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Characteristics and outcomes of mitral valve repair surgery: a single-center experience

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Abstract

Background

The authors performed this retrospective study to report the experience of mitral valve repair (MVR) repair procedures, including the commonly used operative techniques and recorded outcomes.

Patients and methods

A total of 100 patients (76 males) who underwent MVR were enrolled in this study. Diagnosis was mainly based on detailed history taking along with an echocardiographic assessment. Data on preoperative, intraoperative, and postoperative variables were collected retrospectively from the database and patients' records. Missing data for particular outcomes were removed from the analysis.

Results

The four observed pathologies of the mitral valve [ischemic (67%), myxomatous (18%), postinfective (11%), and rupture chordae (4%)] were repaired with annuloplasty ring, leaflet dissection and annuloplasty ring, pericardial patch closure ± ring annuloplasty, and artificial chordae replacement, respectively. The preoperative and postoperative stay durations were 6.21 ± 6.318 and 12.19 ± 11.54 days, respectively. Only two deaths were recorded (one within the first 30 days of the procedure and one after). Operative bleeding occurred in four patients (of 98; 4.1%), and four patients (of 98; 4.1%) developed arrhythmia. Ten (of 98; 10.2%) patients were re-admitted into the ICU. Twelve (of 95; 12.6%) patients developed infection. At discharge, no cases of mitral regurgitation were observed. Except for preoperative and postoperative stay durations (which were significantly longer in the ischemic group), other outcomes showed no significant difference between the four used techniques.

Conclusion

The single-center experience highlights the safety of MVR procedure, but indicates that special caution should be warranted to reduce the incidence of post-operative infections. Except for longer preoperative and postoperative stay durations in the ischemic group, no outcome differences were observed between the used techniques. However, large, multicenter, randomized trials with longer follow-up periods are required to validate these findings.

Keywords: Coronary artery bypass graft, mitral regurgitation, mitral valve repair, valvular heart disease

INTRODUCTION

Mitral valve repair (MVR) has evolved as the first choice procedure for patients with mitral regurgitation (MR). This is because the results of many studies showed lower operative mortality for MVR than mitral valve replacement, and it has consistently shown good long-term results [1]. The first procedure to repair mitral insufficiency (annuloplasty) was developed by Lillehei and colleagues at the University of

Minnesota in 1957[2] and was based on eliminating the leakage site. Ten years later, Carpentier developed a new technique for reconstructive mitral valvuloplasty that targets reducing the

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strain on the diseased subvalvular apparatus [3]. Following that, a surge in the number of surgical techniques for MVR has emerged for different mitral conditions, including infectious, rheumatic, and ischemic mitral valve disease (MVD) [4–6].

Previous investigations, often single-center experiences, highlighted the advantages of MVR on both the short-term and long-term scales [7–9]. A recent systematic review compiled data from 12 studies and showed that MVR had short-term and long-term survival advantages, compared with mitral valve replacement. However, they noted that some outcomes like hospital stay durations and intraoperative characteristics were not often reported in many studies and that these outcomes deserve further attention [10].

In our center (XX), we have been practicing MVR for over two decades now. We performed this retrospective study to report on our experience of MVR repair procedures and to compare the outcomes of the commonly used operative techniques.

PATIENTS AND METHODS

Patients

This is a retrospective study of 100 adult patients, diagnosed with MVD of different etiologies, who underwent MVR at our center (XX) between January 2018 and June 2019. Diagnosis was mainly based on detailed history taking along with an echocardiographic assessment. All patients gave an informed consent for data collection for research purposes, and the study protocol was approved by the Local Ethical Research Committee at King Faisal Specialist Hospital & Research Centre, KSA. We included patients with MVD of operable causes (ischemic, myxomatous, postinfective, and ruptured chordae). Patients with MVD who had other valvular abnormalities of any cause were included. We excluded patients with rheumatic MVD and those with poor general condition.

