The radiological assessment to determine whether the use of assistive devices improve syndesmotic screw placement during surgical fixation of ankle fractures

by

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This dissertation is presented for the degree of

Master of Medicine (Orthopaedic Surgery)

MMed (Orth)

December 2021

Division of Orthopaedic Surgery

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DECLARATION

I, Renier Kriel, hereby declare that the work on which this dissertation is based upon is my original work (except where acknowledgements indicate otherwise). The complete work or any part of it has not been or is to be submitted at this or any other university. I empower the university to reproduce this work to further research, either in its entirety or in any specific portion selected out of the contents.

SIGNATURE:

DATE: 18/08//2021

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ACKNOWLEDGEMENTS

I hereby wish to thank and acknowledge the guidance and assistance I have received from the co-authors and supervisors, Dr Marilize Burger and Prof Nando Ferreira. This project wouldn't have been possible without them. I thank them for their time and effort to always give prompt feedback and to have patience with my response. I thank them for the example they have set in doing research and their ability to lead and teach in such a humble way.

LIST OF ABBREVIATIONS

ACL	Anterior cruciate ligament
AO	Arbeitsgemeinschaft für Osteosynthesefragen
CT	Computed Tomography
LC-DCP	Limited Contact Dynamic Compression Plate
TFCCZ	Tibiofibular cartilage contact zone

RESEARCH MANUSCRIPT

Manuscript based dissertation assignment

The following MMed dissertation is prepared in accordance with a **new format** which requires the candidate to submit said dissertation to a scientific journal of choice.

The following dissertation was written in preparation for submission to the journal,

Indian Journal of Orthopaedics

The candidate is required to fulfil all requirements, as requested by the **Indian Journal of Orthopaedics** and outlined in the author's guidelines (**Appendix III**). These instructions prescribe, for example, the length of the abstract and the full manuscript and the referencing style to be used.

The radiological assessment to determine whether the use of assistive devices improve syndesmotic screw placement during surgical fixation of ankle fractures

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ABSTRACT

Background: Ankle fractures are common injuries, and syndesmotic instability can pose a challenge to the inexperienced surgeon. This study aimed to investigate whether the aid of an assistive device as part of the standard of practice, namely the adapted technique, improves the accuracy of syndesmotic screw placement and reduction of the syndesmosis, compared to the traditional free-hand technique during the operative management of ankle fractures.

Methods: This post-operative radiological assessment serves as a retrospective comparative series. Standard anterior-posterior radiographs were used to measure the height of the screw from the ankle joint line, and axial computed tomography slices at the level of the syndesmosis screw were used to measure the trajectory of screw placement against that of the ideal syndesmotic line, as well as the anterior and posterior syndesmotic spaces.

Results: A total of 67 post-operative ankles were included (n=56 in the free-hand group vs n=11 in the adapted technique group). A difference between the height of screw placement was observed when comparing the historical free-hand technique to the adapted technique (p=0.002). No significant difference for the angle deviation or anterior- and posterior syndesmotic spaces was observed between the two groups. A trend (p=0.074) was observed with the free-hand technique associated with a larger deviation from the intended screw trajectory.

Conclusion: Simple assistive devices may improve the accuracy of syndesmotic screw placement in terms of height and trajectory during the operative management of ankle fractures.

Keywords

Syndesmosis screw; ankle fracture; ideal syndesmotic line; targeting drill guide

Level of Evidence:

Level 3: Retrospective comparative study

INTRODUCTION

Ankle fractures are common injuries, and their surgical management is often one of the first procedures an orthopaedic surgeon would learn. Although these injuries are more complex than they first appear, achieving anatomic reduction might be more challenging than expected, especially in the setting of syndesmotic injuries (1).

The distal fibula articulates with the tibia at the syndesmosis, which is defined as a fibrous joint in which two adjacent bones are linked by a strong membrane or ligaments (2). The syndesmosis consists of four ligaments: the anterior and posterior tibiofibular ligament, the transverse ligament, and the interosseous ligament. The incisura fibularis tibia is the articulating surface of the tibia and forms an open triangle with the apex proximally, ranging from 60 to 80mm in height. The depth of the incisura increases from proximal to distal and ranges from 1mm to 7.5mm (3).

The primary function of the distal tibiofibular syndesmosis is to maintain the congruency of the tibiotalar interface, or ankle mortise, under physiologic axial loads. When the syndesmosis is disrupted, it alters the normal gliding and rotational motion between the talar dome and the distal part of the tibia (4,5). The single most important predictor of functional outcome is an accurate reduction of the syndesmosis (6).

When the syndesmotic ligaments are disrupted, restoring the position of the fibula within the tibial incisura is often difficult to assess both intra-operatively and post-operatively with standard radiographs. Failure to reduce the fibula in the incisura may result in widening of the syndesmosis and alteration of the biomechanics of the ankle joint, which can then lead to lateral translation of the talus. Translation of the talus as little as 1mm in relation to the mortise decreases the contact surface area between the tibia and the talus by as much as 42%, resulting in potential early osteoarthritis and ankle pain (2,7)

Open reduction and internal fixation aim to align and stabilise the ankle joint to allow healing of the ligaments in the anatomical position. Fibula fractures at or above the level of the syndesmosis are potentially unstable and therefore warrants internal fixation and intra-operative assessment of the integrity of the syndesmosis. When the syndesmosis is assessed to be unstable, internal fixation of the syndesmosis is indicated. Multiple surgical options for syndesmotic fixation has been described, but screw fixation remains the most widely practised technique (7).

The ideal syndesmotic line has been described as a line drawn, connecting the centroid of the fibula to the centroid of the tibia. A force vector between these two centroids should not displace the fibula

relative to the tibia. This line is from within 2mm of the postero-lateral apex of the fibula to the anterior half of the medial malleolus (8).

