Cardiovascular Disorders and Medicine

Research Article ISSN: 2398-8878

Hospital outcome and predictors of operative mortality in redo MVR adult population

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Abstract

Background: The operative mortality associated with redo heart valve surgery is higher than that of the primary operation 1. this study aimed to scrutinize the overall hospital morbidity and mortality of adult patients undergoing redo-mitral valve replacement (redo-MVR) at our hospital and identify predictors of operative death and prolonged hospital stay.

Methods: This is a retrospective observational study that included all patients (n = 96) who underwent redo-MVR with either bioprosthetic or mechanical valves between January 2012 and December 2017 at Madinah cardiac center, Kingdom of Saudi Arabia. Patients were excluded if they had undergone alternative MV intervention without replacement. Their data were retrieved from the prospectively maintained electronic database.

Results: In this study, the mean age of the whole cohort was [48.66 ± 12.71] years (range 19-79 years) and the mean additive EuroSCORE was 11 ± 3. Median time to re-operation was [7.87 ± 3.20 years] ranging (2-16 years) for first-time redo-MVR and [6.80 ± 2.86] years ranging 3-10 years for second-time redo-MVR. Indications included prosthetic endocarditis 42 pts (43.8%), para-prosthetic leak 23 pts (24%), structural valve degeneration 18 pts (18.8%) and prosthetic valve thrombosis 14 pts (14.6%). In-hospital mortality was 11 pts (11.5%). Mean hospital stay was [12.68 ± 4.97] days (range 6-24 days). Univariate analysis showed that operative mortality was associated with the LVEF<50% (P=0.016), structural valve degeneration (p<0.001) and total operative time in hours (p=0.015). Similarly, univariate analysis for prolonged hospital stay showed a significant association between it and higher preoperative EuroSCORE (p=0.04).

Conclusion: Repeat-MVR can be done safely and with a good overall outcome. We insist on early intervention before ventricular dysfunction occurs with its deleterious effects on the outcome of the redo surgery.

Introduction

The operative mortality associated with redo heart valve surgery is higher than that of the primary operation [1]. Significant advances in prosthesis design, surgical techniques, approaches and perioperative care had been made since the fifties of this century to improve redo surgery outcomes [2].

Although mitral valve repair is better than replacement, MVR is still required in the first operation if the repair is not feasible or in repeat valve surgery. Moreover, improved survival necessitated that more and more mitral patients become in need for repeat valve operations for a multiplicity of reasons such as structural valve degeneration, thrombosis, endocarditis and paravalvular leaks. However, there is some evidence now that clinical outcomes after repeat-valve surgery have improved which highlights the progress in this area [3]. Studies that investigate the operative morbidity and mortality, survival and freedom from re-intervention of patients undergoing redo-MVR with current techniques and prostheses are thus needed [4]. Of note, it is important to identify the peri-operative variables that are associated with poor outcome in order to offer patients the most appropriate interventions. This study reports a single centre's experience with redo-MVR in adult patients and aims to identify factors that contribute to poor outcome.

Methods

Patient population

This is a retrospective observational study included all patients (n = 96) who underwent redo-MVR with either bioprosthetic or mechanical valves between January 2012 and December 2017 at Madinah cardiac, Kingdom of Saudi Arabia. Patients were excluded if they had undergone alternative MV intervention without replacement (e.g. MV repair, mitral valvuloplasty, open or closed mitral commissurotomy) in the past. Their data were retrieved from the prospectively maintained electronic database. The pathologic state of the valve was obtained from operative and pathologic reports.

