. Witter DJ, van Elteren P, Kayser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988;15:413-20.
23. Witter DJ, de Haan AF, Kayser AF, van Rossum GM. A 6-year follow-up study of oral function in shortened dental arches: Part I. occlusal stability. *J Oral Rehabil* 1994;21:113-25.
24. Allen PF, Witter DF, Wilson NHF, Käyser AF. Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996;23:481-5.
25. Armellini DB, Von Fraunhofer JA. The shortened dental arch: a review of the literature. *J Prosthet Dent* 2004;92(6):531-5.
26. Baba K, Igarashi Y, Nishiyama A, et al. The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008;21(1):72-4.
27. Ueno M, Yanagisawa T, Shinada K, et al. Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008;35:337-44.
28. Zeng X, Sheiham A, Tsakos G. Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008;35:37-44.
29. Owen CP. Appropriate: prosthodontics for the many, not just for the few. *Int J Prosthodont* 2004;17(2):261-2.
30. Sarita PT, Kreulen CM, Witter DJ, Creugers NH. Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 2003;16:265-70.
31. Sarita PT, Witter DJ, Kreulen CM, et al. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003;16:375-80.

32. Sarita PT, Witter DJ, Kreulen CM, Creugers NH. The shortened dental arch concept: attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol* 2003;31:111-5.
33. Sarita PT, Witter DJ, Kreulen CM, et al. Chewing ability of subjects with shortened dental arches. *Community Dent Oral Epidemiol* 2003;31:328-34.
34. Khan S, Chikte UME, Omar R. Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa. *SADJ* 2012;67(2):60-8.
35. World Medical Organization. Declaration of Helsinki. *Br Med J* 1996;313:1448-9.
36. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: interviews and focus groups. *Br Dent J* 2008;204:291-5.
37. Cohen L, Manion L, Morrison K. *Research methods in education*. 5th ed. London: Taylor and Francis, 2005.
38. Creswell JW. *Research design: qualitative, quantitative, and mixed methods approaches*. 2nd ed. Thousand Oaks, CA: Sage Publications, 2003.
39. Dawson B, Trapp RG. *Basic and clinical biostatistics*. 4th ed. New York: McGraw-Hill, 2004.
40. Referencing pages in Principia Cybernetica Web. 2000. At: <http://cleamc11.vub.ac.be/Heylighen>. Accessed: April 17, 2013.
41. Straker D, Rawlinson G. *How to invent (almost) anything*. London: Spiro Press, 2003.
42. Crafford S, Bitzer E. Consumer learning for university students: a case for curriculum. *Higher Educ Res Dev* 2009;28:443-55.
43. Interprofessional Education Collaborative Expert Panel. *Core competencies for interprofessional collaborative practice*. Washington, DC: Interprofessional Education Collaborative, 2011.
44. Straus SE, Tetroe MA, Graham I. Defining knowledge translation. *CMAJ* 2009;181(3-4):165-8.
45. Fluit CRMG, Bolhuis S, Grol R, et al. Assessing the quality of clinical teachers. *J Gen Int Med* 2010;25(12):1337-45.



Differences in Functional Outcomes for Adult Patients with Prosthodontically-Treated and -Untreated Shortened Dental Arches: A Systematic Review

Saadika Khan^{1*}, Alfred Musekiwa², Usuf M. E. Chikte³, Ridwaan Omar⁴

1 Department of Restorative Dentistry, University of the Western Cape, Cape Town, South Africa, **2** Centre for Evidence-Based Health Care, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town, South Africa, **3** Department of Interdisciplinary Health Sciences, Stellenbosch University, Cape Town, South Africa, **4** Head of Prosthodontics, Faculty of Dentistry, Kuwait University, Safat, Kuwait

Abstract

This review examined differences in functional outcomes and patient satisfaction when shortened dental arches are left untreated compared to their restoration to complete arch lengths with different prosthodontic interventions.

Methods: A protocol was developed according to the criteria for a systematic review. All relevant databases were searched to identify appropriate clinical trials regardless of language or publication status. Predetermined eligibility criteria were applied, trial quality assessed and data extracted for each study. Relevant outcomes assessed were: functioning ability, patient satisfaction and harmful effects on oral structures.

Results: Searches yielded 101 articles: 81 from electronic databases and 20 from reference lists of retrieved articles (PEARLing searches). Sixty-nine citations were assessed for eligibility after removing 32 duplicate records. After reading titles and abstracts, a total of 41 records were excluded and the full-texts of the remaining 28 records were read. Only 21 records were included for the SR because 7 records were excluded after reading the full-text reports. These 21 records report the outcomes of four randomized controlled trials (RCTs) and one non-randomized clinical trial (CT) which were pre-specified and used for this review. No on-going studies were found and no eligible studies were excluded for failure to report the reviewer's pre-specified outcomes. Outcomes were reported in the retrieved 21 articles. A narrative explanation of the pre-specified outcomes is reported for the 3 comparison groups (which were based on the different interventions used for the individual clinical trials). The shortened dental arch as a treatment option is encouraging in terms of functioning, patient satisfaction and cost-effectiveness. By using only high quality studies it was expected that the results would be more reliable when making conclusions and recommendations, but some of the included studies had to be downgraded due to methodological errors.

Citation: Khan S, Musekiwa A, Chikte UME, Omar R (2014) Differences in Functional Outcomes for Adult Patients with Prosthodontically-Treated and -Untreated Shortened Dental Arches: A Systematic Review. PLoS ONE 9(7): e101143. doi:10.1371/journal.pone.0101143

Editor: Kimon Divaris, UNC School of Dentistry, University of North Carolina-Chapel Hill, United States of America

Received: February 3, 2014; **Accepted:** June 3, 2014; **Published:** July 3, 2014

Copyright: © 2014 Khan et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Funding: University of the Western Cape funded the services of a statistician for this review. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

* Email: skhan@uwc.ac.za

Introduction

Prosthodontic treatment planning customarily includes the replacement of all missing teeth with the intention of achieving complete dental arches (CDAs) comprising 28 teeth [1–3]. The rationale for this approach includes impaired oral function with a perceived detrimental impact on chewing ability, occlusal stability and temporomandibular joint (TMJ) function due to the loss of the molar teeth [4]. On the other hand, several studies and reviews have indicated that twenty occluding teeth provide sufficient oral functional ability and the need to replace all missing posterior teeth has been questioned [3–11].

The classic shortened dental arch (SDA) is defined as ten pairs of occluding anterior and premolar teeth [5,8]. Many patients present with SDAs since molars are the teeth more commonly lost due to caries, resulting in patients having a posteriorly reduced dental arch [12–13]. Variations of the SDA include a partially

dentate arch described as an interrupted or discontinuous dental arch where individual anterior, premolar or even molar teeth are lost [7]. A considerable number of studies have been conducted, though mostly in industrialized countries, that confirm a range of benefits and adequate oral functioning with a SDA [4–12,14–20]. These studies also propose that the aesthetic features of such partially dentate patients are acceptable [5,8]. Research related to the SDA concept has also been conducted and promoted in some developing countries such as Tanzania and Nigeria [3,5–12]. The 1982 WHO oral health goal for developing countries was set as the retention of twenty functional, aesthetic natural teeth without resorting to a prosthesis which is in line with the findings of the SDA research [4–12,21].

When dentists extend or reconstitute reduced, shortened or discontinuous dental arches and replace missing teeth in either anterior or posterior regions to create a CDA, the following interventions are usually recommended: removable partial denture

prosthesis (RPDP) or fixed denture prosthesis (FDP), including resin-bonded bridges and implant-retained prostheses [9,22–33]. Anecdotal evidence suggests that the choice is largely intuitively based upon the number of missing teeth, their location in the arch, and economic considerations. Currently, RPDPs, FDPs and implant procedures evidently operate on the premise of optimal occlusion encompassing the aesthetics, oral function, oral health and comfort created by the occluding teeth [4–5,33]. This practice appears to have evolved empirically, with no scientific or clinical evidence to support its widespread acceptance by clinicians [3,22–33].

Several research reports tend to support the view that the underlying objective of the SDA to preserve a functional dental arch can be realized through a functionally-oriented treatment approach [5,15–17,22,24,26]. This entails directing the limited resources towards that part of the dentition that can be successfully preserved and in the most cost-effective manner, rather than on the remaining molar teeth that often have a poorer prognosis [5,7,31–58]. The minimum number of teeth or shortness of the arch will also depend on the periodontal condition of the remaining teeth, the age of the patient, occlusal activity, food types and adaptive capacity of the patients' temporomandibular joints [3,7,9].

Research suggests that this seemingly beneficial SDA concept and its variations can be utilized to improve accessibility and affordability to treatment for socially- and economically-deprived middle-aged and elderly communities [5,16,22,24,26]. Other associated benefits of the SDA have been enumerated by several researchers [5–8,10–20,31–58]. A number of studies have been conducted in Tanzania where the evidence obtained was used to advise the government, medical and dental personnel to include the SDA concept within the prosthodontic management protocols for the country [12,16,50–52]. The consequence of the research was that dental institutions reviewed the dental curricula accordingly [12,16,50–52].

Following the large body of published research data related to the SDA conducted in different parts of the world, several efforts at collating these data have been made. Thus a number of systematic reviews (SR) focusing on the SDA have been completed [8,56–58]. A SR conducted by Gotfredsen and Walls (2007) focused on studies that reported on the assessment of normative needs only, although it did not include quality of life studies that considered the perceived oral health needs of partially dentate patients [8]. In the SR by Fueki et al (2011), different types of study designs were included, in addition to the randomised controlled trials (RCT) [56]. The quality of evidence from longitudinal studies related to restorative and non-restorative approaches to adult patients with SDAs were assessed by Faggion (2011) using GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach [58]. With this study, even though all the results from the included studies were not reported, it demonstrated how important methodological rigor is and that these need to be reported [58]. In a recent electronic search in the Cochrane database for systematic reviews, Abt, Carr and Worthington (2012) focused on a broad research question to include all different types of interventions for partially dentate patients, including the SDA [57]. No conclusive evidence was found to indicate that any intervention was better for partially dentate patients, irrespective of particular interventions, procedures or materials used [57].

Given that so few RCTs have been conducted and are available, researchers conducting SRs are faced with the ineluctable option of including different types of study designs and systematic reviews [8,56–58]. This results in the inclusion of lesser strength studies

which could affect the quality of the evidence presented [8,14,31–37,40–48,53–55].

The aim of this systematic review was to identify and analyse existing clinical trials which compare the functional outcomes of prosthodontic interventions used for treating shortened arches versus un-restored shortened arches in partially dentate adult patients.

The following research question addresses the aim and objectives of the study: In adult patients with shortened dental arches, what is the effect of prosthodontics interventions on the functional outcomes compared to having no treatment?

Methods

Protocol Development

A protocol (Registration No: 11/4/39) was developed (not published) to include all aspects of a SR namely: selection criteria, search strategy, selection methods using predetermined eligibility criteria, data collection, data extraction, assessment of risk of bias using the Cochrane tool, the GRADE tool to grade the evidence of each clinical trial and statistical analysis by calculating risk ratios (RR) for dichotomous outcomes and presented at 95% confidence intervals [59–60].

Criteria for considering studies for this review

Types of studies. Only RCTs and Clinical trials (CTs) are included in the systematic review (SR).

Types of interventions. Interventions included in this study are described as any prosthodontic intervention used to restore and treat the SDA such as RPDPs and FDPs. The control group for this study included patients with the classic SDA.

Types of participants. Participants included in the SR were:

1. Adult male and female participants aged 18 years and older.
2. Study population included patients with posteriorly reduced or shortened dental arches.

Types of outcome measures. Primary and secondary outcomes were pre-specified for the SR and these include:

Primary outcomes

- 1) Functional outcomes (patient- or investigator-reported) as measured by masticatory function, chewing ability, occlusal effects, nutrient intake (using nutritional assessments and haematological markers) and subjective functioning ability.
- 2) Survival of the interventions (fixed or removable partial denture prostheses) used for the extension of SDAs.

Secondary outcomes

- 1) Patient satisfaction and oral health-related quality of life (social interaction; aesthetics and effectiveness) using oral health indicators for example Oral Health Indicator Profile (OHIP) or the Oral Impacts of Daily Performance (OIDP).
- 2) Harmful effects (caries; tooth loss; periodontal status, plaque index (PI), gingival index (GI), temporomandibular joint (TMJ) problems, interdental spacing and overbite).

Inclusion criteria. Studies that included above interventions and outcomes and addressed the pre-specified outcomes were eligible for this SR.

Exclusion criteria. The following study designs: case-control, cross-sectional and cohort studies; case-series and case reports; other SRs; analytical and narrative reviews and different types of animal studies that were not eligible for inclusion, were excluded.

Search strategy. All relevant databases were searched: Medline, Cochrane Central Register of Controlled Trials, EMBASE, CINAHL, Science Direct, ProQuest, Science Journals, Scopus, PsycINFO, ClinicalTrials.gov, WHO ICTRP, TRIP and PACTR. Further hand-searching was conducted including citations from reference lists of retrieved studies (PEARLing searches) for additional references [59]. Where data were missing and full texts unavailable, these unclear reports were clarified by contacting authors or research institutes. Efforts were made to obtain English versions of studies reported in other languages either by requesting English versions from authors or using language experts to translate key findings. Authors were also contacted for unpublished reports or conference proceedings, where it was needed. Where registries were available for on-going studies, these were included as well and experts in the field of research related to the SDA were contacted.

Key terms were combined using Boolean operators and search strategies for each database were developed using the database specific functions [59]. Medical subject headings were applied in databases which allowed this function [59]. A wide search strategy was developed and modified according to the requirements of the different databases to ensure no eligible studies were excluded and an example includes the following:

(shortened dental arch OR shortened dental arches) AND (Clinical Trial OR Comparative Study OR Evaluation Studies OR Randomized Controlled Trial OR clinical trial) AND 1980/01/01-2014/12/31).

Search limits. Databases were searched for articles of over a period of three decades from 1980 to April 2014. The limits included in the search strategy were: human studies, adult patients and randomized and non-randomized controlled clinical trials.

Selection methods. Two review authors (SK and AM) independently screened titles and abstracts from the electronic searches to select potentially relevant studies using a predetermined eligibility form based on the inclusion criteria [59]. Full text articles of potential studies were then retrieved and re-assessed for eligibility. Each article was scrutinized to ensure that multiple publications from the same study were included only once. Where eligibility was unclear, clarification was sought from the trial authors and the corresponding articles were re-assessed. Differences between the eligibility results were resolved by consulting the other review authors (UMEC and RO). Studies that did not meet the inclusion criteria were excluded and the reasons for exclusion were reported. Data extraction for the selected studies was completed by the principal researcher (SK) using a specially designed pre-piloted data extraction form for this SR [59]. All disagreements regarding this process were resolved through discussion with the other review authors (AM, UMEC and RO).

Qualitative analysis. The quality of the studies included for this SR were evaluated for any risk of bias by researchers (SK and AM) using the Cochrane Risk of Bias tool and as described in the Cochrane Handbook for Systematic Reviews of Interventions [59]. The assessment was done across the following six components: random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other bias. Each of these were judged as 'yes', 'no', or 'unclear' corresponding to low, high, or unclear risk of bias respectively. Where information in the articles was insufficient for making the judgements, trial authors were contacted for clarification. Disagreements were resolved through discussion with other review authors. Results of risk of bias were summarised in a risk of bias table. In addition, GRADE assessments were completed by the researchers (SK and AM) for each clinical trial and these were used to grade the evidence and strength of recommendations for

clinical intervention (where possible) using the GRADE Profiler system [60]. These are reported in the summary of findings tables.

Data synthesis and management. Results were reported separately for the following three comparisons: 1) FDP versus RPDP; 2) RPDP versus no treatment (SDA); 3) SDA versus CDA. No imputation of missing data was carried out and study authors were requested to provide any missing data. Available case analysis was applied where data were missing. Risk ratios with corresponding 95% confidence intervals were calculated for dichotomous outcomes using Review Manager 5 software. Although a meta-analysis of outcomes across study results had been anticipated, the included studies reported outcomes in different forms that could not be pooled in a meta-analysis. Consequently, results for individual studies were reported separately.

Results

The search strategy identified a total of 101 citations (Figure 1): electronic databases yielded 81 and 20 were from reference lists of retrieved articles (that is, through PEARLing searches). A total of 32 duplicate records were removed, leaving 69 citations which were assessed for eligibility. After reading titles and abstracts, a total of 41 records were excluded and the full-text of the remaining 28 records was retrieved. A further 7 records were excluded after reading the full-text reports, leaving the remaining 21 records as included studies for the SR (Figure 1). Only four RCTs and one CT were used for this review, but outcomes were reported in the retrieved 21 records [14,31–38,40–48,53–55]. No on-going studies were found and no eligible studies were excluded for failure to report the reviewer's pre-specified outcomes.

Study characteristics

The studies were grouped according to types of interventions into the following comparisons:

Comparison 1: FDPs versus RPDPs for SDAs in the lower jaw.

Two included studies from the UK and Denmark assessed comparison 1 [31–38].

Comparison 2: RPDPs versus no treatment (SDA).

Two studies from Germany and Ireland assessed comparison 2 [40–48].

Comparison 3: SDA versus CDA.

Only one study from the Netherlands assessed comparison 3 [14,53–55].

Characteristics of included studies. The study characteristics of the four RCTs and 1 CT included in this SR are summarized according to types of study, population characteristics, types of interventions and the follow-up periods and these are specified on Table 1 [14,31–38,40–48,53–55].

Qualitative analysis. Table 2 specifies the quality assessment of the included studies and these are summarized in the 'risk of bias table' and 'risk of bias graph' where judgements are categorized to indicate a low, high, or unclear risk of bias (Figure 2) following the Cochrane guidelines [59]. Below we give a detailed explanation of these results:

Sequence Generation: Three of the five trials were reported as having been randomised. For sequence generation, two clinical trials used computer-generated numbers and a third trial used randomly permuted block randomisation for generating the allocation sequence, which we judged as having a low risk of bias [34–38,40–48]. The Witter et al (2001) clinical trial invited subjects to join the department for a study, and no attempt was made to randomise patients, thus it is judged as having a high risk of bias [14,53–55]. The Budtz-Jorgensen and Isidor (1987) trial did not mention how the sequence was generated and provided

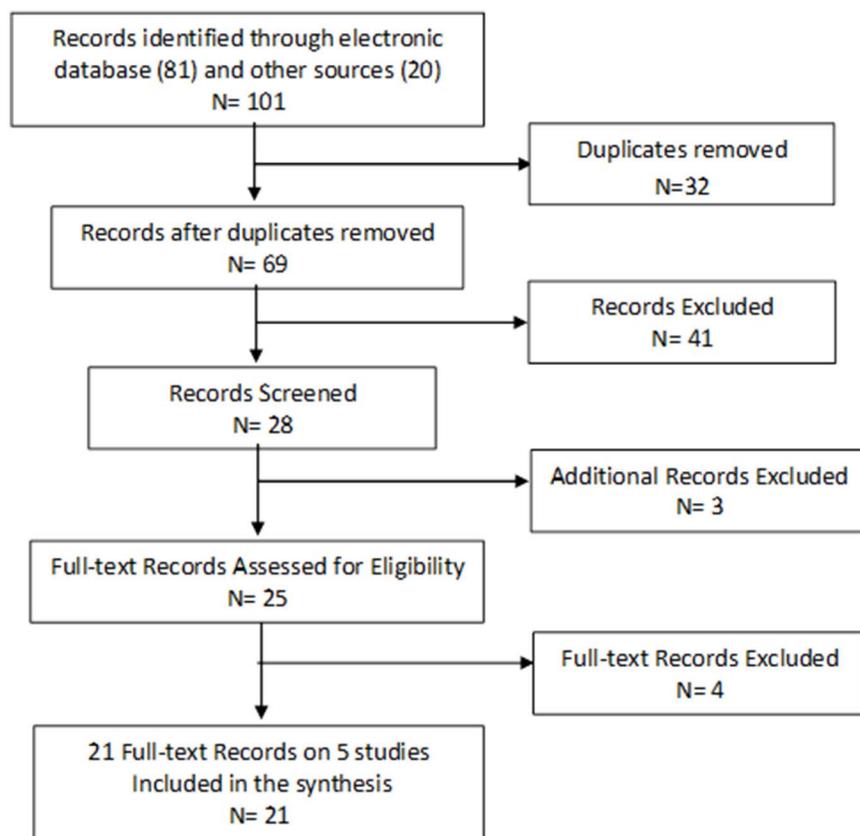


Figure 1. Prisma Flow Chart of Study Selection.
doi:10.1371/journal.pone.0101143.g001

insufficient information to enable us to judge whether there was a high or low risk of bias, and we thus rated it as having an unclear risk of bias [31–33].