The primary aim of this retrospective comparative case series was to determine if assistive devices could increase the accuracy of syndesmotic screw placement. The secondary aim was to assess the accuracy of operative syndesmotic reduction following ankle fracture fixation.

METHODS

A radiological audit was conducted to assess the accuracy of syndesmotic screw placement. All consecutive adult patients who were surgically treated for an ankle fracture involving the syndesmosis and who received a post-operatively computed tomography (CT) scan after syndesmotic screw fixation between June 2016 and November 2017 were included. Institutional ethics committee approval was obtained for this study.

Operative technique

All surgically managed ankle fractures were taken to theatre as soon as soft tissues were amenable to surgery. Bimalleolar ankle fractures were approached through medial and lateral incisions. The lateral malleolus was reduced and fixated with either a one-third tubular plate or a Limited Contact Dynamic Compression Plate (LC-DCP). No anatomically contoured locking plates were used. After fixation of the fibula, the syndesmosis was stressed under fluoroscopy using the Hook test using a bone-hook or reduction clamp (9). If instability was identified, a single syndesmotic screw, traversing three cortices, 20mm above the ankle joint line, at a 30° angle to the horizontal, was inserted as per Arbeitsgemeinschaft für Osteosynthesefragen (AO) surgery guidelines (10).

Surgeries were performed by multiple surgeons over the study period. All surgeons were junior orthopaedic trainees with experience ranging from one to three years of training, supervised by an orthopaedic trauma consultant.

Prior to July 2017, a free-hand technique for syndesmotic screw placement was employed without any assistive devices to aid in the placement of the syndesmotic screw. The height of the screw was placed without any formal measurement. The angle of the screw was determined by aiming at an angle of 30° to the operating table, with the foot placed in neutral. The entry point of the screw was according to the surgeon's preference, aiming from posterior to anterior. The placement of the screw through or adjacent to the plate was decided on merit by the surgeon. For this study, this will be referred to as the free-hand technique.

As international reports on iatrogenic syndesmotic malreduction and incorrect placement of syndesmotic screws surfaced, the departmental standard of practice was changed in July 2017. A standard tool from the small fragment set, a 20mm wide plate-bender, was introduced as a fluoroscopic guide during surgery to ensure that the drill guide was placed 20mm above the ankle joint line (Figure 1) (11). A Smith and Nephew (Smith & Nephew, Memphis, TN) anterior cruciate ligament (ACL) drill guide (Figure 2 and 3) was used to accurately determine the entry-point and endpoint of the drill, and

consequently, the trajectory of the syndesmotic screw. The posterior-lateral ridge of the fibula was used as the entry point, aiming towards the anterior half of the medial tibial cortex.

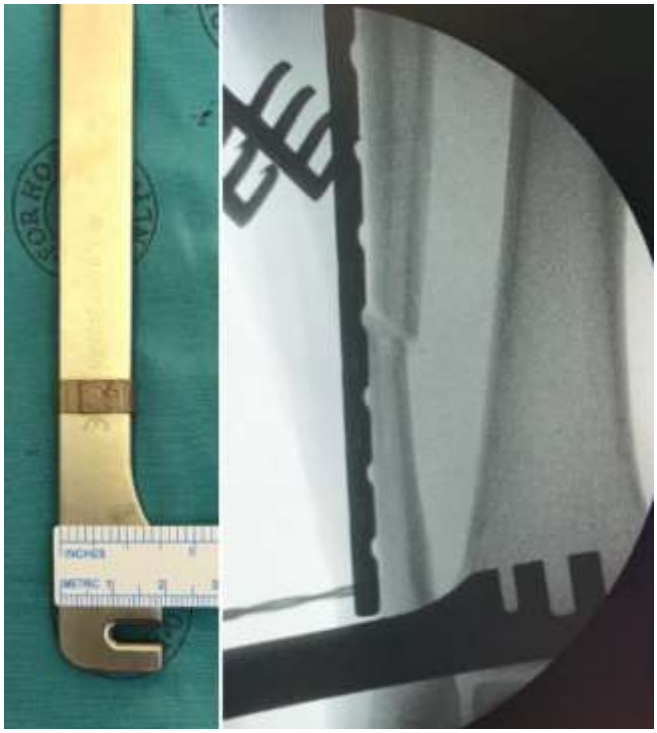

Figure 1 Standard small fragment set plate bender used to gauge the height of screw placement

