Surgical therapy of organic mitral valve disease: Strategy and outcomes

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Early and late results of surgical treatment for isolated active native mitral valve infective endocarditis

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ABSTRACT

Background. Native mitral valve infective endocarditis (IE) is a complicated disease with high mortality and morbidity rates. Mitral valve repair is feasible when limited valve destruction is present. However, recurrent valve dysfunction and reintervention are common.

Methods. Between January 2000 and March 2016, 83 patients underwent surgery for isolated active native mitral valve IE. We applied an early surgery, valve repair-oriented approach with progressive utilization of patch techniques to secure a durable repair; repair was attempted in 67% of patients. Fifty-one (61%) patients underwent valve repair (including full ring annuloplasty in 94%) and 32 (39%) patients underwent mitral valve replacement.

Results. Early mortality was 13%. No cases of early recurrent IE occurred. Pre-discharge echocardiography demonstrated good repaired valve function in all but 1 patient with residual (moderate) regurgitation. The mean duration of follow-up was 3.7 years (interquartile range 1.5–8.4). For hospital survivors, 8-year overall survival rates were 92.4% (95% CI: 84.0%-100%) and 74.2% (95% CI: 53.8%-94.6%) for the mitral valve repair and replacement group, respectively. Propensity score-adjusted Cox regression analysis revealed no significant difference in survival between both groups (hazard ratio 0.359, 95% CI 0.107-1.200; P=0.096). Four reinterventions occurred, 2 in each group. Echocardiographic follow-up demonstrated excellent repair durability; no cases of mitral regurgitation and 1 case of mitral valve stenosis were seen.

Conclusions. Native mitral valve IE is linked to high mortality and morbidity rates. A durable valve repair is feasible in most patients and provides excellent mid-term durability. Mitral valve replacement is a reasonable alternative when a durable repair is not likely.

INTRODUCTION

Active infective endocarditis (IE) is a complex disease, associated with high mortality and morbidity rates [1], and most commonly affecting the mitral valve [2]. Dreyfus et al. were one of the first to demonstrate the feasibility of mitral valve repair (MVRep) in the setting of active IE [3]. A meta-analysis of early studies on the efficiency of MVRep in the setting of IE accordingly demonstrated that valve repair, feasible at the time in 39% of cases, is linked to decreased early and late mortality, reoperation, and recurrent endocarditis rates [4].

More recent reports have demonstrated that an aggressive approach to MVRep will enable MVRep to be performed in a majority of patients undergoing intervention in the acute phase of the disease [5, 6]. This is, however, highly dependent on the extent of valve destruction; uncontrolled infection in the active phase of IE with a delayed referral to surgery might make MVRep impossible after careful resection of all infected tissue is carried out. Furthermore, long-term operated valve dysfunction after MVRep in the setting of active IE remains a concern [5, 7, 8]. Late clinical and echocardiographic data in patients with isolated native active mitral valve IE remain limited.

The aim of this study was to explore our single-center experience in patients with isolated active native mitral valve IE. During the study period, we have utilized an early repair-oriented surgical approach with liberal utilization of prosthetic ring annuloplasty. We sought to determine the early and mid-term clinical and echocardiographic results of surgical treatment in this patient group.

METHODS

Study Population

Patients who underwent surgical mitral valve intervention between January 2000 and March 2016 were potentially eligible for this study. Inclusion criteria were active mitral valve IE and ≥18 years of age. Patients with prosthetic valve IE or multiple-valve endocarditis were excluded. Isolated native mitral valve IE was defined as IE limited to the mitral valve, regardless of the concomitant procedures performed.

During the study period, 303 patients underwent mitral valve operation for mitral valve IE. 113 of these were suffering for isolated active mitral valve IE; 30 of these had prosthetic valve IE. Of the remaining 83 patients eligible for this study, 51 (61%) underwent MVRep and 32 (39%) underwent mitral valve replacement (MVR). Five (6%) of the latter underwent MVR after an initial unsuccessful repair attempt.

Study Methods

Our Institutional Ethics Committee approved this study. Data on preoperative, operative and postoperative details were obtained from our computerized database. Follow-up clinical and echocardiographic data were collected through clinical visits at our institution or affiliated clinics and hospitals and through telephonic interviews. The median survival follow-up time was 3.7 years [interquartile range (IQR) 1.5 – 8.4; 100% complete]. The median follow-up time for valve-related events was 3.6 years (IQR 0.9 – 7.8; 96% complete). The median echocardiographic follow-up time was 3.8 years (IQR 1.8 – 7.3; 90% complete). Patient follow-up was closed in July 2016.

