MITRAL VALVE REPAIR SURGERY

A retrospective audit of mitral valve repair surgery at Tygerberg Hospital

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ABSTRACT

Background: Mitral valve repair is well established as the preferred treatment modality for the majority of patients with degenerative mitral valve disease requiring intervention. Valve repair offers a distinct event-free survival advantage compared with replacement with either a bioprosthetic or mechanical valve. At present, there are little data available on the management and outcome of mitral valve repair in South Africa. The aim of this study is to describe and compare the indications, specific pathology and outcomes of patients accepted for mitral valve repair. Internationally published figures for peri-operative mortality are less than 2% for degenerative mitral regurgitation, with a freedom from mitral valve reoperation of 94% at 10 years.

Methods: All patients referred for mitral valve repair at Tygerberg Hospital, Cape Town, South Africa, between 1 December 2010 and 30 June 2015, were retrospectively included. Demographic characteristics, cardiovascular risk factors, pre-operative (NYHA) functional class, the pre- and post-operative transthoracic and transoesophageal echocardiograms, immediate in hospital mortality and 6-month post-surgical mortality and functional class were analysed. Repair failure was defined as either intra-operative conversion to MVR or need for reoperation at 6 months.

Results: A total of 147 patients were referred for mitral valve repair, of which 114 patients were accepted for mitral valve repair by the local heart team. In total, 106 of the 114 patients underwent surgical intervention, 6 defaulted their surgical dates, and 2 refused surgery. Of those accepted for surgery, 57.9% were males, 42.1% were females, with a mean age of 47.7 years in both groups combined, 44.7% had hypertension, 43.9% were smokers and 21.1% had concomitant IHD; 56.1% were pre-operative NYHA functional class III, 29.8% were class II, 7% class IV, and 7% were class I; 60.2% had a 6-month post-operative NYHA functional class I, 32.3% had class II, 5.4% class III, and 2.2% had class IV. Mitral valve prolapse (MVP) with flail segment due to chord rupture was the predominant etiology (29%); P2 was the most common segment involved (36%), followed by A2 (29.8%). For MVP, including patients with infective endocarditis, the mortality rate was 4.8% at 30 days and 6 months. The overall mortality rates for all patients accepted for mitral valve repair were 4.7% and 6.6% at 30 days and 6 months respectively. Freedom from reoperation was 98% at 6 months. There was a significant association between bileaflet involvement and mitral valve repair failure (p=0.006). Chordal insertion with annuloplasty was the most common intervention used (45.5%).

Conclusion: Mitral valve prolapse was the predominant etiology in patients referred for mitral valve repair. The mortality rate for mitral valve repair in the prolapse group was 4.8% at 6 months. Chordal insertion with annuloplasty was the most common intervention used. Bileaflet involvement was found to be an independent risk factor for repair failure. The mortality rate for all patients accepted for mitral valve repair was 6.6% at 6 months. SAHeart 2018;15:182-189

INTRODUCTION

Degenerative mitral valve prolapse (MVP) as a clinical entity has only been recognised for some 50 years, since Barlow and colleagues proposed that mid to late systolic clicks and apical late systolic murmurs were of mitral valve origin.[1] In a study of the Framingham Offspring Study cohort, the prevalence of mitral valve prolapse was 2.5%, and it is now recognised as the most common cause of chronic mitral regurgitation with more than 150 million people affected worldwide.[2,3] Echocardiographically, mitral valve prolapse is characterised by excessive leaflet motion, defined as displacement of any part of the mitral valve leaflet to ≥2mm above the mitral annular plane.[2]

The natural history of mitral valve prolapse is extremely variable and is largely determined by the severity of mitral regurgitation (MR).[2] Although the majority of patients remain asymptomatic and may have a near normal life expectancy, approximately 5% - 10% have progression to severe mitral regurgitation, which has a mortality rate approaching 6% - 7% per year.[4-6] Internationally published figures of peri-operative mortality for mitral valve repair is less than 2% for degenerative mitral regurgitation, and ranges from 5% - 10% for functional (ischaemic) mitral regurgitation.[7]