Allocation Concealment: The Moynihan et al (2000), Wolfart et al (2005) and Mc Kenna (2012) studies are described as having a low risk of bias for allocation concealment, as they indicated that the clinician was not involved in the allocation and that concealment was warranted following a central randomisation process after patient enrolment [34–38,40–48]. For the Budtz-Jorgensen and Isidor (1987) and Witter et al (2001) studies, there is no indication as to how intervention allocation was concealed and these were judged as having an unclear risk of bias [14,31–33,53–55].

Blinding: The Moynihan et al (2000) study was referred to as a double blinded study with the clinician blinded to allocation of intervention and statistician being blinded to treatment and thus it is judged as having a low risk of bias [34–38]. The Witter et al (2001) study can be considered as a single blinded study because evaluation of outcomes was completed by a calibrated observer at all intervals, but it was not stated as such, thus it is judged as having an unclear risk of bias [14,53–55]. Mc Kenna (2012) indicated that the researcher was not involved in the intervention allocation, making it a single-blinded study, thus it is judged as having a low risk of bias [47–48]. The Wolfart et al (2005) study indicated that it was impossible to blind the dentist and patient due to discrepancies of the treatments; thus it was judged as having a high risk of bias, whereas Budtz-Jorgensen and Isidor (1987) provided insufficient information related to blinding and it was regarded as having an unclear risk of bias [31–33,40–46].

Incomplete Outcome Data: Analyses for the Moynihan et al (2000), Wolfart et al (2005) and Mc Kenna (2012) studies were conducted on the “intention-to-treat” (ITT) principle; and the studies reported proportionate numbers of losses to follow-up (which were small) and some having no losses between the intervention and control [34–38,40–48]. Witter et al (2001) indicated that regression models accounted for the subjects lost during the study [53]. Thus, all 4 studies above were judged as having a low risk of bias [34–38,40–46,53–55]. On the other hand, Budtz-Jorgensen and Isidor (1987) did not indicate and specify how the analysis was completed, but all pre-specified outcomes were reported, and the number of losses to follow-up was small, thus it was judged as having a low risk of bias [31–33].

Selective Reporting: All studies were registered and approved with their respective Review boards [14,31–38,40–48,48,53–55]. The protocol for the Wolfart et al (2005) study was published (41). In the Budtz-Jorgensen and Isidor (1987) and Witter et al (2001) studies all outcomes were reported but outcomes were not pre-specified as primary or secondary outcomes [14,31–33,53–55]. Both these studies were thus judged as having a high risk of bias. The three remaining RCTs specified the outcomes as primary and secondary and reported these as such, thus these were judged as having a low risk of bias [34–38,40–46]. All the included studies except the Wolfart et al (2005) study reported all their pre-specified outcomes in subsequent publications [14,31–38,40–48,53–55].

Other potential sources of bias: No other sources of bias were detected with four of the five included studies. The Budtz-Jorgensen and Isidor (1987) study was judged as having high risk of bias because there were six patients who did not wear the RPDP at all during the study [32–33].

Table 1. Table of Included Studies.

Study Details	Methods	Participants	Interventions	Outcomes	Notes
<i>Author:</i> Budtz-Jorgensen and Isidor (31–33)	<i>Duration of trial:</i> 5 years	<i>Sample:</i> Total N = 53	<i>Intervention:</i> FDP (N = 27)	<i>Outcomes:</i> Caries; Prosthetic condition; periodontal conditions (PI/GI) and	Study approval by Ethics Board was not recorded
<i>Country:</i> Denmark	<i>Assessment periods:</i> 1 and 2 months; 2 and 5 years	<i>Age:</i> 61–83 yrs. (Mean age: 69) <i>Gender:</i> 28 Females; 25 Males	<i>Control:</i> RPDP (N = 26)	Masticatory system (TMJ) and patient opinion.	No verification
<i>Study Design:</i> CT		<i>Country and Setting:</i> Denmark, University Hospital		Outcomes were not divided into primary or secondary	
<i>Author:</i> Witter et al (14, 53–55)	<i>Duration of trial:</i> 9 years	<i>Sample:</i> Total N = 146	<i>Intervention:</i> SDA (N = 74)	<i>Outcomes:</i> Interdental spacing; periodontal support and	Study approved by University Nijmegen Ethics Board.
<i>Country:</i> Netherlands	<i>Assessment periods:</i> Baseline and 3, 6 and 9 years	<i>Age:</i> Mean –36.2 yrs. for CDA; Mean –40.5 yrs. for SDA <i>Gender:</i> 82 Females; 64 Males	<i>Control:</i> CDA (N = 72)	Occlusal contact; Overbite; occlusal wear and TMJ problems	Informed Consent from patients was obtained.
<i>Study Design:</i> CT		<i>Country and Setting:</i> Netherlands, Nijmegen Clinic		Outcomes were not divided into primary or secondary	
<i>Author:</i> Jepson et al (34–37)	<i>Duration of trial:</i> 2 and 5 years	<i>Sample:</i> Total N = 60	<i>Intervention:</i> FDP (N = 30)	<i>Primary:</i> Survival of prosthesis; Influence of diet and nutrient intake	Study approval received from Ethics Board.
<i>Country:</i> United Kingdom (UK)	<i>Assessment periods:</i> 3 months; 1, 2 and 5 years	<i>Age:</i> 39–81 yrs. (Mean age: 67) <i>Gender:</i> 35 Females; 25 Males	<i>Control:</i> RPDP (N = 30)	<i>Secondary:</i> Caries; Periodontal status; patient satisfaction	Informed Consent from patients obtained.
<i>Study Design:</i> RCT		<i>Country and Setting:</i> UK, Newcastle Dental Hospital			Power calculations were completed
<i>Author:</i> Walters et al (40–46)	<i>Duration of trial:</i> 3 year	<i>Sample:</i> Total N = 215 (pilot sample incl. in main study)	<i>Intervention:</i> SDA (N = 106)	<i>Primary:</i> First tooth loss	Study approved by Institutional Ethics Review Board
<i>Country:</i> Germany	<i>Assessment periods:</i> 4–8 wks.; 6 months and 1, 2, 3, 4 and 5 years	<i>Age:</i> 35 yrs. + (Mean age: 59) <i>Gender:</i> 107 Females and 108 Males	<i>Control:</i> RPDP (N = 109)	<i>Secondary:</i> 2 nd tooth loss; caries; survival of treatment; oral health related quality of life; tooth mobility; PI; GI and TMJ Problems	Power calculations were completed
		<i>Country and Setting:</i> Germany, University Hospitals			
<i>Author:</i> McKenna et al (47–48)	<i>Duration of trial:</i> 1 year	<i>Sample:</i> Total N = 44	<i>Intervention:</i> RPDP (N = 21)	<i>Primary:</i> Oral health related quality of Life; Nutritional status	Study approved by Cork University's Ethics Review Board
<i>Country:</i> Ireland	<i>Assessment periods:</i> Baseline and 1 month	<i>Age:</i> 65–82 yrs. (Mean age: 68) <i>Gender:</i> 28 Females; 16 Males	<i>Control:</i> RBB/FDP (N = 23)	<i>Secondary:</i> cost-effectiveness of two treatments	Power calculations completed: Estimated that one treatment was not worse than the other
<i>Study Design:</i> RCT		<i>Country and Setting:</i> Ireland, University Hospitals			

KEY:

RCT—randomized controlled trial.

CT—Clinical Trial.

SDA—shortened dental arch.

CDA—complete dental arch.

FDP—fixed dental prosthesis.

RBB—resin-bonded bridge.

RPDP—removable partial denture/dental prosthesis.
 PI—plaque index.
 GI—gingival index.
 TMJ—temporomandibular joint.
 doi:10.1371/journal.pone.0101143.t001

Effects of interventions

See: Summary of findings for the main comparisons of functional outcomes and patient satisfaction with FDPs compared to RPDPs in treating patients with SDAs (Table 3); Summary of findings for SDA patients treated with RPDPs compared to no treatment (Table 4) [59].

Comparison 1: Fixed Denture Prosthesis vs Removable Partial Denture Prosthesis.

Primary Outcomes: 1. **Functional Outcomes:** *Occlusion:* Budtz-Jorgensen and Isidor (1987) showed no significant difference in the number of patients with satisfactory occlusion during the 2-year period after treatment between the FDP and RPDP groups (RR 1.16, 95%CI: 0.90 to 1.48, 53 participants) [31].

2. **Survival:** Thomason et al (2007) reported time to survival for the restoration of the shortened dental arch but there was no significant difference between the FDP and RPDP groups (Hazard Ratio 0.59, 95%CI: 0.27 to 1.29, 60 participants) [37].

Secondary Outcomes: 1. **Patient Satisfaction:** This outcome was only reported by Jepson et al (2003) but there was no significant difference in median satisfaction scores at 1 year after treatment between the FDP and RPDP groups (p = 0.092 as reported by authors, 52 participants: Table 5) [36].

2. **Harmful Effects:** (caries; tooth loss; periodontal status, plaque index, gingival index; TMJ problems; interdental spacing; overbite).

Caries: Both studies are in agreement regarding the development of caries lesions with FDPs and RPDPs where: Jepson et al (2001) found that treatment with FDPs showed a significant increase in number of patients with no caries experience compared to the RPDP patients (RR 1.89, 95% CI: 1.09 to 3.30, 50 participants) [35]. Similarly, Isidor and Budtz-Jorgensen (1990) observed 22 dental carious lesions in the RPDP group compared with only two lesions in the FDP group; however we could not calculate a treatment effect since the respective number of patients was not reported. Our unit of analysis was individual patients and not individual teeth [33].

The following effects were only reported for the Budtz-Jorgensen and Isidor study (33):

TMJ dysfunction: Isidor and Budtz-Jorgensen (1990) found no significant difference in the number of patients showing TMJ dysfunction between the FDP and RPDP groups (RR 0.64, 95%CI: 0.36 to 1.16, 53 participants) [33].

Tooth Loss: In the Isidor and Budtz-Jorgensen (1990) study, 11 teeth were extracted in the RPDP group compared with only one tooth in the FDP group during the five years of observation. However, no treatment effect could be calculated because the respective numbers of patients were not reported [33].

Plaque Index: Isidor and Budtz-Jorgensen (1990) reported the mean plaque index ranging from 0.4 to 0.7 in the FDP group and from 0.7 to 1.0 in the RPDP group; the difference between the two groups was significant (p < 0.05) during the first two years of examination as reported by study authors [33].

Gingival Index: Isidor and Budtz-Jorgensen (1990) indicated that the mean gingival index was always higher in the RPDP than in the FDP group, the difference being significant (p < 0.05) at the 12-, 18-, 36-, and 48-month examinations [33].

Comparison 2: Removable Partial Denture Prosthesis versus no treatment (SDA).

Primary Outcomes: 1. **Functional outcomes:** *Mini Nutritional Assessment (MNA):* Mc Kenna (2012) reported the change in MNA scores from baseline to final (month 1) for the two treatment groups and these results are summarised in Table 6 [47]. The values in the table were used to calculate a treatment effect which showed no significant difference in the change in MNA score between the RPDP and SDA treatment groups (MD -0.03, 95%CI: -1.35 to 1.29, 42 participants: Table 6). A higher MNA score indicates better nutrition effect.

2. **Survival:** This outcome was not reported in the two studies assessing this comparison.

Secondary Outcomes: 1. **Patient satisfaction:** This outcome was measured using different tools for both the Mc Kenna (2012) and Wolfart studies (2012), but the time periods from baseline to the end of studies were significantly different, thus indicating differences in final outcomes.

Oral Health Related Quality of Life (OHRQoL): Mc Kenna (2012) reported a non-significant difference in the OHRQoL scores from baseline to the end of treatment (month 1) for the two treatment

Table 2. Risk of Bias Table.

Study	Budtz-Jorgensen (31–33)	Witter et al (14, 51–53)	Jepson et al (34–38)	Walter et al (40–46)	Mc Kenna et al (47–48)
Random Sequence Generation (Selection bias)	Unclear	Unclear	Yes	Yes	Yes
Allocation Concealment (Selection bias)	Unclear	Unclear	Yes	Yes	Yes
Blinding (Detection and Performance bias)	No	Unclear	Yes	No	Yes
Incomplete Outcome Assessment (Attrition bias)	Yes	Yes	Yes	Yes	Yes
Free of Selective Reporting (Reporting bias)	No	No	Yes	No	Yes
Free of Other Bias	No	Yes	Yes	Yes	Yes

“Yes” indicates a low risk of bias, “No” indicates a high risk of bias, and “Unclear” indicates either a lack of information or uncertainty over the potential for bias.
 doi:10.1371/journal.pone.0101143.t002

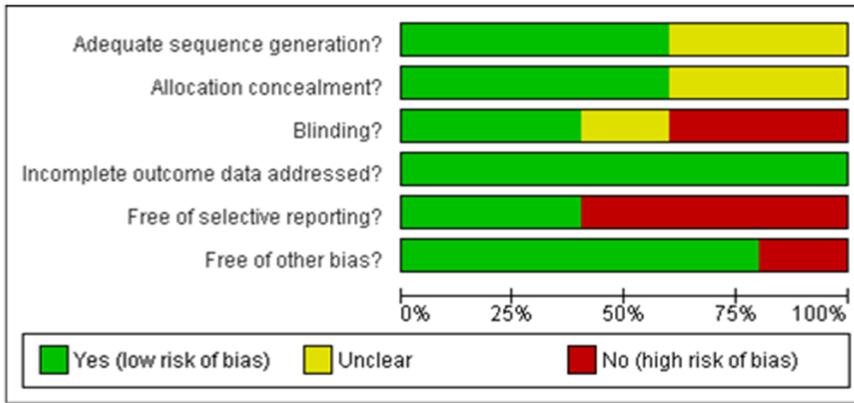


Figure 2. Risk of bias graph: review authors’ judgements about each risk of bias item presented as percentages across all included studies.
doi:10.1371/journal.pone.0101143.g002

groups (Table 7) [47]. The author used the oral health impact profile (OHIP-14) to give a score ranging from 0 (minimum) to 56 (maximum). A high score indicated a poor OHRQoL with low scales indicating good OHRQoL. However, no treatment effect could be calculated to compare the change in the OHIP-14 scores between the two treatment groups because standard deviations of change were not given and also because exact p-values were not reported.

For the Wolfart et al study (2012), the median OHIP-49 scores for pre-treatment, baseline, 1 and 5 years follow-up showed significant reduction of impacts ($p < 0.05$). Before treatment, the median OHIP-49 total score was 38.0 for the RPDP group and 40.0 for the SDA group. Most significant reductions occurred at baseline (27.0; $p < 0.0001$) and 1 year on (13.0; $p < 0.0002$) for the RPDP group (compared to the Mc Kenna study after 1 month). For the SDA group, a significant change in impacts (19.0; $p < 0.05$) were observed only at baseline, no further significant changes were reported [45].

2. **Harmful Effects:** (caries; tooth loss; periodontal status, plaque index, gingival index; TMJ problems; interdental spacing; overbite).

Tooth loss: The Walter et al study (2012) showed no significant difference in the number of patients experiencing first tooth loss within 38 months of observation after treatment between the RPDP and SDA groups (RR 1.23, 95%CI: 0.56 to 2.70, 150 participants) [44]. The respective Kaplan-Meier survival rates at 38 months were 0.83 (95%CI: 0.74 to 0.91) in the RPDP group and 0.86 (95%CI: 0.78 to 0.95) in the SDA group, the difference is not significant (as reported by study authors) [44].

Comparison 3: Shortened Dental Arches (SDA) versus Complete Dental Arches (CDA). Primary Outcomes: 1. **Functional outcomes:**

Occlusal contact: Witter et al, (2001) reported that a significantly higher percent (73%, 95%CI: 67–80%) of teeth in the anterior region had occlusal contact in intercuspal position of the SDA group compared with the CDA group (62%, 95%CI: 55–69%) ($p < 0.05$) [53]. No treatment effect could be calculated because the number of patients per group was not specified [53].

Occlusal tooth wear: Witter et al (1994) reported the mean occlusal tooth wear scores using transformed values for subjects of 40 years of age [55]. However, no significant differences between the SDA subgroups [means (SD) ranging from 1.1(0.1) to 1.6(0.1)] and the CDA group [means (SD) of 1.4(0.0) and 1.5(0.0)] were found when comparing the means of the scores for the upper and for the lower anterior regions. Similarly for the premolar regions, no significant

differences were found between the SDA subgroups [mean (SD) scores 0.7(0.1) to 1.0(0.1)] and the CDA group [mean (SD) score 0.9(0.1)]. No treatment effect could be calculated because the respective number of patients was not reported.

2. **Survival:** This outcome was not reported in the one study assessing this comparison.

Secondary Outcomes: 1. **Patient satisfaction:** This outcome was not reported in the one study assessing this comparison.

2. **Harmful Effects:** (caries; tooth loss; periodontal status, plaque index, gingival index; TMJ problems; interdental spacing; overbite).

Interdental spacing: Witter et al (1994) described a comparison of the mean scores of interdental spacing per region [55]. According to the authors, the premolar regions of the SDA subgroups had significantly higher means [mean (SD): 0.4(0.1) and 0.5(0.1)] than the CDA group [mean (SD): 0.1(0), $p < 0.01$ as reported by authors]. For the anterior regions, the spacing was not significantly different for SDA [mean (SD) range from 0.2(0.1) to 0.5(0.1)]; CDA group [mean (SD) range from 0.1(0.0) to 0.3(0.1)]. They also reported that spacing remained the same in all regions over time in the SDA group [55]. No treatment effect could be calculated because the results were given per region and also because the respective number of patients were not specified in the results.

Overbite: Witter et al (1994) stated this outcome only for some subgroups but did not compare their results between the SDA and CDA groups [55]. Therefore we could not calculate a treatment effect.

Periodontal support: Witter et al (1994) described the mean relative bone heights using transformed values for subjects of 40 years of age [55]. The authors reported that maxillary premolars and mandibular second premolars in the SDA subgroups showed significantly lower mean bone height scores than those in the CDA group, whereas mandibular first premolars did not differ. The values reported were not sufficient for the calculation of a treatment effect.

TMJ problems: The Witter et al study (2007) indicated that patients with SDAs (65–79%) had similar prevalence, severity and changes in signs and symptoms related to the TMJ as patients with CDAs (70–75%) [54].

Excluded study characteristics: All non-RCTs and reviews were excluded from this SR. Other SRs and summary articles were viewed as potentially included studies, but these were however later not considered for inclusion (Table 8).

Table 3. COMPARISON 1: FDP versus RPDP for Treated and untreated Shortened Dental Arches (31–38).

Patient or population: patients with Treated and untreated Shortened Dental Arches						
Settings: Hospital Setting						
Intervention: FDP versus RPDP						
Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	FDP versus RPDP				
Number of patients with satisfactory occlusion	Study population		RR 1.16 (0.9 to 1.48)	53 (1 study)	⊕⊕⊕⊖ very low ^{1,2}	
	769 per 1000	892 per 1000 (692 to 1000)				
	Moderate					
Number of patients with no caries experience	Study population		RR 1.89 (1.09 to 3.3)	50 (1 study)	⊕⊕⊕⊖ moderate ²	
	391 per 1000	740 per 1000 (427 to 1000)				
	Moderate					
Number of patients showing TMJ dysfunction	Study population		RR 0.64 (0.36 to 1.16)	53 (1 study)	⊕⊕⊕⊖ very low ^{1,2}	
	577 per 1000	369 per 1000 (208 to 669)				
	Moderate					
Survival of Intervention	Study population		HR 0.59 (0.27 to 1.29)	60 (1 study)	⊕⊕⊕⊖ moderate ²	
	See comment	See comment				
	Moderate					
Patient Satisfaction	Study population		Not estimable ³	52 (1 study)	⊕⊕⊕⊖ moderate ²	
	See comment	See comment				
	Moderate					

EXPLANATION OF TABLE ABOVE: *The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **KEY: CI:** Confidence interval; **RR:** Risk ratio; **HR:** Hazard ratio.

Explanation for the GRADE Working Group QUALITY of evidence: *High quality:* Further research is very unlikely to change our confidence in the estimate of effect. *Moderate quality:* Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate. *Low quality:* Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate. *Very low quality:* We are very uncertain about the estimate.

REASONS for the QUALITY of the Evidence: ¹High risk of bias for blinding, selective reporting bias and other bias; ²Small sample size; ³No significant difference (p = 0.092).

doi:10.1371/journal.pone.0101143.t003

Discussion

The focus of this review was the classic SDA, irrespective of whether it occurred naturally or was created by means of a FDP. An exhaustive and comprehensive search yielded four RCTs and 1 CT that were included [14,31–38,40–48,53–55]:

Jepson et al (2001) is in agreement with the research conducted by Isidor and Budtz-Jorgensen (1987, 1990) regarding an increase in caries incidence as reported 2 and 5 years post treatment [33,35,38]. In addition, the increase in caries incidence for the RPDP group also concurred with the research of Bergman et al, (1964), cited in Budtz-Jorgensen (1990) [32].

