Archives of Cardiovascular Disease 115 (2022) 160—168

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CLINICAL RESEARCH

Mitral valve repair is better than mitral valve replacement in native mitral valve endocarditis: Results from a prospective matched cohort☆

La réparation valvulaire mitrale donne de meilleurs résultats que le remplacement valvulaire mitral dans l'endocardite mitrale native : résultats d'une cohorte prospective

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Abbreviations: CI, confidence interval; CSH, cause-specific hazard ratio; ESC, European Society of Cardiology; HR, hazard ratio; IE, infective endocarditis; MVR, mitral valve replacement; MVRep, mitral valve repair; NMIE, native mitral valve infective endocarditis.

☆ Tweet: In mitral valve endocarditis, surgical repair is better than replacement. Mitral valve repair should be preferred even in the very acute phase of endocarditis.

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https://doi.org/10.1016/j.acvd.2022.02.002

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Received 17 August 2021; received in revised form 5 February 2022; accepted 7 February 2022
Available online 23 February 2022

KEYWORDS
Mitral valve repair;
Cardiac surgery;
Infective endocarditis

Summary
Background. — In native mitral valve infective endocarditis (NMIE), the respective values of mitral valve repair (MVRep) and replacement (MVR) are still debated.
Aim. — To compare MVRep and MVR in a large prospective matched cohort.
Methods. — Between 2010 and 2017, all consecutive patients operated on for NMIE in our centre were included prospectively. Clinical and outcome features were compared between the two groups. Primary endpoint was event-free survival, including death, reoperation and relapse. Univariate and multivariable survival analyses and a propensity score analysis were performed.
Results. — Among 152 patients, 115 (75.7%) underwent MVRep, and 37 (24.3%) MVR. Median follow-up was 28 ± 22 months. Surgery was performed during the active phase in 75.0% of patients (25.7% on an urgent basis). Compared with the MVRep group, patients in the MVR group were more frequently intravenous drug abusers (10.8% vs. 0.9%; $P = 0.016$), had a more frequent history of rheumatic fever (13.5% vs. 0%; $P = 0.001$), more aortic abscesses (16.7% vs. 3.5%; $P = 0.018$), larger vegetations (16.6 ± 8.1 mm vs. 12.6 ± 9.9 mm; $P = 0.042$) and poorer New York Heart Association status ($P = 0.006$). Overall mortality was lower in the MVRep group than in MVR group (11.3% vs. 29.3%; $P = 0.018$). Event-free survival was better in the MVRep group than in the MVR group in univariate analysis (hazard ratio: 2.72, 95% confidence interval: 1.34—5.52; $P = 0.004$). Survival analysis in the propensity-matched cohort showed that MVRep was safer than MVR (log rank test: $P = 0.018$). Multivariable analysis using the Cox proportional hazard model confirmed this finding (hazard ratio: 3.48, 95% confidence interval: 1.15—10.61; $P = 0.03$).
Conclusions. — MVRep is feasible in most cases of NMIE and, when technically possible, should be preferred, even in urgent surgery.

MOTS CLÉS
Réparation valvulaire mitrale ;
Chirurgie cardiaque ;
Endocardite infectieuse