Pre- and Postoperative Care

Infective endocarditis was diagnosed according to the modified Duke criteria [9]. Active IE was defined as ongoing antibiotic treatment within 6 weeks of the initial diagnosis and/or macroscopic evidence of valve endocarditis and/or positive intraoperative valve cultures or pathological report. Empiric antibiotic therapy was started after IE was diagnosed and blood cultures harvested. Antibiotic therapy was adjusted according to the antibiogram.

Surgical therapy was performed according to the European guidelines recommendations; the indication for surgery included clinical signs of heart failure, signs of uncontrolled infection (signs of locally uncontrolled infections, infection with unfavorable microorganisms or persistent positive blood cultures, despite optimal conservative management) and prevention of embolism [1]. Additionally, early surgery was considered when severe mitral regurgitation (MR) due to valvular destruction was observed on echocardiography. In patients who did not meet these criteria, antibiotic therapy was initiated and repeated echocardiographic examination (usually after 5-7 days) was performed. If progression to severe MR was observed on repeated echocardiography, surgery was performed. In 36 (43%) patients from the final study cohort, severe MR was the only indication for surgical intervention. In these patients, surgery was performed to prevent further valve destruction that would likely prevent subsequent

MVRep. Surgery was performed within 14 days of the diagnosis in 50 (60%) of all patients. All surgeries were performed by experienced mitral valve surgeons. Because to the high risk of failed MVRep in patients undergoing intervention in the active phase of IE, the possibility of MVR was discussed preoperatively in all cases. The decision on the type of prosthesis used was based on a shared decision with the informed patient.

Following surgery, pathogen-specific therapy was continued for a minimum period of 6 weeks. Oral anticoagulation was initiated after the operation and was maintained for 3 months in case of MVRep with prosthetic ring implantation or biological valve implantation (target international normalized ratio: 2.0 – 3.0). In case of mechanical valve implantation (target international normalized ratio: 2.5 – 3.5) or in the presence of other indications, oral anticoagulation was continued indefinitely. All patients underwent transthoracic echocardiography prior to hospital discharge.

Surgical Procedures

All patients were operated through a median sternotomy using standard techniques for extracorporeal circulation with double venous cannulation. Antegrade warm and/or retrograde tepid blood cardioplegia was used for cardioprotection in all cases. Systemic hypothermia was used when retrograde cardioplegia was used or when an extended cross-clamp time was anticipated.

In all patients, radical excision of all macroscopically infected tissue was performed, without concern for the possibility of subsequent MVRep. Isolated resection of vegetations was performed in case of well-circumscribed vegetations that did not invade the leaflet tissue. Annular abscesses were evacuated and closed with autologous or heterologous pericardial patch. Annular decalcification was performed when needed. The operative area was rinsed with a rifampicine solution prior to performing valve repair or replacement.

Following resection, MVRep was attempted when a durable repair was considered feasible. In general, at least 1 normal commissure and two-thirds of normal free edges of the leaflets were considered the minimum requirement to attempt a repair. Small defects were closed directly with a 5-0 polypropylene suture. For the posterior mitral valve leaflet, annular plication or leaflet sliding plasty was performed in case of larger defects. When insufficient residual native posterior mitral valve leaflet tissue remained and in cases of larger anterior mitral valve leaflet defects, reconstruction with autologous or heterologous pericardial tissue was performed. Commissural reconstruction was

performed with pericardial patch and/or leaflet sliding techniques. Commissural closure was additionally performed when indicated and the risk of high inflow gradient was minimal. Polytetrafluoroethylene neochords were implanted to support the neo free edge of reconstructed mitral leaflets and to treat residual leaflet prolapse.