Procedures

Operations were performed through median sternotomy, aortobicaval cannulation, and standard cardiopulmonary bypass (CPB). Myocardial protection was achieved via cold blood cardioplegia combined with topical cooling. Intraoperative transesophageal echo was conducted routinely before and after MVR. The four observed pathologies of the mitral valve (ischemic, myxomatous, postinfective, and rupture chordae) were repaired with annuloplasty ring, leaflet dissection and annuloplasty ring, pericardial patch closure ± ring annuloplasty, and artificial chordae replacement, respectively [11]. The detailed characteristics of the used operative techniques in the enrolled patients are described in details later in the results section.

Outcomes

Data on preoperative, intraoperative, and postoperative variables were collected retrospectively from our database and patients' records. We used the published guidelines for reporting valve-related morbidity and mortality after cardiac valvular operation of the Society of Thoracic

Surgeons/American Association for Thoracic Surgery [12]. Patients were followed for 90 days to record postoperative mortality. The analyzed data included baseline clinical and demographic characteristics, comorbidities, operative characteristics (CPB time, fixation technique, and operative details), and postoperative outcomes (biochemical data, hospital stay durations, and related complications). Operative bleeding was defined as before and after bypass amount of blood loss, calculated by cell saver container. Patients with missing data for each outcome were excluded from its analysis.

It is routine in our center for TEE to be done intra-operatively both before and after bypass and before giving protamine to assess the severity and accurate pathology before going on pump and to assess the success of repair after coming off pump and before heparin reversal. Only mild regurge is allowed after acceptance by the operating surgeon.

Statistical analysis

We analyzed our data using the Statistical Package for the Social Sciences (version 22; SPSS Inc., Chicago, Illinois, USA). Qualitative data were described in terms of frequencies and percentages. Quantitative data were expressed in terms of means and standard deviations if normally distributed or median and interquartile range (IQR) if not normally distributed. For comparisons, we used the analysis of variance test, followed by post-hoc Tukey's test to evaluate the statistical significance of between-group differences. *P* values were considered significant if less than 0.05.

RESULTS

Baseline characteristics

A total of 100 patients with MVD were enrolled in the current study. The median age was 68 years (IQR: 58–72 years), and most patients were males (76%). Their mean BMI was 27.93 ± 5.41 kg/m² (overweight), and the mean EuroScore (ESII) was 5.81 ± 9.4 . In terms of echocardiographic parameters at baseline, the mean ejection fraction was $41.22 \pm 12.95\%$. The detailed baseline characteristics of the enrolled patients are illustrated in Table 1. The observed pathologies in our sample were ischemic MR (67%), followed by myxomatous MR (18%), postinfective (11%), and ruptured chordae (4%). The most common grade was grade 4 (38 out of 99; 38.4%), followed by grade 2 (35 out of 99; 35.4%), whereas fewer patients had grades 1 (8 out of 99; 8.1%) and 3 (13 out of 99; 13.1%).

Comorbidities

Only five (out of 98; 5.1%) patients had previous cardiac surgeries and eight (out of 99; 8.1%) had recent acute myocardial infarction (before 30 days). Approximately 3% of patients had chronic obstructive pulmonary disease. The enrolled sample contained 54 diabetics, 20 of them were on regular insulin. The median HbA1C was 6.5 (IQR: 5–8). Only three patients were on dialysis before the surgery. No patients had coagulopathy, infection, or neurological dysfunction. Table 2 presents the associated comorbidities in the enrolled sample.