Surgical technique

On-table transoesophageal echocardiography was used routinely from 2005. Surgery was undertaken through a redo-median sternotomy

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Key words: *predictor, mortality, repeat, mitral, outcome*

Received: January 31, 2018; **Accepted:** February 20, 2018; **Published:** February 23, 2018

and cardiopulmonary bypass (CPB) was established with - cannulation. Where there was a close proximity of the sternum to the heart evidenced by lateral CXR or CT chest, CPB was established electively via the -femoral route or the femoral vessels were at least exposed before redo-sternotomy. Myocardial protection comprised both antegrade and retrograde cold blood cardioplegia and moderate hypothermia (32°C). Concomitant AVR was performed before MVR, while concomitant TVR was performed after MVR. The left atrium (LA) was opened after developing the inter-atrial groove. The old mitral valve prosthesis was taken, and annulus was debrided. Partial preservation of mitral valve apparatus (leaving posterior valve leaflet intact) was routinely done with enough space for at least 25-mm valve size. A mechanical or bioprosthetic valve was then inserted with horizontal mattress 2/0 Ethibond sutures. Sutures were placed from LA to LV.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (X^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:
- Probability (P-value)
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

Results

Table 1 demonstrates the demographic criteria of the study group. In this study, the mean age of the whole cohort was [48.66 ± 12.71] years (range 19-79 years) and the group consisted of 50 (52.1%) females and 46 (47.9%) males. The mean additive EuroSCORE was 11 ± 3. (30.2%) of the study group had LV dysfunction with EF <50%, 60 patients (62.5%)in this study had mechanical valves at first time MVR versus 36 patients (37.5%) who had tissue valves. whereas the most common indication for redo surgery in our series (43.8%) was the prosthetic valve endocarditis, the least one (14.6%) was prosthetic valve thrombosis. Patients had only AVR and TVR as concomitant procedures with first MVR, (20.8%), (9.4%) respectively, were included and CABG patients at first MVR were excluded. As far as haemodynamic presenting pathology is concerned, the majority of our patients had (64.6%) mitral regurgitation followed by stenosis (15.6%) and then mixed lesions (15.6%).

The operative data are shown in table 2. (44.8%) of the study group was done electively, (40.6%) was done urgently, and (14.6%) was done emergently. Cardiopulmonary bypass time mean (m) was [127.03 ± 37.93] with a range of 80-180 m, while Cross-clamp time mean (m) was [92.65 ± 20.81] with a range of 60-120 m. Total operative time in hours was [7.47 ± 2.28] with a range of 5-12 h. We did AVR, AVR+TVR, TVR and CABG at the time of redo MVR as concomitant procedures [(30.2%), (7.3%), (24.0%) and (5.2%) respectively]. [27.85 ± 2.09] was the mean prosthesis size of the implnated mitral valve. (30.2%) of our patients had tissue valves compared to (68.8%) mechanical valves.

The early postoperative outcome is portrayed in table 3 where the hospital mortality in our series reached (11.5%). (5.2%) of our patients were explored for bleeding, (14.6%) had permanent pacemaker implantation, (8.3%) had renal failure necessitating haemofiltration

Table 1. Demographic critertia of the study group.

	Total (N=96)
Sex	
Female	50 (52.1%)
Male	46 (47.9%)
Age (years)	19-79[48.66±12.71]
LVEF <50%	29 (30.2%)
Mean additive EuroSCORE	11±3
Previous MVR	
Once	91 (94.8%)
Twice	5 (5.2%)
Type of prosthesis at last MVR	
Bioprosthetic	36 (37.5%)
Mechanical	60 (62.5%)
Time to re-operation	
First time redo-MVR	2-16[7.87±3.20]
Second time redo-MVR	3-10[6.80±2.86]
Concomitant procedures performed at the time of 1st MVR	
AVR	20 (20.8%)
TVR	9 (9.4%)
Indications for re-operation	
Prosthetic valve endocarditis	42 (43.8%)
Paravalvular leak	23 (24%)
Structural valve degeneration	18 (18.8%)
Prosthetic valve thrombosis	14 (14.6%)
Haemodynamic pathology	
Mitral regurgitation	62 (64.6%)
Mitral stenosis	15 (15.6%)
Mixed	10 (10.4%)

LVEF: left ventricular ejection fraction, EuroSCORE: European System for Cardiac Operative Risk Evaluation. MVR: Mitral valve replacement, AVR: aortic valve replacement, TVR: tricuspid valve replacement. Data are presented as mean ± SD or as number and percentage.