Degenerative MVP is considered as a spectrum rather than an entity, and it is responsible for the syndromes of mitral valve thickening with bileaflet prolapse (Barlow's syndrome), MVP and flail leaflet. The pathology of these is mainly caused by 2 processes – myxomatous degeneration and fibroelastic deficiency.[8,9] Myxomatous degeneration is typically seen in younger individuals and is recognised by thickening of the mitral leaflets (>5mm) on echocardiography, with associated prolapse of the mitral valve (usually bileaflet). Fibroelastic deficiency, on the other hand, is seen in elderly patients and is characterised on echocardiography by normal leaflet thickness with either prolapse or chordal rupture and flail segments.[8,9]

The management of severe MR has changed dramatically with the development of surgical mitral valve repair introduced by Alain Carpentier.[10] Mitral valve repair is now well established and is the standard of care for patients with mitral valve prolapse due to degenerative mitral valve disease.[11] Repair has a distinct advantage in terms of event-free survival compared with replacement with a bioprosthetic or mechanical valve.[12] Matching echocardiographic findings to the appropriate surgical skill level is required to consistently deliver a durable repair. Different surgical techniques are used, including leaflet resection, plication, implantation of artificial chords, and leaflet reduction. Most modern techniques incorporate restrictive annuloplasty with an annuloplasty ring, as it supports the repair and improves the durability thereof.[2]

The current practice at Tygerberg Hospital (TBH), Cape Town, South Africa, for the management of patients with mitral valve prolapse requiring surgical intervention, is based on international studies and guidelines.[7,13,17] Data on the management and outcomes of mitral valve prolapse requiring surgical intervention in South Africa are limited.

METHODS

This is a retrospective, descriptive study of all patients referred for mitral valve repair at TBH between 1 December 2010 and 30 June 2015. The start date was chosen to coincide with the introduction of an electronic image database for storage and review of all echocardiography studies at TBH (ECHOPAC image Vault, GE Healthcare) – to ensure access to and quality control of all echocardiograms of participants included in the study. The end date was chosen to allow for the study defined follow up of all patients included, and is therefore 5 months short of 5 years. The patient's clinical notes, echocardiogram assessment and surgical records were retrieved from the relevant databases.

Patient demographics, including age, gender, race, address, cardiovascular risk factors, medical history and pre-operative (NYHA) functional class, were obtained from the clinical notes prior to surgery. In addition, specific parameters were obtained from the pre-operative transthoracic and transoesophageal echocardiograms pertaining to assessment of the etiology, mechanism of mitral valve disease, and the severity of mitral regurgitation.

Data relating to the surgical process were also collected, including: time from acceptance to performance of surgery, type of surgical repair, associated CABG, post-operative transthoracic echocardiogram, in hospital mortality, and post-operative hospital stay. The outcomes at 6 months from index surgery were compared to internationally published results.

STATISTICAL ANALYSIS

IBM SPSS version 23 was used to analyse the data. A p value <0.05 was considered as statistically significant. Categorical variables were described using frequency tables and percentages. Continuous data were checked for normality of distribution and summarised with mean and standard deviation if found to be plausibly normally distributed or with median and interquartile range if skewed. Associations between categorical variables were tested with the Pearson's chi square test or Fisher's exact test, if the chi square assumptions were not met.

ETHICAL ASPECTS

The research was in accordance with the Belmont Report guidelines for the protection of human research subjects, and was approved by Stellenbosch University's Research Ethics Committee. A waiver of informed consent was approved based on the retrospective nature of the study, the fact that patients were not subjected to any study-specific investigations or interventions beyond routine clinical care, and because patient anonymity could be ensured.

RESULTS

One hundred and forty seven (147) patients were referred for mitral valve repair in the study period, of which 33 were not accepted for repair by the local heart team. One hundred and fourteen (114) patients were accepted for mitral valve repair between 1 December 2010 and 30 June 2015, of which 106 patients underwent surgical intervention, 6 defaulted their surgical dates, and 2 refused surgery. Of those who underwent surgical intervention, ninety six (96) patients had mitral valve repair and 10 had intra-operative switch to mitral valve replacement (Figure 1).

Of those accepted for surgery, 66 patients (57.9%) were males, 48 patients (42.1%) were females, and they had a mean age of 47.7 years; 57% of patients were of mixed ancestry, 22.8% were African, 19.3% white, and 0.9% were undetermined.

Seventy five patients (65.8%) originated from rural areas, and 39 patients (34.2%) from urban areas.