Survival of fixed bridges 5 years post study was similar to other trials [30–32,37–38]. RPDP patients chose not to wear RPDPs which was similar to other studies [31–32,37–38]. For patient satisfaction, the small sample size does not allow us to generalize our results to other settings, thus it is advised to conduct these studies amongst different populations.

For the Wolfart et al study (2010): Post hoc power calculations implied that the pilot sample size was too small to generalize results and for comparison to other studies [40–43]. The larger study results are free of bias with a large enough sample due to it being a multi-centre study. While it reduced the bias, it still could not be generalized to patients that are different to the study

Table 4. COMPARISON 2: RPD versus SDA for Treated and untreated Shortened Dental Arches (40–48).

Patient or population: patients with Treated and untreated Shortened Dental Arches					
Settings: Hospital setting					
Intervention: RPD versus SDA					
Outcomes	Illustrative comparative risks* (95% CI)	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk				
	Control				
	Corresponding risk				
Change in MNA scores	RPD versus SDA The mean change in MNA scores in the intervention groups was 0.03 lower (1.35 lower to 1.29 higher)		42 (1 study)	⊕⊕⊕⊕ moderate ¹	
Number of patients with first tooth loss in 38 months	Study population 130 per 1000 Moderate 130 per 1000	0.83 (0.74 to 0.91)	150 (1 study)	⊕⊕⊕⊕ low ^{2,3}	
Patient Satisfaction	Study population See comment Moderate	Not estimable ⁴	215 (1 study)	See comment	

EXPLANATION OF TABLE ABOVE: *The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **KEY:** **CI:** Confidence interval; **RR:** Risk ratio;
Explanation for the GRADE Working Group QUALITY of evidence: *High quality:* Further research is very unlikely to change our confidence in the estimate of effect. **Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate. **Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate. *Very low quality:* We are very uncertain about the estimate.
REASONS for the QUALITY of the Evidence: ¹Small sample size; ²High risk of bias for blinding and selective reporting bias; ³Wide confidence interval- the 95% CI includes both null effect and appreciable harm and ⁴No significant changes were reported for the Irish study. For the German study: Significant differences were seen at baseline (27.0; p<0.0001) and 1 year on (13.0; p<0.0002) for the RPD group and a significant change in impacts (19.0; p<0.05) were observed only at baseline for the SDA group.
 doi:10.1371/journal.pone.0101143.t004

Table 5. Summary satisfaction scores for the UK-based study at 1 year (a lower score indicates more satisfaction).

Group	N	Median (baseline)	Median (1 year)	p-value per group	p-value between groups
FDP (Intervention)	26	18	11	<0.001	0.092
RPDP (Control)	26	16.5	13	0.009	

FDP = Fixed dental prosthesis; RPDP = Removable partial denture/dental prosthesis (34–38).
doi:10.1371/journal.pone.0101143.t005

sample. For the patient satisfaction outcome, the summary scores of the pilot study were similar to another German study (John and Micheelis, 2003, cited in Walter et al (2012) [45]). For temporomandibular disease (TMD) pain scores, the instrument used in other studies was more reliable (Dworkin, 2002, cited in Walter et al (2012) [44]). Tooth loss as a primary outcome is questioned due to extended time periods, thus it was advised to use caries and periodontal attachment loss as outcomes instead [44].

The Mc Kenna study (2012), which is the most recently conducted RCT; the results are similar to other RCTs completed in the past, where small sample sizes would not necessarily show a significant difference between interventions given the follow-up period [47–48]. In this case, follow-up after only one month of treatment was too short to show any difference between interventions [47–48]. But the cost-effectiveness reported with this RCT has been noted as researchers and clinicians are under the impression that the cost for FDPs far outweighs that of RPDP treatment [22,39,48]. And this has been in line with the findings of the Danish study published some years ago [32–33].

For the Witter et al study (2001), results were similar to other studies with regards to outcomes reported and the effect of outcomes on the dentition in the SDA group (tooth wear, TMJ effects) (Aukes, 1988; Mohl, 1988; Eliasson, 1997, cited in Witter et al (2001) [53]).

The quality of the evidence is indicative of the integrity of the study and the research conducted. With reference to the quality assessment of the included studies, this has been described in detail above. More importantly, this quality is determined by the study designs. Study designs are graded according to the quality of evidence that they provide. Systematic reviews and RCTs are considered to be designs of the highest quality [59–60]. Within the different design groups, certain concessions can be made for those designs that do not follow the exact guidelines [59–60]. For instance RCTs can be downgraded if their risk of bias is high [59–60].

Only RCTs and CTs were however included in this systematic review which provides stronger evidence and increases the strength of the recommendations [59–60]. After completing the quality assessment (using the GRADE approach) of the included studies, it clearly showed that some of the studies had not followed the exact guidelines for RCTs, but nevertheless had the features thereof [59–60]. These can be regarded as downgraded RCTs

(Tables 3–4). These downgraded RCTs did not use randomization, allocation concealment or blinding, and failed to specify the outcomes as primary or secondary. These downgraded RCTs could thus affect the quality of evidence only slightly [59–60]. For example, the Budtz-Jorgensen (1987, 1990) and Witter et al (2001) studies could be regarded as downgraded CTs [14,31–33,53–55,60].

A meta-analysis could not be completed for this SR for the following reasons: Some of the outcomes for the SR (for example survival of intervention) were not reported by all the included studies; sufficient RCTs were not found related to SDAs; the outcomes were reported in so many different ways for each of the studies that a narrative approach for this review had to be adopted and not all outcomes are reported for the Wolfart et al (2005) study (and no correspondence was received when the authors were contacted). In addition, there was insufficient information reported by studies to allow us to combine continuous data using the mean difference (MD). The outcomes from the studies were thus grouped for this review.

For this SR, a systematic approach to the evaluation of the evidence obtained from the studies was adopted by the researchers and disagreements were resolved by discussion. The researchers highlighted the areas where bias could have been expected (Table 2). Study samples, settings, age categories, interventions and outcomes for the included studies were mostly similar, creating strong evidence (Table 1). Comparison between the groups of the different studies could be systematically recorded in the stipulated groups. And again, for this SR all potential sources were searched and reported. Most studies followed guidelines to protect against bias (some without making reference to the method followed) [14,31–33,53–55]. And this was assessed using the Cochrane's risk of bias tool [59]. Since all the included studies in this SR were conducted in developed countries, our findings cannot be generalized to patients in all countries because cultural and socio-economic differences that exist between countries and within communities can influence patients' reactions.

Other SRs were also conducted in the past ten years [8,56–58], where researchers included studies with different study designs and not only RCTs. For the most current SR [57], the research question was so broad that the focus on the SDA was minimal, thus many of the data related specifically to SDAs were not even included in the analysis [57]. For this SR, only the British and

Table 6. Change in MNA scores for the Irish study.

Group	n	Baseline MNA score average	Final MNA score average	p-value per group	Calculated SD of change
RPDP	21	23.65	24.75	0.03	2.15
SDA	21	23.24	24.37	0.03	2.21

MNA = Mini nutritional assessment; SD = Standard Deviation; RPDP = Removable partial denture/dental prosthesis; SDA = Shortened dental arch (47–48).
doi:10.1371/journal.pone.0101143.t006

Table 7. Change in OHIP-14 scores for the Irish study.

Group	n	Baseline OHIP-14 score average	Final OHIP-14 score average	p-value per group
RPDP	21	12.4	3.3	<0.001
SDA	21	11.4	1.8	<0.001

OHIP = Oral health impact Profile; RPDP = Removable partial denture/dental prosthesis; SDA = Shortened dental arch (47–48).
doi:10.1371/journal.pone.0101143.t007

German RCTs were mentioned and only the results of the pilot study for the German RCT was reported [57]. The authors concluded citing insufficient evidence to report a difference between RPDP and FDPs in the treatment of SDAs [57]. In addition, when evaluating the quality of the evidence of a systematic review, it is recommended that the GRADE approach should be used [60]. It is a method of evaluating the quality of evidence and strength of recommendations in healthcare, and thus provides the needed rigor and transparency when making specific recommendations [60].

Quality of evidence

As stated above, the quality of evidence was assessed using the GRADE methodology for this SR (Tables 3 and 4). With the assessment, the small sample sizes seriously affected the imprecision, and the risk of bias was very serious with studies where no blinding and selective reporting was observed (Tables 3 and 4).

From the combined effects, the overall quality of the assessment is regarded as being low (Tables 3 and 4). This implies that further research (as in conducting more RCTs) is likely to have an important impact on our confidence in the estimate of effect, and may change the estimate.

Implications for practice

The SDA concept has been researched and used in industrialized countries and this review aimed to highlight its appropriateness and relevance for a developing country such as South Africa. A change in paradigm or thinking should be encouraged, even though results of clinical trials conducted in other countries may not necessarily be generalizable to South African populations. By regarding the research related to SDAs in a positive light (patient satisfaction, caries incidence, TMJ effects and tooth loss), this SR specifies that policy-makers and/or institutions should be encouraged and recommend its teaching and clinical implemen-

Table 8. Excluded studies, with reasons for exclusion.

Study	Reasons for exclusion
Abt, Carr and Worthington (57)	A systematic review
	Focused on treatment options for all types of partially dentate patients
	Did not specifically focus on the interventions for SDAs
	SDA was considered as only one treatment option
Fueki et al (56)	A systematic review completed in Japan
	Included different study designs
	All the RCTs included in this review were used for the present review as well. But other RCTs were included for the present SR The analysis for this SR is different to that of the present SR
Faggion (58)	A systematic review
	Intention was to include RCTs and CTs, but a prospective study was included
	All RCTs used for this SR was included in the present review with the inclusion of other RCTs
	Outcomes that were not reported in this SR has been included in the present review Focus of this paper was the GRADE assessment completed
Emami and Feine: 2010 (62)	Is a summary of a clinical trial completed on this SDA subject. Above RCT has been included in this review
Gotfredsen and Walls (8)	Is a SR of the literature related to the SDA topic
	Similar outcomes as addressed in this SR
	Different study design types were included SR concluded the acceptable level of oral function obtained with 20 natural teeth (which is line with the WHO goal for the year 2000)

KEY:

SDA: shortened dental arch.

RCT: randomized controlled trial.

CT: clinical trial.

SR: systematic review.

GRADE: Grading of Recommendations Assessment, Development and Evaluation.

WHO: World Health Organization.

doi:10.1371/journal.pone.0101143.t008

tation by students and clinicians. These are considered as instances where low-quality evidence can still make a strong recommendation due to the body of available evidence on SDAs.

Implications for research

Sufficient RCTs related to SDAs were not found, and thus it would be advisable to conduct more randomized clinical trials. The RCTs were also conducted in European and Nordic countries and these results may not be generalizable to other context, due to substantial cross-cultural and socio-economic differences between countries. External validity or generalizability of studies conducted in other countries depends on: settings where studies were conducted; participants' characteristics; interventions researched across studies; relevance of the endpoints achieved with each study; results obtained and their comparison to one another and the indirect/direct costs when conducting each study.

Conclusions

The results from this SR related to SDAs as a treatment option were encouraging in terms of functioning, patient satisfaction and cost-effectiveness. However, only the Moynihan et al (2000) study reported on the primary outcome of survival of the SDA, and had this been determined by the other studies, it would have strengthened the recommendation of the SDA as a treatment option even further [34].

Recommendations

The stronger the evidence, the stronger the recommendation for the implementation of the SDA as a treatment option for partially

dentate patients. By using only high quality studies such as RCTs and CTs for this SR, it was expected that the results would be more reliable when making conclusions and recommendations. Nevertheless, any conclusion/s from such a SR can still be regarded in a positive light, even though the included studies had to be downgraded due to methodological errors [60]. It is also recommended that when conducting clinical trials, strict protocols need to be prepared and the reporting of the RCT should follow the CONSORT guidelines [61]. This could then be of great benefit to other researchers when critically appraising these clinical trials. More importantly, outcomes for the RCT have to be pre-specified and all should be reported so that future systematic reviews may be conducted with the inclusion of a meta-analysis, instead of a narrative report as needed to be done for this SR. Thus further research (as in conducting clinical trials) should be encouraged and for the different settings and contexts (for example developing countries) to create a comprehensive database related to SDAs.

Supporting Information

Checklist S1 PRISMA 2009 Checklist.
(DOC)

Author Contributions

Conceived and designed the experiments: SK AM UMEC RO. Performed the experiments: SK. Analyzed the data: SK AM. Contributed reagents/materials/analysis tools: SK AM UMEC RO. Wrote the paper: SK. Checked Drafts: AM UMEC RO.

References

- Zarb GA, Bolender CL, Carlsson GE (1997) *Boucher's Prosthodontics Treatment for edentulous Patients*, 11th ed. Missouri, USA: Mosby.
- Müller F, Naharro M, Carlsson GE (2007) What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe? *Clin Oral Impl Res* 18(Sup 3): 2–14.
- Carlsson GE (2010) Some dogmas related to prosthodontics, temporomandibular disorders an occlusion. *Acta Odon Scand* 68: 313–322.
- Witter DJ, van Elteren P, Käyser AF, Van Rossum MJM (1989) The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 16: 27–33.
- Käyser AF (1981). Shortened dental arches and oral function. *J Oral Rehabil* 8: 457–462.
- Witter DJ, van Elteren P, Käyser AF (1988) Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 15: 413–420.
- Käyser AF (1989) The shortened Dental Arch: A Therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 9(6): 426–449.
- Gotfredsen K, Walls AWG (2007) What dentition assures oral function? *Clin Oral Impl Res (Suppl. 3)*: 34–45.
- Creugers NHJ, Witter DJ, Van't Spijker A, Gerritsen AE, Kreulen CM (2010) Occlusion and temporomandibular function among subjects with Mandibular Distal Extension Removable Partial Dentures. *Int J Dent* 1–7. [DOI:10.1155/2010/807850].
- Gerritsen AE, Witter DJ, Bronkhorst EW, Creugers NHJ (2012) An observational cohort study on shortened dental arches- clinical course during a period of 27–35 years. *Clin Oral Invest* 1–8 [DOI:10.1007/s00784-012-0765-6].
- Zhang Q, Witter DJ, Bronkhorst EM, Creugers NHJ (2012) Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Invest* 1–11.
- Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, et al. (2007) Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Sci* 115(4): 265–274.
- Elias EC, Sheiham A (1998) The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 25: 649–661.
- Witter DJ, de Haan AF, Kayser AF, van Rossum GM (1994) A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 21(2): 113–25.
- Allen PF, Witter DF, Wilson NHF, Käyser AF (1996) Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 23: 481–485.
- Sarita PT, Witter DJ, Kreulen CM, Creugers NHJ (2003) The shortened dental arch concept and attitudes of dentists in Tanzania. *Comm Dent Oral Epidemiol* 31: 111–115.
- Armellini DB, Von Fraunhofer JA (2004) The shortened dental arch: A review of the literature. *J Prosthet Dent* 92(6): 531–535.
- Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y (2008) Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 35: 337–344.
- Zeng X, Sheiham A, Tsakos G (2008) Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 35: 37–44.
- Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, et al. (2008) Patterns of missing occlusal units and oral health-related quality of life in SDA patients. *J Oral Rehabil* 35: 621–628.
- World Health Organization (1992) A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Geneva: WHO regional office for Europe. WHO Technical Report Series No. 826: 16–17.
- Khan S, Omar R, Chikte UME (2012) Perceptions of practitioners regarding shortened dental arch. *SADJ* 67(2): 60–68.
- Ivanhoe JR, Cibirka RM, Parr GR (2002) Treating the modern complete denture patient: A review of the literature. *J Prosthet Dent* 88: 631–635.
- Omar R (2004) Reappraising prosthodontic treatment goals for older, partially dentate people: Part I. Traditional management strategy. *SADJ* 59(5): 198–202.
- Carlsson GE, Omar R (2010) The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil* 37: 143–156.
- Khan S, Chikte UME, Omar R (2013) From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* (In press).
- Creugers NHJ, Käyser AF, van't Hof MA (1992) A seven-and-half-year survival study of resin-bonded bridges. *J Dent Res* 71: 1822–1825.
- Creugers NHJ, De Kanter RJ, van't Hof MA (1997) Long-term survival data from a clinical trial on resin bonded bridges. *J Dent* 25: 239–242.
- De Kanter RJ, Creugers NHJ, Verzijden CW, van't Hof MA (1998) A five year multi-practice clinical study on posterior resin-bonded bridges. *J Dent Res* 77: 609–614.
- Frank RP, Brudvik JS, Le roux B, Milgrom P, Hawkins N (2000) Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet Dent* 83: 521–7.
- Budtz-Jørgensen E, Isidor F (1987) Cantilever bridges or removable partial dentures in geriatric patients: a two-year study. *J Oral Rehabil* 14: 239–249.

32. Budtz-Jorgensen E, Isidor F (1990) A 5-year longitudinal study of cantilever fixed partial dentures compared with removable partial dentures in a geriatric population. *J Prosthet Dent* 64: 42–47.
33. Isidor F, Budtz-Jorgensen E (1990) Periodontal conditions following treatment with distally extending cantilever bridges or removable partial dentures in the elderly patients. A 5-year study. *J Periodont* 61: 21–26.
34. Moynihan PJ, Butler TJ, Thomason JM, Jepson NJA (2000) Nutrient intake in partially dentate patients: the effect of prosthetic rehabilitation. *J Dent* 28: 557–563.
35. Jepson NJA, Moynihan PJ, Kelly P, Watson GW, Thomason JM (2001) Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. *BDJ* 191(3): 140–144.
36. Jepson NJA, Allen F, Moynihan PJ, Kelly P, Thomason JM (2003) Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 16(4): 409–414.
37. Thomason JM, Moynihan PJ, Steen N, Jepson NJA (2007) Time to Survival for the restoration of the Shortened lower Dental Arch. *J Dent Res* 86(7): 646–650.
38. Balevi B (2008) No difference in the 5-year survival rates between the resin-bonded cantilever bridge and removable partial denture for the restoration of the shortened dental arch. *Evid Based Dent* 9(4): 105–106.
39. Abu-Saleh T, Marnewick J (2008) Implant-supported crowns for a shortened dental arch: A Case Report. *J Contemp Dent Prac* 9(5): 114–121.
40. Wolfart S, Heydecke G, Luthardt RG, Marré B, Freesmeyer WB, et al. (2005) Effects of prosthetic treatment for SDAs on OHRQoL, self-reports of pain and jaw disability: results from pilot-phase of a randomized multicentre trial. *J Oral Rehabil* 32: 815–822.
41. Luthardt RG, Marré B, Heineck A, Gerss J, Aggstaller H, et al. (2010) The randomized shortened dental arch study (RaSDA): design and protocol. *Trials* 11(15): 1–9.
42. Walter MH, Weber A, Marré B, Gitt I, Gerß J, et al. (2010) The randomized Shortened dental arch study: Tooth Loss. *J Dent Res* 89: 818–822.
43. Walter MH, Weber A, Marré B, Gitt I, Gerß J, et al. (2012) The randomized shortened dental arch study: 5 year results of the pilot phase. *Deutsch Zahnärztl Zeits* 67: 360–363.
44. Walter MH, Hannak W, Kern M, Mundt T, Gernet W, et al. (2012) The randomized shortened dental arch study: tooth loss over five years. *Clin Oral Invest* 1–10 [DOI:10.1007/s00784-01-0761-x].
45. Wolfart S, Muller F, Gerß J, Heydecke G, Marré B, et al. (2012) The randomized shortened dental arch study: oral-health-related quality of life. *Clin Oral Invest*, DOI:10.1007/s00784-013-0991-6.
46. Wolfart S, Marré B, Wöstmann B, Kern M, Mundt T, et al. (2012) The randomized shortened dental arch study: 5-year Maintenance. *J Dent Res* 91(1): 65–71.
47. McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, et al. (2012) Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodontology* 29: e883–e890. [DOI:10.1111/j.1741-2358.2011.00579.x].
48. McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, et al. (2012) A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodontology* 1–7.
49. De Sa e Frias V, Toothaker R, Wright RF (2004) Shortened Dental Arch: A review of current treatment concepts. *J Prosthodont* 13(2): 104–110.
50. Sarita PT, Kreulen CM, Witter DJ, Creugers NHJ (2003) Signs and symptoms associated with TMD in adults with shortened dental arches. *Int J Prosthodont* 16(3): 265–270.
51. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, et al. (2003) A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 16(4): 375–380.
52. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, et al. (2003) Chewing ability of subjects with shortened dental arches. *Comm Dent Oral Epidemiol* 31(5): 328–334.
53. Witter DJ, Creugers NHJ, Kreulen CM, de Haan AF (2001) Occlusal stability in Shortened Dental Arches. *J Dent Res* 80(2): 432–436.
54. Witter DJ, Kreulen CM, Mulder J, Creugers NHJ (2007) Signs and symptoms related to temporomandibular disorders- Follow-up of subjects with shortened and complete dental arches. *J Dent* 35: 521–527.
55. Witter DJ, de Haan AF, Käyser AF, van Rossum GM (1994) A 6-year follow-up study of oral function in shortened dental arches. Part II: Craniomandibular dysfunction and oral comfort. *J Oral Rehabil* 21(4): 353–366.
56. Fueki K, Yoshida E, Igarashi Y (2011) A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 47: 167–174.
57. Abt E, Carr AB, Worthington HV (2012) Interventions for replacing missing teeth: partially absent dentition. *Cochrane Database of Systematic Reviews* Issue 2. Art. No: CD003814. DOI:10.1002/14651858.CD003814.pub2.
58. Faggion CM (2011) The shortened dental arch revisited: from evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 38: 940–949.
59. Higgins JPT, Green S (2009) *Cochrane Handbook for systematic reviews of interventions*. 1st Edition. West Sussex, UK: Wiley-Blackwell.
60. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, et al. (2008) GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*, 336: 924–926.
61. CONSORT Guidelines. Available: <http://www.consort-statement.org>.