Table 2. The operative data of the study group

	Total (N=96)
Priority of surgery	
Elective	43 (44.8%)
Urgent	39 (40.6%)
Emergency	14 (14.6%)
Total operative time (h)	5-12[7.47±2.28]
Cardiopulmonary bypass time (m)	80-180[127.03±37.93]
Cross-clamp time (m)	60-120[92.65±20.81]
Concomitant procedures performed at the time of redo MVR	
AVR	29 (30.2%)
TVR	23 (24.0%)
AVR+TVR	7 (7.3%)
CABG	5 (5.2%)
Median prosthesis size (mm)	25-31[27.85±2.09]
Type of prosthesis at redo MVR	
Bioprosthetic (%)	29 (30.2%)
Mechanical (%)	66 (68.8%)

CABG: coronary artery bypass grafting, Data are presented as mean ± SD or as number and percentage.

Table 3. Early postoperative outcome of the study group

	Total (N=96)
Hospital mortality (%)	11 (11.5%)
Re-exploration for bleeding	5 (5.2%)
Sepsis	17 (17.7%)
AF	29 (30.2%)
Permanent pacemaker	14 (14.6%)
Haemofiltration	8 (8.3%)
Cerebrovascular event	6 (6.3%)
Mean Hospital Stay (d)	6-24[12.68±4.97]

Data are presented as mean ± SD or as number and percentage.

and stroke rate was (6.3%). Mean hospital stay ranged between 6-24 days with a mean of [12.68 ± 4.97] d.

The univariate analysis was done for both hospital mortality and prolonged hospital stay defined as more than 10 days in this study. All preoperative as well as operative data were taken into the univariate model in both Table 4 and 5. In Table 4, we found a significant association between hospital mortality and LVEF<50% (P=0.016), structrucal valve degeneration (p<0.001) and total operative time in hours (p= 0.015). Causes of death included cardiac (*n* = 3), cerebrovascular accident (*n* = 3), sepsis (*n* = 2), pneumonia (*n* = 2) and multi-organ dysfunction (*n* = 1). Similarly, the univariate analysis for prolonged hospital stay was portrayed in table 5 where a significant association between it and higher preoperative EuroSCORE (p= 0.04).

Comment

Despite the fact that recent years brought a substantial amelioration of repeat valve surgery results in terms of both clinical and functional outcomes, repeat valve surgery is a challenge [3]. It is also quiet conceivable that patients who had MVR are surviving longer and, therefore, they will need more redo operations due to prosthesis failure or valve-related complications. Consequently, we can expect a rise in the number of redo valve operations. Studies which provide information about clinical and functional outcomes of this type of surgery are therefore required to enrich the surgical knowledge of the aramentarium of cardiac surgeons facing this problem as well as improving patients' outcome [4].

Generally speaking, prosthetic valves' complications can be divided into structural valvular degeneration, non-structural dysfunction, valve thromboembolic complications, bleeding and endocarditis [5-7]. For the most common indications for the redo operation in our series, it was endocarditis (43.8%) which contrasts Jignesh [8] findings who reported pannus formation as the most common cause in 61(94%) patients. Others reported pannus formation followed by perivalvular leakage, endocarditis and thrombosis or thromboembolism as the most common causes [5-7]. Other investigators reported paravalvular leak as the most common cause for redo surgeries for mechanical prosthesis [9]. Although thrombosis has been directly linked to anti-coagulation use, a direct relationship with the intensity of anti-coagulation had not been proved by some studies [10].

In agreement with our finding, Vohra et al in 2012 [4] found that endocarditis was the most common cause of repeat mitral valve surgery. In our study, it was (43.8%) versus 60% for mechanical valves and 29% for bioprosthetic valves whereas in his study, it was much >6% that what had been reported in the literature [11,12]. Sturctural valve degeneration occurred in (18.8%) of our patients ranking third in indications for reoperation which can be attributed to improvements in valve technology, manufacturing and design. Similarly, Others such as Tyers and collegueas had found that endocarditis was a more frequent cause of re-operation in patients with mechanical when compared with bioprosthetic valves [13].