Cardiovascular risk factors and past medical history (Table 1)

Fifty one patients (44.7%) had hypertension, 11 (9.6%) suffered from diabetes mellitus type II, 18 (15.8%) had hypercholesterolaemia, 50 (43.9%) were smokers, 8 (7%) had previous cerebrovascular accidents (CVA), 17 (14.9%) had atrial fibrillation, and 24 (21.1%) had IHD.

Pre- and post-operative NYHA functional class at 6 months

Sixty four patients (56.1%) had a pre-operative NYHA functional class III, 34 (29.8%) were class II, 8 (7%) were class IV, and the rest (7%) were class I (Figure 2).

Fifty six patients (60.2%) had a 6-month post-operative NYHA functional class I, 30 (32.3%) were class II, 5 (5.4%) class III, and only 2 (2.2%) were class IV (Figure 3).

Etiology of mitral valve disease

The predominant etiology was mitral valve prolapse with flail segment due to chord rupture (29%) (Figure 4).

Pre-operative transthoracic and transoesophageal echocardiogram parameters

The echocardiographic parameters used in the study are illustrated in Table 2.

The estimated systolic pulmonary pressure was normal in 44 patients (38.6%), mildly elevated in 13 patients (11.4%), moderate in 17 patients (14.9%), severe in 34 patients (29.8%)

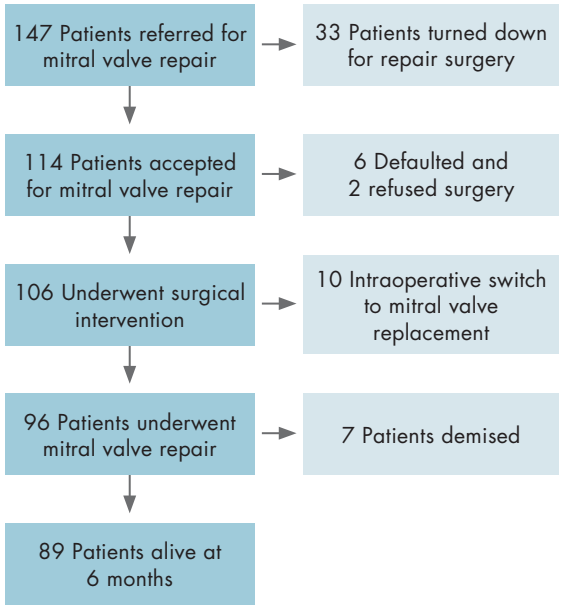


FIGURE 1: Flow chart of patients referred for mitral valve repair and their outcomes.

TABLE I: Demographics and cardiovascular risk factors.

Demographics		Number (n)	Percentage
Gender	Female	48	42.1%
	Male	66	57.9%
Race	Mixed ancestry	65	57.0%
	African	26	22.8%
	White	22	19.3%
	Other	1	0.9%
Address	Urban	39	34.2%
	Rural	75	65.8%
CV risk factors		**Number (n)**	**Percentage**
Hypertension		51	44.7%
Diabetes		11	9.6%
Hypercholesterolaemia		18	15.8%
Smoking		50	43.9%
Family History		9	7.9%
IHD		24	21.1%
Stroke		8	7.0%
CABG		1	0.9%
Atrial Fibrillation		17	14.9%

and was undetermined in 6 patients (5.3%). The degree of mitral regurgitation pre-operatively was severe in 101 patients (86.8%) and of moderate degree in 15 patients (13.2%). The underlying etiology of MR in the moderate degree group was congenital heart disease (6), ischaemic MR (5), infective endocarditis with large vegetation on MV (3), and post traumatic (1) (Table 3). The primary indication for surgery in these patients was not the mitral regurgitation. The repair of the mitral valve in these cases was done at the time of surgery for the primary indication, according to current guidelines.[17]

There were 38 patients (33.3%) with posterior leaflet involvement, 37 (32.5%) with anterior leaflet involvement, and 25 patients (21.9%) with bileaflet involvement. With regard to segment involvement, P2 was the most common segment involved (36%) (Figures 5 and 8).