An Overview of Systematic Reviews Related to Aspects of the Shortened Dental Arch and Its Variants in Adults

Saadika B Khan, BChD, PDD, MSc (Dent)¹/Usuf ME Chikte, BChD, DHSM, Mdent, MSc, PhD²/Ridwaan Omar, BSc, BDS, MSc³

Purpose: The aim of this study was to conduct an overview of systematic reviews (SRs) related to aspects of the shortened dental arch (SDA) and its variants and critically appraise the methodologic quality of included SRs using the AMSTAR checklist. **Materials and Methods:** A comprehensive computerized search and a hand search of reference lists were conducted for SRs related to SDAs to identify publications from 2000 to 2016. All the present authors and a research assistant independently screened the results of the electronic searches using an eligibility form and extracted information using a specially designed prepiloted data extraction form. An 11-question AMSTAR checklist was completed for each included SR. Disputes were resolved by discussion between all researchers, and results were collated and interpreted. **Results:** For the period of 2007 to 2016, the search yielded 9 SRs incorporating 228 related articles. The research questions for each SR differed but were related to SDAs, thus the included articles were similar across SRs. Characteristics such as aims/objectives, study outcomes, and conclusions of the 9 included SRs were compared. The AMSTAR evaluation indicated that 5 out of 9 studies were of a high quality (used a rigorous methodology) and the remaining 4 were of medium quality. All 9 SRs provided designs and characteristics of included studies. None of the SRs assessed publication bias. **Conclusion:** Of the 9 SRs, 7 drew positive conclusions regarding the SDA concept, finding it functionally sound, although some suggested that more high-quality primary studies are still needed. The AMSTAR calculation indicated that most included SRs had an acceptable methodologic quality, emphasizing the reliability of their results. *Int J Prosthodont* 2017 (10 Pages); doi: 10.11607/ijp.5287

Translation and clinical implementation of even the most compelling research evidence takes a long time. For example, it took more than 20 years before the documented evidence for using intravenous streptokinase for the management of acute myocardial infarction became the norm.¹ Similarly, although ample evidence is available for the benefits of the shortened dental arch (SDA) approach as a viable treatment option for a number of population groups, translation into clinical practice is noticeably lacking in these settings.^{2,3} The reasons for this are not fully understood, although undergraduate curricula and syllabi, educational backgrounds and beliefs of clinical teachers, and societal factors play roles.³ Implementation

of the SDA concept may be further compromised by the fact that it can be a financial disincentive.^{2,3} What cannot be contested regarding the SDA is that much of the primary research on it has documented favorable functional efficacy and patient satisfaction.

At about the same time as Käyser's⁴ (1981) formulation of the SDA concept, a strategy of "the retention of 20 functional natural teeth throughout life without resorting to the use of a prosthesis" was adopted by the World Health Organization (WHO) as part of its oral health goals for developing countries.^{5,6} Subsequently, this concept has been included in the National Oral Health Policy of South Africa to ensure optimal oral health for all. However, inclusion and implementation at a practice level has been absent.^{2,3,7}

Classically, patients having 10 pairs of occluding anterior and premolar teeth are considered to have SDAs.^{4,5} The clinical description of the SDA denotes the occluding posterior teeth as occluding units (OU), with one OU equalling two opposing premolars in occlusion and two OUs equalling two opposing molars in occlusion.⁵ Thus, the classic SDA comprises an intact anterior dentition and four symmetrically distributed posterior OUs.^{4,5} Other descriptions mentioned in the literature include posterior occluding pairs (POPs) of teeth with three to four POPs arranged symmetrically

¹Department of Restorative Dentistry, Faculty of Dentistry, University of the Western Cape, South Africa.

²Department of Community Health, Faculty of Health Sciences, University of Stellenbosch, South Africa.

³Department of Prosthodontics, Faculty of Dentistry, Kuwait University, Kuwait.

Correspondence to: Dr S.B. Khan, Department of Restorative Dentistry, University of the Western Cape, Private Bag X01, Tygerberg 7505, South Africa. Fax : +27 21 9382281. Email: skhan@uwc.ac.za

©2017 by Quintessence Publishing Co Inc.

and five to six asymmetrically, or a posteriorly reduced dentition.^{4,5,8–20} These occlusal arrangements have been shown to be useful and have been accepted in some communities in terms of patients' ability to function, subjective satisfaction, and oral comfort with a positive impact on their oral health-related quality of life (OHRQoL).^{4,5,8–20}

Both primary and secondary studies have indicated that the SDA as an alternative treatment approach is scientifically valid and has no harmful effects on the remaining dentition when prescribed appropriately.^{4,5,8–10,12–15,17,21–32} The broad findings of these studies state that: (1) 20 anterior and posterior occluding teeth (the classic SDA) are adequate for oral function, emphasizing the value of a functional dentition; (2) patient satisfaction increases with premolar occlusion, and adding occluding molars does not improve it any further; (3) occlusal stability and support are satisfactory with 3 to 4 POPs of symmetrically arranged and 5 to 6 POPs of asymmetrically arranged teeth; and (4) OHRQoL is directly proportional to 9 or more pairs of anterior and posterior occluding teeth.

Advantages of preserving a functional dentition with 20 teeth or 4 well-distributed OUs have been reported in the literature.^{4,5,16–18} Such an alternative to the normal 28 teeth when limitations such as cost and patient compliance and/or ability are a concern produces adequate function. The prosthodontic interventions normally used to replace molars include removable or fixed partial denture prostheses (RPDPs or FPDPs) and implant-supported prostheses.^{19,20} No difference regarding temporomandibular problems and no clinically significant differences in OHRQoL of patients who do not have molar teeth are reported.^{4,5,16,17} Indeed, the SDA is regarded as a rehabilitative or reconstructive alternative treatment option when its prescription is possible.^{19–20} More specifically, it can be considered an appropriate and relevant treatment strategy in developing countries, especially in a resource-constrained environment such as South Africa, for more effective management of the needs of the population.^{2,3}

Correspondingly, problems related to the use of RPDPs that may mitigate against the extension of shortened arches to 28 teeth include the large number of those who find RPDPs unacceptable and choose not to wear them due to the limited retention and support, chewing incapacity, and unacceptable esthetics.^{4,5,8,10,18,21,22,33,34} Moreover, circumstances where patients would be advised against extension of a shortened arch include an increase in caries (especially root caries) and periodontal disease of remaining teeth, inconsistent reports of improvement in oral function when using distal-extension RPDPs, and the improvement in OHRQoL with RPDPs

only when esthetics is a concern but to a lesser extent when chewing ability, speech, and comfort are important.^{4,5,8,10,18,21,22,33,34}

It is suggested that a rigorous overview related to the SDA will allow synthesis of the results from multiple systematic reviews (SRs) conducted in different parts of the world with slightly different inclusion criteria and resulting in different sample sizes but where the findings overlapped.^{35,36} Moreover, this SDA overview would facilitate identification of high-quality and reliable SRs on the topic, explore consistency of findings, create more evidence, and consequently strengthen the SDA evidence already collected and collated.^{35,36} Adopting such a rigorous methodology has advantages in that it allows summarizing of evidence already collected on the SDA, facilitating the process of translating this knowledge to clinical practice.^{35,37} This type of critical assessment of SRs related to the SDA concept has not been completed, thus it is a novel approach to doing secondary research.^{35,37}

In addition, each included SR will be critically appraised using the AMSTAR tool, which assesses the methodologic quality of SRs (Fig 1).³⁷ The AMSTAR checklist used for this study is an 11-question checklist with 4 responses (yes/no/cannot answer/not applicable) and a score of 1 for each yes response (Fig 1).³⁷ The ratings are grouped according to scores obtained into high (score of 8–11), medium (4–7) and low (0–3) with the responses following a rigorous explanation and interpretation of what constitutes a yes answer.³⁷

The aim of this study was to identify high-quality SRs related to the SDA concept and its variants and to explore consistency of findings across reviews with specific reference to function, OHRQoL, and the various prosthodontic interventions that may be prescribed for the purpose of arch extension, when deemed appropriate.

Materials and Methods

Protocol Development

A protocol (Registration No: 15/2/9) was developed (not published) to include all aspects of an overview of SR, namely selection criteria, search strategy, selection methods using predetermined eligibility criteria, data collection, data extraction using a preformed data sheet, and AMSTAR tool to evaluate the methodologic quality of each included SR.

Ethical clearance for the primary studies that were included in each of the SRs used for this overview had to have been obtained from the respective institutions involved at that time. Written informed consent had

AMSTAR: A measurement tool to assess the methodological quality of systematic reviews³⁷	
<p>1. Was an a priori design provided? The research question and inclusion criteria should be established before the review is conducted. <i>Note: Need to refer to a protocol, ethics approval, or predetermined/a priori published research objectives to score a "yes."</i></p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>	<p>7. Was the scientific quality of the included studies assessed and documented? A priori methods of assessment should be provided (eg, for effectiveness studies if the authors chose to include only randomized, double-blinded, placebo-controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>
<p>2. Was there duplicate study selection and data extraction? There should be at least two independent data extractors, and a consensus procedure for disagreements should be in place.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>	<p>8. Was the scientific quality of the included studies used appropriately in formulating conclusions? The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review and explicitly stated in formulating recommendations.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>
<p>3. Was a comprehensive literature search performed? At least two electronic sources should be searched. The report must include years and databases used (eg, Central, EMBASE, MEDLINE). Key words and/or MeSH terms must be stated, and where feasible, the search strategy should be provided. All searches should be supplemented by consulting current content, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>	<p>9. Were the methods used to combine the findings of studies appropriate? For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (ie, chi-square test for homogeneity, I²). If heterogeneity exists, a random effects model should be used and/or the clinical appropriateness of combining should be taken into consideration (ie, is it sensible to combine?).</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>
<p>4. Was the status of publication (ie, grey literature) used as an inclusion criterion? The authors should state that they searched for reports regardless of publication type. The authors should state whether or not they excluded any reports (from the systematic review), based on publication status, language, etc.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>	<p>10. Was the likelihood of publication bias assessed? An assessment of publication bias should include a combination of graphical aids (eg, funnel plot) and/or statistical tests (eg, Egger regression test, Hedges-Olken).</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>
<p>5. Was a list of studies (included and excluded) provided? A list of included and excluded studies should be provided.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>	<p>11. Was the conflict of interest included? Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>
<p>6. Were the characteristics of the included studies provided? In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions, and outcomes. The ranges of characteristics in all the studies analyzed (eg, age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases) should be reported.</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> Can't answer <input type="checkbox"/> No <input type="checkbox"/> Not applicable</p>	

Fig 1 The AMSTAR tool, a measurement tool used to assess the methodologic quality of systematic reviews.

also been obtained from the participants in the primary studies according to the Declaration of Helsinki.³⁸

Criteria for Considering Studies for This Overview

All systematic reviews making reference to SDAs, including those describing different patterns of tooth

arrangements and discussing interventions used for SDAs, were included. Men and women aged 18 years and older and having different SDAs and/or posterior reduced dental arches were included. Primary and secondary outcomes were prespecified. Primary outcomes were subjective or investigator- or patient-reported outcomes, including outcomes focusing on, for

example, function, patient satisfaction, and OHRQoL in patients with SDAs or any related tooth arrangements. Secondary outcomes were survival of teeth in patients with SDAs, arrangement and location of teeth (patterns of tooth loss), survival of prosthodontic intervention (RPDPs, FPDs, and implant-retained prostheses) used to treat SDAs.

SRs related to SDAs (including those describing the location of teeth for SDAs) and studies that discuss prosthodontic interventions used for SDA patients were included. Primary and secondary research studies on animals that did not meet the inclusion criteria were excluded from this review.

A computerized search was conducted for all SRs for the period of January 2000 to August 2016 to identify literature related to the SDA, including studies using the SDA as a treatment strategy for partially dentate adult patients within the following databases: MEDLINE, CINAHL, the Cochrane Central Register of Controlled Trials (CENTRAL) of the Cochrane Library, Science Direct, Science Journals, Scopus, Dentistry and Oral Science Source (DOSS), Springerlink, and Wiley.^{35,36} Further hand searching was also conducted from reference lists of retrieved studies (PEARLing searches).

Key terms were combined using Boolean operators, and search strategies for each database and these were developed using their specific functions. A broad search strategy was used and it focused on types of reviews related to patients with SDAs: (shortened dental arch OR shortened dental arches) AND (literature reviews OR reviews OR systematic review OR meta-analysis OR meta-analyses) AND (2000/01/01-2016/08/31).

Databases were initially searched for SRs published in English from January 2000 to December 2015. Another search was conducted on August 2016. The limits included human studies, adult patients, and systematic reviews.

Selection Methods

An eligibility form compiled from the inclusion criteria was used by the review authors and a research assistant to independently screen and include potentially relevant studies.³⁵ Reasons for inclusion were reported. Full-text articles were retrieved, and data extraction was completed by the principal researcher and a research assistant on study designs, methods, participants, interventions, outcomes, and conclusions from each SR using a specially designed prepiloted data extraction form.³⁶ Disagreements regarding data extraction were resolved by discussion among all reviewers.

The primary author and a research assistant independently completed the AMSTAR checklist to critically assess the methodologic quality of SRs (Fig 1).³⁷

Qualitative Analysis

A qualitative discussion related to the primary and secondary outcomes stipulated for this overview from the data extracted from each SR (Table 1). In addition, the AMSTAR checklist was completed to assess the quality of each included SR and the scores were calculated using the online system where a yes answer equalled a score of 1 and any other response equalled a score of 0.³⁷ Results of the AMSTAR evaluation are summarized in Tables 2 and 3. Observer agreement scores were calculated, and disagreements were again resolved by discussion among the research assistant and review authors.

Data Synthesis and Management

This process included analyzing all Cochrane and nonCochrane SRs, collating and reporting the results separately for the outcomes—namely, the effects of the SDA on patient satisfaction, function, OHRQoL, and arrangement of teeth. In addition, characteristics of each included SR were collated and comparisons between SRs reported using tables and by discussion. The results also include a report on the methodologic quality of each included SR according to the AMSTAR checklist and summarized in the tables.

Results

A comprehensive search generated a combined total of 45 articles and reviews related to SDAs (Fig 2). Duplicates ($n = 21$) of SDA articles obtained from the different search engines were excluded, leaving only review articles ($n = 24$). These articles included other types of nonsystematic reviews, after exclusion of which only 5 SRs were left. An additional 4 were found through hand searching, for a final sample size of 9 SRs, as shown in Fig 2. No SRs were found earlier than 2007; the final 9 SRs were from the period of 2007 to 2016, which included a total of 228 articles (Table 2).^{13,23-31}

Study Characteristics

The key features of the included SRs are summarized and reported in Table 2. These are recorded by author, year, location where SR was conducted, aims and/or objectives, outcomes, conclusions, and the findings related to the SDA (Table 2). While SRs related to SDAs were conducted in eight different countries, each research group investigated different but related aspects of SDA research (Tables 2 and 3).

Design. The 9 included SRs could be broadly grouped according to their included study designs

Table 1 Characteristics of Included Systematic Reviews

Author(s)	n	Objectives	Outcomes	Conclusions	SDA
Abt et al ²⁹	21	Assess effects of different prostheses for a partially absent dentition	Primary: long-term success Secondary: function, morbidity, PS	Insufficient evidence to say one intervention better than others; not all outcomes were reported	
Faggion ²⁶	9	Systematically assess outcomes from nontreatment and treatment approaches for SDA cases; assess effectiveness of restorative approaches for SDAs; assess quality of retrieved evidence (using GRADE)	Qualitative: QoL, function, esthetics Quantitative: temporomandibular disorder, occlusal problems, tooth loss	No difference between the two approaches; two studies showed treatment of SDAs with FPDP greater benefit compared to RPDP	Positive
Fueki et al ²⁸	21	To review literature for effect of prosthetic restorations on SDA patients: whether RPDPs for distal extensions increases function/PS/OHRQoL versus FPDPs; advantages and disadvantages of treatment with RPDP over FPDP and SDA	Chewing; PS, QoL, function, periodontal problems, survival of treatment	RCTS conducted in Europe not generalizable to Japan due to socioeconomic and/or healthcare system differences	Positive
Gerritsen et al ²⁵	35	Analyze relationship between number/location of missing teeth and OHRQoL: Is TL associated with impaired OHRQoL? What is the role of location and distribution of tooth location?	Primary: TL associated with impairment of OHRQoL Secondary: location and distribution of teeth affect OHRQoL	Strong evidence that TL is associated with impairment of OHRQoL and location of TL affects severity	Positive
Gotfredsen and Walls ¹³	83	Evaluate relationship between dentition and oral function	Masticatory function, esthetics, PS, occlusal support/stability, other functions (tactile/phonetics /taste)	Few studies with high level of evidence; low evidence: masticatory efficiency decrease with TL but 9–10 OUs ensures functioning/stability; dietary intake and OHRQoL unchanged with 9–10 OUs	Positive
Khan et al ³⁰	21	Compare SDA and CDA; compare differences between interventions (FPDs/RPDs) used to extend SDAs; determine PS with these interventions; determine functional outcomes with different interventions	Primary: functional outcomes, survival of intervention Secondary: PS, negative effects	SDA as a treatment option is encouraging (function/PS/costs); RCTs conducted in Europe not generalizable to South Africa due to cultural differences	Positive
Shahmiri and Atieh ²³	9	Evaluate the use of implant-tooth-borne RPDPs in prosthetic rehabilitation of Kennedy Class I partially edentulous arches; evaluate existing evidence to determine whether implant-supported RPDs provided better performance compared to other treatments	PS, masticatory efficiency, bone loss, prosthetic maintenance, soft and hard tissue response	Improvement in function, esthetics, and stability has been demonstrated in all studies with minimal prosthetic care, but RCTs are needed to provide evidence that will validate use of these treatment modalities	Positive
Liang et al ³¹	8	To synthesize available knowledge about effects of distal extension RPDPs on masticatory performance of subjects with moderate or extreme SDA	Comminuting, chewing, mixing ability, occlusal force	Patients with extreme SDA had 30–40% reduction in masticatory performance; distal extension RPDPs partially compensated for performance (50%); more false teeth on RPDPs resulted in better performance.	Positive toward SDA, not the extreme SDA
Zhang et al ²⁴	21	To assess oral health and prosthodontic conditions of Chinese adults over time: review DMFT and number and location of teeth in adults; consider need for prosthodontic appliances	Mean DMFT values, components of DMFT, number of teeth/roots/occluding teeth	Insufficient information to answer objectives as outcomes	

PS = patient satisfaction; SDA = shortened dental arch; QoL = quality of life; FPDP = fixed partial dental prosthesis; RPDP = removable partial denture prosthesis; OHRQoL = oral health–related quality of life; TL = tooth loss; OU = occlusal unit; CDA = complete dental arch; FPD = fixed partial denture; RPD = removable partial denture; RCT = randomized controlled trial; DMFT = decayed, missing, and filled teeth.

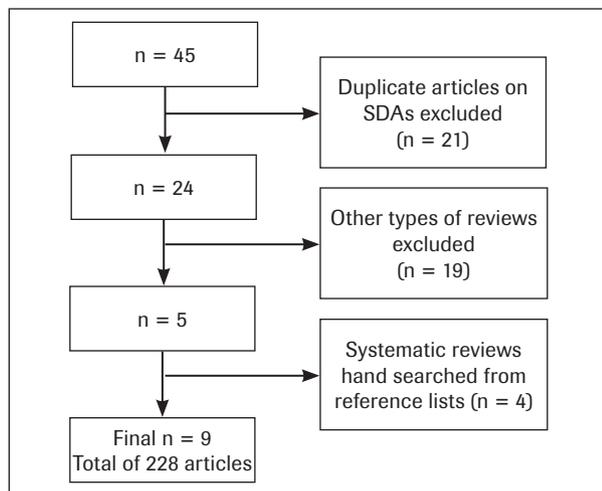


Fig 2 Flow chart of included systematic reviews (electronic and PEARLing searches).

into (1) those where only clinical trials were included and (2) those that included a range of designs.