As far as hospital mortality and factors influencing it are concerned, there are reports of up to 30% mortality in the literature that now declined to 5-6% [5-7,14]. higher figures were also linked to female gender, higher NHYA class, and emergency operation. Jignesh and associates found that redo surgeries for valve thrombosis with NYHA class of I to II compared favourably with routine redo operations (10%) whereas valve thrombosis with haemodynamic instability and / or higher NYHA class had significantly higher mortality (45%) [15].

It is important to bear in mind that on the interpretation of the studies reporting hospital mortality for redo valve surgeries that theses do not usually discriminate between the anatomical position of the valve, with results regularly being mixed for aortic, mitral and tricuspid valve replacements [16-18]. Another factor to consider is that some studies had also included patients who previously underwent MV procedures other than replacement (e.g. MV repair and mitral

Table 4. Univariate analysis for in hospital mortality.

Parameters	In-hospital mortality (%)		x2/t#	p-value
	No (N=85)	Yes (=11)		
Demographic characteristics				
Sex				
Female	46 (54.1%)	4 (36.4%)	1.230	0.267
Male	39 (45.9%)	7 (63.6%)		
Age (years)	38.32±12.67	41.27±13.32	0.524#	0.471
LVEF <50%	22 (75.8%)	7 (24.1%)	6.58	0.016
Previous MVR Once	81 (95.3%)	10 (90.9%)	0.379	0.538
Twice	4 (4.7%)	1 (9.1%)	0.379	0.538
Bioprosthetic	33 (38.8%)	3 (27.3%)	0.554	0.457
Mechanical	52 (61.2%)	8 (72.7%)	0.554	0.457
First time redoMVR	7.98±3.32	7.00±1.89	0.823#	0.367
Second time redoMVR	7.75±2.22	3.00±0.00	3.671#	0.151
Concomitant procedures performed at the time of previous MVR AVR	17 (20.0%)	3 (27.3%)	0.312	0.576
TVR	7 (8.2%)	2 (18.2%)	1.134	0.287
Prosthetic valve endocarditis	38 (44.7%)	4 (36.4%)	0.275	0.600
Paravalvular leak	22 (25.9%)	1 (9.1%)	1.507	0.220
Structural valve degeneration	12 (14.1%)	6 (54.5%)	10.449	<0.001
Prosthetic valve thrombosis	13 (15.3%)	1 (9.1%)	0.301	0.583
Haemodynamic pathology Mitral regurgitation	53 (62.4%)	9 (81.8%)	1.613	0.204
Mitral stenosis	15 (17.6%)	0 (0.0%)	2.301	0.129
Mixed	10 (11.8%)	0 (0.0%)	1.445	0.229
Operative data				
Elective	39 (45.9%)	4 (36.4%)	0.357	0.550
Urgent	34 (40.0%)	5 (45.5%)	0.120	0.729
Emergency	12 (14.1%)	2 (18.2%)	0.129	0.719
Total operative time	7.25±2.18	9.80±2.17	6.263#	0.015
Cardiopulmonary bypass time	125.38±37.88	139.82±37.59	1.418#	0.237
Crossclamp time	93.12±20.89	88.70±20.72	0.400#	0.529
Concomitant procedures AVR	26 (30.6%)	3 (27.3%)	0.051	0.822
TVR	21 (24.7%)	2 (18.2%)	0.228	0.633
AVR+TVR	6 (7.1%)	1 (9.1%)	0.059	0.807
CABG	5 (5.9%)	0 (0.0%)	0.683	0.409
Median prosthesis size	27.85±2.06	27.91±2.43	0.009#	0.927
Bioprosthetic (%)	26 (30.6%)	3 (27.3%)	0.051	0.822
Mechanical (%)	58 (68.2%)	8 (72.7%)	0.091	0.762

#t- Independent Sample t-test; x^2- Chi-square test
p-value <0.05 significant; p-value >0.05 non-significant