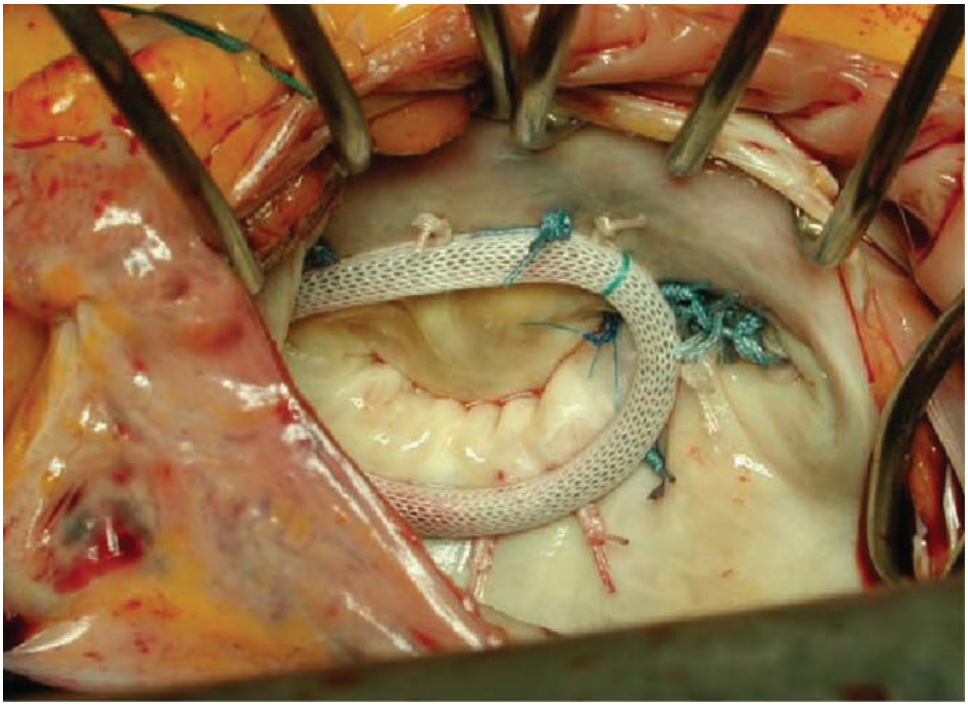

FIGURE 1. Intraoperative water test demonstrating restored valve competency.

Over the entire study period, pericardial patch techniques were progressively used to compensate for the lack of native valve tissue. Smaller defects were reconstructed with untreated autologous pericardium. Earlier in the series, bigger defects were reconstructed with glutaraldehyde-treated autologous or bovine pericardium; nowadays, we utilize decellularized bovine (CardioCel; AdmedusRegen Pty Ltd., Perth, WA, Australia) pericardium for extensive leaflet reconstruction. Ring annuloplasty was performed in all but 3 patients from the MVRep group; ring annuloplasty was deemed not necessary in patients with limited reconstruction and otherwise normal anatomy of the mitral valve. Intraoperative water-test was performed to asses any residual valve leakage (**Figure 1**).

In case of an unsuccessful repair attempt, infection of a considerable proportion of the mitral valve and/or when durable valve repair was beleived impossible, MVR was performed. Whenever possible, the subvalvular apparatus was spared; later in our series, we have utilized polytetrafluoroethylene neochords to substitute the infected or ruptured chords and enable maintenance of the continuity between the left ventricle and the mitral annulus.

Study Endpoints

Postoperative mortality and morbidity endpoints were defined according to the joint Society of Thoracic Surgeons, American Association for Thoracic Surgery, and European Association for Cardio-Thoracic Surgery Guidelines [10]. Early mortality was defined as mortality within 30 days after the operation or during the index hospitalization. Residual and recurrent MR were defined as ≥moderate regurgitation.

Statistical Analysis

Continuous data are presented as means ± standard deviation for normally distributed data or medians and interquartile ranges (IQR) when not normally distributed. Categorical data are presented as counts and percentages. The χ^2 and Fisher's exact tests were used for to analyze categorical variables. Independent-sample t-test and Mann-Whitney U-test (skewed data) were used to analyze continuous variables. Multivariable binary logistic regression analysis with a backward selection method was performed to identify the independent predictors of MVR. Variables showing a P-value of <0.10 on univariable analysis were included in the multivariable model.

For each patient, a propensity score was calculated from a multivariable logistic regression model on preoperative characteristics as independent variables with MVRep versus MVR as a binary dependent variable. Covariates included in the propensity score model were: female gender, age, hypertension, duration of antibiotic therapy (≥7 days), annular infection, *Staphylococcus aureus* infection, symptomatic MR, presence of degenerative mitral valve disease, haemodialysis, atrial fibrillation, previous cardiac surgery, impaired left ventricular function, critical preoperative state and aortic valve intervention. The propensity score was used as an independent variable in the multivariable regression and Cox proportional hazards regression analysis to correct for baseline differences between the 2 groups. Odds ratios (ORs) and hazard ratios (HRs) are reported with 95% confidence intervals (CIs).