For group 1, two of the SRs^{29,30} used only RCTs and/or nonrandomized controlled clinical trials in their analyses. Both used the Cochrane format to conduct the SR, and both completed quality assessments of the evidence for any risk of bias using the Cochrane Risk of Bias tool.^{29,30,36} SRs that include only clinical trials are considered to be of a high standard as the primary studies follow a rigorous methodology, and the SRs follow an equally strict methodology by including the assessment of the risk of bias of each included study.³⁶

For group 2, six of the included SRs^{23-28,31} each included a range of designs (cross-sectional, cohort, and case reports) and indicated that they did not exclude any studies based on design. Gotfredsen and Walls,¹³ while including a mixed range of designs, nevertheless excluded other study types, such as case reports, expert opinions, animal studies, and technical descriptions.

Thus, it can be said that the ideal for an SR that includes only clinical trials was not strictly followed by several of the SRs included in this overview.^{13,23-31}

Research Questions. While the research questions of the included SRs differed, they were all still related to the SDA. The articles reviewed in the SRs included in this overview were mostly the same. The research questions for the SRs related to interventions used oral function, impact on OHRQoL, location, and tooth arrangements with one epidemiologic study determining the state of teeth for a specific Chinese community.^{13,23-31} Not surprisingly, the more specific the research question, the fewer articles were included in the analysis.^{23,26,27,31} For example, Gotfredsen

Table 2 AMSTAR Scores for Included Systematic Reviews

Author	Year	Country	AMSTAR Total/11	Grade
Abt et al ²⁹	2012	USA	10	H
Faggion ²⁶	2011	Germany	8	H
Fueki et al ²⁸	2011	Japan	5	M
Gerritsen et al ²⁵	2010	Netherlands	8	H
Gotfredsen and Walls ¹³	2007	Denmark	6	M
Khan et al ³⁰	2014	South Africa	9	H
Shahmiri and Atieh ²³	2007	New Zealand	8	H
Liang et al ³¹	2015	Netherlands	6	M
Zhang et al ²⁴	2007	China	5	L

H = high score (8-11); M = medium score (4-7); L = low score (0-3).

and Walls¹³ used a broad research question; thus, more articles were included in their study (Table 2).

Outcomes of Each SR. Study outcomes should be prespecified as primary or secondary when conducting a SR. However, outcomes were specified as primary and/or secondary in only three out of the nine included SRs.^{25,29,30} Aside from the epidemiologic study, the study outcomes focused mainly on function, esthetics, patient satisfaction, and QoL (Table 2).

When comparing the primary outcomes stipulated for the present overview to those of the included SRs, it was noted (Table 2) that most of the included SRs (n = 8) provided evidence for at least one primary outcome that was also stipulated for this overview,^{13,23,25-31} with seven SRs investigating two or more of these primary outcomes.^{13,23,25,28-31} Specifically, seven SRs assessed oral function^{13,23,26-31} and five assessed patient satisfaction^{13,25,28-30} and OHRQoL.^{13,25,28,30,31}

Regarding secondary outcomes, four SRs looked at tooth loss,^{13,24,26,30} four investigated survival of intervention,^{23,28-30} and two looked at number, arrangement, and location of teeth.^{24,25}

Conclusions of Each SR. Abt et al²⁹ stated that there was not enough evidence to definitively conclude that one intervention is better than the other, thus the research question was not answered (Table 2). Khan et al³⁰ specified that the SDA as a treatment option was encouraging as regards function, patient satisfaction, and cost, even though sufficient RCTs with acceptable rigor have not been conducted (Table 2). Khan et al³⁰ and Fueki et al²⁸ concluded that the results from certain regions may not be generalizable to the rest of the world due to cultural and/or socioeconomic differences (Table 2). It was also mentioned

Table 3 Responses of Systematic Reviews to the AMSTAR Questions

AMSTAR item	Reviews meeting criteria (n)	Systematic Review Researchers								
		Abt et al ²⁹	Faggion ²⁶	Fueki et al ²⁸	Gerritsen et al ²⁵	Gotfredsen and Walls ¹³	Khan et al ³⁰	Liang et al ³¹	Shahmiri and Atieh ²³	Zhang et al ²⁴
1 Was an a priori design provided?	9	Y	Y	Y	Y	Y	Y	Y	Y	Y
2 Was there duplicate study selection and data extraction?	7	Y	N	Y	Y	N	Y	Y	Y	Y
3 Was a comprehensive literature search performed?	8	Y	Y	Y	Y	Y	Y	Y	Y	N
4 Was the status of publication used as inclusion criteria?	6	Y	Y	N	Y	N	Y	N	Y	Y
5 Was a list of included and excluded studies provided?	8	Y	Y	N	Y	Y	Y	Y	Y	Y
6 Were the characteristics of included studies provided?	9	Y	Y	Y	Y	Y	Y	Y	Y	Y
7 Was scientific quality of included studies assessed and reported?	5	Y	Y	N	N	Y	Y	N	Y	N
8 Was scientific quality of studies used appropriately in formulating conclusions?	5	Y	Y	N	N	Y	Y	N	Y	N
9 Were the methods used to combine findings appropriate?	2	Y	N	N	Y	N	N	N	N	N
10 Was the likelihood of publication bias assessed?	0	N	N	N	N	N	N	N	N	N
11 Was the conflict of interest included?	6	Y	Y	Y	Y	N	Y	Y	N	N
AMSTAR score		10	8	5	8	6	9	6	8	5

Y = yes (score of 1); N = no (score of 0).

that primary studies with a rigorous study design were visibly absent, and it was thus recommended that more RCTs following a strict protocol should be conducted (Table 2).

With specific reference to the SDA, seven of the nine SRs supported and recommended that the SDA concept be included as a viable treatment option when appropriate (Table 2).

Quality of Evidence

Quality assessments of studies, whether primary or secondary research, adds reliability and allows the merging of study outcomes, and is thus always recommended.³⁵⁻³⁷ The SRs conducted by Faggion^{26,27} also assessed the quality of evidence of the included primary studies using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach, as did Khan et al³⁰ SR. These studies evaluated the evidence and strength of recommendations for clinical interventions of each included clinical trial in the respective SR.^{26,27} Khan et al³⁰ also assessed the quality of the evidence using the risk of bias tool for all included clinical trials, as was mentioned previously.

The quality of the evidence for the present overview of SRs was determined using an AMSTAR checklist by assessing the methodologic rigor of each included study. Each of the nine SRs had a high ($n = 5$)^{24-27,29,30} or a medium ($n = 4$)^{13,23,28,31} AMSTAR score (Table 3 and Fig 1).

Table 3 highlights the responses for each of the 11 AMSTAR questions, indicating that all the SRs provided the design and some characteristics of the studies included.^{13,23-31,37} None of the included SRs, however, assessed publication bias, which is normally indicated by funnel plots or statistical tests such as Egger regression tests; thus, a score of zero was recorded for this question (Table 3).^{13,23-31,36} The AMSTAR evaluation showed that some of the included SR researchers had not carried out a quality assessment of the included primary studies, so drawing definitive conclusions was not possible.³⁷ Only 6 of the 9 SRs reported a conflict of interest statement (Table 3), an item that has become mandatory when submitting articles to scientific journals.³⁷

Disagreements Between Researchers Related to the AMSTAR Assessment. The 11-question AMSTAR checklist was completed independently by the primary author and a research assistant (Fig 1).

On completion, disagreements between the principal author and the research assistant were observed. The Pearson correlation coefficient at 0.494 indicated that the differences were not significant ($P = .177$). The disagreements were discussed, and when consensus could not be reached the other review authors were brought in to resolve the disagreement.

For the SRs by Abt et al²⁹ and Liang,³¹ researchers were in total agreement in their AMSTAR scoring. Differences in scoring were found most often with questions 2, 8, and 9 (Fig 1) and for two or more of the SRs.^{13,24,25,28,30,35} These differences could easily be linked to the reporting of how the study was conducted. With questions 3 and 6, authors reached a consensus that even if not all characteristics of a study (eg, year, databases searched, participant demographics) were included (Fig 1), the AMSTAR score for the SR would still be recorded as yes.³⁵

Discussion

Although some variations were observed between the different SRs with respect to research questions, outcomes, and conclusions, the evidence, once collated and summarized, can be regarded as reliable. For overviews, however, results are hampered by the fact that review protocols and outcome measures of the component SRs cannot be assumed to have been consistent. For this reason, the findings of the present overview are reported in the form of a narrative.³⁶

This overview covered a range of aspects of SDA research in the form of SRs.^{13,23-31} Among these were aspects related to tooth arrangements and their effect on QoL and OHRQoL, epidemiologic studies determining the patterns of tooth loss among older communities, and the different interventions used to extend SDAs.^{13,23-31}

The results of the present overview showed that a number of different interventions are variously employed for SDA patients ranging from RPDPs, FPDPs, resin-bonded bridges, and implant-supported prostheses. It was also found that a SDA with 9 to 10 occluding units adequately satisfies the oral functional needs of many patients.^{13,23-31} Studies have also indicated the negative effect a RPDP (especially distal extension mandibular dentures) may have on patients.^{39,40} The positive outcomes with implant-supported procedures that may be considered ideal are hardly available to those in already resourced-constrained developing countries and disadvantaged communities.²³

These conclusions support the oral functionality of the SDA concept and are in line with other primary and secondary research studies related to function, indicating that restoration of a shortened

arch to completeness may, in certain clinical conditions, be considered overtreatment.^{4,5,8-15,17-20,22-34} It has also been reported that QoL is not negatively affected by a SDA management approach, although it may be affected with an extreme SDA.^{13,17,19-21,25,28,30,39-42} The SDA approach further emphasizes how socioeconomic constraints and issues of poor access for care experienced by patients can be addressed. The evidence gathered through the appraisal of the included SRs by means of a reliable tool indicates support for a noninterventionist approach in certain cases of reduced posterior occlusions,^{4,5,8-13,15,17-20,22-31,33,35,37,39-42} benefitting underprivileged communities.

Quality of the Evidence

Though the quality of the evidence as assessed using the AMSTAR tool was acceptable (SRs had a medium or high score), the quality of the component primary studies making up the various SRs had not been assessed for most of the clinical trials, either by performing Cochrane risk of bias or using the GRADE analysis.^{36,43} In addition, publication bias was not assessed for any of the included SRs.³⁶ However, this did not affect the quality of the SRs given the generally high AMSTAR scores.^{36,43} It would be useful, though, to ensure that quality assessments are completed at primary and secondary research levels.

Implications for Practice

It is recommended that the continuing disjuncture between the evidence for the positive role of the SDA concept and dental clinical education, continuing education, and clinical implementation be addressed. Including the SDA concept in undergraduate clinical education would be an important step in adjusting the longstanding clinical paradigm of tooth replacement to a complete 28-tooth arch. The benefit of the SDA approach in disadvantaged communities is substantial. Better translation of the SDA concept into clinical practice should be pursued. Barriers known to hinder this critical phase need to be highlighted; the evidence gathered over the last 35 years must be shared with decision makers and clinical teachers.

Implications for Research

The reasons for the failure in knowledge translation for concepts such as the SDA, which has been extensively researched and corroborated, need to be explored further.⁴⁴ Specifically, the acceptance of the SDA amongst communities who have been made aware of its benefits should be researched.

Conclusions

The research questions, types of studies, and study outcomes of each included SR varied, which meant that the conclusions of each were somewhat different from the others. Nevertheless, most of the SRs ($n = 7$) emphasized the significance of the SDA concept as a functionally satisfactory approach to managing certain groups of partially dentate patients. According to the AMSTAR evaluation, the methodologies of the included SRs were of a high standard and most were of good quality. Reliance on their results would be acceptable.^{37,43}

Acknowledgments

The present research was presented at the International Association of Dental Research (South Africa Division) in Pretoria, South Africa, in September 2015. The authors thank Dr Q. Isaacs for her invaluable assistance and knowledge related to this research, especially the assessment of each SR according to AMSTAR. The authors reported no conflicts of interest related to this study.

References

- White HD, Van de Werf FJ. Thrombolysis for acute myocardial infarction. *Circulation* 1998;97:1632–1646.
- Khan S, Omar R, Chikte UME. Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa. *SADJ* 2012;67:60–68.
- Khan S, Chikte UME, Omar R. From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014;78:906–913.
- Käyser AF. Shortened dental arches and oral function. *J Oral Rehabil* 1981;8:457–462.
- Käyser AF. Shortened dental arch: A therapeutic concept in reduced dentitions and certain high-risk groups. *Int J Periodontics Restorative Dent* 1989;9:426–449.
- World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe, WHO Technical Report Series No. 826. Copenhagen: WHO Europe regional office, 1982.
- Department of National Health and Population Development. National Policy for Oral Health in South Africa, Act 116. National Policy for Oral Health, 1990.
- Allen PF, Witter DJ, Wilson NH, Käyser AF. Shortened dental arch therapy: Views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996;23:481–485.
- Witter DJ, van Elteren P, Käyser AF. Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988;15:413–420.
- Witter DJ, van Elteren P, Käyser AF, van Rossum MJ. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil* 1989;16:27–33.
- Carlsson GE. Some dogmas related to prosthodontics, temporomandibular disorders and occlusion. *Acta Odont Scand* 2010;68:313–322.
- Creugers NH, Witter DJ, Van 't Spijker A, Gerritsen AE, Kreulen CM. Occlusion and temporomandibular function among subjects with mandibular distal extension removable partial dentures [pub 5 July 2010]. *Int J Dent* doi: 10.115/2010/807850.
- Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin Oral Impl Res* 2007;18(Suppl 3):34–45.
- Zhang Q, Witter DJ, Bronkhorst EM, Creugers NH. Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Invest* 2013;17:1425–1435.
- Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998; 25:649–661.
- Owen CP. Appropriate: Prosthodontics for the many, not just for the few. *Int J Prosthodont* 2004;17:261–262.
- Wolfart S, Heydecke G, Luthardt RG, et al. Effects of prosthetic treatment for shortened dental arches on oral health-related quality of life, self-reports of pain and jaw disability: Results from the pilot-phase of a randomized multicentre trial. *J Oral Rehabil* 2005;32:815–822.
- Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all—and for life? The oral healthcare system needs revision. *J Oral Rehabil* 2013;40:707–722.
- De Sa e Frias V, Toothaker R, Wright RF. Shortened dental arch: A review of current treatment concepts. *J Prosthodont* 2004;13:104–110.
- Armellini DB, Von Fraunhofer JA. The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004;92:531–535.
- Käyser AF, Witter DJ, Spanauf AJ. Overtreatment with removable partial dentures in shortened dental arches. *Aus Dent J* 1987;32:178–182.
- Thomason JM, Moynihan PJ, Steen N, Jepson NJA. Time to survival for the restoration of the shortened lower dental arch. *J Dent Res* 2007;86:646–650.
- Shahmiri RA, Atieh MA. Mandibular Kennedy Class I implant-tooth-borne removable partial denture: A systematic review. *J Oral Rehabil* 2010; 37:225–234.
- Zhang Q, Kreulen CM, Witter DJ, Creugers NHJ. Oral health status and prosthodontic conditions of Chinese adults: A systematic review. *Int J Prosthodont* 2007;20:567–572.
- Gerritsen AE, Finbarr Allen P, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: A systematic review and meta-analysis. *Health Qual Life Outcomes* 2010;8:126.
- Faggion CM. The shortened dental arch revisited: From evidence to recommendations by the use of the GRADE approach. *J Oral Rehabil* 2011;38:940–949.
- Faggion CM, Giannakopoulos NN, Listl S. How strong is the evidence for the need to restore posterior bounded edentulous spaces in adults? Grading the quality of evidence and strength of recommendations. *J Dent* 2011;39:108–116.
- Fueki K, Yoshida E, Igarashi Y. A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011;47:167–174.
- Abt E, Carr AB, Worthington HV. Interventions for replacing missing teeth: Partially absent dentition. *Cochrane Database Syst Rev* 2012;2. doi: 10.1002/14651858.CD003814.pub2.
- Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated shortened dental arches: A systematic review. *PLoS One* 2014;9:e101143.
- Liang S, Zhang Q, Witter DJ, Wang Y, Creugers NH. Effects of removable dental prostheses on masticatory performance of subjects with shortened dental arches: A systematic review. *J Dent* 2015;43:1185–1194.

32. Zeng X, Sheiham A, Tsakos G. Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008;35:37–44.
33. Jepson NJA, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Caries incidence following restoration of shortened lower dental arches in a randomized controlled trial. *Br Dent J* 2001;191:140–144.
34. Frank RP, Brudvik JS, Le Roux B, Milgrom P, Hawkins N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet D* 2000;83:521–527.
35. Cheung C, Weir M, Mayhew A, Kozloff N, Brown K, Grimshaw J. Overview of systematic reviews of the effectiveness of reminders in improving healthcare professional behaviour. *Syst Rev* 2012;1:36.
36. Higgins JPT, Green S. *Cochrane Handbook for Systematic Reviews of Interventions*, ed 1. West Sussex: Wiley-Blackwell, 2009.
37. Shea B, Grimshaw JM, Wells GA, et al. Development of AMSTAR: A measurement tool to assess methodological quality of systematic reviews. *BMC Med Res Methods* 2007;7:10.
38. World Medical Organization. Declaration of Helsinki. *Br Med J* 1996;313:1448–1449.
39. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003;16:409–414.
40. Tan H, Peres KG, Peres MA. Do people with shortened dental arches have worse oral health-related quality of life than those with more natural teeth? A population-based study. *Community Dent Oral Epidemiol* 2015;41:33–46.
41. Sarita PT, Witter DJ, Kreulen CM, van't Hof MA, Creugers NH. A study on occlusal stability in shortened dental arches. *Int J Prosthodont* 2003;16:375–380.
42. Sarita PT, Witter DJ, Kreulen CM, Matee MI, Van't Hof MA, Creugers NH. Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Oral Sci* 2007;115:265–274.
43. Creugers NH, Kreulen CM. Systematic review of 10 years of systematic reviews in prosthodontics. *Int J Prosthodont* 2003;16:123–127.
44. Straus SE, Tetroe J, Graham I. Defining knowledge translation. *CMAJ* 2009;181: 65–168.

Outcomes with a posterior reduced dental arch: a randomised controlled trial

S. KHAN* , U. M. CHIKTE[†] & R. OMAR[‡] **Department of Restorative Dentistry, Faculty of Dentistry, University of the Western Cape, Cape Town, [†]Department of Community Health, Faculty of Health Sciences, University of Stellenbosch, Cape Town, South Africa and [‡]Department of Prosthodontics, Faculty of Dentistry, Kuwait University, Safat, Kuwait*

SUMMARY To compare function, patient satisfaction and quality of life of patients with a posterior reduced mandibular arch with those who had all missing teeth replaced with removable partial dentures. Patients with at least three and not more than six posterior occluding pairs of teeth were enrolled sequentially and randomised into one of two treatment groups: a denture and no-denture group. A research assistant allocated interventions; concealment was ensured using opaque-sealed envelopes. Analysis of data was performed in stages, adding samples of 10 incrementally, and stopping when the relevant statistical tests indicated a clear conclusion as judged by the power set at 80% or above. Study outcomes included patient satisfaction, function and survival of remaining teeth at 3 and 12 months post-intervention, using a visual analogue scale and the Oral Impacts on Daily Performance). Statistical analysis was performed by the 'intention-to-treat'

principle. Age range of included patients was 23–55 years (mean = 42.3; s.d. = 9.2), with 78% being females. Most patients (70%) belonged to the low- or no-income group. Nine patients left the study, for different reasons. Primary outcomes for the denture group: 10% of the patients were not satisfied and 20% were unhappy with their function; for the no-denture group: 85% of the patients (with 15% having left the study) were satisfied with both their function and their non-denture status. Patients with posterior reduced mandibular dental arches reported greater perceived satisfaction, function and quality of life compared to those who had received a cobalt-chrome clasp-retained partial removable prosthesis. **KEYWORDS:** prosthodontics, posterior reduced mandibular arch, randomised clinical trial, sequential sampling, patient satisfaction and function

Accepted for publication 5 August 2017

Introduction

Research data increasingly support a functional approach in treatment planning. In prosthodontic clinical decision-making for older patients, such an approach not only encourages patient input, but has been shown to achieve improvements in subjective function and quality of life (QoL), thus ensuring overall treatment success (1–3). A functional approach also addresses the discrepancies that are known to exist between accepted normatively defined clinical practices and patients' evaluations of their oral functional needs (1–6).