Table 5. Univariate analysis for in prolonged hospital stay >10 days

Parameters	Prolonged hospital stay >10 days		x2/t#	p-value
	Yes (N=56)	No (N=39)		
Demographic characteristics				
Sex				
Female	27 (48.2%)	23 (59.0%)	1.068	0.301
Male	29 (51.8%)	16 (41.0%)		
Age (years)	40.29±14.53	36.72±9.18	1.837#	0.179
Euro Score	12.11±3.23	10.02±2.14	3.195#	0.044
LVEF <50%	20 (35.7%)	9 (23.1%)	1.731	0.188
Previous MVR Once	53 (94.6%)	37 (94.9%)	0.002	0.961
Twice	3 (5.4%)	2 (5.1%)	0.002	0.961
Bioprosthetic	21 (37.5%)	15 (38.5%)	0.009	0.924
Mechanical	35 (62.5%)	24(61.5%)	0.009	0.924
First time redo-MVR	8.08±3.03	7.38±3.26	1.079#	0.302
Second time redo-MVR	8.67±1.53	4.00±1.41	11.76#	0.042
Concomitant procedures performed at the time of previous MVR AVR	12 (21.4%)	7 (17.9%)	0.174	0.677
TVR	5 (8.9%)	4 (10.3%)	0.047	0.828
Prosthetic valve endocarditis	26 (46.4%)	15 (38.5%)	0.595	0.441
Paravalvular leak	13 (23.2%)	10 (25.6%)	0.074	0.786
Structural valve degeneration	12 (21.4%)	5 (12.8%)	1.159	0.282
Prosthetic valve thrombosis	7 (12.5%)	7 (17.9%)	0.543	0.461
Haemodynamic pathology Mitral regurgitation	33 (58.9%)	28 (71.8%)	1.656	0.198
Mitral stenosis	10 (17.9%)	5 (12.8%)	0.439	0.508
Mixed	6 (10.7%)	4 (10.3%)	0.005	0.943
Operative data				
Elective	25 (44.6%)	17 (43.6%)	0.01	0.919
Urgent	24 (42.9%)	15 (38.5%)	0.184	0.668
Emergency	7 (12.5%)	7 (17.9%)	0.543	0.461
Total operative time	7.61±2.36	7.23±2.18	0.383#	0.539
Cardiopulmonary bypass time	126.70±39.02	128.08±37.14	0.03#	0.863
Cross-clamp time	94.78±20.47	88.73±20.83	1.906#	0.171
Concomitant procedures AVR	14 (25.0%)	15 (38.5%)	1.964	0.161
TVR	16 (28.6%)	7 (17.9%)	1.414	0.234
AVR+TVR	4 (7.1%)	3 (7.7%)	0.01	0.92
CABG	1 (1.8%)	4 (10.3%)	3.308	0.069
Median prosthesis size	27.96±2.09	27.62±2.06	0.649#	0.423
Bioprosthetic (%)	20 (35.7%)	9 (23.1%)	1.731	0.188
Mechanical (%)	35 (62.5%)	30 (76.9%)	2.213	0.137

#t- Independent Sample t-test; x^2- Chi-square test
p-value <0.05 significant; p-value >0.05 non-significant

valvuloplasty) [16,19]. In our study, hospitaly mortality was (11.5%) which is concordant with the recent literature [3,5,12], despite the fact that 66.7% of our patients had concomitant procedures.

Actually, there are so many factors that can affect hospital mortality which can include preoperative, operative and understandably postoperative factors. Some studies found different mortality figures for repeat valve surgeries such as Jones study in 2001 who reported an overall mortality figure of 8.6% which compared well with Gillinov [20], Niederhauser [21], and their associates who found an operative mortality of 8.6% and 8.8%, respectively, and he also found that mortality was higher for those patients requiring reoperation on a prosthetic valve than mitral valve repair or valvuloplasty. Moreover, repair of periprosthetic leak or replacement of the whole valve had a similar surgical risk and therefore mortality was similar for both in mitral or aortic positions. Higher mortality, however, was linked to endocarditis and prosthetic valve thrombosis [5].

