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Evaluating Short-Term Postoperative Outcomes in Minimally Invasive Mitral Valve Surgery for Patients with Rheumatic Disease

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INTRODUCTION

Minimally invasive mitral valve surgery (MIMVS) is widespread and has become a standard procedure in cardiac surgery [Chitwood 1997; Carpentier 1996]. Therefore, MIMVS is a common procedure for patients with degenerative disease [Raanani 2010; Iribarne 2010] as well. However, the safety of MIMVS in patients with rheumatic heart disease (RHD) has not thoroughly been investigated, due to the low prevalence of RHD in developed countries, where MIMVS is standardized [Miceli 2015]. Here, we investigated the safety of MIMVS for patients with RHD at Lampang Hospital in Thailand.

PATIENTS AND METHODS

We retrospectively analyzed patients who underwent MIMVS at our institution, Lampang Hospital in Thailand, between May 2017 and May 2022. Out of 180 patients, 13 patients with infective endocarditis were excluded, and a total of 167 patients were divided into two groups: the rheumatic mitral valve disease group (R group with 77 patients) and degenerative mitral valve disease group (D group with 90 patients). At our institution, MIMVS is the primary choice for mitral valve surgery. In this study, if moderate-to-severe tricuspid valve regurgitation is found in preoperational transthoracic echocardiogram, we performed tricuspid valve repair (TVRp) simultaneously with a semi-rigid ring. Patients did not have atrial fibrillation surgery performed, due to device unavailability in Thailand. Principal exclusion criteria for MIMVS consisted of poor left ventricular ejection fraction (LVEF) < 20%, severe cardiomegaly (left ventricular end-diastolic diameter > 7.5 cm), congenital heart disorders, severe coronary disease, severe chest deformities such as severe pectus excavatum and scoliosis, severe chronic obstructive pulmonary disease (COPD) cases that could not tolerate single lung, a recent history of stroke (4 weeks prior to surgery), calcification in aorta and/or mitral annulus, previous right thoracotomy, and combined aortic aneurysm (diameter > 4cm). Relative contraindications included active smokers, tuberculosis or interstitial lung disease history, morbid obesity, and previous cardiac surgery.

Surgical technique: For rheumatic mitral valve (MV), mitral valve replacement (MVR) was first choice, and mitral valve repair (MVRp) was prioritized for valve degeneration. All procedures were performed using cardiopulmonary bypass (CPB) with normothermic perfusion and crystalloid cardioplegia. CPB was established with arterial cannulation into the femoral artery and venous cannulation to both the internal jugular vein and femoral vein with mild hypothermia at 34°C. Thoracotomy was made in the fourth intercostal space. In cases without TVRp, the mitral valve was exposed through a right-sided left atriotomy with a retractor, whereas superior transseptal approach was applied in cases with TVRp.

Follow up: Follow-up information on all patients was collected through regular clinical follow up. The follow-up rate was 100%, and the mean duration of follow up was 303±388 days.

Statistical analysis: Results are expressed as mean ± standard deviation. Statistical analysis was performed using Student's t-test for continuous variables or X^2 tests (Fisher's exact tests if n<5) for categorical variables. A *P*-value of less than 0.05 was considered significant. All statistical analyses were performed using SPSS 22.0 software (SPSS Inc., Chicago, IL).

RESULTS

The demographic characteristics of the groups are summarized in Table 1. (Table 1) The average age of patients was 54.1±9.3 years in the R group and 52.2±11.8 years in the D group ($P = 0.267$). The R group was in more urgent preoperative condition than the D group (16.9% in the R group versus 3.3% in the D group; $P = 0.003$). Regarding indications for MIMVS, the R group had more mitral valve stenosis (MS) (68.8% in the R group versus 0% in the D group; $P < 0.001$), and mitral valve regurgitation (MR) was found in every patient in the D group (49.4% in the group R versus 100% in the group D; $P < 0.001$).