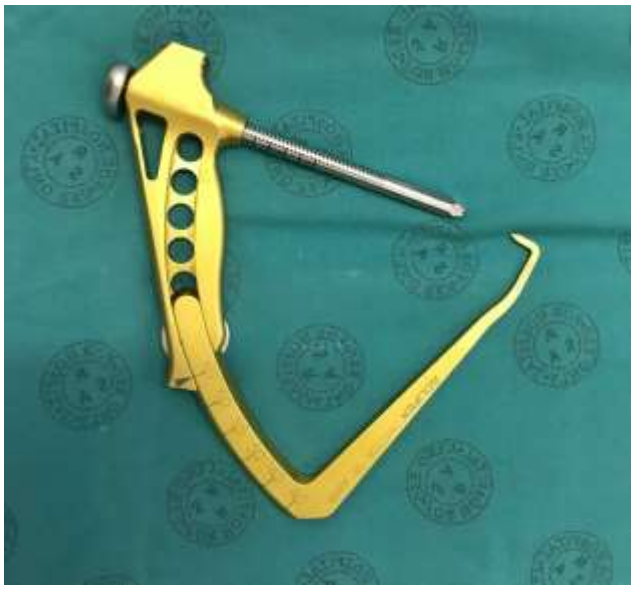

Figure 2 Smith & Nephew ACL drill guide

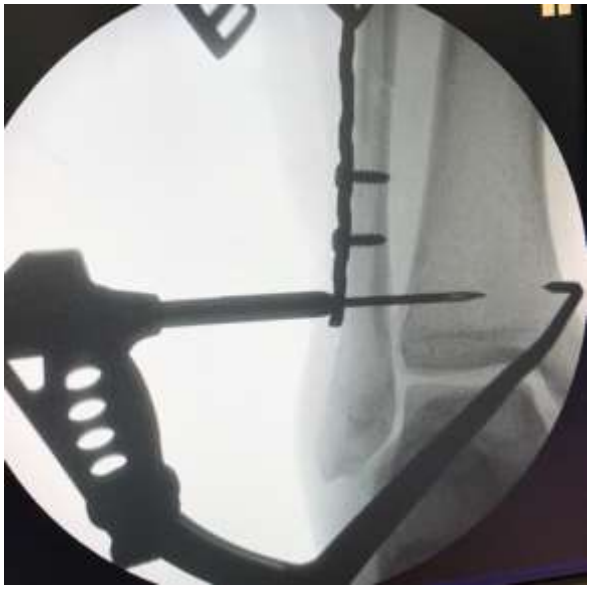

Figure 3 Intra-operative fluoroscopy image of the ACL drill guide being used for syndesmotic screw placement

Post-operative radiographs and CT scans were performed as standard of practice. Only the operated ankle was scanned, and no comparison was made to the unaffected ankle. In the present study, the axial slice at the height of the syndesmotic screw was used for assessment for all patients included in this series, those operated with the free-hand technique and those operated with the ACL drill guide. AGFA Enterprise Unlimited software (Version 6.6.1.0 2015, Manufacturer AGFA Healthcare N.V.) was used for all measurements. The screw trajectory or angle deviation was measured and compared to the ideal syndesmotic line (8) (Figure 4). The difference between the anterior (A) and posterior space (B) (Figure 4) between the tibia and fibula within the syndesmosis was measured to assess the congruency of the joint. The height of the syndesmotic screw placement relative to the ankle joint was measured on standard anteroposterior radiographs. All these measurements were documented in millimetres.

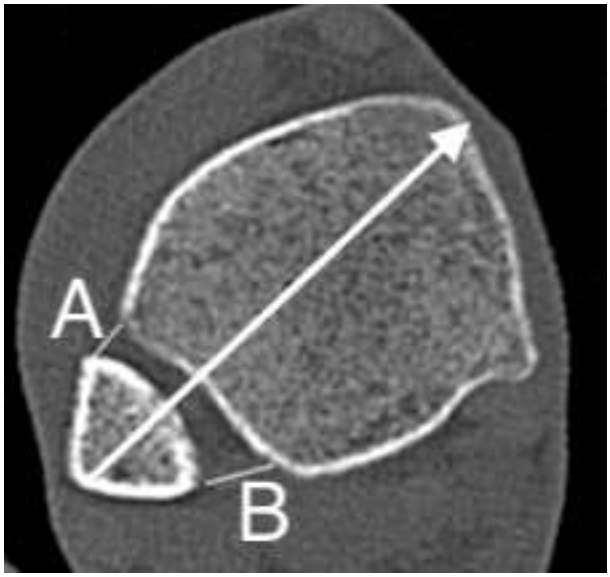

Figure 4 An axial CT image with an arrow indicating the trajectory of ideal screw placement, and with lines A indicating anterior space and B showing posterior space

Data were analysed using Statistica (version 13, TIBCO software) and was tested for normality. Demographic data are reported as mean ± standard deviation, whilst categorical variables are reported as frequencies and counts. All outcome variables, except for 'height', was not normally distributed. Subsequently, all outcome variables are reported as medians and interquartile ranges (IQR). Comparisons between outcome variables in the two different groups (free-hand vs adapted technique) were performed using a Mann Whitney U test for non-parametric data or an independent t-test for the outcome variables. A retrospective power analysis was performed using STATA v15 together with measured means and standard deviations of the primary outcome variable (height). This power analysis indicated that a sample size of 56 in the free-hand group versus a sample size of 11 in the adapted technique group was adequately powered to detect differences at an α-level = 0.05 for the primary outcome of the study (height), (free-hand group 15.4 ± 6.2mm vs adapted technique 21.8 ± 2.8mm).

RESULTS

A total of 67 patients (40 males, 27 females) with a mean age of 35.9 ±14.9 years (range 60) (95% CI 32.2 – 39.5) were included in this 18-month investigative series. A total of 34 (50.7%) left and 33 (49.3%) right ankles were included (Table 1). The free-hand technique was employed in 56 patients, while 11 patients were included in the ACL drill guide group with no differences between demographic variables (Table 1).

Table 1 Demographic variables of all patients, as well as the free-hand and adapted technique groups

	All (n=67)	Free hand (n=56)	Adapted technique (n=11)	p-value
Age	35.9 ± 14.9	36.7 ± 15.0	31.9 ± 14.8	0.143
Sex (% Male)	59.7 (40)	62.5 (35)	45.4 (5)	0.329
Affected side (% Right)	49.3 (33)	50.0 (28)	45.4 (5)	>0.999

Data are presented as mean ± standard deviation or frequencies with counts indicated in parentheses.

A significant difference between the height of screw placement measured in millimetres on a standard anterior-posterior (AP) radiograph was observed when comparing the historical free-hand technique to the adapted technique (p=0.002). Interestingly, a much smaller interquartile range (IQR) was observed in the adapted technique (median 21.0 (IQR 20.0 – 23.0)) compared to the free-hand technique (median of 32.5 (IQR 26.5 – 46.0) (Table 2). No significant differences for the anterior, posterior, difference between anterior and posterior and angle deviation was observed. However, a trend (p=0.074) was observed with the free-hand technique associated with a larger deviation from the intended screw trajectory.