Survival and freedom from reintervention rates were estimated using the Kaplan-Meier method. The log-rank test was used for statistical comparison of the Kaplan-Meier curves. A double sided P-value of <0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS Statistics for Windows (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp).

RESULTS

Demographic Characteristics

Demographic characteristics are presented in **Table I**. A higher proportion of females was seen in the MVR group. Preoperative peripheral embolism was seen in 28 (34%) patients with no significant differences between both groups; in 20 patients this included emboli to the central nervous system. The frequency of annular infection between both groups failed to reach statistical significance. Interestingly, underlying degenerative mitral valve disease was more commonly observed in the MVRep group.

Intraoperative Details

Intraoperative details are shown in **Table II**. Multivariable analysis demonstrated underlying degenerative mitral valve disease as a predictor of successful MVRep (**Table III**). Of notice, annular infection or calcification and the timing of surgery were not predictive factors for MVR .

Early Mortality and Morbidity

There were no significant differences in the postoperative mortality and morbidity rates between the 2 groups (**Table IV**). When corrected for the propensity score, multivariable regression analysis demonstrated no effect of MVR versus MVRep on early mortality (OR: 2.010, 95% CI 0.372-10.863; P=0.41).

Early Echocardiographic Result

In the MVRep group, pre-discharge echocardiography demonstrated good function of the repaired valve in all but 1 patient in whom residual moderate MR was seen. Due to the poor clinical condition of this patient, no early reoperation was performed.

TABLE I. Baseline characteristics and intraoperative details.

	Mitral valve repair (n=51)		Mitral valve replacement (n=32)		
	n	**%**	**n**	**%**	**P-value**
Age (years)	55±14		60±13		0.11
Female sex	13	*26*	15	*47*	0.045
Hypertension	16	*31*	11	*34*	0.78
Chronic lung disease	3	*6*	5	*16*	0.25
Diabetes mellitus	6	*12*	8	*25*	0.12
Atrial fibrillation	6	*12*	2	*6*	0.48
Creatinine (mmol/l)	82 (IQR 66–100)		70 (IQR 55–102)		0.19
Preoperative hemodialysis	3	*6*	4	*13*	0.42
Previous cardiac surgery	2	*4*	2	*6*	0.64
Symptomatic mitral regurgitation	15	*29*	9	*28*	0.90
Critical preoperative state	5	*10*	5	*16*	0.50
Impaired left ventricular function	10	*20*	3	*9*	0.21
Peripheral embolism	16	*31*	12	*38*	0.57
Causative microorganism					0.35
Streptococcus species	33	*65*	15	*47*	
Staphylococcus species	9	*17*	10	*31*	
Staphylococcus aureus	8	*15*	8	*25*	
Enterococcus fecalis	5	*10*	5	*16*	
Other or culture negative	4	*8*	2	*6*	
Indication for surgery					
Heart failure	6	*12*	5	*16*	0.74
Uncontrolled infection	7	*14*	6	*19*	0.54
Prevention of embolism	16	*13*	17	*53*	0.049
Severe mitral regurgitation	41	*80*	12	*38*	<0.001
Preoperative antibiotic therapy duration (days)	13 (IQR 8–29)		9 (IQR 5–16)		0.034
≤7 days	12	*24*	13	*41*	0.098
Degenerative mitral valve disease	22	*43*	6	*19*	0.022
Annular infection	5	*10*	8	*25*	0.064
Annular calcification	5	*10*	7	*22*	0.20
Concomitant procedures					
Coronary artery bypass grafting	5	*10*	3	*9*	1.00
Aortic valve or root replacement	1	*2*	6	*19*	0.012
Tricuspid valve repair	6	*12*	4	*13*	1.00
Aortic cross-clamp time (min)	165 (IQR 120-184)		137 (IQR 112–239)		0.69
Cardiopulmonary bypass time (min)	203 (IQR 158-234)		175 (IQR152–243)		0.97

Continuous data are presented as means ± SD or medians with IQR.

TABLE II. Mitral valve repair and replacement details.