Table 1: The demographic characteristics, baseline echocardiographic parameters, and clinical staging of patients before undergoing mitral valve repair operations

Demographics	
Age[median (IQR)] (years)	68 (58-72)
Sex	
Male	76 (76)
Female	24 (24)
Height (m)	1.62±0.09
Weight (kg)	73.1±14.65
BMI	27.93±5.41
Body surface (m ²)	1.8±0.2
EuroScore II	5.81±9.4
Ejection fraction (%)	41.22±12.95
PAP pressure	43.24±14.46
NYHA class (I-IV)	
Class 0	18/99 (18.2)
Class 1	1/99 (1)
Class 2	30/99 (30.3)
Class 3	43/99 (43.4)
Class 4	7/99 (7.1)
CCS class angina (1-4)	
Class 0	54/99 (54.5)
Class 1	2/99 (2)
Class 2	21/99 (21.2)
Class 3	17/99 (17.2)
Class 4	5/99 (5.1)

Data are means±SD or frequencies (percentages) unless otherwise indicated. The sample size is 100, unless otherwise indicated. CCS, Canadian Cardiovascular Society angina grading; NYHA, New York Heart Association classification; PAP, pulmonary artery pressure.

Several patients had other valvular comorbidities. Tricuspid regurge (combined) was found in 35.2% of patients, and it was mostly owing to rheumatic causes. Aortic regurgitation was found in 11.1% of patients, and it was mostly owing to rheumatic causes. Only one patient in the enrolled sample had pulmonary regurge. The details of other valvular abnormalities are displayed in Table 2.

Operative characteristics

The four observed pathologies of the mitral valve (ischemic, myxomatous, postinfective, and rupture chordae) were repaired with annuloplasty ring, leaflet dissection and annuloplasty ring, pericardial patch closure ± ring annuloplasty, and artificial chordae replacement, respectively. The mean CPB time was 141.3 ± 36.5 min, whereas the mean X-clamp time was 112.3 ± 30.8 min. In fact, 67% of patients had CABG in addition to valve repair surgeries. All patients had MVR; of which 17% had aortic valve repair surgeries and 20% had tricuspid valve repair besides MVR. The details of operative characteristics are illustrated in Table 3.

Outcomes and complications

Seventy-one (74.4%) patients had an uneventful stay. The preoperative stay duration was 6.21 ± 6.318 days. The first and second ICU stay durations were 3.61 ± 3.7 and

Table 2: Co-morbidities in the included patients with emphasis on other valvular abnormalities

Comorbidity	
Recent acute myocardial infarction (≤90 days)	8/99 (8.1)
Acute myocardial infarction (>90 days)	2/99 (2)
Previous cardiac surgery	5/98 (5.1)
Extracardiac arteriopathy	1/98 (1)
Chronic obstructive pulmonary disease	3/99 (3)
Critical preoperative status	5/98 (5.1)
Preoperative dialysis	3/99 (3)
Preoperative creatinine (μmol/l)	97.56±76.16
Preoperative creatinine clearance (ml/min)	92.33±46.22
Poor mobility	2/98 (2)
Diabetes mellitus	54/99 (54.5)
Diabetes mellitus on insulin	20/99 (20.2)
HbA1c median (IQR)	6.5 (5-8)
On plavix	10/99 (10.1)
On aggrastat	1/99 (1)
Preoperative intra-aortic balloon pump	2/99 (2)
Preoperative Hb	12.83±2.46
Preoperative bilirubin	11.2±8.72
Preoperative platelets	236.77±82.93

Data are either frequency (%) or mean±SD unless otherwise indicated. Hb, hemoglobin; IQR, interquartile range.

0.65 ± 3.52 days, respectively. The postoperative stay duration was 12.19 ± 11.54 days. In the postoperative period, the mean lowest hemoglobin was 9.31 ± 1.68 g/dl, mean lowest platelets count was 120.9 ± 56.57, the mean highest troponin was 0.866 ± 1.05, and the mean highest bilirubin was 17.27 ± 18.75 mg/dl.

Only two deaths were recorded in the current sample (one within the first 30 days of the procedure and one after). At hospital discharge, we observed no cases of clinically significant MR. Operative bleeding occurred in four patients (out of 98; 4.1%), and the amount of bleeding within the first postoperative 24 h was 87.37 ± 236.58 ml. Only a single case of stroke and four cases of arrhythmia were recorded. Ten patients were re-admitted into the ICU for bleeding and respiratory distress among other causes. Twelve patients developed infection, one of which had mediastinitis and two developed deep sternal infections. Table 4 lists all complications, recorded in the enrolled patients.