Table 2 Measurements: Screw height, anterior and posterior syndesmotic spaces, the difference between the two spaces, and the angle deviation from the ideal syndesmotic line for all patients, as well as the free and adapted technique groups

	All (n=67)	Free hand (n=56)	Adapted technique (n=11)	p-value
Height (mm)	31.0 (25.0 - 47.0)	32.5 (26.5 – 46.0)	21.0 (20.0 – 23.0)	0.002
Anterior (mm)	3.3 (2.4 - 4.2)	3.3 (2.3 – 4.0)	3.5 (2.7 – 5.0)	0.294
Posterior (mm)	3.7 (2.8 - 4.7)	3.7 (2.9 – 4.7)	3.7 (2.8 – 5.7)	0.856
Difference between anterior and posterior (mm)	0.7 (0.3 - 1.6)	0.8 (0.4 – 1.8)	0.5 (0.2 – 1.0)	0.114
Angle deviation (degrees)	10.4 (5.3 - 19.4)	10.8 (6.1 – 19.9)	4.2 (2.5 – 17.7)	0.074

Data are expressed as medians (interquartile ranges).

DISCUSSION

This study aimed to compare the accuracy of syndesmotic screw placement using assistive devices to aid syndesmotic screw placement compared to the traditional free-hand technique during the operative management of ankle fractures.

The main finding of this study was that a significant difference was observed between the height of the syndesmotic screw insertion when performed with the free-hand technique versus the adapted technique. Controversy remains regarding the optimal level of syndesmotic screw insertion. Authors have advocated different heights, ranging from just above the tibial plafond to 50mm proximal to the ankle joint (12,13). Studies have also failed to show any significant difference between supra-syndesmotic and trans-syndesmotic screw position (14,15). A minimum height above the joint has been suggested by Shuler et al., who measured 3158 anatomical and cadaveric specimens, specifically looking at the distal tibiofibular cartilage contact zone (TFCCZ) as well as the syndesmotic recess and determined that hardware placed above 12mm from the joint is safe from causing iatrogenic syndesmotic injury (16). In terms of syndesmotic function, McBryde et al. showed less syndesmotic widening under external rotation stress when screws were placed 20mm above the tibiotalar joint compared to screws placed 35mm above the joint. (13). It is, therefore, evident that screw placement between 20 and 40mm from the joint is preferred (7). A height of 20mm was considered ideal, in the context of the present study, per AO guidelines (10), and although the operating surgeon, using the free-hand technique, was cognitive of the fact that the desired height is 20mm, a median height of 32.5mm (IQR 26.5 – 46.0mm) was observed. However, in the adapted technique, a much narrower range was observed, with a median close to the optimal 20mm height (21.0mm (IQR 20.0 – 23.0)).

It was not analyzed or recorded whether the screw was placed through a hole in the plate, or adjacent to the plate. Another factor that could lead to discrepancy and variability of screw height would be the height of the fracture, leading the surgeon to safely put the screw above the fracture line. Both these above-mentioned factors, together with the fact that all cases were done by junior surgeons in training, speculating that they still have a less accurate ‘orthopaedic eye’, would possibly lead to the bigger differences in the free-hand technique group.

Classical AO teaching recommends a syndesmosis screw trajectory that is 25-30° to the coronal plane of the ankle. The rationale underlying this method is the posterolateral location of the fibula secondarily to the tibiofibular joint axis being externally rotated by approximately 30° in relation to the femoral trans-epicondylar axis (17). Although not statistically significant, a median deviation from the intended screw trajectory of 4.2° in the adapted technique versus 10.8° in the free-hand technique was observed. Although the dispersion was quite wide, this finding tended towards significance and is considered

clinically important, illustrating that the adapted technique reduced the deviation from the ideal trajectory. Kennedy et al. have previously demonstrated the difficulty of accurately judging this angle intra-operatively (8). The natural externally rotated resting position of the lower extremity further complicates accurate screw trajectory. Rotatory motion of the ankle, hindfoot and midfoot joints, as well as individual variation in ankle anatomy, should also be considered (18,19). These findings support our observation that placing the syndesmotic screw free-handed is inherently more challenging and likely more prone to more inadequate positioning.

Anterior and posterior syndesmotic spaces were measured in the present study and compared between the free-hand and adapted groups. When considering the difference in anterior versus posterior spaces, the reduction was not significantly improved by aiding the screw placement with the adapted technique. Elgafy et al. measured 100 uninjured ankles and reported that the posterior space (4mm ± 1.19) could be up to double the distance of the anterior space (2 ± 0.53mm) and differed between men and women (20). Similarly, Elliot et al. measured anterior, central and posterior widths, 10mm above the joint, in 38 individuals and found it statistically significantly different: 1.7mm ± 0.9, 1.7mm ±0.6, 2.3mm ± 1. respectively, (P=.004) (21). From the literature, it is evident that there can be a large inter-observer variability when syndesmotic spaces are measured in the uninjured ankle. Pelton et al. compared open versus percutaneous fibula fracture fixation in Maisonneuve injuries. They measured congruency of reduction in the form of a ratio of the anterior to the posterior distance measured from the deepest point of the incisura to the anterior edge of the fibula and the posterior-most edge. Normal ankles showed a ratio of approximately 1:1 (22).