Operative data are shown in Table 2. (Table 2) Mean total operation time (218.1±55.9 min in the group R and

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241.8±53.9 min in the group D; $P = 0.006$), mean CPB time (145.0±40.6 min in the group R and 160.5±45.7 min in the group D; $P = 0.024$), and mean aortic clamp time (92.2±30.7 min in the group R and 106.4±33.0 min in the group D; $P = 0.005$) were significantly shorter in the R group than in the D group. The dominant surgical procedure was MVR in the R group and MVRp in the D group (MVR rate was 94.8% in the R group versus 6.7% in the D group, $P < 0.001$). MVR included 22 biological valves (20 cases in the R group versus 2 cases in the R group) and 57 mechanical valves (53 cases in the R group versus 4 cases in the R group). The rate of simultaneous TVRp was higher in group R than in group D (16.9% in the group R versus 5.6% in the group D, $P = 0.025$). Intraoperative conversion from MVRp to replacement occurred

Table 1. Patient characteristics and preoperative data

Variables	Rheumatic (*N* = 77)	Degenerative (*N* = 90)	*P*-value
Age	54.1±9.3	52.2±11.8	0.267
Male gender, n (%)	49 (63)	27 (30)	< 0.001
Weight (kg)	55.1±9.4	60.4±11.8	0.002
Height (cm)	158.6±8.0	163.2±8.3	< 0.001
NYHA class (≧III), n (%)	11 (14.3)	13 (14.4)	1.000
Euro SCORE II	0.93±0.61	0.88±0.53	0.584
Comorbidity, n (%)			
Atrial fibrillation/flutter	67 (87)	27 (30.0)	< 0.001
Hyperlipidemia	21 (27.3)	13 (14.4)	0.053
Hypertension	14 (18.2)	30 (33.3)	0.615
Diabetes mellitus	11 (14.3)	3 (3.3)	0.011
Chronic renal disease (Cr≧1.5)	3 (3.9)	6 (6.7)	0.051
Dialysis	0 (0)	0 (0)	-
Lung disorder	1 (1.3)	5 (5.6)	0.219
Smoker	2 (2.6)	2 (2.2)	1.000
Stroke	5 (6.5)	1 (1.1)	0.087
PAD	2 (2.6)	1 (1.1)	0.595
Immunosuppressive therapy	4 (5.2)	1 (1.1)	0.182
Cardiogenic shock	1 (1.3)	0 (0)	0.461
Echocardiography			
LVDd (mm)	5.3±1.0	5.9±0.7	<0.001
LVDs (mm)	3.5±0.9	3.6±0.7	0.147
LVEF (%)	61.5±9.6	66.8±10.2	< 0.001
LA diameter (mm)	5.7±1.0	5.0±0.9	< 0.001
LA clot, n (%)	6 (7.8)	0 (0)	0.009
TR (≧), n (%)	23 (29.9)	8 (8.9)	< 0.001
MS (≧ moderate), n (%)	53 (68.8)	0 (0)	< 0.001
MR (≧ moderate), n (%)	38 (49.4)	90 (100)	< 0.001
Urgency			
Elective, n (%)	64 (83.1)	87 (96.7)	0.003
Urgent, n (%)	13 (16.9)	3 (3.3)	0.003
Emergent, n (%)	0 (0)	0 (0)	-
Salvage, n (%)	0 (0)	0 (0)	-

NYHA, New York Heart Association; PAD, peripheral arterial disease; LVDd, left ventricular end-diastolic diameter; LVDs, left ventricular end-systolic diameter; LVEF, left ventricular ejection fraction; LA, left atrial; TR, tricuspid valve regurgitation; MS, mitral valve stenosis; MR, mitral valve regurgitation

with four patients (1.3% in the R group versus 3.3% in the D group, $P = 0.625$). There were no intraoperative conversion cases from right minimal incision to median sternotomy.

Short-term outcomes are shown in Table 3. (Table 3) Intensive care unit (ICU) stay, hospital stay, drain contents, early extubation, and rates of complications did not differ significantly between the two groups. Regarding 30-day mortality, one patient in the R group died due to bleeding reoperation and lethal arrhythmia, and two patients died in the D group (one patient due to bleeding reoperation and the other patient due to pneumonia). Reoperation, due to bleeding, occurred in four patients in the Group R and in three patients

Table 2. Operative data

Variable	Rheumatic (*N* = 77)	Degenerative (*N* = 90)	*P*-value
Operating time, min	218.1±55.9	241.8±53.9	0.006
CPB time, min	145.0±40.6	160.5±45.7	0.024
Clamp time, min	92.2±30.7	106.4±33.0	0.005
Defib after de-clamp	11 (14.3)	13 (14.4)	1.000
Surgical techniques			
MVR, n (%)	73 (94.8)	6 (6.7)	<0.001
Tissue valve	20	2	-
Mechanical valve	53	4	-
MVRp, n (%)	4 (5.2)	84 (93.3)	<0.001
TVRp, n (%)	13 (16.9)	5 (5.6)	0.025
Conversion from MVRp to MVR	1 (1.3)	3 (3.3)	0.625
Blood transfusion			
Cell saver, n (%)	38 (49.4)	48 (53.3)	0.643
RBC (units)	1.6±1.5	1.5±1.5	0.657
FFP (units)	4.2±1.2	3.9±1.7	0.243
PC (units)	3.8±1.7	3.2±1.8	0.029