Comparison of the pre-operative echocardiographic parameters with the immediate and 6 month post-operative findings

All echocardiograms available at each follow-up time point were included in the analysis. Immediately post-operative, 102 echocardiograms were available as 4 patients had died peri-operatively before their echocardiograms were done. A fifth patient died 2 weeks post-operatively to account for the 5 early deaths. Only 71 patient echocardiograms were available at 6 months; 26 patients were evaluated clinically and no echocardiogram was requested at follow-up, and 2 patients defaulted follow up. Both the latter patients were contacted telephonically for mortality data. The echocardiographic parameters assessed at each time point were significantly different from pre-operative values ($p<0.001$), with the exception of the pulmonary pressure, in which only the 6 month post-operation time point was significantly different from pre-operation ($p<0.001$). There was a significant reduction in both LVED and LVES post-operatively – the former also showing an immediate post-operative reduction. Functional parameters such as LVEF and TAPSE decreased immediately post-operatively, with partial recovery at 6 months when compared to pre-op values (Figure 6).

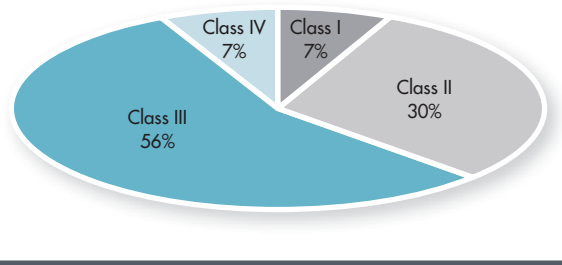


FIGURE 2: Pre-operative NYHA functional class.

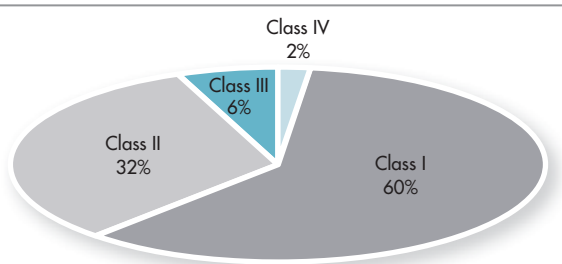
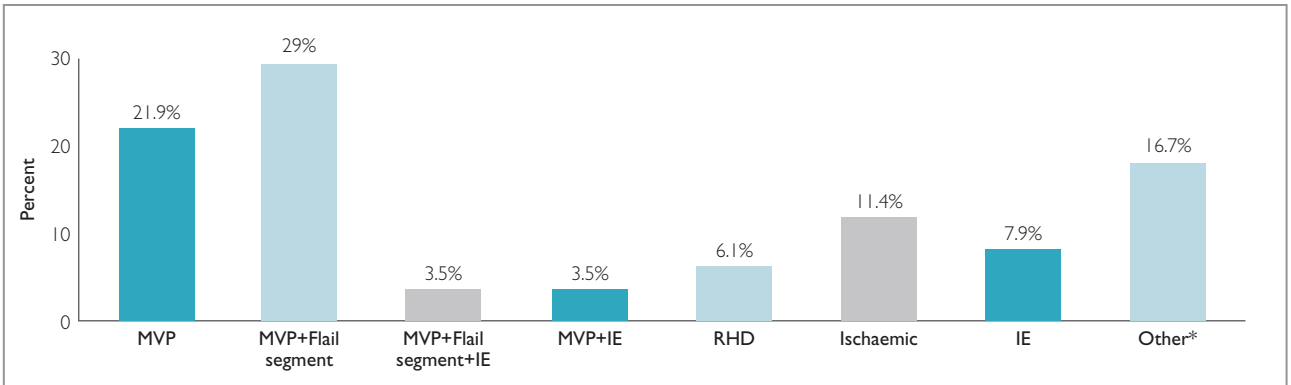


FIGURE 3: Post-operative NYHA functional class at 6 months.



*Other: Post-traumatic, Submitral aneurysm, Congenital (AVSD, Primum/Secondum ASD, Cleft AMVL, Trileaflet mitral valve)

FIGURE 4: Etiology of mitral valve disease.

TABLE II: Comparison of the pre-operative echocardiographic parameters with the immediate and 6 month post-operative findings.

Echocardiographic parameters	Pre-operative values		Immediate post-operative values		p value	6 month post-operative values		p value
	n=114		n=102			n=71		
	mean	SD	mean	SD		mean	SD	
LVED cm	LVED cm	1.09cm	5.13cm	0.92cm	p<0.001	4.86cm	1.09cm	p<0.001
LVES cm	LVES cm	1.1cm	4.01cm	1.06cm	p<0.001	3.59cm	1.21cm	p<0.001
EF %	EF %	11.77%	50.49%	13.09%	p<0.001	55.61%	12.66 %	p=0.004
LA area cm^2	LA area cm^2	11.49cm^2	22.44cm^2	7.82cm^2	p<0.001	21.63cm^2	7.57cm^2	p<0.001
TAPSE	TAPSE	0.64cm	1.19cm	0.39cm	p<0.001	1.54cm	0.38cm	p<0.001
E' m/s	E' m/s	0.03m/s	0.07m/s	0.03m/s	p<0.001	0.07m/s	0.03m/s	p<0.001
Sa m/s	Sa m/s	0.03m/s	0.07m/s	0.02m/s	p<0.001	0.07m/s	0.02m/s	p<0.001

TABLE III: Severity of MR in percentage at 3 time points.