From this study, it became evident that there is an apparent association between a well-placed – pertaining to height – syndesmotic screw and the use of assistive devices. Although a trend was reported for trajectory, this finding should be interpreted with caution as the study was underpowered to detect true differences in this secondary outcome. The difference in anterior and posterior spaces measured within the syndesmosis did not improve significantly using assistive devices, however, future studies that are powered to detect differences in these variables might detect differences which the present study was unable to do.

Anatomical landmarks have been observed to aid in guiding the syndesmotic screw trajectory (17,18). Park et al. enrolled 134 patients with calcaneal fractures with an intact tibiofibular syndesmosis. They used the second proximal phalanx as a reference and determined the ideal angle of syndesmotic screw placement as 18.8 ± 5.6° from horizontal. Thus, when the second toe was positioned anteriorly (towards the roof), the angle from horizontal was significantly less than the proposed 25-30°. Similarly, Kumar et al. proposed using bony landmarks, namely the posteromedial and posterolateral surface of the distal

tibia, bimalleolar tips, and anterior and posterior extents of both malleoli (18). They, however, were reliant on fluoroscopic confirmation of these landmarks, which poses its own intra-operative risks and challenges (18). In the present study, anatomical landmarks were used to aid in the placement of the drill guide, as proposed by the ideal syndesmotic line. Without intra-operative use of fluoroscopy, the postero-lateral ridge of the fibula and anterior half of the medial malleolus could reliably be used as entry and endpoints of the targeting drill guide. This aided to place the screw at an improved trajectory, compared to relying on a free-hand technique.

Only one case study, by Scott et al., describes using a targeting drill to aid syndesmotic screw placement. They used Kennedy's (8) anatomical references and aimed for 4mm anterior to the medial malleolus, from a starting point in line with the tip of the fibular apex. A post-operative CT scan showed a satisfactory reduction. The authors concluded that the more accurate trajectory was a major advantage and that it was faster and required potentially less screening while drilling (23). Our study agreed with Scott et al. that using a drill guide aids in more accurate placement of the syndesmotic screw.

Limitations of this study include the fact that groups were not equally distributed, and the sample size of the adapted technique group was substantially smaller than the free-hand technique group, potentially leading to type II errors for the secondary outcomes. Although the study was adequately powered for the primary outcome, the small sample size of the adapted technique group resulted in the study being underpowered for secondary outcomes, and future research should investigate the potential presence of true differences in these variables between techniques. We did, however, feel that reporting the information was of clinical value and therefore included it in this study. The anterior and posterior spaces were measured at the level of the screw and not at a standardised height, which could lead to inconsistency of measurements taken. This, together with measurements of the uninjured ankle, could better futures studies on similar topics. However, we believe that the findings of this study could potentially be used to inform future, more standardised work that can further investigate the potential usefulness of using simple intra-operative assistive devices to guide the surgeon to more accurate placement of the syndesmotic screw. Further to the above, recommended work could include doing post-operative pain and clinical analysis of the patient, to identify potential associations between the clinical outcome and the placement of the screw and to investigate what effect this had on the biomechanical recovery of the ankle at serial follow-ups. Associations between the placement of the screw and the experience of the surgeon, and to further incorporate this into the recovery score, could also be investigated in future work.

CONCLUSION

Surgical guidelines aid but do not ensure correct and accurate placement of syndesmotic screws. By implementing simple assistive devices as part of the departmental standard of practice, the operative parameters of surgically managed ankle fractures could potentially be improved.

The main finding of this study was the clear discrepancy in height between the free-hand versus the adapted technique group. Further research on these pertinent aspect could add valuable information to these discrepancies.

FUNDING

No funding was necessary for the completion of this study.

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APPENDIX I: HEALTH RESEARCH ETHICS COMMITTEE APPROVAL

Approval Notice

New Application

12/10/2020

Project ID:15399

HREC Reference No: C20/05/013

Project Title: The use of assistive devices to improve syndesmotic screw placement during surgical fixation of ankle fractures

Dear Dr Renier Kriel

The Response to Stipulations received on 06/10/2020 07:36 was reviewed by members of Health Research Ethics Committee via expedited review procedures on 12/10/2020.

Thank you for attending to the specified stipulations, your Case Report is now finally approved.

Please note the following information about your approved research protocol:

Protocol Approval Date: 18 June 2020

Protocol Expiry Date: 17 June 2021

Please remember to use your Project ID 15399 and Ethics Reference Number C20/05/013 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

Translation of the informed consent document(s) to the language(s) applicable to your study participants should now be submitted to the HREC.

Please note you can submit your progress report through the online ethics application process, available at: Links Application Form Direct Link and the application should be submitted to the HREC before the year has expired. Please see *Forms and Instructions* on our HREC website (www.sun.ac.za/healthresearchethics) for guidance on how to submit a progress report.

The HREC 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.

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 Departement of Health and/or City Health) to conduct the research as stated in the protocol. Please consult the Western Cape Government website for access to the online Health Research Approval Process, see: https://www.westerncape.gov.za/general-publication/health-research-approval-process. 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 instructions, please visit: Forms and Instructions on our HREC website https://applyethics.sun.ac.za/ProjectView/Index/15399

If you have any questions or need further assistance, please contact the HREC office at 021 938 9677.

Yours sincerely,

Mrs. Brightness Nxumalo
HREC 2 Coordinator

National Health Research Ethics Council (NHREC) Registration Number:

REC-130408-012 (HREC1)·REC-230208-010 (HREC2)

Federal Wide Assurance Number: 00001372

APPENDIX II: HOSPITAL CLEARANCE

Western Cape Government
Health

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 0866: fax: +27 21 483 6058
5th Floor, Norton Rose House,, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za)

REFERENCE: WC_202006_034
ENQUIRIES: Dr Sabela Petros

Francie van Zijl Drive
Tygerberg
7505
Cape Town
South Africa

For attention: Dr Renier Kriel, Prof Nando Ferreira, Dr Marilize Burger

Re: The use of assistive devices to improve syndesmotic screw placement during surgical fixation of ankle fractures

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.
Please contact the following people to assist you with any further enquiries in accessing the following sites:

Worcester Hospital	**Ms Roshen Ahmed- Meyson**	**021 803 2757**

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.
2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final feedback (**annexure 9**) within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).
3. In the event where the research project goes beyond the *estimated completion* date which was submitted, researchers are expected to complete and submit a progress report (**Annexure 8**) to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).
4. The reference number above should be quoted in all future correspondence.