Résumé
Contexte. — Dans l'endocardite mitrale sur valve native (EMVN), l'intérêt respectif de la réparation valvulaire mitrale (RepVM) et du remplacement valvulaire prothétique (RVM) est débattu.
Objectif. — Comparer RepVM et RVM dans une cohorte prospective d'EMVN.
Méthodes. — Entre 2010 et 2017, tous les patients opérés pour EMVN ont été inclus prospectivement. Les données cliniques et pronostiques ont été comparées entre les 2 groupes. Le critère de jugement principal était la survie sans décès, réoperation, ou récidive. Une analyse de survie uni- et multivariée a été pratiquée ainsi qu'un score de propensité.
Résultats. — Parmi 152 patients opérés, 115 (75,7 %) ont bénéficié d'une RepVM, et 37 (24,3 %) d'un RVM. Le suivi moyen était de 28 ± 22 mois. La chirurgie a été pratiquée en phase active chez 75,0 % des patients, en urgence chez 25,7 %. Les patients ayant eu un RVM étaient plus fréquemment toxicomanes (10,8 % vs 0,9 % ; $p = 0{,}016$), avaient plus d'antécédent de rhumatisme articulaire aigu (13,5 % vs 0 % ; $p = 0{,}001$), plus d'abcès aortique (16,7 % vs 3,5 % ; $p = 0{,}001$) et de plus longues végétations ($16{,}6 \pm 8{,}1$ vs $12{,}6 \pm 9{,}9$ mm ; $p = 0{,}042$). La mortalité était plus faible dans le groupe RepVM (11,7 % vs 29,7 % ; $p = 0{,}022$). La survie sans évènement était meilleure dans le groupe RepVM en analyse univariée (HR : 2,72, IC95 % : 1,34—5,52 ; $p = 0{,}004$). L'analyse par score de propensité montre que le RepVM est meilleur que le RVM (log rank test : $p = 0{,}018$). L'analyse multivariée utilisant le modèle de Cox confirme ces données (HR : 3,48, IC95 % : 1,15—10,61 ; $p = 0{,}03$).
Conclusions. — La réparation mitrale est faisable dans la majorité des cas d'EMVN et doit être la technique chirurgicale préférée, même en cas de chirurgie urgente.

Background

Infective endocarditis (IE) remains a life-threatening disease, despite recent medical and surgical improvements, with a 10% in-hospital mortality rate [1] and a 20—30% 1-year mortality rate [1,2]. Surgery, along with antibiotic therapy, is the treatment cornerstone. Indeed, around 75% of cases require surgery, according to European Society of Cardiology (ESC) guidelines [3], but it is actually only performed in almost half of cases [4].

In patients with native mitral valve infective endocarditis (NMIE), mitral valve repair (MVRep) is technically challenging. Some surgeons favour mitral valve replacement (MVR), because of the frequent need for extensive resection of the infected tissue [5,6]. Although several recent publications have reported the feasibility and good long-term outcomes of MVRep in active endocarditis, conclusions remain uncertain because of retrospective design and unmatched cohorts [6—9].

The aim of our study was to compare the value of MVRep and MVR in terms of outcome in patients with acute NMIE.

Methods

Population

All patients with NMIE, who were hospitalized in the Cardiology Department of La Timone Hospital (Marseille, France) between January 2010 and January 2017, were included in this prospective cohort study. We included all cases of definite NMIE, according to the ESC modified criteria [3] and confirmed by the endocarditis team, who underwent surgery. Patients with prosthetic mitral valve endocarditis, patients aged < 18 years and pregnant women were excluded.

Data registration

For each patient, clinical, biological, microbiological and echocardiographic data were gathered prospectively. Medical treatment and surgical indications were based on the ESC guidelines, and then adapted to each patient case after discussion with the endocarditis team, using a multidisciplinary approach. A full-body computed tomography scan was usually carried out on each patient. Time to surgery was specified as follows: ''emergency surgery'' was performed within 24 hours; ''urgent surgery'' was performed within 7 days; ''elective surgery'' was performed after 1 week, but within 45 days; and ''delayed surgery'' was performed after 45 days. Each surgery was realized by an expert surgeon who was part of endocarditis team.

Systematic postoperative transthoracic and transoesophageal echocardiography were performed to evaluate repair results and to quantify mitral stenosis and regurgitation according to current recommendations [10,11]. Significant mitral stenosis was defined as a mitral valve area < 1.5 cm^2, and was considered mild to moderate when the mean gradient was 5—10 mmHg, and severe when the mean gradient was > 10 mmHg [11]. Mitral regurgitation severity was classified as absent, mild, moderate or severe, according to current guidelines [10]. Data were collected during regular visits by the cardiologist and infectious disease specialist at 1, 3, 6 and 12 months after the end of the treatment. Whenever data were missing, we gathered them by contacting the patient's physician, the patient or their family.

Endpoints

The primary endpoint was ''event-free survival'', defined as a composite endpoint, including all-cause mortality, relapse and reoperation. Secondary endpoints were in-hospital mortality, overall mortality, relapse, reoperation, presence and severity of postoperative mitral regurgitation or stenosis and postoperative left ventricular ejection fraction, defined as a continuous covariate.