CPB, cardio-pulmonary bypass; MVR, mitral valve replacement; MVRp, mitral valve repair; TVRp, tricuspid valve repair; RBC, red blood cell; FFP, fresh frozen plasma; PC, platelet concentrate

Table 3. Postoperative outcomes

Variables	Rheumatic (*N* = 77)	Degenerative(*N* = 90)	*P*-value
ICU stay, days	2.5±2.9	1.9±1.0	0.064
Hospital stay, days	5.3±3.8	5.5±9.0	0.830
Early extubation (≦24h), n (%)	65 (84.4)	85 (94.4)	0.410
30 days mortality, n (%)	1 (1.3)	2 (2.2)	1.000
Drain contents (ml)	513.1±362.6	463.3±350.7	0.372
Postoperative complications, n (%)			
New dialysis	1 (1.3)	1 (1.1)	1.000
New onset atrial fibrillation/ flutter	25 (32.5)	18 (20.0)	0.077
Reintubation	2 (2.6)	0 (0)	0.211
Infection	2 (2.6)	2 (2.2)	1.000
Reoperation	4 (5.2)	3 (3.3)	0.705

ICU, intensive care unit

in the Group D (P = 0.705). During the follow-up period, one patient in the D group required reoperation for mitral valve failure. Kaplan–Meier survival analysis showed no significant difference between the two groups (P = 0.542). (Figure 1)

DISCUSSION

When compared with degenerative cases, we found no significant difference in short-term post-operation outcome in MIMVS for RHD patients.

RHD in developing countries: RHD still is a common cause of valvular disease in developing countries [Zilla 2020]. Typical rheumatic valve lesions are thick, with leaflet adhesions and calcifications, causing MS [Chernov 2020; Zhai 2017]. In the present study, approximately 70% of patients had moderate-to-severe MS in the R group, similar to previous reports. Differentiation between calcific degeneration and calcific rheumatic is not that difficult, our criteria comprised (1) age (rheumatic comes with earlier i.e. 30-50 years of age); (2) in rheumatic mitral valve disease, 15-20% of cases also will affect the aortic valve in the same manner; (3) mitral valve degeneration from rheumatic typically involves thickened leaflets, commissural fusions, and sub-valvular apparatus problems such as shortened chordae; (4) calcific infiltration can involve all structures of the mitral apparatus but least to the annulus. Although there are several reports that the promising results of MVRp for RHD correlates with improved long-term outcomes of repair in degenerative disease [Chauvaud 2001; Dillon 2015; Askut 1996], severe MS cases are limited in these studies.

Jeswant et al. reported on 253 rheumatic and 148 degenerative mitral valves in 40-year-old patients that were repaired with median sternotomy. Postoperative freedom from valve failure at 5 and 10 years was 91.4% and 81.5% for rheumatic repairs and 82.5% and 75.4% for degenerative repairs (P = 0.15). They concluded that the durability of rheumatic MVRp in the current era has improved, to where there is no significant difference between that of repairs for degenerative disease. To note, however, there were only eight patients (3.2%) of MS in the rheumatic group in their report [Dillon 2015].

Despite previous reports demonstrating favorable results of MVRp for rheumatic etiology, MVR sometimes is unavoidable for RHD patients in general, especially in cases of MS. Some concerns are for complex rheumatic MVRp, due to imperfect long-shaft instruments. For simple lesions, commissure plasty and delamination of the leaflets are doable in our institution but above this, open complex repair or valve replacement will be the answer, depending on discussion with the patient and family. In the present study, approximately 70% of patients in the R group had MS, and therefore MVR was preferred. Moreover, even in patients of RHD without MS, MVR was prioritized in the present series, due to the below mentioned reason, specific to developing countries.