Yours sincerely

DR M MOODLEY
DIRECTOR: HEALTH IMPACT ASSESSMENT
DATE: 14/09/2020

APPENDIX III: INDIAN JOURNAL OF ORTHOPAEDICS GUIDE FOR AUTHORS

INSTRUCTIONS FOR AUTHORS

Types of Papers

ORIGINAL ARTICLE:

Structured abstract of 250 words with 10 keywords. A concept diagram/graphical abstract should be placed just after the abstract.

The text word limit should not exceed 4000 words (including references).

The reference list should not exceed 30 in number.

A total of up to 6 tables / flow diagrams / colored figures/text boxes/other illustrations would enrich the article.

The article should be organized into an introduction section that conveys the background and purpose of the report, followed by Materials and Methods, Results and Discussion.

Compliance with ethical requirements just before reference section is mandatory (see link)

Conflict of Interest and Ethical Standards: http://www.springer.com/authors?SGWID=0-111-6-791531-0 Informed Consent: http://www.springer.com/authors?SGWID=0-111-6-608209-0 Statement of Human and Animal Rights: http://www.springer.com/authors?SGWID=0-111-6-608309-0

Manuscript Submission

Manuscript Submission

Submission of a manuscript implies: that the work described has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all co-authors, if any, as well as by the responsible authorities – tacitly or explicitly – at the institute where the work has been carried out. The publisher will not be held legally responsible should there be any claims for compensation.

Permissions

Authors wishing to include figures, tables, or text passages that have already been published elsewhere are required to obtain permission from the copyright owner(s) for both the print and online format and to include evidence that such permission has been granted when submitting their papers. Any material received without such evidence will be assumed to originate from the authors.

Online Submission

Please follow the hyperlink “Submit manuscript” on the right and upload all of your manuscript files following the instructions given on the screen.

Please ensure you provide all relevant editable source files. Failing to submit these source files might cause unnecessary delays in the review and production process.

Please note:

First time authors have to “register” themselves on the Editorial Manager. If you already are registered on Editorial Manager, please use your provided user name and password and log in as “Author” to submit a NEW manuscript or to track your submitted manuscript (do not register again as you will then be unable to track your manuscript).

Copyright / Authorship / Financial Disclosure

Copyright on all accepted manuscripts will be held by the Indian Orthopaedic Association (IOA). It is mandatory that the Copyright/Authorship/Disclosure Form is signed by all the authors, expressly transferring copyright to the IOA in the event the manuscript is accepted for publication. This form must be submitted along with the manuscript on the Editorial Manager. The form can be downloaded from the hyperlink on the right side of the screen. Manuscripts without this form will not be considered for publication.

This form also allows each author to declare their conflict of interest statements. Authors should also acknowledge in the manuscript all financial support for the work and other personal connections and affiliations. Further information on this can be found under COMPLIANCE WITH ETHICAL REQUIREMENTS.

Compliance with Ethical Requirements

Ethics statements pertaining to (1) conflict of interest/financial disclosure, (2) informed consent in studies with human subjects and (3) animal studies should be clearly indicated for all articles. Include the ethical statements under a new heading named as “Compliance with Ethical Requirements” and place this section as part of the title page only.

(1) Conflict of Interest (CoI) statements

When authors submit a manuscript they are responsible for disclosing all financial and personal relationships that might bias their work. To prevent ambiguity, authors must state explicitly whether potential conflicts exist or do not exist. Each author must indicate whether they have financial relationship with the organization that sponsored the research.

The CoI statements should be mention each author separately by name and the recommended wording is as follows:

John Smith declares that he has no conflict of interest.

Paula Taylor has received research grants from Drug Company A.

Mike Schultz has received a speaker honorarium from Drug Company B and owns stock in Drug Company C.

If multiple authors declare no conflict, this can be done in one sentence:

John Smith, Paula Taylor, and Mike Schultz declare that they have no conflict of interest.

Please note: The manuscript must also be accompanied with the Copyright/Authorship/Disclosure form that contains the CoI statements signed by each author.

Springer’s Conflict of Interest statement can be found at:

Conflict of Interest statement

(2) Informed Consent in Studies with Human Subjects

For studies with human subjects include the following statement:

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from all patients for being included in the study.

If doubt exists whether the research was conducted in accordance with the Helsinki Declaration, the authors must explain the rationale for their approach, and demonstrate that the institutional review body explicitly approved the doubtful aspects of the study.

If any identifying information about patients is included in the article, the following sentence should also be included:

Additional informed consent was obtained from all patients for whom identifying information is included in this article.

Springer's Informed Consent statement can found at:

Springer's Informed Consent statement

(3) Animal Studies

For studies with animals include the following sentence:

All institutional and national guidelines for the care and use of laboratory animals were followed.

For articles that do not contain studies with human or animal subjects, while it is not absolutely necessary, it is recommended to include the following sentence, just to make sure that readers are aware that there are no ethical issues with human or animal subjects.

This article does not contain any studies with human or animal subjects.

Springer's Human and Animal Rights statement can be found at:

Springer's Human and Animal Rights statement

Important: The editors reserve the right to reject to reject manuscripts that do not comply with the above-mentioned requirements.