In the same study, operative mortality was higher for a mechanical valve compared with a tissue valve for at all valve positions which agrees with the findings of Tyers [13],Magilligan [22], Bortolotti [23]. Nevetheless, there are some authors who found no difference [24,25]. Mortality in patients with concomitant tricuspid valve replacement was also high in the same study which is similar to some authors' findings [26,27]. This can be easily explained by severely compromised right ventricular function. On the other hand, coronary artery disease can have a detrimental effect on the outcome or to be of borderline significance as some authors stated [24,28]. In our study these factors did not have a significant impact on operative mortality.

Sex did not have an effect on the operative mortality in our series, which agrees with the findings of Cohn [28]. This is in contrary to what had been reported by Lytle [24] who found that female gender had an increased mortality risk for redo aortic valve, and Akins [11] who found that male gender had an increased mortality risk for any redo valve surgery at any given position. Again, age was not a significant risk factor in the univariate analysis of our study, but it was significantly associated with increased operative risk in some studies [24] whereas others had not found any [28].

A very acceptable explanation for falling mortality figures of repeat valve surgeries recently, is the advancement of intraoperative and perioperative care. For example, the improvements in valve technology, manufacturing and design, myocardial protection with multidose cardioplegia, improved monitoring facilities in intensive care units and relatively early detection and intervention of valve related complications [4,5].

Some authors also found a correlation between the degree of urgency of the reoperation and operative mortality. Thus Nonelective operation was documented as a predictor of death by Mazzucco [29]. Wei-Guo Ma *et al.,* [30] in 2015 concluded that the high mortality of 28.6% in emergency patients can be attributed to the poor general conditions, worsened cardiac function and inappropriately sufficient preoperative preparation. Therefore, he suggested that emergency reoperation, being a life saving, can be the only exemption from not preparing the patient properly [30]. In Akins study [6] 38% of the operations were nonelective and 44% required another concurrent cardiac procedure, and he concluded that best results were achieved when the valve replacement is done for a failed bioprosthesis electively and without the requirement for concurrent procedures. In several other reports, acute bacterial endocarditis was identified as a predictor of hospital mortality [19,23,24,29]. In our series endocarditis was not a significant predictor of hospital mortality.

In agreement with other studies, we found significant postoperative complications after redo-MVR such as supraventricular arrhythmias, sepsis, acute renal failure requiring renal replacement therapy and stroke [4]. This is expected owing to the high-risk profile of our patients giving the fact that (30.2%) of them had LV dysfunction as well as mean additive EuroSCORE of 11 ± 3. The association of complications with higher additive EuroSCORE was demonstrated by univariate analysis in this study. We also demonstrated that the LVEF <50% was an independent predictor of operative death in the short-term. Some authors for that reason recommend early intervention before irreversible myocardial damage and/or deteriorating LV function with their inherent surgical risk [16,31]. Prolonged hospital stay is not well described in the studies investigating redo MVR [17,19]. In this study, we had not found any correlation between pre-operative and operative variables and prediction of prolonged hospital stay. It is also

understandable that this is strongly linked to the early postoperative course and the occurrence of complications.

In some studies, early mortality had been associated with older age [3,5,18], female gender [16], advanced NYHA class [16,19], low left ventricular ejection fraction (<35), increased left ventricular end-diastolic diameter (>50 mm), pulmonary oedema, urgent operations [3,16,12], concomitant procedures [5,19] and previous myocardial infarction [12]. we found that preoperative impairment of the LVEF remains the most consistent risk factor for early and overall mortality following redo-MVR.

Conclusion

Repeat-MVR can be done safely and with a good overall outcome. We insist on early intervention before ventricular dysfunction occurs with its deleterious effects on the outcome of the redo surgery.

Limitations

This study has all the limitations of retrospective nature. The relatively small number of patients and the lack of late follow-up after the reoperation is another factor. In particular, information was not always available about the previous surgical techniques and details of valve prostheses used in initial valve replacement. Details of anticoagulation management after the initial procedure was also not clear, such as the target international normalized ratio (INR) pursued, the frequency of INR measurements and especially the INR values before the occurrence of valve dysfunction.

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