	Mitral valve replacement (n=32)	
	n	*%*
Biological prosthesis	16	*50*
Medtronic Mosaic*	9	*28*
Perimount Magna***	7	*22*
Mechanical prosthesis	16	*50*
St. Jude Medical Regent**	16	*50*
Prosthesis size (mm)		
27	5	*16*
29	13	41
31	11	*34*
33	3	*9*

	Mitral valve repair (n=51)	
Ring annuloplasty	48	*94*
Physioring***	43	*90*
Memo 3D****	3	*6*
Medtronic CG Future*	1	*2*
CarboMedics AnnuloFlex*****	1	*2*
Ring annuloplasty size (mm)		
26-28	12	*24*
30-34	27	*53*
≥36	9	*17*
Annular plication	21	41

	AMVL		PMVL		Commissures	
	n	**%**	**n**	**%**	**n**	**%**
Resection	23	*45*	35	*69*	10	*20*
Reconstruction with auto-/xenologous pericardium (or commissural closure)	22	*43*	14	*28*	14	*28*
Neochords implantation	17	*33*	10	*20*	4	*8*
Chordal transposition	-		1	*2*	-	
Papillary muscle head repositioning	-		-		3	*6*
Vegectomy	3	*6*	5	*10*	1	*2*
Leaflet sliding plasty	-		8	*16*	-	
Identation closure	-		1	*2*	-	

Abbreviations: AMVL: anterior mitral valve leaflet; PMVL: posterior mitral valve leaflet
**Medtronic, Minneapolis, MN, USA; **St. Jude Medical, Little Canada, MN, USA; ***Edwards Lifesciences, Irvine, CA, USA; ****Sorin Group, Milan, Italy; *****CarboMedics, Austin, Tex, USA*

TABLE III. Univariable and multivariable analysis on predictors of mitral valve replacement.

	Univariable analysis			Multivariable analysis		
	OR	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Annular infection	3.07	(0.90 – 10.40)	0.072	…	…	…
Annular calcification	2.58	(0.74 – 8.96)	0.14	…	…	…
Female sex	2.58	(1.01 – 6.59)	0.048	2.51	(0.95 – 6.60)	0.063
Age (years)			0.42	…	…	…
60 – 74.9	1.92	(0.65 – 5.65)	0.24	…	…	…
≥75	2.57	(0.42 – 17.05)	0.30	…	…	…
Staphylococcus aureus infection	1.79	(0.60 – 5.38)	0.30	…	…	…
Early surgery (≤7 days)	2.22	(0.85 – 5.79)	0.102	…	…	…
Degenerative disease	0.30	(0.11 – 0.87)	0.026	0.31	(0.11 – 0.91)	0.032
Peripheral embolism	1.31	(0.52 – 3.32)	0.57	…	…	…
Symptomatic mitral regurgitation	0.94	(0.35 – 2.50)	0.90	…	…	…
Preoperative hemodialysis	2.29	(0.48 – 10.96)	0.30	…	…	…
Critical preoperative state	2.18	(0.54 – 8.80)	0.28	…	…	…
Impaired left ventricular function	0.42	(0.11 – 1.68)	0.22	…	…	…
Commissural involvement	1.06	(0.36 – 3.16)	0.91	…	…	…

Hosmer-Lemeshow goodness-of-fit: 0.93; Nagelkerke R^2 square: 0.14
Abbreviations: CI: confidence interval; OR: odds ratio.

TABLE IV. Postoperative mortality and morbidity.

	Mitral valve repair (n=51)		Mitral valve replacement (n=32)		
	n	**%**	**n**	**%**	**P-value**
Early mortality	6	*12*	5	*16*	0.74
Mechanical circulatory support	2	*4*	1	*3*	1.00
Surgical re-exploration	10	*20*	3	*9*	0.21
Prolonged intubation (≥48 h)	15	*30*	6	*20*	0.28
Postoperative renal failure	9	*18*	6	*19*	0.89
Intensive care unit stay (days)	2 (IQR 1–7)		2 (IQR 1–5)		0.81
Postoperative stroke	1	*2*	0	*0*	0.39
Pacemaker implantation	0	*0*	2	*6*	0.15

Continuous data are presented medians with IQR.