Outcome comparisons

The four observed pathologies observed were ischemic annular dilatation, myxomatous MR, postinfective MR, and ruptured chordae and were fixed by annuloplasty ring, leaflet dissection and annuloplasty ring, pericardial patch closure ± ring annuloplasty, and artificial chordae replacement, respectively. Comparing the outcomes of the four observed pathologies and their repair techniques, we observed no significant differences in terms of mortality ($P = 0.13$), operative bleeding ($P = 0.25$), arrhythmia ($P = 0.35$), ICU readmission ($P = 0.19$), infection ($P = 0.37$), and permanent pacemaker insertion ($P = 0.15$). However, the preoperative and

Table 3: Cardiopulmonary bypass timing, fixation characteristics, and the employed mitral valve repair procedure in the enrolled patients

Variables	
CPB (min)	141.28±36.49
X-clamp (min)	112.33±30.8
Second run CPB (min)	30.38±35.82
Second run X-clamp (min)	25.5±24.75
Lowest temperature (°C)	34.78±3.06
Lowest Hb (mg/dl)	8.89±3.22
Highest blood sugar (mmol/l)	11.75±2.63
Highest lactate	3.03±1.47
Fixation characteristics	
Valve only	33 (33)
CABG plus valve repair	67 (67)
MVR+AVR	17 (17)
MVR+TVR	20 (20)
MVR repair procedure	
Technique	
Annuloplasty ring	67 (67)
Leaflet dissection and annuloplasty ring	18 (18)
Pericardial patch closure+ring annuloplasty	11 (11)
Artificial chordae replacement	4 (4)

Data are frequencies (percentages). The total number of patients is 100 unless mentioned otherwise. AVR, aortic valve repair; CPB, cardiopulmonary bypass; Hb, hemoglobin; MVR, mitral valve repair; TVR, tricuspid valve repair.

postoperative stay durations were significantly longer in the ischemic group ($P = 0.02$ and 0.01 , respectively), compared with other groups.

DISCUSSION

The current study was a retrospective, single-institution experience of MVR procedures, performed in patients with MR. We showed that patients with MR had several associated comorbidities, including other valvular abnormalities that required attention before, during, and after the surgery. Moreover, most patients had uneventful hospital stay, highlighting the safety of the procedure. However, we recorded 12 cases of infection, which is a relatively high frequency. Except for longer hospital stay durations in the ischemic MR group, no other differences were detected among the four compared groups.

Most enrolled patients were elderly with multiple comorbidities as illustrated in Table 2. This may explain the unusually high Euroscore, compared with former studies on patients undergoing MVR, as well as the prolonged preoperative hospital stay (to perform all required investigations). Although grade I MR is not an indication for surgical repair, these patients were operated for other multiple cardiac reasons and during the surgery, the operating surgeon decided to intervene regarding the mildly leaking mitral valve.

In comparison with previous studies, Costa *et al.*[13] analyzed data of 125 MR patients and reported an early mortality rate of

Table 4: Postoperative complications in included patients during their hospital stay duration

Variables	
Death within 30 days	1/99 (1)
Death after 30 days	1/99 (1)
Sternum left open	2/99 (2)
Operative bleeding	4/98 (4.1)
Poor hemodynamics	3/97 (3.1)
Intra-aortic balloon pumping	4/98 (4.1)
Extracorporeal membrane oxygenation	0/100 (0)
Prolonged intubation	7/99 (7.1)
Delayed awaking	4/98 (4.1)
Arrhythmias	4/95 (4.2)
Stroke	1/100 (1)
Readmission in Adult Cardiac Intensive Care Unit	10/98 (10.2)
Cause of readmission	
Bleeding	3/98 (3.1)
Respiratory distress	2/98 (2)
Cardiac arrest	1/98 (1)
Desaturation	1/98 (1)
Ventricular fibrillation	1/98 (1)
Sternal wound closure	1/98 (1)
PPM insertion	1/98 (1)
Infection	12/95 (12.6)
Positive blood picture	0/98 (0)
Deep sternum infection	2/95 (2.1)
Mediastinitis	1/98 (1)
Wound closed in operation room	13/95 (13.7)
Dialysis	3/97 (3.1)
PPM insertion	2/95 (2.1)