Severity of MR	None	Mild	Moderate	Severe
Pre-operative	-	-	13.2%	86.8%
6 month post-operative	40.2%	49%	10.8%	-
Address	25.3%	59.1%	12.7%	2.9%

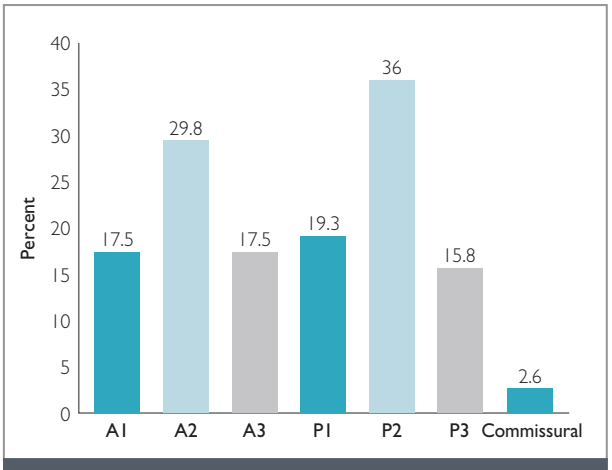


FIGURE 5: Scallop involvement.

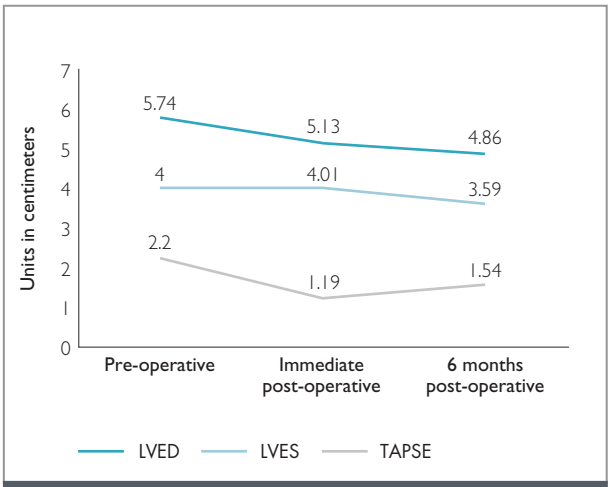


FIGURE 6: Comparison of the pre-operative echo-cardiographic parameters with the immediate and 6 month post-operative findings.

Immediate and 6 month post-operative survival

Of the 106 patients that underwent surgical intervention, 5 died within 30 days (mortality rate 4.7%) and a further 2 at 6 months post-operative (mortality rate 6.6%). The underlying etiology in those patients that did not survive was MVP (2), MVP with flail segment (1), ischaemic MR (3), and AVSD (1) with a cleft anterior mitral valve leaflet. The immediate post-operative survival was 95.3% versus 93.4% at 6 months. The mortality rate at 6 months post-operative, excluding those with ischaemic MR, was 3.7%, and for those with MVP only as the underlying etiology the mortality rate was 4.8%. Freedom from reoperation was 98% at 6 months post-operative. Mitral valve repair for ischaemic MR was associated with significant mortality at 6 months (23%). All patients undergoing mitral valve repair for ischaemic MR had simultaneous revascularisation.

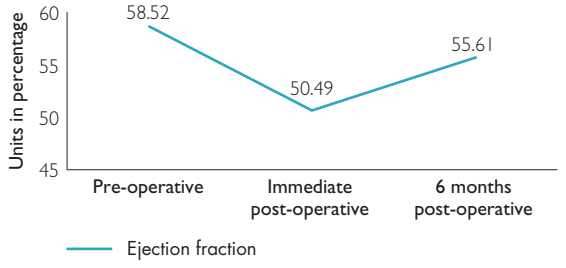


FIGURE 7: Comparison of the pre-operative ejection fraction with the immediate and 6 month post-operative findings.