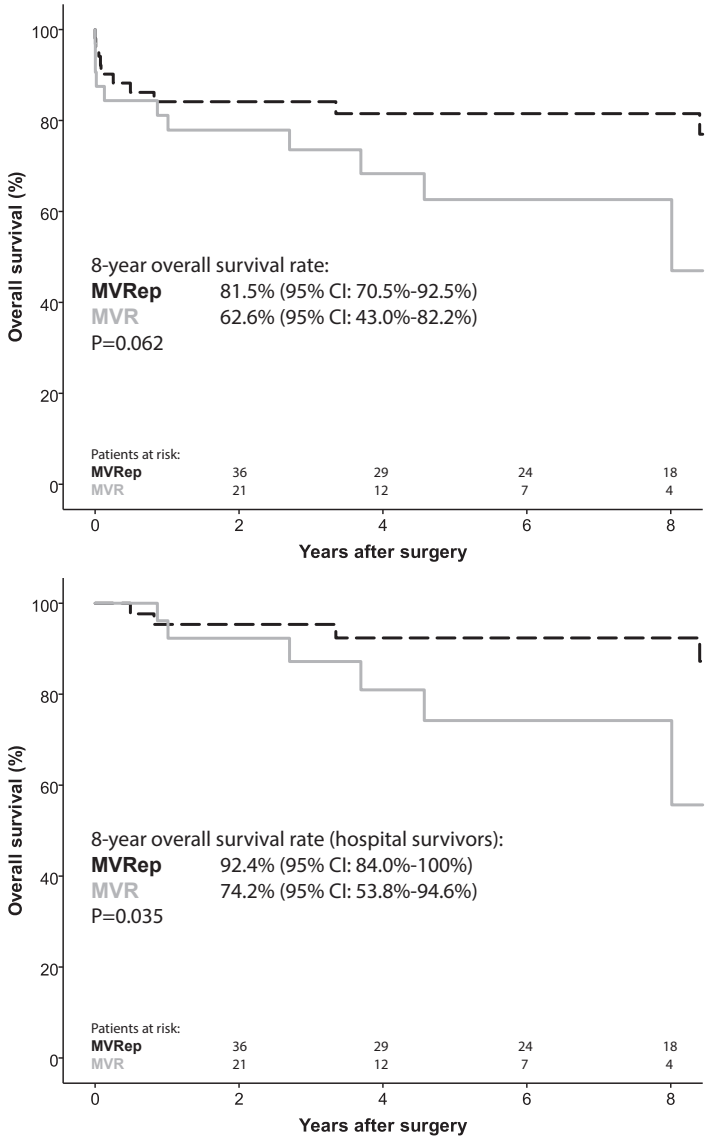

FIGURE 2. **Above**: Overall survival for all patients. **Below**: Overall survival excluding cases of early mortality.

Late Morbidity and Mortality

Fourteen late deaths occurred. There were 2 valve-related deaths (1 due to intracranial hemorrhage after previous mechanical valve replacement and 1 after transapical mitral valve-in-valve implantation), 1 death due to congestive heart failure, 5 sudden

unexplained deaths, and 6 non-cardiac deaths. At 8 years after surgery, the overall survival rates were 81.5% (95% CI: 70.5%-92.5%) and 62.6% (95% CI: 43.0%-82.2%) for the MVRep and MVR group, respectively (P=0.062; **Figure 2**). For hospital survivors only, the 8-year overall survival rates were 92.4% (95% CI: 84.0%-100%) and 74.2% (95% CI: 53.8%-94.6%) for the MVRep and MVR group, respectively. Corrected for the propensity score, Cox regression analysis failed to demonstrate a statistical significance difference between the 2 groups (HR 0.359, 95% CI 0.107-1.200; P=0.096).

No thromboembolic events or episodes of recurrent IE occurred. Four patients experienced serious haemorrhagic complications (1 resulting in death). The most recent follow-up reported 58 patients to be alive: 85% were in NYHA functional class I and 15% were in NYHA functional class II (follow-up complete in 55 patients).

Freedom from Reintervention

Four patients needed mitral valve reintervention; 2 from the MVRep and 2 from the MVR group. At 8 years after surgery, the freedom from reintervention rates were 94.8% (95% CI: 87.7%-100%) and 94.7% (95% CI: 84.7%-100%) for the MVRep and MVR group, respectively (P=0.38) (**Figure 3**).