Results from several randomised and non-randomised clinical trials (RCT and CT) related to the shortened dental arch (SDA) concept have indicated its functional effectiveness, and application of the concept in selected patients has received general acceptance (4–11). Examination of these RCTs and CTs, however, highlights their differences, including the interventions used, aspects of study design and outcomes assessed (Table 1) (4–11). A recent systematic review on the SDA concluded that the results of the included studies were not always consistent, and that generalisability may only be possible for specific

Table 1. Comparison of randomised controlled trials related to the shortened dental arch

	British Jepson <i>et al</i> 2003	German Wolffart <i>et al</i> 2014	Irish Mc Kenna <i>et al</i> 2012	South African Khan <i>et al</i> (This article)
Sequence generation Allocation concealment	Computer generated numbers Clinician not involved in process. No indication how it was done. Patients stratified for age/sex	Randomly permuted blocks Warranted; Randomization occurred centrally. Patients stratified for treatment centre/age	Computer generated schedule Allocation concealed and randomization, (assistant). Patients stratified for age/gender	Randomly allocated, pairwise Opaque sealed envelopes, (assistant)
Blinding	Double Blinded: 1. Clinician to allocation process. 2. Statistician	No Blinding: Not possible to blind clinician as treatments differed	Single Blinded: Clinician to allocation	Double Blinded: 1. Researcher to allocation. 2. Statistician
Sample size (N)	N = 60 Bridge Group = 30 RPDP Group = 30 Sample size: Hypothesis testing using power calculations set at 80% on survival data	N = 215 RPDP Group = 109 SDA Group = 106 Sample size: Hypothesis testing using power calculations (75%) on tooth loss. Multi-centre analysis method of O'Brien/Fleming	N = 44 RPDP Group = 21 SDA Group = 23 Sample size: Hypothesis testing using power calculations (80%) on SDA patients not worst off than RPDP group	N = 50 RPDP Group = 25 PRDA Group = 25 <i>Sequential Sampling & Analysis</i> (Power at 80%; min. mean difference = 20) on the effect of RPDP/PRDA on quality of life. Predetermined stopping rule
Clinical set up	A Dental Hospital, Requests for RPDP, Max 8 lower teeth, Ant teeth replaced: FPDP/RPDP and No maxillary molars	14 Dental Hospital Centres, Anterior teeth replaced: FPDP lassic SDA	Patients recruited from 2 Hospital Settings, Min of 6 teeth, SDA restored with RBB (10 contacts)	University Dental Hospital, Requests for RPDP, Anterior teeth, Man: 3–5 POPs Maxilla: Complete/RPDP
Gender	M = 25 F = 35	M = 68 F = 82	M = 16 F = 28	M = 11 F = 39
Age category	39–81 years Median age: 67	35 years and over Median age: 59.6	65 years and over Median age: 68.2	23–55 years only Median age: 42.3 (s.d. = 9.2)
Intervention	Group 1: Cantilever RBB Group 2: Cobalt-Chrome RPDP	Group 1: RPDP molars (precision-attachments) Group 2: Classic SDA	Group 1: RPDP Group 2: RBB/FPDP	Group 1: RPDP (Cobalt-Chrome) Group 2: No RPDP/PRDA
Outcomes: Primary Secondary	1. Survival of RPDP/FPDP, dietary nutrient intake. 2. Caries incidence, aatisfaction; periodontal status	1. First tooth loss. 2. OHRQoL, second tooth loss, cariesc periodontal lesions, TMJ dysfunction and RPDP problems	1. OHRQoL, mini-nutrient assessment. 2. Survival, nutritional status, cost effectiveness	1. Satisfaction, OHRQoL, function. 2. Intervention success, caries, periodontal status, tooth loss, change
Instruments/Tools	Self-designed questionnaire and 2–3/day food record	OHIP-49 (German version)	OHIP-14, caries assessment system	OIDP, global visual analogue scale

SDA, shortened dental arch; RCT, randomized controlled trial; OHRQoL, oral health-related quality of life; RPDP, removable partial denture prosthesis; FPDP, fixed partial denture prosthesis; TMJ, temporomandibular joint; RBB, resin bonded bridge; OHIP, oral health impact profile; OHIP, oral health impact profile; OHIP, oral health impact profile; OHIP, oral health impact profile.

regional and, perhaps cultural contexts (12). As tooth loss and oral function are indicators of the oral health status of individuals and communities (13), their impact on the perceived need for replacement of missing teeth is critical (2, 14, 15). Studies have indicated that the loss of teeth and their location significantly affect the oral health-related quality of life (OHRQoL) of patients (2, 6, 15, 16). The evidence for dentitions with fewer teeth, such as an extreme SDA confirms the negative effect on function and OHRQoL (1, 2, 6, 15).

Of the several available instruments for measuring OHRQoL, the oral impact on daily performance (OIDP) tool is a multidimensional instrument that provides information related to oral conditions (4–6, 12, 13, 15–17). When used concurrently with clinical measures, a more comprehensive assessment of patients' oral status may be determined (13, 17). The OIDP has been validated, and together with a global visual analogue scale (VAS), may be used to assess oral status, patients' satisfaction and OHRQoL (13, 17).

Given the wide variations in missing posterior tooth distributions, the definition of a SDA has evolved (2, 3, 15). A less formulaic, and perhaps more generic, clinical description may thus include a posteriorly reduced dental arch (PRDA) with 3–4 symmetrically- and 5–6 asymmetrically arranged posterior occluding pairs (POPs) of teeth (1, 2). In some situations, specific occlusal arrangements as in PRDAs which include the classic SDA are considered acceptable and adequate for oral function, occlusal support and stability (2, 15).

South Africa (SA) is a developing country, which by virtue of its wide socio-economic disparities, affords only a limited range of treatment procedures for the majority of its population at public health clinics (viz. extractions, fillings and preventive procedures); at the same time, the exorbitant costs associated with current prosthodontic treatment options (complete or partial removable, or conventional or implant-retained fixed prostheses) that are provided by private practitioners make these options inaccessible for most. Management approaches such as the SDA or PRDA would seem to be an appropriate primary healthcare measure for the underprivileged majority of the population (18).

The aim of this study was to determine whether the daily functional needs and the quality of life of

adult patients with a posterior reduced mandibular dental arch would be satisfied without having all their missing teeth replaced with a mandibular removable partial denture prosthesis (RPDP), as compared to having a prosthesis. The null hypothesis was that, in adult patients with a posterior reduced mandibular arch, there would be no difference in oral functional satisfaction and quality of life with or without the presence of a prosthesis to replace all missing teeth.

Methods

Ethical clearance was obtained from the Research and Ethics Committees of Stellenbosch University (Registration No: S13/04/066) and University of the Western Cape (UWC) (Registration No: 12/5/14), SA. This single-centre double-blinded RCT was designed according to the guidelines of the International Organization for Standardisation (ISO/EN540) and the Guidelines for Good Clinical Practice in SA (19, 20). Informed consent was obtained from all patients prior to commencement according to the Declaration of Helsinki (21). The results of this study are reported according to the Consolidated Standards of Reporting Trials (CONSORT) statement (19, 22). The design aspects, study outcomes, data collection and follow-up details can be viewed in a detailed protocol and can be accessed at: clinicaltrials.gov; Identifier: NCT01597206.

Initially, the RCT sample recruited at the UWC dental hospital included patients with a classic SDA scheme for the mandible only, and requesting a RPDP. They were randomly allocated into one of two treatment approaches: Group A, with a cobalt-chrome RPDP as intervention; and Group B, with no RPDP (viz. a classic SDA), as control (19). In both groups, reduced and interrupted dentitions would first have been restored to the classic SDA scheme using fixed partial denture prostheses (FPDPs) (23).

The standard hypothesis testing method to estimate sample size, using the primary outcome of patient satisfaction, indicated that 420 patients (210 per study group) needed to be recruited. But after conducting a pilot study ($N = 6$), patients with these specific clinical criteria were not easily obtainable. Thus, alternative recruitment criteria were set as follows: traditional sampling changed to sequential sampling; sourcing of patients was extended to include public health clinics; eligible mandibular arch types were modified from only classic SDAs to patients with three, and not more

than six, POPs of teeth, and a complete natural maxillary arch or one rendered as complete by provision of either a complete or partial denture (2). For this double-blinded RCT, healthy young adult patients (21–55 years) having a mandibular PRDA with three and not more than six POPs formed the final sample (Table 1).

All basic restorative and preventive procedures were completed by the UWC service-rendering department, and the maxillary RPDP or complete denture and mandibular FPDPs were constructed by a clinical assistant according to standard clinical protocols (23). Patients were randomly entered and interventions allocated by a research assistant using sealed opaque envelopes into: Group A to replace all missing mandibular posterior teeth with a cobalt-chrome clasp-retained RPDP following standard prosthodontic design principles and constructed by the clinical

assistant; or Group B with a mandibular PRDA (17, 23) (Fig. 1).

The following subjective and objective outcomes with the mandibular intervention were determined:

Primary outcomes: patient satisfaction, oral function and OHRQoL; and

Secondary outcomes: clinical performance, survival of remaining teeth and mandibular RPDP (caries, periodontal problems, loss of teeth or inability to wear the RPDP), or a change in treatment allocated.

Evaluation of the outcomes was performed by the principal researcher 3 and 12 months after receiving the intervention, as applicable, using the global VAS and OIDP (13, 17, 24). The global VAS is a 100 mm scale comprising five questions which focused on patient satisfaction, need for treatment and quality of life regarding the current state of their teeth and the

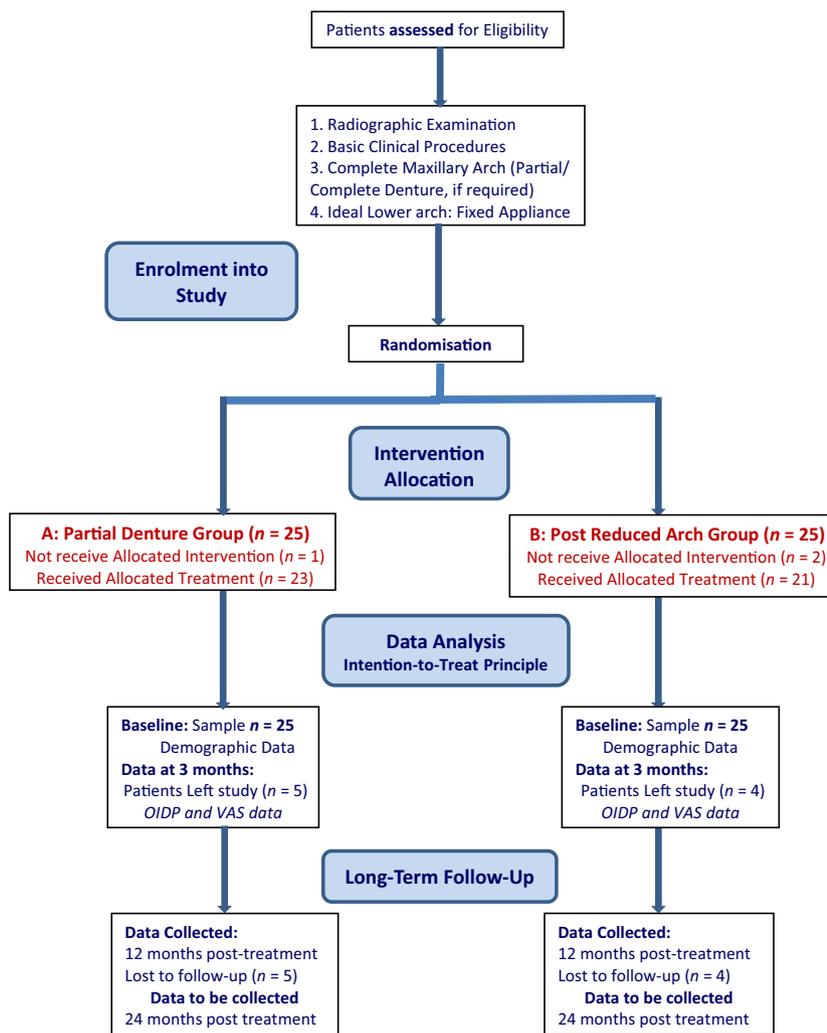


Fig. 1. Patient flow diagram.

intervention provided. Questions 1–3 were completed at baseline and prior to provision of the intervention, and questions 4–5 were completed 3 months after receiving the intervention (17). The specific oral impacts questions in the OIDP relating to OHRQoL measures include oral function, oro-facial appearance and psychological impact (13). The OIDP gave an overall rating of patients' satisfaction as well as oral health, QoL and OHRQoL.

Statistical analysis of data was completed by the 'intention-to-treat' principle, and patients' personal details were omitted for this phase (25). Analysis included finalising the sample size, frequency calculations of demographic data, oral impacts and VAS scores, calculation of correlation coefficient and comparisons using the Chi-square test (25). It also included primary outcomes investigation and adjustment for confounding, where necessary.

Results

Sampling for the study

Sampling was by necessity sequential, and the data were similarly analysed sequentially. Because VAS questions 4 and 5 were related to the intervention (i.e. 'the impact of the intervention on the patients' oral health' and 'quality of life', respectively), they were used as the primary variables upon which the conclusion to stop sampling was based (26, 27)

(Table 2). Patients were included as they presented for treatment and the allocation of mandibular intervention was made pairwise into the two study groups A and B. Sample size was not fixed in advance but finalised as data was obtained. For this purpose, a pre-defined stopping rule had to be set:

- 1 If the estimated power was greater than 80%, accept either the null or alternative hypothesis and stop sampling, or
- 2 Continue sampling and increase the sample size incrementally by 10 patients (26, 27).

Assessment of data collected was performed sequentially on sets of $N = 10$ patients, using a two-sample t -Test to determine the power of the study which was set at 80% and above. The first set of $N = 10$ patients was thus Stage 1 of the sequential process, and $N = 20$ was Stage 2, and so on. For this assessment, a mean difference of 20 (which was a figure considered by the researchers to indicate the smallest difference that may be considered clinically important) between the two groups for variables VAS4 and VAS5 and a statistical significance of 0.05 was set (25). The decision to continue sampling was based on the power determined at each $N = 10$ increment; further sampling and analysis, which would similarly be completed sequentially, stopped as significant results were obtained (26, 27).

At Stage 1 ($N = 10$) and Stage 2 ($N = 20$), the power determined was below 80% and thus unacceptable; recruitment of further sets of patients thus continued (Table 2). At Stage 3, the sample size was

Table 2. Sequential sampling calculations using a two-sample t -test

Sample size (N) per stage	VAS question	Sample size for analysis	Minimum mean difference	Standard deviation, s.d.	Statistical significance	Power %
$N = 10$	4	5	20*	20.28	0.05	27.9%
	5	5	20	22.86	0.05	23%
$N = 20$	4	10	20	15.40	0.05	78.4%
	5	10	20	17.11	0.05	69.5%
$N = 30$	4	13	20	13.92	0.05	93.9%
	5	13	20	16.43	0.05	84%
$N = 40$	4	17	20	12.39	0.05	99.4%
	5	17	20	14.61	0.05	97.4%
$N = 50$	4	20	20	18.36	0.05	91.9% [†]
	5	20	20	19.15	0.05	90.2% [†]

VAS, Visual Analogue Scale (100 mm ruler); VAS Question 4, How would you rate the effect of the intervention on your mouth/oral health? (Responses: Very Bad to Excellent); VAS Question 5, How would you rate the effect of the intervention on your quality of life? (Responses: Very Bad to Excellent).

*Minimum Mean difference for VAS4 and VAS5 which are considered clinically important and are required when determining the Power of the t -test

[†]The power calculated decreased as the data included an unexpected extreme response (an OUTLIER)

acceptable ($N = 30$) on the basis that the power of the study was calculated as 80% and above (26, 27) (Table 2). At this stage, further recruitment of patients could have been stopped, but we wanted to see the effects on outcomes with additional groups of 10 participants ($N = 40$ and $N = 50$) (Table 2).

Demographic data obtained at baseline

Fifty patients were included in the RCT, with ages ranging from 23 to 55 years (mean = 42.3; s.d. = 9.2), and with a bias towards the female gender at 39 (78%) (Table 3). Education level of patients indicated that 41 (82%) had been to school. Many worked in the public sector, 19 (38%) in all, or were unemployed, 26 (52%). Seventy per cent were in the 'low' or 'no-income' category. The periodontal status of the group at baseline was acceptable (a requirement to be enrolled into the study) with acceptable oral hygiene

practices, with 38 (76.47%) brushing teeth twice a day).

Patient satisfaction, QoL and OHRQoL

At baseline, using the global VAS (0–100 mm scale): 41 (84%) had a score of below 50 mm and rated the state of their mouth or teeth poorly, while 42 (84%), with a score of 50 mm or less, were not satisfied with their current oral status. Forty-nine (92%) of included patients, with scores ranging from 50 to 100 mm, felt that they were in need of treatment (Table 3).

Three months after receiving the intervention (mandibular denture or no denture), with reference to the *OIDP* questions 8–10: 40 (80%) of all patients indicated an acceptable dental health, and 36 (76%) an acceptable patient satisfaction rating (Table 3). The *OIDP* questions were completed after all basic restorative or preventive procedures were completed. Three months after receiving the mandibular intervention, only participants in the 'denture group' rated the effect of the RPDP on their oral health and quality of life negatively, relating to questions 4 and 5 on the global VAS (Table 3).

Table 3. Detailed comparison between two intervention groups

	Posterior reduced dental arch group	Denture group
Pre-Intervention		
Baseline data		
Sample (N) recruited	25	25
Gender (Females)	21	18
Full Maxillary Denture	5	7
VAS 1 (0–50 mm)	22	19
VAS 2 (0–50 mm)	21	21
VAS 3 (50–100 mm)	25	24
Post-Intervention		
3 Months		
VAS 4 (65–100 mm)	21	18
VAS 5 (58–100 mm)	21	18
<i>OIDP</i> 8: Good	21	19
<i>OIDP</i> 9: Satisfied	19	17
<i>OIDP</i> 10: No treatment	20	18
<i>OIDP</i> : 13a (eating)	1	4
<i>OIDP</i> : 13b (speaking)	0	2
<i>OIDP</i> : 13i (emotional)	1	2
Primary outcomes		
Patient satisfaction	21	18
Function	21	14
Secondary outcomes		
Success of treatment	21	15
Treatment change	2	2
Patient loss	4	5

VAS, visual analogue scale; *OIDP*, oral impact of daily performance

Correlation between VAS and *OIDP* results

For satisfaction, the VAS1 question (84% not satisfied with their oral state) was completed prior to treatment, while the related *OIDP* question (76% satisfied and very satisfied with their oral state) was completed 3 months post-mandibular intervention (Fig. 2, Table 4). As the VAS4 score (50 mm and above) for 'rating the effect of the intervention on oral health' increased, patient satisfaction also increased ($P = 0.05$). Similarly, 'rating the effect of the intervention on quality of life' increased (as reflected in VAS5 scores of 50 mm or more), thus increasing patient satisfaction ($P = 0.05$). Both VAS4 and VAS5 scores (i.e. 'the impact of the intervention on the patients' oral health' and 'quality of life', respectively) indicated a negative correlation (viz. a decrease) with the need for treatment (Table 4).

Oral impacts

Oral impacts for measures relating to oral function, oro-facial appearance and psychological impact, and an overall health rating were fully explored to the

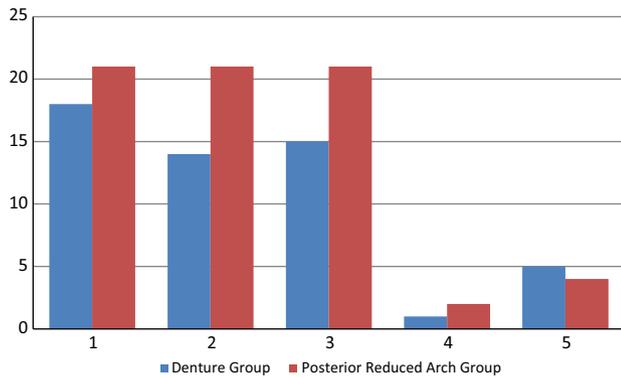


Fig. 2. Primary and secondary outcomes reported with the interventions in the mandibular arch: ‘denture’ or ‘posterior reduced dental arch’ (viz. ‘no denture’). Primary outcomes: 1. Patient satisfaction with intervention; 2. Function with intervention. Secondary outcomes: 3. intervention is a success; 4. Treatment changed; 5. Number of patients left study.

Table 4. Correlation coefficients for VAS questions versus OIDP questions rating oral health, patient satisfaction and need for dental treatment

VAS Questions	Oral Impacts on daily performance questions		
	Dental health	Patient satisfaction	Need for treatment
State of mouth	-0.003	0.109	-0.261
Satisfaction	-0.018	0.014	-0.256
Need treatment	-0.042	-0.130	0.225
Intervention on mouth	0.566	0.628 (<i>P</i> = 0.05)*	-0.536*
Intervention on quality of life	0.465	0.648 (<i>P</i> = 0.05)*	-0.452

VAS, visual analogue scale; OIDP, oral impacts on daily performance.

PRE-INTERVENTION (Baseline): Questions VAS1, VAS2 and VAS 3; POST-INTERVENTION (3 months Post Intervention): Questions VAS4, VAS5, OIDP8, OIDP9 and OIDP10.