In Thailand, economic disparity is severe and there are very many patients with low socioeconomic backgrounds. Those patients tend to prefer MVR, due to the risk of reoperation for early failure because they cannot afford short-term reoperation due to financial reasons, despite of the potential benefits of MVRp in the long term (such as preserving ventricular function, avoiding anticoagulation-related complications, increasing survival [Askut 1996; Suri 2006; Enriquez-Sarano 1995]). This situation also is common in other developing countries, and therefore MVR will continue to be the primary choice of procedure in patients with RHD.

Comparison of previous studies with our study of MIMVS for RHD: For the reasons above, there still is lack of evidence regarding the standards of MIMVS for RHD because MIMVS has been developed mainly for degenerative mitral regurgitation in developed countries. Previous studies reported that MIMVS for RHD can provide good cosmetic

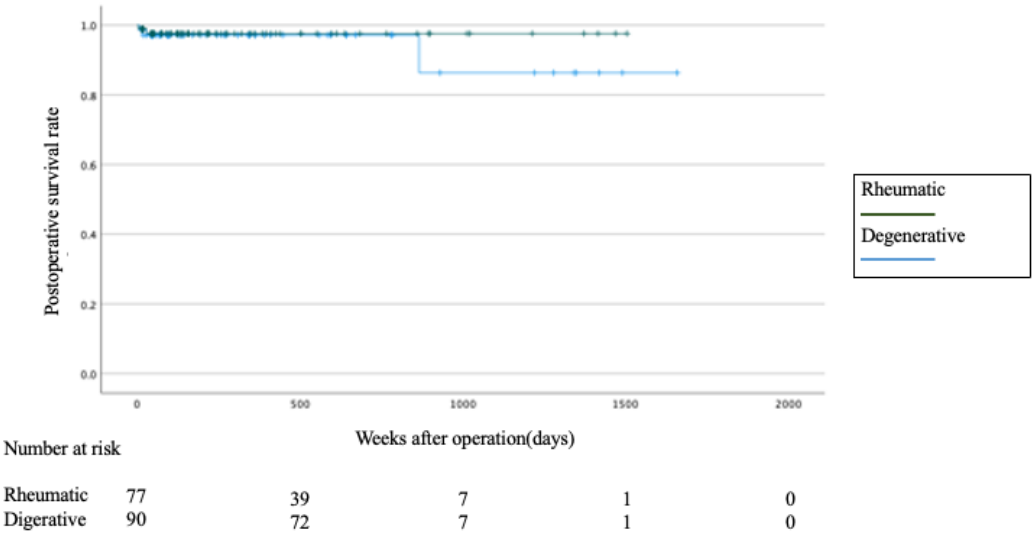

Figure 1. Survival post-MIMVS in the rheumatic and degenerative mitral valve disease groups

effect, shorter period of hospitalization, and reduce trauma, while maintaining the safety and effectiveness compared with median sternotomy [Chernov 2020; Chahal 2016]. Anh et al. reported on 142 patients with rheumatic mitral valve dysfunction who underwent MIMVS at the University Medical Center of Ho Chi Minh City in Vietnam. MVRp was performed in 16 patients (11.3%) and MVR in 126 patients. MVRp effectively was performed with few perioperative complications and good midterm results (the overall survival rate was 98.6%, and reoperation was only 2.9%) [Vo 2019]. Similarly, in our study, MIMVS for RHD cases was not inferior to that for degenerative disease cases, regarding ICU stay (2.5±2.9 days in the R group and 1.9±1.0min in the D group; $P = 0.064$), 30-day mortality (1.3% in the R group vs 2.2% in the D group; $P = 1.000$), and postoperative complications.

MIMVS for RHD is presumed to be good for trainees: MIMVS has become a popular operation, but most are MVRp that are performed by skilled and experienced operators. Even in this study, MIMVR MVRp was performed by three surgeons, all with more than 10 years of experience. Most of the surgical procedures in our study were MVR in the R group (94.8% in the R group versus 6.7% in the D group, $P < 0.001$). This study demonstrated that MIMVS MVR for RHD could safely be performed, and without mitral annular calcification, MVR is usually a very standard procedure that can be suitable for trainees (under strict patient selection).

Study limitations: This study is a retrospective, nonrandomized analysis from a single medical center. Clinical decisions were made in a nonblinded fashion. Our institution was unable to perform follow-up echocardiography to accurately confirm recurrence of MR.

CONCLUSION

MIMVS for RHD could safely be performed with acceptable short- and long-term results compared with those for degenerative disease. Considering the technical simplicity and shorter operative time, MIMVS MVR for RHD might be suitable for trainees.

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