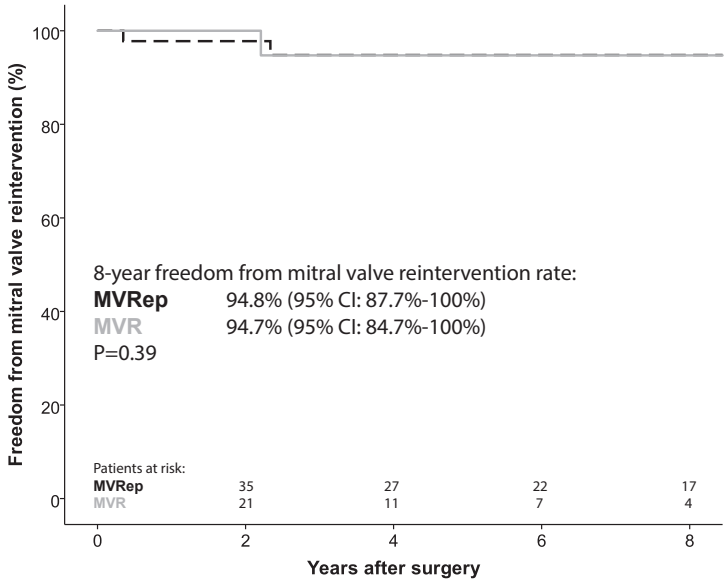

FIGURE 3. Freedom from operated valve reintervention.

In the MVR group, structural valve degeneration necessitating reintervention occurred in 2 patients, 2.5 and 10 years after (biological) valve implantation. The first patient underwent a re-MVR with a biologic prosthesis. The other patient underwent a transapical mitral valve-in-valve implantation and died in the early postoperative period [11].

In the MVRep group, reoperation was needed in 2 patients, 4 months and 2.5 years after initial repair. The first patient, discharged initially with residual, moderate MR, developed severe MR originating from the posterior commissure (commissural closure was performed during the initial operation). Following acute cardiac decompensation, an urgent MVR was performed. The other patient underwent an MVR after development of clinical and echocardiographic signs of mitral valve stenosis due to pannus formation. An annuloplasty ring size 26mm was implanted during the initial operation.

FIGURE 4. Freedom from structural valve deterioration.

Echocardiographic Follow-up

Following successful repair, 1 patient from the MVRep group developed mitral valve stenosis and underwent reintervention. No other cases of recurrent MR or mitral valve stenosis occurred in this group. For MVRep, the 8-year freedom from structural valve

deterioration rate was 96.4% (95% CI: 89.3%–100%). Although the small number of patients at risk needs to be taken into account while interpreting the data, valve performance following valve repair showed better results than after MVR (**Figure 4**).

DISCUSSION

Surgical intervention for mitral valve IE has been linked to high early mortality and morbidity [5, 8, 12]. Similar early results were seen in our experience. We failed to demonstrate a significant effect of MVRep on early mortality. Our decision to perform valve repair or replacement was driven predominantly by the extent of valve destruction, and primary MVR did not negatively affect the early outcome.

Prompt surgical intervention was considered the standard of care when a patient was presented with a guideline-defined trigger for intervention [1]. However, a proportion of our patient cohort underwent operation without a guideline-defined trigger for surgical intervention. In these patients, early surgery was performed as ongoing tissue destruction would lower the probability of subsequent MVRep [3, 7]. Such strategy of early surgical intervention has enabled us to perform MVRep in 61% of all patients. In many patients with IE of the mitral valve, the diagnosis is commonly delayed, often resulting in significant tissue destruction prior to the initiation of antibiotic therapy. The duration of antibiotic therapy is therefore of little help to predict valve reparability. We reason that patients with newly diagnosed mitral valve IE should be presented to centers experienced in reconstructive valve surgery immediately after the diagnosis is established to further improve the probability of MVRep.

A high proportion of patients presented with a history of peripheral embolism and the central nervous system was involved in the majority of these. One week after the initiation of antibiotic therapy, the risk of peripheral embolism decreases substantially, challenging the need to perform surgery when prevention of peripheral embolism is the sole indication for surgery [13]. In patients with a recent neurological complication, surgery was historically postponed for 2-4 weeks to prevent further neurological deterioration resulting from the operation. Recent evidence has challenged such an approach, demonstrating that surgery within the first 2 weeks of a neurological event might be

performed safely [14, 15]. In these patients an individualized approach is needed and the expected risk of further neurological deterioration needs to be weighed against the probability and expected clinical gain of MVRep.

Interestingly, underlying degenerative mitral valve disease with the presence of excessive leaflet tissue was predictive of successful MVRep. In our experience, MVRep is somehow technically less challenging in these patients as often there will be sufficient excessive native leaflet tissue to support a durable MVRep. The demonstrated durability of MVRep supports an aggressive repair approach even in the presence of active IE in patients with degenerative mitral valve disease.