Manuscript Organization

Title Page

The title page should include the title of the article, as well as the first and last names for each contributing author [first name, middle initial(s), surname, degree (s)]. For all contributing authors, indicate the departmental and institutional affiliation(s) and the e-mail address, telephone numbers and surface mail address for each affiliation, including the city, state or province, and country where the work was performed.

Abstract

For Original Articles please provide a structured abstract of 250 words. Organize it into background/purpose of the study, methods, results and conclusion. The structured abstract should state the purpose of the studay or investigation, basic procedures (study subjects or experimental animals and observational and analytical methods), main findings (give specific data and their statistical significance, if possible), and the principal conclusions

For Review Papers please provide a structured abstract of 250 words. The abstract should not contain any undefined abbreviations or unspecified references.

Keywords

Please provide 4-6 keywords which can be used for indexing purposes.

Text

Text Formatting

Manuscripts should be submitted in Word.

- Use a normal, plain font (e.g., 10-point Times Roman) for text.
- Use italics for emphasis.
- Use the automatic page numbering function to number the pages.
- Do not use field functions.
- Use tab stops or other commands for indents, not the space bar.
- Use the table function, not spreadsheets, to make tables.
- Use the equation editor or MathType for equations.
- Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

Manuscripts with mathematical content can also be submitted in LaTeX.

Headings

Please use no more than three levels of displayed headings.

Abbreviations

Abbreviations should be defined at first mention and used consistently thereafter.

Footnotes

Footnotes can be used to give additional information, which may include the citation of a reference included in the reference list. They should not consist solely of a reference citation, and they should never include the bibliographic details of a reference. They should also not contain any figures or tables.

Footnotes to the text are numbered consecutively; those to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data). Footnotes to the title or the authors of the article are not given reference symbols.

Always use footnotes instead of endnotes.

Acknowledgments

Acknowledgments of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full.

Please note:

For Original Articles, organize the main body/text into an introductory section that conveys the background/purpose of the study, followed by sections titled Material and Methods, Results and Discussion.

For Review Articles, organize the main body/text into an introductory section that conveys the background and purpose of the review, followed by a Discussion and Conclusion and Perspective.

Scientific style

- Please always use internationally accepted signs and symbols for units (SI units).
- Genus and species names should be in italics.
- Generic names of drugs and pesticides are preferred; if trade names are used, the generic name should be given at first mention.

References

Please type references double-spaced and number them in order of their first appearance in the text (not alphabetically). Once a reference is cited, all subsequent citations should be to the original number. References may not appear in your Reference List unless they have been cited in the text or tables. Papers that have been accepted for publication or are in press may be listed as references, but the Journal does not reference unpublished data and personal communications. Use the form for references adopted by the U.S. National Library of Medicine, as in Index Medicus. For each reference, show inclusive page ranges (e.g., 7-19). Ideally, the names of all authors should be provided, but the usage of “et al” in long author lists will also be accepted.

Journal Article

Ibdah JA, Bennet MJ, Rinaldo P, Zhao Y, Gibson B, Sims HF, Strauss AW. A fetal fatty-acid oxidation disorder as a cause of liver disease in pregnant women. N Engl J Med 1999;340:1723-1731, Jun 3, 1999

Book

Krishnamurthy G, Krishnamurthy S. Nuclear Hepatology: A Text Book of Hepatobiliary Disease, New York, Springer-Verlag, 2002; 6-12

Book Chapter

Jones MC, Smith RB. Treatment of gastric cancer. In Ford TL, editor, Cancer of the Digestive System, Berlin, Springer-Verlag, 1999;140-154

Article by DOI

Mori K, Arai H, Abe T, Takayama H, Toyoda M, Ueno T, Sato K. Spleen stiffness correlates with the presence of ascites but not esophageal varices in chronic hepatitis C patients.

Biomed Res Int. 2013;2013:857862. doi: 10.1155/2013/857862. Epub 2013 Aug 1

Tables

- All tables are to be numbered using Arabic numerals.
- Tables should always be cited in text in consecutive numerical order.
- For each table, please supply a table caption (title) explaining the components of the table.

- Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.
- Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

Artwork and Illustrations Guidelines

Electronic Figure Submission

- Supply all figures electronically.
- Indicate what graphics program was used to create the artwork.
- For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MSOffice files are also acceptable.
- Vector graphics containing fonts must have the fonts embedded in the files.
- Name your figure files with "Fig" and the figure number, e.g., Fig1.eps.

Line Art

- Definition: Black and white graphic with no shading.
- Do not use faint lines and/or lettering and check that all lines and lettering within the figures are legible at final size.
- All lines should be at least 0.1 mm (0.3 pt) wide.
- Scanned line drawings and line drawings in bitmap format should have a minimum resolution of 1200 dpi.
- Vector graphics containing fonts must have the fonts embedded in the files.

Halftone Art

- Definition: Photographs, drawings, or paintings with fine shading, etc.
- If any magnification is used in the photographs, indicate this by using scale bars within the figures themselves.
- Halftones should have a minimum resolution of 300 dpi.

Combination Art

- Definition: a combination of halftone and line art, e.g., halftones containing line drawing, extensive lettering, color diagrams, etc.
- Combination artwork should have a minimum resolution of 600 dpi.

Color Art

- Color art is free of charge for online publication.
- If black and white will be shown in the print version, make sure that the main information will still be visible. Many colors are not distinguishable from one another when converted to black and white. A simple way to check this is to make a xerographic copy to see if the necessary distinctions between the different colors are still apparent.
- If the figures will be printed in black and white, do not refer to color in the captions.
- Color illustrations should be submitted as RGB (8 bits per channel).