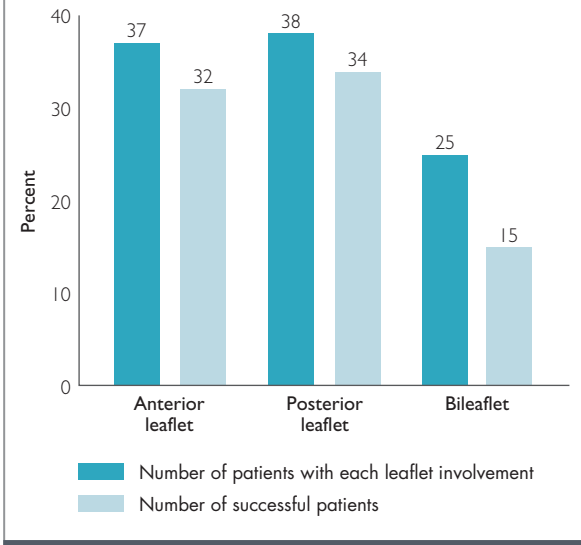


FIGURE 8: Leaflet involvement versus successful repair.

Successful versus failed repairs

In total there were 12 (11.2%) failed repairs, in which 10 patients were switched intra-operatively from mitral valve repair to replacement with either a bioprosthesis or a mechanical valve, and 2 had redo surgery. Eight patients in the failed repair group had bileaflet involvement. Of the 10 patients requiring intra-operative switch to mitral valve replacement, 5 had mitral valve prolapse with a flail segment due to chord rupture, 3 had infective endocarditis, and 2 had rheumatic heart disease as the cause of MR. Both of the patients requiring reoperation had complicated repairs for infective endocarditis and submitral aneurysm respectively, and both had subsequent mitral valve replacement. There was a significant association between bileaflet involvement and mitral

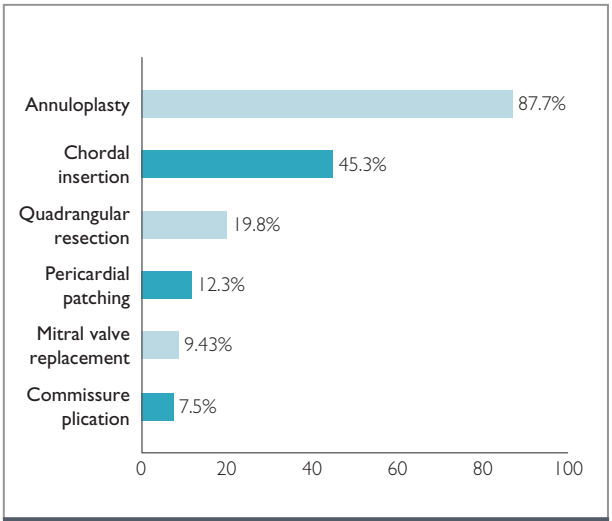


FIGURE 9: Percentage of patients with different types of surgical intervention.

valve repair failure (p=0.006), with those having failed repairs being more likely to have bileaflet prolapse or involvement (Figure 8). There was no significant association between the pathological segment involved and failed repair. Time from acceptance to performance of surgery was quite variable, ranging from 0 days - 193 days, and with a median of 48 days. There was no difference in median time between those who failed and those who had a successful repair.

Post-operative MR

The majority of patients had trace/mild mitral regurgitation at 6 months post-surgery. Only 2 patients had severe MR at 6 months after complicated repairs for infective endocarditis and a submitral aneurysm respectively. Both had redo surgery, with subsequent mitral valve replacement (Table 3).

Type of surgical repair

Most patients (87.7%) had an annuloplasty ring inserted as part of the mitral valve repair strategy. Chordal insertion was favoured as a strategy for repair (45.3%). The graph above demonstrates the percentage of patients with different types of surgical intervention (Figure 9); 12 patients had concomitant tricuspid valve repair (11.3%) in the form of a tricuspid annuloplasty ring.