The durability of MVRep in the setting of IE remains a concern [5, 7, 8, 16]. Combined with an early surgery strategy, our systematical approach to MVRep with progressive utilization of patch techniques has yielded encouraging mid-term repair durability. Previously, de Kerchove et al. reported a repair rate of 80% in a study on 137 patients with active mitral valve IE [5]. The authors demonstrated a remarkable level of surgical expertise and utilized several technical demanding techniques (e.g. partial homograft MVR) to secure such a high repair rate. While their repair rate exceeds the repair rate observed in our experience, the authors reported a freedom from mitral valve reoperation of only 89% at 8-years after surgery. In our experience, recurrent valve dysfunction was uncommon after successful valve repair (without residual MR), and only 1 reoperation was seen during the follow-up period. Based on the previously reported inferior results of partial homograft MVR and the known possibility of fibrosation and/or calcification of the implanted pericardial patches [17, 18], we are reluctant to perform valve repair when valve destruction is too severe. It seems that such an approach has enabled us to select patients in whom a durable valve repair was feasible. In cases of extensive destruction of the native mitral valve, MVR provides satisfactory results and should therefore be preferred to a complex repair with questionable durability. When the mitral valve is replaced, it is of paramount importance to preserve the left ventricular geometry by sparing the subvalvular apparatus (or replacing it with neochords).

Controversy on the use of prosthetic materials in the setting of active IE remains. This is partially caused by the fear of bacterial colonization prior to endothelization of prosthetic materials as well as by the fear of late prosthetic valve IE occurrence; both are associated with high mortality and morbidity [19]. Available evidence, however, suggest that the risk of residual IE is actually low [4]. We liberally utilize prosthetic ring annuloplasty in cases of active IE. In our experience, no residual cases or recurrences of IE

were observed. This might partially be explained by rigorous resection of infected tissue consistently performed in our institution in combination with rinsing the operation field with a rifampicin solution. Irrespective of the underlying cause, our data confirm that prosthetic ring annuloplasty is safe in the setting of active IE, provided that radical resection of all infected tissue is performed.

Based on the demonstrated durability of MVRep seen in our experience, we believe that ring annuloplasty is an important prerequisite for successful valve repair. In most of these patients, the mitral valve annulus is diseased as well, either in the context of underlying degenerative valve disease or IE involving the annulus itself, and needs to be addressed. Furthermore, annuloplasty reduces the stress on reconstructed mitral valve leaflets and the tension on the subvalvular apparatus, improving the durability of valve repair. However, in case of a small, non-dilated mitral valve annulus, the possible advantages of ring annuloplasty should be weighed against the possible risk of mitral valve stenosis development. Our data also seem to suggest that in case of tissue resection and lack thereof for reconstruction, patch material should be used to reconstruct the leaflets. This should be preferred to annular plication and/or the implantation of a small ring.

It has been demonstrated that minimal invasive mitral valve surgery is feasible in patients with active mitral valve IE [20]. In our opinion, mitral valve surgery in this setting is complex in cases of both MVRep or MVR. Minimal invasive surgery should be performed only if radical resection and the probability of MVRep are not jeopardized. Further research is needed to establish the role of minimal invasive surgery in this setting.

LIMITATIONS

This is a retrospective single-center study with study limitations inherent to the study design. The limited number of patients at risk –our sample size compares fairly with other available studies- lowered the power of our statistical analyses. The findings of our study will need to be confirmed further. Furthermore, the proportion of patients with underlying degenerative disease was uneven between patients undergoing MVR and MVRep. The severity and duration of MR (possibly resulting in complications related to long-lasting MR) prior to the diagnosis of IE was unknown, making patients with underlying degenerative disease highly heterogenic and introducing a bias we were

unable to statistically correct for. One could, however, assume that because of the asymptomatic patient status prior to the diagnosis of IE, the likelihood of long-standing severe MR that would result in irreversible changes is limited.

CONCLUSIONS

Native mitral valve IE is linked to high mortality and morbidity rates. The probability of residual IE occurrence is low and prosthetic ring annuloplasty is not contraindicated in these patients. MVRep in the setting of active IE provides excellent mid-term durability. MVR is a reasonable alternative for patients in whom a durable repair is not feasible.

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