Figure Lettering

- To add lettering, it is best to use Helvetica or Arial (sans serif fonts).
- Keep lettering consistently sized throughout your final-sized artwork, usually about 2–3 mm (8–12 pt).
- Variance of type size within an illustration should be minimal, e.g., do not use 8-pt type on an axis and 20-pt type for the axis label.
- Avoid effects such as shading, outline letters, etc.
- Do not include titles or captions within your illustrations.

Figure Numbering

- All figures are to be numbered using Arabic numerals.
- Figures should always be cited in text in consecutive numerical order.
- Figure parts should be denoted by lowercase letters (a, b, c, etc.).
- If an appendix appears in your article and it contains one or more figures, continue the consecutive numbering of the main text. Do not number the appendix figures,"A1, A2, A3, etc." Figures in online appendices [Supplementary Information (SI)] should, however, be numbered separately.

Figure Captions

- Each figure should have a concise caption describing accurately what the figure depicts. Include the captions in the text file of the manuscript, not in the figure file.
- Figure captions begin with the term Fig. in bold type, followed by the figure number, also in bold type.
- No punctuation is to be included after the number, nor is any punctuation to be placed at the end of the caption.
- Identify all elements found in the figure in the figure caption; and use boxes, circles, etc., as coordinate points in graphs.
- Identify previously published material by giving the original source in the form of a reference citation at the end of the figure caption.

Figure Placement and Size

- Figures should be submitted separately from the text, if possible.

- When preparing your figures, size figures to fit in the column width.
- For large-sized journals the figures should be 84 mm (for double-column text areas), or 174 mm (for single-column text areas) wide and not higher than 234 mm.
- For small-sized journals, the figures should be 119 mm wide and not higher than 195 mm.

Permissions

If you include figures that have already been published elsewhere, you must obtain permission from the copyright owner(s) for both the print and online format. Please be aware that some publishers do not grant electronic rights for free and that Springer will not be able to refund any costs that may have occurred to receive these permissions. In such cases, material from other sources should be used.

Accessibility

In order to give people of all abilities and disabilities access to the content of your figures, please make sure that

- All figures have descriptive captions (blind users could then use a text-to-speech software or a text-to-Braille hardware)
- Patterns are used instead of or in addition to colors for conveying information (colorblind users would then be able to distinguish the visual elements)
- Any figure lettering has a contrast ratio of at least 4.5:1

Supplementary Information (SI)

Springer accepts electronic multimedia files (animations, movies, audio, etc.) and other supplementary files to be published online along with an article or a book chapter. This feature can add dimension to the author's article, as certain information cannot be printed or is more convenient in electronic form.

Before submitting research datasets as Supplementary Information, authors should read the journal's Research data policy. We encourage research data to be archived in data repositories wherever possible.

Submission

- Supply all supplementary material in standard file formats.
- Please include in each file the following information: article title, journal name, author names; affiliation and e-mail address of the corresponding author.
- To accommodate user downloads, please keep in mind that larger-sized files may require very long download times and that some users may experience other problems during downloading.

Audio, Video, and Animations

- Aspect ratio: 16:9 or 4:3
- Maximum file size: 25 GB
- Minimum video duration: 1 sec
- Supported file formats: avi, wmv, mp4, mov, m2p, mp2, mpg, mpeg, flv, mxf, mts, m4v, 3gp

Text and Presentations

- Submit your material in PDF format; .doc or .ppt files are not suitable for long-term viability.
- A collection of figures may also be combined in a PDF file.

Spreadsheets

- Spreadsheets should be submitted as .csv or .xlsx files (MS Excel).

Specialized Formats

- Specialized format such as .pdb (chemical), .wrl (VRML), .nb (Mathematica notebook), and .tex can also be supplied.

Collecting Multiple Files

- It is possible to collect multiple files in a .zip or .gz file.

Numbering

- If supplying any supplementary material, the text must make specific mention of the material as a citation, similar to that of figures and tables.
- Refer to the supplementary files as “Online Resource”, e.g., "... as shown in the animation (Online Resource 3)", “... additional data are given in Online Resource 4”.
- Name the files consecutively, e.g. “ESM_3.mpg”, “ESM_4.pdf”.

Captions

- For each supplementary material, please supply a concise caption describing the content of the file.

Processing of supplementary files

- Supplementary Information (SI) will be published as received from the author without any conversion, editing, or reformatting.

Accessibility

In order to give people of all abilities and disabilities access to the content of your supplementary files, please make sure that

- The manuscript contains a descriptive caption for each supplementary material
- Video files do not contain anything that flashes more than three times per second (so that users prone to seizures caused by such effects are not put at risk)

APPENDIX IV: TURN-IT-IN REPORT

Renier Kriel

ORIGINALITY REPORT

11%	5%	10%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Young Hwan Park, Won Seok Choi, Gi Won Choi, Hak Jun Kim. "Ideal angle of syndesmotic screw fixation: A CT-based cross-sectional image analysis study", Injury, 2017 Publication	1%
2	Pelton, Kevin, David B. Thordarson, and Jonathan Barnwell. "Open Versus Closed Treatment of the Fibula in Maissoneuve Injuries", Foot & Ankle International, 2010. Publication	1%
3	Arvind Kumar, Jigyasa Passey, Lakshay Goel, Dushyant Chouhan, Akhil Agnihotri, Shishir Chauhan, Surabhi Gupta, Rizwan Khan. "New landmarks for ideal positioning of syndesmotic screw: a computerised tomography based analysis and radiographic simulation", International Orthopaedics, 2019 Publication	1%
4	Jeffrey R., James P., Mark Hutchinso. "Chapter 23 Syndesmotic Injuries in Athletes", InTech, 2012 Publication	1%