Statistical analysis

Continuous variables are expressed as medians ± standard deviations and categorical variables as numbers (percentages). Continuous variables were compared by Student's *t*-test or the Mann—Whitney—Wilcoxon test, as appropriate, and categorical variables by Pearson's χ^2 test or Fisher's exact test, as appropriate. A survival analysis was performed using the Cox hazard model for the primary outcome analysis, and the Cox cause-specific hazard model (adapted to a competing risk framework) for the secondary outcome analysis. The proportionality assumptions were tested by graphical checks. The multivariable model was built by including initially all risk factors for primary outcome that met the 0.20 significance threshold in the univariate analysis. The final model resulted from a stepwise variable selection process using the Akaike information criterion. Potential interactions were tested in the final model. Missing data were dealt with as follows: multiple imputation by chained equations if < 30%; and variable excluded if > 30%. In case of multiple imputation by chained equations, data were imputed using an imputation model repeated 10 times. An analysis model was fitted in each of the 50 imputed datasets separately, and these 50 datasets were therefore pooled, and gave overall sets of estimates and corresponding standard errors. The results are given as hazard ratios (HRs) and 95% confidence intervals (CIs) for the Cox hazard model, and as cause-specific hazard ratios (CSHs) and 95% CIs for the Cox cause-specific hazard model.

We then constructed a propensity score, which represented the probability of treatment assignment, conditional on observational baseline characteristics. Using logistic regression, we used the following variables: age, sex, comorbid condition (history of IE, human immunodeficiency virus, intravenous drug abuse, diabetes mellitus, high blood pressure, chronic kidney disease, end-stage renal disease, cancer), initial presentation at admission (heart failure, cardiogenic or septic shock, cerebral embolism, complete atrioventricular block), IE characteristics at admission (severe aortic stenosis, severe mitral stenosis, presence of vegetation, maximal length of vegetation, multiple valves), presence of IE complication (pseudoaneurysm, fistula, aortic annular abscess), positive blood culture, left ventricular ejection fraction at admission and biological data at admission (brain natriuretic peptide, creatinine concentration, leukocyte count and C-reactive protein). Patients

with MVRep were matched 1:1 with patients with MVR by the estimated propensity score, using nearest neighbour matching, with a caliper of 0.2 standard deviations of the logit of the propensity score. Standardized differences were determined to ascertain balance between the propensity-matched groups. The Cox proportional hazard model was performed in the matched cohort to assess primary outcome.

All analyses were carried out using R 3.5.3 (R foundation for Statistical Computing, Vienna, Austria).

Results

Patient characteristics

Between January 2010 and January 2017, 152 patients were included in this study: 68.2% were male, and the median age was 60 ± 14 years (Table 1). Systemic embolism was present in 48.2% of patients (24.6% cerebral embolism). The most frequently isolated pathogens were *Streptococcus viridans* (28.3%), methicillin-sensitive *Staphylococcus aureus* (20%) and *Enterococcus* (16.7%). In addition, 51 patients (33.6%) had aortic localization. IE was nosocomial in 9.9% of patients.

Mitral valvular lesions were mostly severe mitral regurgitation (73.7%) and vegetations (67.8%), with valvular perforation in 64 patients (42.7%), mitral chordae rupture in 27 (18.6%) and mitral annular abscess in 24 (16.1%). One hundred and fifteen patients (75.7%) underwent a mitral valve repair (MVRep group), and 37 patients (24.3%) had a mitral replacement (MVR group). Fifty-five patients (36.2%) underwent concomitant aortic valve replacement. Only four patients had concomitant tricuspid annuloplasty (2.6%). Median duration of follow-up was 28 ± 22 months.

Patients in the MVR group more frequently had previous rheumatic fever and mitral stenosis and were more frequently intravenous drug abusers than patients in the MVRep group. The MVR group also had more aortic annular abscesses and larger vegetations than the MVRep group. The MVR group presented poorer clinical status, poorer New York Heart Association status and a tendency towards more cerebral embolism.