Data are represented as frequencies (percentages). PPM, Permanent Pacemaker

2.4%, which is almost similar to our rate. In addition, similar rates were recorded by Enriquez-Sarano *et al.*[1] (2.6%). Lower rates, however, were reported by LaPar *et al.* [8]. However, it is mandatory to mention that the different rates of using different techniques in these studies could account for the observed differences. Furthermore, the differences in baseline characteristics (e.g. prevalence of advanced New York Heart Association class in our study) may account for some differences as well. Another interesting difference was the prevalence of ischemic etiology among our patients. This is in contradiction to European studies that showed predominance of the degenerative etiology in their patient samples.

In terms of operative outcomes, the frequencies of postoperative mortality, stroke, bleeding, and arrhythmias were markedly low in the overall sample. This highlights the safety of the reportedly used techniques. However, one alarming result was the relatively high percentage of infection in our patient sample (12%). This may be owing to the high percentage of diabetics in our sample, prolonged hospital stay durations, or the need to implement more strict infection control policies in our center.

We recorded no significant differences among the four groups compared in the current study (based on mitral valve

pathology and repair techniques) in the majority of outcomes. This may be owing to the overall small number of recorded events. We should note that our sample size was relatively small with few patients in some arms, which may have precluded the detection of statistically significant differences between the groups. However, patients in the ischemic MR group had longer preoperative and postoperative hospital stay durations, which may be owing to the complex nature of their surgery (MVR + CABG) and needing to perform more investigations before the surgery.

Although our study focused on the short-term outcomes, other studies that assessed long-term outcomes showed promising results [14–16]. At hospital discharge, we observed no cases of clinically significant MR. However, we already planned to perform longitudinal follow-up and report the outcomes of our patients, including MR at 1, 3, and 5 years. David *et al.*[17] evaluated the late outcomes in 840 patients who underwent MVR. At 20 years, the freedom from recurrent severe MR was 90.7%, and the freedom from moderate or severe MR was 69.2%. Similarly, Costa *et al.*[12] reported freedom from MVR failure in 84.5% at 10 years, as well as high long-term survival rate in comparison with matched general population. Multivariate analysis demonstrated that residual New York Heart Association class III and IV, poor preoperative ejection fraction, functional MR, and ischemic MR were all independent predictors of late death [18]. Along with our results, these data show the efficacy and safety of MVR at the short and long-term.

There are some limitations to this study. First, this is a single-center study with a relatively small sample size. Second, we only focused on short-term outcomes because they are growingly less investigated in the literature. However, we are planning to provide follow-up data at 3, 5, and 10 years. Third, our database did not capture all data of the participants; therefore, there were missing data in some outcomes. Future studies should enroll a larger sample size. Furthermore, the results of the current study, as with any retrospective study, may not be generalizable to all patients with MVR.

CONCLUSION

In conclusion, our single-center experience highlights the safety of MVR procedure, but indicates that special caution should be warranted to reduce the incidence of postoperative infections. Except for longer preoperative and postoperative stay durations in the ischemic group, no outcome differences were observed between the used techniques. However, large, multicenter, randomized trials are required to validate these findings.

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Ashraf Zahrah contributed to idea conception, data acquisition and analysis; Mohamed Fouly contributed to data analysis and manuscript drafting.

The manuscript has been read and approved by all the authors, that the requirements for authorship as stated earlier in this document have been met, and that each author believes that the manuscript represents honest work.

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Conflicts of interest

There are no conflicts of interest.

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