*Indicate significant correlations

extent that OIDP permitted, but only significant results are reported. Total OIDP score measures prevalence (proportion of subjects reporting one or more oral impact), extent (number of daily performances impacted) and severity (more severe effect in one performance) of oral impacts on daily life using a 5-point Likert scale (13).

Total OIDP score (2.98%) recorded after receiving the mandibular intervention was very low, signifying a good self-rated health status. Only one patient

reported all oral impacts as negative, with six patients having problems with the oral impacts of eating, and three having negative feelings of being emotional. These were experienced daily for the one patient, and once a month for the others with similar effects on their daily life.

Outcomes reporting

From a sample of 50, nine patients left the study: four from the ‘no-denture’ and five from the ‘denture’ group (Fig. 2). Reasons for leaving included the following: unhappy with being allocated to the ‘no-denture’ group, losing teeth, moving cities and work commitments. Only two of these patients continued with a change in treatment (Fig. 1).

Data related to the primary outcomes obtained 3 months after receiving the mandibular intervention indicated that, for the ‘denture group’, 4% were not satisfied, 12% were unhappy with their function, each of which negatively affected the success with the allocated intervention (Fig. 2). In comparison, for the ‘no-denture group’, all of those who remained in the study were satisfied with their non-denture status and content with their function.

Regarding clinical performance, two patients complained about adapting to the mandibular RPDP and another mentioned the instability of the lower free-end saddle. No other negative secondary outcomes were reported by either group at this stage (Fig. 2).

One year after treatment, no negative reports were received regarding patients’ PRDA status or any other secondary outcomes. However, reports of adaptation to RPDPs (both upper and lower), the need for a restoration in the maxillary arch and the usual check-ups were recorded.

Discussion

Our main finding in this RCT was that patients with a PRDA on the mandible reported greater satisfaction, and perceived success of treatment relating to function and OHRQoL without a RPDP compared to those who had had their missing teeth replaced with a cobalt-chrome clasp-retained mandibular RPDP. This was encouraging given the known constraints on access to conventional prosthodontic treatment for a large proportion of partially dentate patients, especially in developing countries. A functional approach

to treatment planning that the present findings would appear to support also addresses the differences that are known to exist between normatively defined clinical practices and patients' evaluations of their oral functional needs (1–6). Furthermore, none of the present PRDA patients not provided with a RPDP expressed the need to have their missing mandibular teeth replaced 12 months post-treatment. Clinically, the significance of these results cannot be overstated especially coming from a resource-constrained setting such as SA.

A not infrequent concern of patients allocated to the 'denture group' was regarding the use of distal extension mandibular dentures, which has also been reported in the literature (1–4, 14, 28, 29). These concerns typically relate to 'adapting to dentures' and the 'high expectations' patients have with RPDPs (3, 10, 23, 28, 29). Equally, the positive responses from the 'no-denture group' that imply acceptable function, satisfaction and OHRQoL with a PRDA concur with extensive literature elsewhere, albeit whose context was not identical with the present study (1–10, 15, 16, 18, 29, 30).

The sequential sampling used in the present study made it possible to purposefully limit the sample size. Thus, patients' responses were statistically validated when the analysis indicated no difference in their responses, from one staged point to the next, when comparing denture-wearing to non-denture-wearing patients as regards function, comfort, aesthetics, patient satisfaction and OHRQoL. Moreover, several primary and secondary research studies have concluded that the SDA treatment option is justified on the basis of reduced costs, patient satisfaction and temporomandibular concerns (1–10, 15, 16, 18, 29, 30). Lastly, problems experienced by patients with mandibular RPDP usage were comparable with those previously reported as it relates to function, comfort, aesthetics, limitations of denture-wearing, increase in root caries formation and costs of RPDPs (1–12, 14–16, 18, 28–30).

The clinical implications of these results emphasise the need for evidence-based practices. Patients are receptive to such alternative treatments, especially when the clinician has adequately educated and guided them to practices that would be beneficial to them. Approaches such as the SDA or PRDA may be considered primary healthcare measures and may address the widespread socio-economic constraints.

A RCT study design is by its very nature challenging. Making changes to what is already a complicated design may present with even more difficulties. The sampling method adopted in this RCT is fairly novel and has rarely been used in clinical dental research, so that its implementation may be regarded as a limitation. While a small sample size may be construed as a limitation, an explanation following statistical validation has been provided. Nevertheless, some researchers may disagree about the generalisability of the results to the population at large given the small sample size. Gender bias may also be considered a limitation, but the random inclusion of patients was from the general population who were in need of denture treatment and who visited the University and general public hospitals. No stratification for age or medical conditions was conducted and this may also be regarded as a limitation. Moreover, the exclusion of patients treated with FPDPs or implant-retained prostheses, and the use of one examiner for recalls may also be considered as limitations.

Conclusion

Patients with a mandibular PRDA reported greater satisfaction, perceived success of treatment relating to function and OHRQoL without a RPDP compared to those with a complete dental arch that was extended with a cobalt-chrome clasp-retained RPDP.

Acknowledgments

The study was funded by the University of the Western Cape and Stellenbosch University, South Africa. The authors also thank everyone who participated in this clinical trial.

Conflict of Interest

All authors declare that they have no conflict of interest with regard to the content of the manuscript or funding of the study.

References

1. Käyser AF. The shortened dental arch: a therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent.* 1989;9:426–449.
2. Gotfredsen K, Walls AWG. What dentition assures oral function? *Clin Oral Impl Res.* 2007;18:34–45.

3. Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all – and for life? The oral healthcare system needs revision. *J Oral Rehabil.* 2013;40:707–722.
4. Jepson NJA, Allen PF, Moynihan PJ, Kelly PJ, Watson GW, Thomason JM. Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont.* 2003;16:409–414.
5. Wolfart S, Muller F, Gerß J, Heydecke G, Marre B, Böning K *et al.* The randomized shortened dental arch study: oral-health-related quality of life. *Clin Oral Invest.* 2014;18:525–533.
6. Gerritsen AE, Allen FP, Witter DJ, Bronkhorst EM, Creugers NHJ. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health Qual. Life Outcomes.* 2010;8:126–139.
7. Walter MH, Hannak W, Kern M, Mundt T, Gernet W, Weber A *et al.* The randomized shortened dental arch study: tooth loss over five years. *Clin Oral Invest.* 2012;17:877–886.
8. McKenna G, Allen PF, Flynn A, O'Mahony D, DaMata C, Cronin M *et al.* Impact of tooth replacement strategies on the nutritional status of partially-dentate elders. *Gerodontology.* 2012;29:e883–e890.
9. McKenna G, Allen PF, Woods N, O'Mahony D, DaMata C, Cronin M *et al.* A preliminary report of the cost-effectiveness of tooth replacement strategies for partially-dentate elders. *Gerodontology.* 2012;30:207–213.
10. Budtz-Jørgensen E, Isidor F. 5-year longitudinal study of cantilever fixed partial dentures compared with a removable partial denture in a geriatric population. *J Prosthet Dent.* 1990;64:42–47.
11. Isidor F, Budtz-Jørgensen E. Periodontal conditions following treatment with a distally extending cantilever bridge with removable partial dentures in elderly patients: a 5-year study. *J Periodontol.* 1990;61:21–26.
12. Khan S, Musekiwa A, Chikte UME, Omar R. Differences in functional outcomes for adult patients with prosthodontically-treated and -untreated Shortened Dental Arches: a systematic review. *PLoS One.* 2014;9:e101143.
13. Hobdell M, Tsakos G, Ladrillo TE, Ross MW, Myburgh N, Gordon N *et al.* Using an oral health-related quality of life measure in three cultural settings. *Int Dent J.* 2009;59:381–388.
14. Creugers NHJ, Witter DJ, Van't Spijker A, Gerritsen AE, Kreulen CM. Occlusion and Temporomandibular function among subjects with mandibular distal extension removable partial dentures. *Int J Dent.* 2010;807850:1–7 <https://doi.org/10.1155/2010/807850>.
15. Elias EC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil.* 1998;25:649–661.
16. Baba K, Igarashi Y, Nishiyama A, John MT, Akagawa Y, Ikebe K *et al.* The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont.* 2008;21:72–74.
17. Lamb DJ, Ellis B. Comparison of patient self-assessment of complete mandibular denture security. *Int J Prosthodont.* 1996;9:309–314.
18. Owen CP. Appropriatech: prosthodontics for the many, not just for the few. *Int J Prosthodont.* 2004;17:261–262.
19. Webb P, Bain C, Pirozzo S. *Essential epidemiology: an introduction for students and health professionals.* Cambridge, UK; New York: Cambridge University Press; 2005.
20. International Organisation for Standardisation. *European Standard (ISO/EN 540).* Berlin, Germany: Clinical Investigation of Medical Devices for Human Subjects; 2011.
21. World Medical Organization. *Declaration of Helsinki.* *Br Med J.* 1996;313:1448–1449.
22. Moher D, Schulz KF, Altman DG. CONSORT Group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. *Lancet.* 2001;357:1191–1194.
23. Zarb GA, Bolender CL, Carlsson GE, Boucher CO. *Boucher's prosthodontic treatment for edentulous patient.* London: McGraw-Hill; 2004.
24. Sutton AF, Worthington HV, Mc Cord JF. RCT comparing posterior occlusal forms for complete dentures. *J Dent Res.* 2007;86:651–655.
25. Dawson B, Trapp RG. *Basic and clinical biostatistics,* 4th edn. New York, NY: Lange Medical Books/McGraw-Hill Publishing Division; 2004.
26. Armitage P. *Sequential methods in clinical trials.* *Am J Public Health.* 1958;48:1995–2002.
27. Donaldson AN, Whitehead J, Stephens R, Machin D. A simulated sequential analysis based on data from two MRC trials. *Br J Cancer.* 1993;68:1171–1178.
28. Frank RP, Brudvik JS, Le Roux B, Milgrom P, Hawkins N. Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet Dent.* 2008;83:521–527.
29. Witter DJ, van Elteren P, Kayser AF, Van Rossum MJM. The effect of removable partial dentures on oral function in shortened dental arches. *J Oral Rehabil.* 1989;16:27–33.
30. Sarita PT, Witter DJ, Kreulen CM, Van't Hof MA, Creugers NHJ. Chewing ability of subjects with shortened dental arches. *Community Dent Oral Epidemiol.* 2003;31:328–334.

Correspondence: Saadika Khan, Department of Restorative Dentistry, University of the Western Cape, Private Bag X01, Tygerberg 7505, South Africa.
E-mail: skhan@uwc.ac.za

Impact of Removable Partial Dental Prostheses on the Oral Health-Related Quality of Life of a South African Cohort with Varied Distributions of Missing Posterior Teeth

Sadika Khan, BChD, PDD, MSc,¹ Usuf Chikte, BChD, MSc, DHSM, MDent, PhD,² & Ridwaan Omar, BDS, LDSRCS, MSc, FRACDS, FDSRCSEd³

¹Department of Restorative Dentistry, University of the Western Cape, South Africa

²Department of Interdisciplinary Health Sciences, Stellenbosch University, Matieland, South Africa

³Kuwait University Faculty of Dentistry, Safat, Kuwait

Keywords

Clinical diagnostic reasoning; function; Kennedy Classification; patient satisfaction; quality of life.

Correspondence

Sadika Khan, Department of Restorative Dentistry, University of the Western Cape, Private Bag X01 Tygerberg Bellville, Western Cape 7535, South Africa.
E-mail: skhan@uwc.ac.za

Previously presented at the European Prosthodontic Association, Rotterdam, Netherlands, 2012.

All authors declare that they have no conflict of interest with regards to the content of the manuscript or funding of the study.

Accepted June 28, 2017

doi: 10.1111/jopr.12692

Abstract

Purpose: To determine the impact of removable partial dental prostheses on satisfying the daily functioning and quality of life (QoL) of adult patients with different distributions of missing posterior teeth.

Materials and Methods: A cross-sectional interventional study was carried out on 80 patients having variously distributed posteriorly shortened and interrupted arches. Treatment comprised provision of partial dentures by senior dental students, supervised by senior clinical teachers who had knowledge of the potential benefits of the shortened dental arch (SDA) concept. The Oral Impacts on Daily Performance Index was completed before and 6 months after prosthetic treatment across groups comprising Kennedy Classes I, II, and III arches. Analysis included descriptive statistics and associations and comparisons between variables.

Results: Mean age of patients was 57.4 years (SD = 13.1), many were retired (72.2%), and a majority were females (60%). Most patients lived in urban areas (95%), and were largely unemployed (63.3%). At pretreatment, only 31.3% of patients reported having good dental health and satisfaction with their current oral state, while 82.5% said they had a great need for treatment. The negative oral impacts that were most frequently experienced were those of eating (67.5%), smiling (50%), and being emotionally disturbed (63.8%). Post-treatment, 76.3% indicated good oral health and satisfaction with no significant differences between the 3 Kennedy groups. Any further negative impacts were reported mostly for Kennedy Classes I and II.

Conclusions: Overall, significant reductions of negative impacts were observed following treatment with dentures, across the 3 Kennedy groups, with respect to improved function, satisfaction, and oral health-related QoL. The findings confirm the reliance by partially dentate patients in all 3 Kennedy groups on dentures for improved oral health, although the possible benefits of the SDA concept as an alternative treatment option was not specifically explored.

Evidence from several sources recommends that reduced or interrupted dentitions should be categorized according to their ability to ensure satisfactory oral function.¹⁻⁴ Studies on oral function suggest that oral health related quality of life (OHRQoL) can be related to the presence of nine or more pairs of anterior and posterior occluding teeth,^{1,2,5} and that anything less than this negatively affects patient satisfaction and OHRQoL.^{1,2,5-7} Generalizability of these results cannot be assumed, as contexts differ considerably regarding cultural and socioeconomic circumstances, which

in turn have been shown to impact OHRQoL and patient satisfaction.^{5,7}

Normative and perceived needs regarding the functional adequacy of partial edentulism, including reduced posterior dentitions, differ,^{2,8,9} and thus assessments for prosthetic replacement vary widely. In general, normative assessments of treatment needs, especially in older, partially dentate adults, exceed the perceived needs of the patients themselves.^{2,9} There is growing evidence that the prosthetic management approach, especially in such an older group of patients, should include

treatment options predicated on the maintenance of a functional dentition.^{3,10-13} This differs from the traditional approach of a morphologically intact dentition being considered the determinant of satisfactory function.

The shortened dental arch (SDA) concept, introduced by Käyser in the 1980s, has been proposed as an alternative treatment option for older, partially dentate adults.^{1,3,4,10-26} The concept is functionally oriented and has been shown to satisfy the functional needs and OHRQoL of such patients in several population groups.¹¹⁻³³ The classic SDA is defined as having 20 occluding anterior and premolar teeth, although several variations relating to the number of posterior occluding pairs (POPs) of teeth have been described as well.^{1,5,11-13,17-27} The benefits of the classic SDA and its many variations have been described in a global context^{1,3,11,12,17-21,23-31} and a South African context.^{22,32,33}

Gotfredsen and Walls referred to the difficulties patients experience when expressing their satisfaction regarding their oral function, and advised that these patients should optimally be guided by clearly defined concepts and validated indicators when their needs are assessed and treatments recommended.¹ Adopting a problem-oriented and patient-centered treatment approach would increase the possibility of achieving successful treatment outcomes.³⁴

Several statistically validated OHRQoL indicators are available that would simultaneously determine patients' clinical status and psychological and social dimensions when determining dental needs, that is, combining normative and perceived needs.^{2,35-39} The Oral Impacts on Daily Performance (OIDP) index, described by Adulyanon and Sheiham in 1997, has been used to assess diverse populations' dental needs and for planning dental services.^{36,39} Importantly, the OIDP adequately encompasses the concepts related to basic needs and demands.^{2,36,39}

In studies conducted within the South African context, knowledge of the SDA among dentists in private practice and those teaching at a large dental institution was not widespread, and not surprisingly, it was rarely translated into clinical practice.^{22,32} The commonly accepted and applied method of treating such patients is with removable partial dental prostheses (RPDPs). Since patients tend to value and trust the judgements of clinicians without questioning the treatment offered (a clinician-centered approach), the impact and effect of treatment with RPDPs on patients' daily life, in light of alternatives such as the SDA approach, has not been adequately explored. In particular, no studies alluding to the functioning ability and OHRQoL benefits for patients with differing partially dentate scenarios as defined by their Kennedy classification, viz. Class I (which incorporates classic SDAs), II, and III, have been conducted in South Africa.

The aim of this study was to assess the impact of RPDPs on satisfying the functioning ability and OHRQoL of a group of partially dentate adult patients, with various distributions of missing posterior teeth according to Kennedy Class I, II, and III. The null hypothesis was formulated as follows: In partially dentate patients with a Kennedy Class I and II (posteriorly reduced) or Class III (discontinuous and interrupted) dental arch, the use of RPDPs do not influence daily functional ability, satisfaction, and OHRQoL.

Materials and methods

Ethical clearance (Registration No. 11/1/50 and S13/04/066) was obtained from the Research and Ethics Committees of the University of the Western Cape (UWC) and the Stellenbosch University. Written informed consent was obtained from the participants according to the Declaration of Helsinki.⁴⁰ The study population for this cross-sectional interventional study comprised a convenience sample of partially dentate patients ($n = 80$), presenting to the clinic requesting replacement of missing posterior teeth with cobalt-chrome clasp-retained RPDPs. Patients had to have a Kennedy Class I, II (posterior reduced or shortened), or III (discontinuous or interrupted) dental arch and had to be considered suitable for treatment by senior dental students after a thorough screening by academic staff. After being fully informed about the nature and purpose of the study, and agreeing to participate, enrolled patients were interviewed by the principal researcher using the OIDP questionnaire prior to receiving any prosthetic treatment. Subsequent to the prosthetic treatment, and after the patients had worn the prosthesis for 6 months, the principal researcher again completed the OIDP questionnaire with patients so that they served as their own controls. Treatment comprised provision of patients with cobalt-chrome clasp-retained RPDPs to replace all missing teeth by senior dental students supervised by clinical teachers.

The modified OIDP index (validated for the South African population) was used in this study and administered by the principal researcher.³⁹ Patients' demographic details (age, gender, economic, and employment status) were recorded. Participants were classified into groups according to socioeconomic category (middle, low working class, no income) and occupation (professional, skilled, unskilled, and unemployed).^{39,41} In addition, responses to the general and oral health questions were recorded using a 5-point Likert-type scale: for example, responses for rating aspects of dental health ranged from *very poor* (score of 1) to *very good* (score of 5) and for patient satisfaction from *not at all satisfied* (score of 1) to *very satisfied* (score of 5).⁴⁰ With regard to the OIDP assessment, the sections that focused on the OHRQoL required a *yes/no* response for each of the 10 dimensions included, as well as for reasons for patients' particular responses.³⁹ The corresponding frequency and severity for each dimension was recorded using a 5-point Likert-type scale (*no effect* to *very severe effect*).³⁹ Similarly for health behaviors (including dietary intake) and dental care habits, responses were again recorded using a *yes/no* response or a Likert-type scale.³⁹

Frequencies were calculated for the demographic data and for oral impacts and oral health behaviors at pre- and post-intervention stages and recorded according to the first 3 Kennedy classifications. The associations between qualitative variables (e.g., *dental health* and *need for dental treatment* and *oral impacts*) were studied by drawing up contingency tables and applying the Chi-square test or Fisher's exact test where necessary (p -values indicating the significance) at both pre- and post-intervention stages. For comparisons of means, the t -test or, when appropriate, the paired t -test was used. Cross tabulations were also completed between pre- and post-intervention responses

Table 1 Demographic distributions and postintervention patient responses according to Kennedy Classifications

	Kennedy Class I	Kennedy Class II	Kennedy Class III	Total
1. Demographic data				
Gender: Male	13 (35.1%)	7 (43.7%)	12 (44.4%)	32 (40%)
Female	24 (64.9%)	9 (56.3%)	15 (55.6%)	48 (60%)
Age category	35-54: N = 14	29-54: N = 5	28-54: N = 12	31 (38.8%)
	55-86: N = 23	55-79: N = 11	55-83: N = 15	49 (61.2%)
Location: Urban	35	16	25	76 (95%)
2. Sample size (N)	N = 37	N = 16	N = 27	80
Post-intervention				
3. Oral health:				
Good dental health	27 (72%)	12 (75%)	22 (82%)	76.3%
Patients satisfied	26 (70%)	12 (75%)	23 (85%)	76.3%
Need treatment	9 (24.3%)	3 (18.7%)	4 (14.8%)	20 %
4. Negative oral impacts:				
Eating	9 (24.3%)	3 (18.8%)	4 (14.8%)	20 %
Smiling	6 (16.2%)	0	3 (11%)	11.25%
Emotional	6 (16.2%)	3 (18.8%)	3 (11%)	15%
Contact with family	4 (10.8%)	0	3 (11%)	8.8%

using McNemar's test to observe statistically significant differences stated by the *p*-values. The data were analyzed using the Epi-Info and R-statistical programmes.