Surgical findings and techniques (Table A.1)

One hundred and fourteen patients (75.0%) were operated on during the active phase (2.0% as an emergency; 25.7% during the first week). Thirty-seven patients (24.3%) had delayed surgery (a mean of 99.26 [range: 35—260] days after admission). No difference was observed in surgical delays between the two groups.

In the MVRep group, the most frequently used techniques were mitral annuloplasty (71.1%), use of pericardial patch (49.1%), quadrangular section (30.7%) and commissuroplasty (23.7%). Artificial neochordae were used in 12.3% of cases.

Outcomes

In-hospital mortality was observed in five patients (4.3%) in the MVRep group and six (16.2%) in the MVR group. Relapse occurred in three patients (2.6%) in the MVRep group and six (16.2%) in the MVR group. Finally, reintervention was necessary in two patients in each group, corresponding to 1.3% of the MVRep group and 5.4% of the MVR group (Table 2).

Type of surgery (MVRep versus MVR) was strongly associated with the occurrence of in-hospital mortality (CSH: 3.51, 95% CI: 1.35—9.10; $P = 0.008$) and relapse of IE (CSH: 4.79, 95% CI: 1.35—17.01; $P = 0.015$). Reintervention was not associated with surgery (CSH: 2.21, 95% CI: 0.36—13.28; $P = 0.21$) (Table 3, Fig. 1 and Central Illustration). The timing of surgery did not affect prognosis.

Propensity score

By using propensity score matching, 37 patients were selected from each group. The patients' characteristics in the two groups after matching are detailed in Table A.2. The distribution of propensity score is detailed in Fig. A.1.

Principal outcome was observed in six patients (16.2%) in the MVRep matched group and in 14 (37.8%) in the MVR matched group. Kaplan—Meier curve analysis highlighted a statistical difference (P for log rank test = 0.018; Fig. 2).

Univariate cox proportional hazard regression analysis in the matched cohort showed that MVR was strongly associated with poor outcome in both univariate analysis (HR: 3.52, 95% CI: 1.16—10.70; $P = 0.02$) and multivariable analysis (HR: 3.48, 95% CI: 1.15—10.61; $P = 0.03$). Nosocomial infection and diabetes mellitus were also associated with poor outcomes (Table A.3).

A repeat propensity analysis was performed after exclusion of patients with delayed surgery. We identified 27 patients matched from each group, and found similar protective effects of MVRep.

Discussion

To the best of our knowledge, our study represents the largest prospective cohort of operated NMIE comparing MVR and MVRep. Results indicated that: (1) MVRep was often technically feasible (in 76% of cases); (2) MVRep was associated with better outcome, better survival and fewer relapses than MVR in NMIE; and (3) this remained true using propensity score analysis.

MVRep versus MVR

In our study, MVRep was associated with better event-free survival than MVR. Our results are consistent with, but overcome those of previously published studies. In 2005, Ruttmann et al. showed in 68 patients operated on for mitral IE that MVRep offered better survival than MVR at both 1-year and 10-year follow-up [12]. In a recent large retrospective cohort from the USA, including 1970 patients with primary MVRep ($n = 367$, 19%) or MVR ($n = 1603$, 81%) for active IE, 12-year survival was 68.8% after MVRep vs 53.5% after MVR ($P = 0.002$). MVRep was associated with a lower rate of recurrent IE at 12 years (4.7% vs. 9.5%; $P = 0.03$), and a similar rate of reoperation (9.1% vs. 8.6%; $P = 0.12$) [6]. In another large retrospective cohort (6627 patients), Gammie et al. [13] reported a higher operative mortality with MVR than with MVRep (3.7% vs. 10.8%). In a meta-analysis of 24 studies, involving 724 patients who had MVR and 470 who

Table 1 Patient characteristics.