DISCUSSION

Mitral valve repair is associated with an operative mortality of approximately 3%, depending on the population and the pre-operative risk of patients undergoing surgery.[14,15] Interna-

tionally published figures for peri-operative mortality are less than 2% for degenerative mitral regurgitation, with a freedom from mitral valve reoperation of 94% at 10 years.[7] In our series, the mortality rate for MVP was 4.8% at 30 days and 6 months – which is higher than the published data. The mortality rate at 30 days and 6 months post-operative for all repairs irrespective of etiology was 4.7% and 6.6% respec-tively, with ischaemic MR as the main cause of increased mortality. Ischaemic MR is well known to have a significantly higher operative mortality than MVP. To our surprise, other etiologies included in this cohort – i.e. infective endocarditis and sub-mitral aneurysms – were not associated with a significant increase in mortality. This might be due to selection bias, with patients with more advanced involvement not accepted/ considered for mitral valve repair. In our cohort, the 6 month mortality rate of patients undergoing surgery for ischaemic MR was higher than reported mortality rates (23% vs. 10%).[7] Given the limited number of patients undergoing surgery for ischaemic MR in our cohort, no clear conclusion can however be drawn from this. Freedom from reoperation was 98% at 6 months, which is similar to the published literature.[7,13] Surprisingly, there was no association between functional class and survival in our cohort.

There was a significant improvement in symptoms at 6 months post-operative. NYHA functional class improved dramatically, most patients were asymptomatic (60%), and only a few had significant symptoms at 6 months (8%). The etiology in this group was mitral valve prolapse due to flail segment (3), infective endocarditis (3), and ischaemic MR (1). Echocardiographic parameters were in keeping with the functional class improvement, with statistically significant improvement in mean LVED from 5.74cm - 4.8cm, LVES from 4cm - 3.6cm and recovery of LVEF at 6 months to pre-surgical values (58% vs. 56%). There was a significant improvement in pulmonary pressure at 6 months.

Mitral valve prolapse with flail segment due to chord rupture was the most common etiology. This correlates with the frequent use of chordal implantation with annuloplasty ring insertion as a surgical technique in our cohort. High rates of repair success were accomplished with low rates of severe mitral regurgitation immediately post-operatively (0%). This was maintained at 6 months, with only 2 patients documented to have severe mitral regurgitation at 6 month follow-up. Both of these patients required reoperation (2%), which is comparable to published data. In the literature, reoperation to treat recur-rent mitral regurgitation after primary repair is required in approximately 0.5% - 1.5% of patients per year.[6]

Isolated P2 prolapse was the most common segment involved (36%), and it correlates with international figures where up to 60% of patients referred for mitral valve repair have P2 prolapse.[2] P2 segment repair carries the highest rate of successful repair.[2] There were 38 patients (33.3%) with posterior leaflet involvement, 37 patients (32.5%) with anterior leaflet involvement, and 25 patients (21.9%) with bileaflet involvement. Our study demonstrated similar involvement of the posterior and anterior leaflet; posterior leaflet involvement is more common according to the published literature.[16]

There was a significant association between bileaflet involvement and mitral valve repair failure ($p=0.006$) – with those having failed repairs being more likely to have bileaflet involvement.

Patients undergoing surgery for moderate MR (n=15/13.2%) had another primary indication for surgery, and the mitral valve was repaired at the time of addressing the primary pathology. This group included patients with congenital heart disease with moderate MR (6), ischaemic MR at the time of CABG (5), infective endocarditis with large vegetations (3), and 1 patient with traumatic mitral valve injury.

STUDY LIMITATIONS

This is a small cohort of patients undergoing mitral valve repair – in particular only a small number of patients underwent surgery for secondary (ischaemic) MR. The high mortality rate in this group should be interpreted with caution.

Conclusions drawn from retrospective analyses such as this should be made with caution, as it is often very difficult to control for all forms of bias. In this regard, one particular shortcoming in the echocardiographic analysis is the large cohort of patients for which a 6-month echocardiogram is not available. Most of these patients (26 of 28) were clinically evaluated at 6 months post-surgery, and no echocardiogram was requested – presumably due to the combination of a good immediate post-operative result on echocardiogram and good symptomatic status at follow up. Information on the exact circumstance related to the events leading up to the patients who died was not available, making it difficult to draw conclusions regarding cause of death.

CONCLUSION

Mitral valve prolapse was the predominant etiology in patients referred for mitral valve repair. The mortality rate for mitral valve repair in the prolapse group was 4.8% at 6 months. Chordal insertion with annuloplasty was the most common intervention used. Bileaflet involvement was found to be an independent risk factor for repair failure. The mortality rate for all patients accepted for mitral valve repair was 6.6% at 6 months.

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