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Comparison of Clinical and Echocardiographic Outcomes After Valve Repair: Degenerative Versus Rheumatic Mitral Regurgitation

We compared clinical (30 ±24 months) and echocardiographic follow-up (22 ± 20 months) data of 184 consecutive patients with myxomatous degenerative mitral regurgitation (Group A) and 85 consecutive patients with rheumatic mitral regurgitation (Group B) after repair. Selection criteria for rheumatic etiology was predominant mitral regurgitation with valve area ≥2.0 cm^2 and with no significant calcification in valvular apparatus. Repair was successful in 93% of group A and in 92% of group B (p>0.05). There was no difference of operative mortality (1% vs 0%) and of the incidence of the second-pump valve replacement (4% vs 5%). The 4-yr survival, 4-yr event-free survival, and 4-yr mitral regurgitation-free survival rates in group A were 96 ±2%, 89 ±4%, and 76 ±5%, respectively, which were not different from those in group B (97 ±2%, 93 ±4%, and 68 ±7%, p>0.05). Independent determinants of development of at least moderate regurgitation in group A were no use of ring annuloplasty (hazards ratio 6.6, 95% CI 2.0 to 21.5) and new chordae formation (hazards ratio 3.5, 95% CI 1.4 to 8.7). In group B, no use of ring annuloplasty (hazards ratio 15.3, 95% CI 3.5 to 66.7) also was independent predictor. Valve repair is highly feasible in selected patients with rheumatic mitral regurgitation, and clinical course is not significantly different from that of patients with degenerative mitral regurgitation.

Key Words : *Heart Valve Diseases; Mitral Valve Insufficiency; Rheumatic Heart Disease; Eclrocardiography, Transesophageal; Mitral Valve Repair*

Jae-Kwan Song, Hyun-Sook Kim, Jong Min Song, Duk Hyun Kang, Hyun Song*, Suk Jung Choo*, Meong Gun Song*, Jae Won Lee*

Divisions of Cardiology and Cardiothoracic Surgery*, Asan Medical Center University of Ulsan, College of Medicine, Seoul, Korea

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Address for correspondence
Jae-Kwan Song, M.D.
Associate Professor of Medicine, Asan Medical Center University of Ulsan, College of Medicine, 388-1 Poongnap-dong, Songpa-gu, Seoul 138-040, Korea
Tel : +82.2-3010-3147, Fax : +82.2-486-5918
E-mail : jksong@www.amc.seoul.kr

INTRODUCTION

Mitral valve repair has been accepted as a procedure of choice for surgically treating significant mitral regurgitation (1-3). Currently, this procedure is widely applied to correct mitral valve prolapse or chordae rupture due to myxomatous degeneration (4-6), but mitral regurgitation due to rheumatic involvement has been reported to have lower feasibility of repair and higher rate of re-operation compared to myxomatous degenerative mitral regurgitation (1, 7-10). Recent improvement of surgical technique and availability of intraoperative transesophageal echocardiographic monitoring have encouraged many surgeons to attempt valve repair in rheumatic mitral regurgitation. However, not many reports on clinical outcomes are available and most available clinical data of repair in rheumatic pathology were based on mixed results of patients with both mitral stenosis and regurgitation; less than one-third had pure, predominant rheumatic mitral regurgitation (11-13). In a few reports of patients with pure rheumatic mitral regurgitation, the mean age of the subjects was less than 30 yr (14, 15), and their conclusions remain to be reconfirmed in different patient population including higher mean age. Moreover, no use of routine preoperative echocardiographic screening, intraoperative monitoring and postoperative follow-up study in the previous studies might affect the assessment of the exact role of reconstructive procedures for rheumatic mitral regurgitation in recent days. The purpose of this study was to address if the underlying etiology of mitral regurgitation affects the feasibility and outcomes of valve repair, and as a method, clinical and echocardiographic follow-up data after valve repair were compared between patients with rheumatic mitral regurgitation and those with degenerative mitral regurgitation.

MATERIALS AND METHODS

Subjects

The present study was based on our consecutive experience with mitral valve repair for the surgical correction of significant mitral regurgitation from 1990 to 2000. Inclusion criteria were (1) mitral regurgitation due to prolapse or chordae rupture associated with myxomatous degeneration, and (2) predominant mitral regurgitation due to rheumatic

involvement. Preoperative echocardiography (both transthoracic and transesophageal) was performed in all patients (within 2 months before surgery) and prolapse or chordae rupture was confirmed by both echocardiography and surgical observation. Patients with rheumatic mitral regurgitation selected for valve repair had predominant moderate to severe regurgitation with mitral valve area $\geq$2.0 cm^2 and with no significant calcification in valvular or subvalvular apparatus. Patients with unfavorable echocardiographic morphology, such as significant mitral stenosis (valve area <2.0 cm^2) or subvalvular calcification underwent valve replacement, were excluded in this analysis. Other exclusion criteria were as follows: significant aortic valve disease with aortic valve repair or replacement, previous valve repair or replacement, congenital or pericardial disease, and mitral regurgitation due to ischemic heart disease with or without ruptured papillary muscle. Associated incidental coronary artery disease was not an exclusion criterion.