	Total ($n = 152$)	MVRep ($n = 115$)	MVR ($n = 37$)	*P*
Medical history				
Age (years)	60 ± 14	59 ± 15	58 ± 14	0.77
Male sex	103 (68.2)	78 (67.8)	25 (67.6)	1
Previous IE	9 (5.9)	7 (6.1)	2 (5.4)	1
HIV	2 (1.3)	1 (0.9)	1 (2.7)	1
IV drug abuse	5 (3.3)	1 (0.9)	4 (10.8)	0.016
Diabetes mellitus	24 (15.8)	15 (13)	9 (24)	0.17
HBP	46 (30.3)	34 (29.6)	13 (35.3)	0.67
AF	13 (9.3)	13 (11.3)	2 (5.4)	0.47
Coronary arterial disease	13 (8.6)	8 (7.0)	6 (16.2)	0.171
PAD	10 (6.6)	8 (7.0)	2 (5.4)	0.99
Stroke	9 (5.9)	5 (4.3)	5 (13.5)	0.12
COPD	15 (9.9)	11 (9.7)	4 (10.8)	1
Chronic kidney disease	13 (8.6)	7 (6.1)	6 (16.2)	0.11
Cancer	19 (12.5)	15 (13.0)	4 (10.8)	0.94
Rheumatic fever	5 (3.3)	0 (0)	5 (13.5)	0.001
Previous mitral regurgitation	21 (13.9)	16 (13.9)	6 (16.2)	0.94
Previous mitral stenosis	3 (2.0)	0 (0)	3 (8.1)	0.016
Previous mitral valvular prolapse	14 (9.3)	12 (10.4)	2 (5.4)	0.51
Nosocomial IE	15 (9.9)	10 (8.7)	5 (13.5)	0.73
Clinical findings				
Weight (kg)	70 ± 16.5	69.2 ± 15.5	77.0 ± 19.1	0.069
HR	88 ± 16.4	88 ± 17	85 ± 14	0.54
NYHA status				0.006
I	70 (46.0)	56 (48.7)	14 (37.8)	
II	30 (19.7)	23 (20.0)	7 (18.9)	
III	22 (14.5)	19 (16.5)	3 (8.1)	
IV	30 (19.7)	17 (14.8)	13 (35.1)	
HF	64 (46.4)	44 (38.3)	20 (54.1)	0.13
Cardiogenic shock	6 (4.3)	3 (2.9)	3 (8.1)	0.35
Septic shock	9 (6.7)	6 (5.9)	3 (8.1)	0.85
Systemic embolism	68 (48.2)	56 (46.2)	19 (54.3)	0.53
Cerebral embolism	35 (24.6)	22 (20.6)	13 (37.1)	0.08
Stroke	26 (19.1)	17 (16.8)	9 (25.7)	0.37
Cerebral haemorrhage	6 (4.0)	4 (3.5)	2 (5.4)	1
Biological findings				
Haemoglobin (g/L)	10.7 ± 1.8	10.8 ± 1.6	10.3 ± 1.8	0.14
WBC (10^9/L)	11.4 ± 4.6	10.8 ± 4.3	13.02 ± 5.3	0.015
C-reactive protein (U/L)	100.6 ± 87.6	95.5 ± 87.6	119.1 ± 86.8	0.19
Creatinine concentration (μmol/L)	130 ± 133	115 ± 110	172 ± 182	0.023
BNP (pg/mL)	609.1 ± 867.3	587.4 ± 915.1	688.4 ± 672.4	0.58
Positive blood culture	119 (78.3)	89 (78.1)	30 (78.9)	1.00
Echocardiographic findings				
Aortic IE	51 (33.6)	34 (29.8)	17 (44.7)	0.14
Tricuspid IE	4 (2.6)	3 (2.6)	1 (2.6)	1.00
Mitral vegetation	99 (67.8)	72 (65.5)	27 (75.0)	0.39
Maximal vegetation length (mm)	13.7 ± 9.6	12.6 ± 9.9	16.6 ± 8.1	0.042
Aortic annular abscess	10 (6.7)	4 (3.5)	6 (16.7)	0.018
Mitral annular abscess	24 (16.1)	19 (16.8)	5 (13.9)	0.88
Severe aortic regurgitation	33 (21.7)	23 (20.2)	10 (26.3)	0.57
Severe mitral regurgitation	112 (73.7)	82 (71.9)	30 (78.9)	0.52
Severe mitral stenosis	6 (3.9)	0 (0)	6 (15.8)	< 0.001