Results

Demographics

The age range of participants was 28 to 86 years (mean age = 57.4, SD = 13.1) with a 60% female majority. Most patients lived in urban areas (95%), very few were in the upper middle class group (1.3%), and most were retired (72.2%). The majority of patients were unemployed (63.3%), with equal numbers within the other categories at 6.3% in the skilled and unskilled groups.

The demographic variables that may be considered as confounders were patients' general health, socioeconomic status, level of education, and residential location. From an assessment of the data, however, no significant results with respect to possible confounders were noted. Notably, post-intervention, whereas complaints or negative impacts were reported among patients from different socioeconomic and education levels, the only demographic variable showing significant differences was gender. It was also noted that most complaints for the different impacts post-intervention were by men in the Kennedy Class I and III groups, even though women formed the majority of the sample (Table 1).

General oral health

For all patients attending the prosthetic clinic for the specific purpose of receiving a RPDP, institutional protocol required that all basic restorative and periodontal procedures had to be completed before these prostheses were provided. Pretreatment, 31.3% of the total sample indicated their perceived dental health as good or very good compared to a post-treatment proportion of 76.3% ($p < 0.0001$). Correspondingly, *patient satisfaction*

with perceived oral health was recorded as 76.3% ($p < 0.0001$) 6 months after receiving the prostheses. At post-intervention, for both these oral health indicators, non-significant differences were recorded across the Kennedy classifications, although the numbers of those reporting being most satisfied was from the Kennedy Class III group (Table 1). Prior to receiving their RPDPs, 82.5% ($p < 0.0001$) of the total sample had felt they were in great need of dental treatment while this need for further treatment decreased substantially (with the greatest need noted for the Kennedy Class I group) after provision of the RPDP (Table 1). Cross tabulations completed for the total sample, however, showed highly significant differences between pre- and post-intervention responses as specified by the *p*-values obtained after applying McNemar's test. At post-intervention, significant gender differences were observed, with more men indicating poor satisfaction and a greater need for more treatment.

Oral impacts

Total OIDP score measures *prevalence* (proportion of subjects reporting one or more daily oral impact), *extent* (number of daily performances affected), and *severity* (more severe effect in one performance) of oral impacts on daily life. Even though the total OIDP score at the pre-intervention stage was fairly low (20.7%), signifying good self-rated oral health status, some specific negative oral impacts (*eating, smiling, being emotional, and contact with family*) were experienced almost daily. Based on the 5-point scale of responses ("no effect" to "very severe effect"), the negative impacts were reported to have affected their daily life severely; however, following treatment with a RPDP and after 6 months of use, the total OIDP score was reduced to 5.9%. The acquisition of a RPDP, which was still worn by this cohort of patients, thus seemingly improved their perceived dental health and subsequently had a positive effect on their quality of life and OHRQoL.

Table 2 Pre-intervention associations between general health and oral impacts indicating patients' "Yes" responses

	1	2	3	4	5	p-Value
Dental health						
Eating	100	62.5	68	68.2	33.3	§ 0.312
Smiling	100	62.5	32	45.5	33.3	0.024
Being emotional	100	83.3	52	54.5	0	0.005
Contact with family	100	50	24	36.4	33.3	0.013
Patient satisfaction						
Eating	76.5	68.8	54.5	73.7	66.7	§ 0.617
Smiling	100	43.8	50	21.1	16.7	<0.001
Being emotional	82.4	87.5	63.6	42.1	16.7	0.002
Contact with family	76.5	50	31.8	26.3	0	0.003
Need for dental treatment						
Eating		60	66.7	69	67.6	§ 0.997
Smiling		0	33.3	41.4	67.6	0.009
Being emotional		20	33.3	55.2	83.8	0.002
Contact with family		0	33.3	31	56.8	0.034

KEY:

Dental health:(1) Very poor, (2) Poor, (3) Fair, (4) Good, (5) Very good**Patient satisfaction:**(1) Not at all satisfied, (5) Very satisfied**Need for dental treatment:**(1) Not at all, (5) A great deal

§: p-value indicates that the results were not significant.

The oral impacts of *speaking, cleaning teeth, physical activity (both light and vigorous), sleeping, and relaxing* were unaffected by patients' oral state, and thus are not reported. The oral impacts experienced most frequently by patients with shortened and/or interrupted posterior dental arches were those of *eating* (67.5%), *smiling* (50%), and *being emotional* (63.8%). Statistically significant reductions in the prevalence of negative impacts were observed for *eating* (20%), *smiling* (11.3%), and *being emotional* (15%) following treatment with clasp-retained RPDPs across all Kennedy groups ($p < 0.0001$).

At post-intervention, the negative oral impacts affecting OHRQoL were mostly reported from men and from the Kennedy I and III groups for *eating, smiling, and being emotional* (Table 1). Only women reported negative oral impacts in the Kennedy Class II group for *eating* and *being emotional*. Most-negative OHRQoL impacts reported were in the following descending order: Kennedy Class I, Class III, and Class II groups, and for those impacts specified above (Table 1). Negative impacts were reported for patients from different age, socioeconomic, and occupation groups, but these were not significant. Only gender differences were significant (as mentioned previously).

Associations between general oral health and oral impacts

Preintervention stage: The association between negative oral impacts (*eating, smiling, being emotional, and contact with family*) and perceived dental health data were summarized in 5×2 cross tabulation frequency distributions (Table 2). While there was variation between the percentages, the differences between them for *eating* were not statistically significant ($\chi^2 = 4.77$; $df = 4$; $p = 0.312$) according to the results of a Chi-square test. The responses of participants changed for

eating (recorded as "no problems with eating") as their perceived dental health status improved (Table 1).

The results for *smiling, being emotional, and contact with family* versus perceived dental health are also recorded in Table 2. Here, the p -values indicate the significance, or otherwise, of association, and these were confirmed by Fischer's exact tests where needed. Patients' responses for dental health versus *smiling* showed a similar trend to the results for *eating*, but for *smiling* the trend was statistically significant ($\chi^2 = 11.26$; $df = 4$; $p = 0.024$). Similarly, for patient satisfaction, the trend was comparable to that of perceived dental health, with the percentage of respondents saying "Yes" (that is 'not satisfied') decreasing with improved dental health status; however, the trend was in the opposite direction with need for treatment versus the reported negative oral impacts (*eating, smiling, being emotional, and contact with family*); that is, the need for treatment was perceived as greater when patients indicated experiencing negative oral impacts.

Discussion

In this study, the oral impacts most noticeably affected preoperatively were *eating, smiling, the emotional state of patients, and contact with family*. Eating was possibly impacted by loss of posterior teeth and their different distributions, while concerns with smiling, given that all anterior teeth were present, may be attributed to missing premolar teeth, especially in patients with a broad smile.

Following treatment with RPDPs, patients generally expressed satisfaction as well as an improvement in oral impacts, oral functional satisfaction, and more specifically in OHRQoL, although differences across the three groups were noted. Overall OIDP scores were lower, indicating that the presence of a clasp-retained cobalt-chrome RPDP improved their self-rated oral health and also the importance that such a denture has for function, and possibly esthetics, among this cohort. Any negative responses reported after receiving RPDPs were from the Class I and III groups, and most were reported by the men. It is important to mention that the confounder, viz. provision of basic restorative and periodontal treatment prior to all such interventions, could have influenced the changes in their responses. The fact that the OIDP was completed 6 months after RPDP placement may, however, have reduced this potential effect.

The literature consistently states that the presence or absence of anterior teeth plays a major role in how patients respond to treatment with RPDPs, and thus to questionnaires or oral health indicators that focus on this treatment option.²¹ Having excluded such patients from our sample, the responses seem surprising in that a substantial number reported negative responses for smiling. Such a response might have been expected had a Kennedy Class IV group been included as a cohort. At the same time, it is known that many patients in the community from which our sample was drawn request to have their anterior teeth extracted as a culturally driven preference. Since the present focus was on reduced posterior arches, these patients were deliberately excluded. Accordingly, patients were grouped according to their Kennedy classification into the first three classes only. These three groups facilitated recording specific

results reflecting the QoL or OHRQoL with different posteriorly reduced and interrupted arches. The specific number of posterior occluding units was not reported, which is an important aspect that should be explored further, considering the body of evidence related to benefits of a functional dentition.¹¹⁻³³

The reactions and responses of patients in this study were somewhat at variance with what some of the literature has indicated. Whether this might in some way be on account of patients' lack of knowledge of the potentially negative effects of distal extension clasp-retained RPDPs for Kennedy Class I and II scenarios, including the risk they could pose to the remaining teeth, is difficult to say.^{24,34} Research has shown that patients frequently do not use their distal extension clasp-retained RPDPs.^{1,21,42} A survey conducted by Jepson *et al* illustrates this point very well, with only 40% of RPDP patients actually wearing their dentures, and doing so especially when the anterior components were a priority.²¹

Perhaps also related to the observation of improved OIDP score after clasp-retained RPDP provision is the lack of knowledge related to the benefits of the non-interventional rationale of the SDA concept (which has indeed been accepted in South African Oral Health Policy) among undergraduate students, clinical teachers, and general practitioners.^{22,32} It follows that such a lack of awareness on the part of clinicians of the benefits that the SDA concept offers would likely not be conveyed to patients for whom such an option for managing reduced posterior occlusions is both viable and valid.^{22,32} It can also be speculated whether the fact that students' clinical education is premised upon achieving clinical requirements for graduation, and a "fee-for-service" dental care system compounds the problem of poor dissemination and uptake of the SDA concept. Thus, while the observed reduction in the total OIDP scores post-treatment indicates patients' satisfaction with prosthetic treatment that addressed their main complaint, whether this was so because it is actual or the perceived norm in clinical practice needs also to be investigated further.

In addition, the general absence among dental professionals of a patient-centered treatment approach has been noted. Gotfredsen and Walls were explicit about how patients have difficulties in voicing their opinions regarding oral function and their treatment requirements to practitioners.¹ They suggest that patients be guided by evidence-based concepts when being treated to ensure a more patient-centered approach, and at the same time emphasizing the need for educating patients with regard to all treatment options, as well applying validated indicators to assess their needs.¹ Knowledge related to the different oral health indicators introduced over time that address diverse aspects of QoL are thus very important. The OIDP index is a comprehensive indicator that addresses perceived needs of patients based on the daily activities of the individual.^{26,36,39} The severity of the condition with respect to function can be determined, and indeed, the changes following treatment with appropriately-designed RPDPs were very noticeable in the present population. As a follow-up to this research, however, it would be useful to investigate the OHRQoL for patients with a classic SDA, and those with a reduced posterior occlusion but with acceptable numbers of posterior occluding pairs of teeth, while not having any interrupted arches and with intact anterior teeth. Such a design might unambiguously

indicate whether the need for clasp-retained RPDPs, where cost is a major obstacle for readily obtaining these, is overstated in the South African context.

Conclusions

Considering the limitations of the current study, the following conclusions can be drawn:

1. In patients presenting with a range of posteriorly reduced, interrupted and/or discontinuous arches, the overall negative oral impacts were greatly reduced after provision of clasp-retained RPDPs.
2. Satisfaction with oral function was increased, and OHRQoL was improved across the three Kennedy groups.
3. Total OIDP score decreased significantly (from 20% to 5.9%) subsequent to RPDP provision, as oral health status and level of satisfaction improved.
4. Whereas the value of RPDPs in this South African cohort, which is at variance with many global studies, was confirmed, the effects of other possible confounders to this apparent outcome need further study.

Relevance of findings

The findings of this study show the reliance on a clasp-retained RPDP by this cohort of partially dentate South African patients, where application of the SDA concept offering functional benefits could arguably have worked equally successfully. It is also apparent that a clinician-driven treatment approach is still used among the population studied, indicating an absence of patient-centeredness in treatment planning. Clinicians should not offer the RPDP treatment as the only treatment option, especially to patients who come from a low income and education group, when they present for treatment. In light of this, it can only be suggested that the outcomes of the study should be investigated further.

References

1. Gotfredsen K, Walls AWG: What dentition assures oral function? *Clin Oral Implants Res* 2007;18:34-45
2. Sheiham A, Tsakos G: Oral health needs assessments. In: Pine CM, Harris R (eds): *Community Oral Health*, Chapter 4. Oxford, Wright Publishers, 2004
3. Zhang Q, Witter DJ, Bronkhorst EM, *et al*: Chewing ability in an urban and rural population over 40 years in Shandong Province, China. *Clin Oral Investig* 2013;17:1425-1435
4. Gerritsen AE, Allen FP, Witter DJ, *et al*: Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health Qual Life Outcomes* 2010;8:126-139
5. Elias EC, Sheiham A: The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998;25:649-661
6. Brennan DS, Spencer AJ, Roberts-Thomson KF: Tooth loss, chewing ability and quality of life. *Qual Life Res* 2008;17:227-235
7. Baba K, Igarashi Y, Nishiyama A, *et al*: The relationship between missing occlusal units and oral health-related quality of life in patients with shortened dental arches. *Int J Prosthodont* 2008;21:72-74

8. Bradshaw JS: A taxonomy of social need. In McLachlan G (ed): *Problems and Progress in Medical Care* (ed 7). Oxford, Oxford University Press, 1972, pp.69-82
9. Narby B, Kronström M, Söderfelt B, et al: Prosthodontics and the patient: Need becoming demand, demand becoming utilization. *Int J Prosthodont* 2007;20:183-189
10. Käyser AF, Witter DJ, Spanauf AJ: Overtreatment with removable partial dentures in shortened dental arches. *Aus Dent J* 1987;32:178-182
11. Käyser AF: The shortened dental arch: A therapeutic concept in reduced dentitions and certain high risk groups. *Int J Perio Rest Dent* 1989;9:426-449
12. Sarita PT, Witter DJ, Kreulen CM, et al: The shortened dental arch concept – attitudes of dentists in Tanzania. *Community Dent Oral Epidemiol* 2003;31:111-115
13. Witter DJ, van Elteren P, Käyser AF: Signs and symptoms of mandibular dysfunction in shortened dental arches. *J Oral Rehabil* 1988;15:413-420
14. Witter DJ, van Elteren P, Käyser AF, et al: Oral comfort in shortened dental arches. *J Oral Rehabil* 1990;17:137-143
15. Witter DJ, de Haan AF, Käyser AF, et al: A 6-year follow-up study of oral function in shortened dental arches. Part I: Occlusal stability. *J Oral Rehabil* 1994;21:113-125
16. Käyser AF: Shortened dental arches and oral function. *J Oral Rehabil* 1981;8:457-462
17. Kanno T, Carlsson GE: A review of the shortened dental arch concept focusing on the work by the Käyser/ Nijmegen group. *J Oral Rehabil* 2006;33:850-862
18. Allen PF, Witter DF, Wilson NHF, et al: Shortened dental arch therapy: views of consultants in restorative dentistry in the United Kingdom. *J Oral Rehabil* 1996;23:481-485
19. Armellini DB, Von Fraunhofer JA: The shortened dental arch: A review of the literature. *J Prosthet Dent* 2004;92:531-535
20. De Sa e Frias V, Toothaker R, Wright RF: Shortened dental arch: A review of current treatment concepts. *J Prosthodont* 2004;13:104-110
21. Jepson NJA, Allen PF, Moynihan PJ, et al: Patient satisfaction following restoration of shortened mandibular dental arches in a randomized controlled trial. *Int J Prosthodont* 2003;16:409-414
22. Khan S, Chikte UME, Omar R: From classroom teaching to clinical practice: Experiences of senior dental students regarding the shortened dental arch concept. *J Dent Educ* 2014;78; 906-913
23. Korduner EK, Söderfelt B, Kronström M, et al: Attitudes toward the shortened dental arch concept among Swedish general dental practitioners. *Int J Prosthodont* 2006;19:171-176
24. Owen CP: Appropriate: Prosthodontics for the many, not just for the few. *Int J Prosthodont* 2004;17:261-262
25. Sarita PT, Witter DJ, Kreulen CM, et al: Oral health status related to the shortened dental arch concept in Tanzania. *Eur J Sciences* 2007;115:265-274
26. Tan H, Peres KG, Peres MA: Do people with shortened dental arches have worse oral health-related quality of life than those with more natural teeth? A population-based study. *Community Dent Oral Epidemiol* 2015;43:33-46
27. Zeng X, Sheiham A, Tsakos G: Relationship between clinical dental status and eating difficulty in an old Chinese population. *J Oral Rehabil* 2008;35:37-44
28. Omar R: Reappraising prosthodontic treatment goals for older, partially dentate people: Part II. Case for a sustainable dentition? *SADJ* 2004;59:228-237
29. Allen PF, Witter DF, Wilson NHF: The role of the shortened dental arch concept in the management of reduced dentitions. *Br Dent J* 1995;179:355-357
30. Ueno M, Yanagisawa T, Shinada K, et al: Masticatory ability and functional tooth units in Japanese adults. *J Oral Rehabil* 2008;35:337-344
31. Fueki K, Yoshida E, Igarashi Y: A systematic review of prosthetic restoration in patients with shortened dental arches. *Jap Dent Sci Rev* 2011;47:167-174
32. Khan SB, Chikte UME, Omar R: Perceptions regarding the shortened dental arch among dental practitioners in the Western Cape Province, South Africa. *SADJ* 2012;67:60-68
33. Khan SB, Musekiwa A, Chikte UME, et al: Functional outcomes and relevance of prosthodontic interventions for shortened dental arches in adults: A Systematic Review. *PloS One* 2014;9:e101143.
34. Carlsson GE, Omar R: The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil* 2010;37:143-156
35. Slade GD, Spencer AJ: Development and evaluation of the Oral Health Impact Profile. *Community Dent Health* 1994;11:3-11
36. Adulyanon S, Sheiham A: Oral impacts on daily performances. In Slade GD (ed): *Measuring Oral Health and Quality of Life*. Chapel Hill, UNC Press, 1997, pp. 151–160
37. Strassburger C, Heydecke G, Kerschbaum T: Influence of prosthetic and implant therapy on satisfaction and quality of life: A systematic literature review. Part I– Characteristics of the studies. *Int J Prosthodont* 2004;17:83-93
38. Strassburger C, Heydecke G, Kerschbaum T: Influence of implant and conventional prostheses on satisfaction and quality of life: A literature review. Part 2– Qualitative analysis and evaluation of the studies. *Int J Prosthodont* 2006;19:339-348
39. Hobdell M, Tsakos G, Ladrillo TE, et al: Using an oral health-related quality of life measure in three cultural settings. *Int Dent J* 2009;59:381-388
40. World Medical Organization. Declaration of Helsinki. *Br Med J* 1996;313:1448-1449
41. World Health Organization. A review of current recommendations for the organization and administration of Community Oral Health services in Northern and Western Europe. Copenhagen: WHO regional office for Europe. WHO Technical Report Series No. 826; 1982, p. 16-17
42. Frank RP, Brudvik JS, Le Roux B, et al: Relationship between the standards of removable partial denture construction, clinical acceptability and patient satisfaction. *J Prosthet Dent* 2008;83:521-527

ERRATUM:

CORRECTIONS TO THE ARTICLES:

1. Page 25: SADJ Paper, paragraph 3; left column paragraph 3: 4/84 is 5%, not 0.5%.
2. Page 27:SADJ, paragraph 2, left column: random sampling
3. Page 29: SADJ, paragraph 3, left column: random sampling methods
4. Page 31, paragraph 1, right column: 'especially non-response bias'
5. Page 31, paragraph 2, right column: 'sampling error that would occur'
Added ... Possible confounders could not be identified as such, but how representative of the target population of general dental practitioners the sample was that could affect the generalizability of the study must be highlighted. Moreover with the small sample size, had the sample been stratified for age, gender and race, reduction of sampling error would have been achieved to some extent.
6. Page 907, paragraph 4, right column, added: 'The selection of students for the quantitative part of the study included a convenience sample of final year dentistry students, because' ...
7. Page 908, paragraph 2, left column: Added: 'These participating students were purposively selected from the class (n=73) [37] and
Deleted: 'via the process of statistical randomization accomplished through computer-generated numbers'
8. Page 908, paragraph 3, left column: Added: 'purposively chosen' and
Deleted: 'chosen by randomization'
9. Page 100: International J Prosthodontic Paper: Table 2, line under the table: MH should probably be H.
10. On page 23 the candidate refers to figure 1; it is called figure as it was the original study questionnaire that was included.
11. For all the tables and figure in the paper the author used shades of blue; changed within the Thesis.
12. On page 51, first column, 3 line the authors referee Walter et al (2012) [45]. In the references however Walter et al (2012) is reference 44.
13. The subtitle "conclusions" should be explicitly included in the "**abstract**". Currently the conclusions are included under the heading "Results". These were the requirements of the journal.
14. 11.16 Page 96. Last word in the paragraph before **Materials and Methods**. "Appropriate" misspelled.