Table 1 (*Continued*)

	Total ($n = 152$)	MVRep ($n = 115$)	MVR ($n = 37$)	*P*
Mitral valvular perforation	64 (42.7)	49 (43.4)	15 (40.5)	0.91
Mitral chordae rupture	27 (18.6)	23 (20.9)	4 (11.4)	0.32
LVEF (%)	61 ± 8.7	61 ± 8.7	61 ± 7.7	0.76

Data are expressed as median ± standard deviation or number (%). AF: atrial fibrillation; BNP: brain natriuretic peptide; COPD: chronic obstructive pulmonary disease; HBP: high blood pressure; HF: heart failure; HIV: human immunodeficiency virus; HR: heart rhythm; IE: infective endocarditis; IV: intravenous; LVEF: left ventricular ejection fraction; MVR: mitral valve replacement; MVRep: mitral valve repair; NYHA: New York Heart Association; PAD: peripheral arterial disease; WBC: white blood cells.

Table 2 Outcomes.

Outcomes	Total ($n = 152$)	MVRep ($n = 115$)	MVR ($n = 37$)	*P*
In-hospital mortality	11 (7.3)	5 (4.3)	6 (16.2)	0.008
Relapse	9 (5.9)	3 (2.6)	6 (16.2)	0.015
Reintervention	4 (2.6)	2 (1.3)	2 (5.4)	0.21
Mortality at the end of follow-up	24 (15.8)	13 (11.3)	11 (29.7)	0.018
Duration of follow-up (months)	28 ± 22	27 ± 21	28 ± 22	0.36
Postoperative LVEF (%)	55 ± 8	55 ± 8.4	56 ± 9	0.93
Mitral regurgitation				< 0.001
None	61 (40.1)	34 (30.6)	27 (73)	
Grade 1	61 (40.1)	56 (50.0)	5 (13.5)	
Grade 2	20 (13.1)	18 (16.1)	2 (5.7)	
Grade 3	3 (2.0)	3 (2.6)	0 (0)	NS
Mitral stenosis				
Mild to moderate (5—10 mmHg)	15 (9.9)	11 (9.6)	8 (21.6)	0.13
Severe (> 10 mmHg)	0 (0)	0 (0)	0 (0)	

Data are expressed as number (%) or median ± standard deviation. LVEF: left ventricular ejection fraction; MVR: mitral valve replacement; MVRep: mitral valve repair; NS: not significant.

had MVRep, Feringa et al. found that MVRep had lower early and late mortality rates, and lower rates of reoperation and recurrent IE [5]. Solari et al. studied 192 consecutive patients operated on for NMIE (of these, 81% had MVRep and 19% had MVR); they showed a better 15-year survival rate with MVRep than MVR (57 ± 6% vs. 36 ± 12%, respectively; $P = 0.03$) [8]. In addition, a slightly lower survival with MVR compared with MVRep has been reported for degenerative mitral valve lesions [14].

However, all these studies present with important limitations, including low number of patients studied [12], retrospective nature [5,6,13] and small proportions of repair [13] and patients operated on during the acute phase of IE [13]. In practice, the rates of valve repair in published series range from 10% to 81%, depending on the surgeon's experience and the percentage of patients with acute versus healed endocarditis [5,6,11,13,15]. In addition, patient characteristics may differ between the MVRep and MVR groups. In our study, for instance, patients in the MVR group presented with a more severe illness, more frequent rheumatic valve disease, more aortic annular abscesses and mitral stenosis and larger vegetations than the MVRep group. Logically, those patients presented a poorer clinical status than patients who benefited from MVRep.

Our study overcomes these limitations, because it was prospective, and included a larger number of patients, with a high proportion of valve repair. In addition, we found that the MVRep benefit persisted once confounding factors were considered, thanks to the propensity score analysis. Although this statistical method has been used previously in this setting [9], our study is the first to demonstrate a benefit of MVRep in NMIE using propensity score.

Importance of surgical technique and timing

In a recently published study, Perrotta et al. speculated that incomplete resection of the infected tissue was associated with a higher rate of relapse and reoperation [16]. More recently, Defauw et al. studied 149 patients who underwent surgery for NMIE with a structured approach, consisting of early surgery and radical resection of infected tissue; MVRep was possible for 97 patients (67%), without difference in survival, recurrence or reoperation compared with patients who underwent MVR [7]. We showed in our cohort that the rate of valve repair could be safely extended upwards by using a large panel of surgical techniques, such as patch

Table 3 Univariate and multivariable analysis in the whole population.

Variable	Univariate analysis		Multivariable analysis	
	HR (95% CI)	*P*	HR (95% CI)	*P*
IV drug abuse	3.48 (1.05–11.51)	0.04	–	–
Diabetes mellitus	2.87 (1.31–6.26)	0.008	2.73 (0.76–10.10)	0.12
HBP	1.98 (0.97–4.02)	0.06	1.83 (0.88–3.79)	0.10
Coronary arterial disease	2.20 (0.67–7.27)	0.19	–	–
Chronic kidney disease	3.90 (1.67–9.08)	0.002	–	–
Dialysis	5.20 (1.56–17.31)	0.007	–	–
Nosocomial IE	4.13 (1.67–10.25)	0.002	4.03 (1.52–10.67)	0.005
Native aortic valve	0.35 (0.12–1.02)	0.05	–	–
Previous mitral regurgitation	0.36 (0.08–1.51)	0.16	–	–
Previous mitral valve prolapse	0.26 (0.04–1.89)	0.19	–	
Weight	1.02 (1.01–1.03)	0.02	1.28 (1.10–1.49)	0.001
HF	2.32 (1.12–4.78)	0.02	2.58 (1.12–5.96)	0.03
Cerebral embolism	1.65 (0.79–3.45)	0.18	3.01 (1.27–7.11)	0.01
Stroke	2.65 (1.25–5.63)	0.005	–	–
Complete AV block	49.1 (5.18–479)	0.001	–	–
Aortic vegetation	1.81 (0.85–3.85)	0.12	–	–
Aortic annular abscess	5.12 (2.19–11.96)	< 0.001	–	–
Fistula	6.07 (0.82–45.1)	0.07	–	–
Mitral chordae rupture	0.37 (0.11–1.24)	0.11	–	–
Creatinine clearance by Cockcroft	1.08 (0.99–1.16)	0.06		
BNP (+100 IU/mL)	1.03 (1.01–1.06)	0.01		
Mitral replacement	2.72 (1.34–5.52)	0.004	1.66 (0.81–3.64)	0.13

Stepwise backward selection of variables. Variables included in the initial model: age, diabetes mellitus, HBP, IV drug abuse, coronaropathy, native aortic valve, stroke, complete AV block; creatinine clearance, BNP, aortic annulus abscess, nosocomial IE and mitral replacement. Test of the proportional hazards assumption for a Cox regression model fit: $P = 0.32$. AV: atrioventricular; BNP: brain natriuretic protein; HBP: high blood pressure; CI: confidence interval; HF: heart failure; HR: hazard ratio; IE: infective endocarditis; IV: intravenous.

material, quadrangular resection, annuloplasty and neochordae.

Another particularly important point is the timing of surgery. Delay to surgery may favour extensive valve destruction and compromise the feasibility of MVRep. Early surgery was used by Solari et al. [8] and Tomsic et al. [9], with 30% of patients operated on during the first week, with good results. In our study however, up to 75% of the patients were operated on in the active phase of IE, including 25.7% in the first week. This aggressive strategy of early surgical intervention permitted a high rate of MVRep [9].

Study limitations

First, MVRep durability in IE is still a matter of debate. In our study, the rate of reoperation was low (1.3% in MVRep group vs. 5.4% in MVR group; $P = 0.57$), calculated on a median follow-up duration of 28 ± 22 months. Freedom from reoperation was $85.7 \pm 5.7\%$ and $75.4 \pm 8.6\%$ at 10 and 15 years, respectively, in the report by Solari et al. [8]. Toyoda et al. [6] showed that cumulative incidence of mitral reoperation at 12 years was 9.1% (95% CI: 6.2–12.8%) after MVRep and 8.6% (95% CI: 7.1–10.4%) after MVR ($P = 0.12$). Finally, the long-term durability of MVRep in IE seems quite similar to degenerative mitral valve disease [12,17,18].

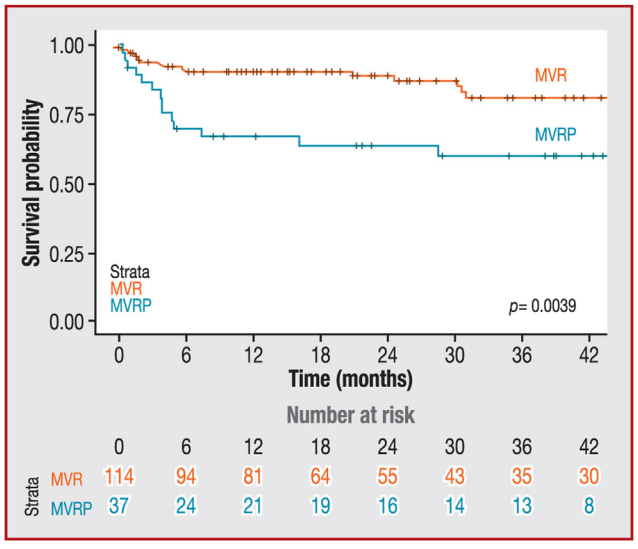

Figure 1. Kaplan–Meier curve analysis. Comparison of event-free survival between the mitral valve repair (MVR) group and the mitral valve replacement (MVRP) group. [Publishers: please standardize abbreviation within figure (i.e. MVRep).].

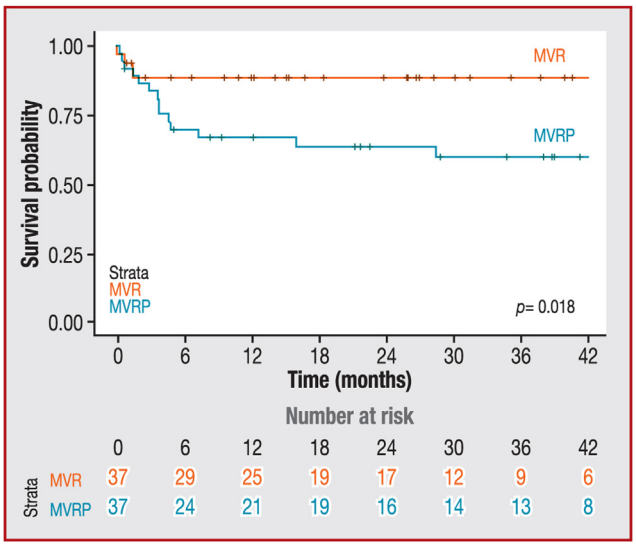

Figure 2. Kaplan—Meier curve: analysis in the matched cohort. Comparison of ''event-free survival'' between the mitral valve repair (MVR) group and the mitral valve replacement (MVRP) group. [Publishers: please standardize abbreviation within figure (i.e. MVRep).].

Second, the non-randomized design of our study limited our conclusions, but this was partly overcome by the propensity analysis.

Third, the number of patients who underwent MVR was small. For instance, the higher frequency of MVR we observed in intravenous drug abusers should be interpreted with caution, given the very low number of such patients.

Finally, our study was performed in a tertiary centre with considerable experience in cardiac surgery and the management of severe patients by an endocarditis team. These results might not be applicable to other less-experienced centres. This further confirms that complicated IE should be referred to an expert centre, especially when surgery is indicated [3].

Conclusions

In a large monocentric prospective cohort, MVRep appeared better than MVR for the surgical treatment of NMIE, and was associated with better survival and fewer relapses. MVRep was frequently feasible in our centre, even when urgent surgery or even emergency surgery was required. Future multicentre large-scale studies are required to confirm these results, and to prove that they can be applied in other centres.

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.acvd.2022.02.002.

Disclosure of interest

The authors declare that they have no competing interest.

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