Surgical Procedure

In all patients, surgical repair was attempted and the 3 important procedures were subvalvular (chordal splitting, shortening or new chordae formation), valvular (commissurotomy, resection or plication), and annular (mostly ring insertion) interventions. Intraoperative assessment of mitral regurgitation was based on transesophageal echocardiography in all patients; failed valve repair was defined as persistence of at least moderate mitral regurgitation.

Follow-up

Clinical (30 $\pm$ 24 months) and echocardiographic (22 $\pm$ 20 months) follow-up was feasible in all patients. The clinical events in this study included death, reoperation, stroke, endocarditis, and development of at least moderate mitral regurgitation on follow-up echocardiography. Distal regurgitant jet area and the radius of proximal flow convergence using color Doppler flow mapping were used for semiquantitation of mitral regurgitation; at least moderate mitral regurgitation was defined as distal regurgitant jet area $\geq$8 cm^2 or the radius of proximal flow convergence >0.5 cm at the aliasing velocity of 40 cm/sec.

Statistical Analysis

Numerical variables were expressed as mean $\pm$SD. Group comparisons were performed with standard Student t test or chi-square test as appropriate. The Kaplan-Meier method was used to estimate the cumulative probability of survival, clinical event-free survival, and mitral regurgitation-free survival; the 2-tailed log-rank test was used to compare the difference between groups. Multivariate analysis to determine the factors associated with development of at least moderate mitral regurgitation after repair in each disease entity was performed by using the Cox proportional hazards method, and the initial candidate independent variables were age, sex, New York Heart Association functional class, rhythm, site and numbers of mitral valve segments with prolapse or chordae rupture, preoperative left ventricular dimensions, preoperative left ventricular ejection fraction, and surgical procedures. A value of p<0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

During the study period, mitral valve surgery was done in 642 patients; among them, repair was attempted in total of 269 patients with moderate to severe mitral regurgitation due to myxomatous degeneration (184 patients, 68%) or rheumatic involvement (85 patients, 32%). In degenerative mitral regurgitation group, 61 patients showed prolapse or chordae rupture in the anterior leaflet, and 82 (45%) in the posterior leaflet; 41 patients showed degenerative changes in both leaflets. Table 1 summarizes the overall baseline characteristics. The mean age and the prevalence rates of male gender and hypertension were higher in degenerative mitral regurgitation group, whereas the prevalence rate of atrial fibrillation was higher in rheumatic mitral regurgitation group. Ring annuloplasty was the most commonly performed surgical procedure regardless of the underlying etiology of mitral regurgitation. In degenerative mitral regurgitation

Table 1. Baseline characteristics of the subjects

	Degenerative MR	Rheumatic MR
No. of patients	184	85
Preoperative characteristics		
Age* (yr)	52 $\pm$ 14	39 $\pm$ 14
Male/female*	104/80	15/70
NYHA class III-IV	91 (50%)	34 (40%)
Hypertension*	47 (26%)	1 (1%)
Atrial fibrillation*	63 (34%)	38 (45%)
LVIDS, mm*	41 $\pm$ 8	44 $\pm$ 6
EF, %	63 $\pm$ 10	60 $\pm$ 9
Surgical procedures		
Ring annuloplasty	169 (92%)	74 (87%)
Commissurotomy*	7 (4%)	46 (54%)
New chordae formation*	117 (64%)	25 (29%)
Leaflet mobilization*	1 (0.5%)	59 (69%)
CABG*	14 (8%)	1 (1%)
Maze operation*	23 (13%)	21 (25%)
Pump time, min	132 $\pm$ 45	129 $\pm$ 53
Clamp time, min	95 $\pm$ 36	91 $\pm$ 44

*p<0.05, MR; mitral regurgitation, NYHA; New York Heart Association, LVIDs; systolic left ventricular internal dimension, EF; ejection fraction, CABG; coronary artery bypass graft.

group, new chordae formation (117/184, 64%) and quadrangular resection of the posterior leaflet (78/184, 42%) were also frequently performed. Leaflet mobilization (59/85, 69%) and commissurotomy (46/85, 54%) were frequently performed in rheumatic mitral regurgitation group. Coronary artery bypass graft (CABG) was more frequently done in degenerative mitral regurgitation group, whereas maze operation in rheumatic mitral regurgitation group; however, there was no significant difference of pump and aortic clamp time between 2 groups.

Surgical Outcomes and Follow-up Results

The comparison of the surgical outcomes and the follow-up results between 2 groups were summarized in Table 2. Immediately after repair, 12 patients in degenerative mitral regurgitation group revealed moderate regurgitation on intraoperative transesophageal echocardiography; in rheumatic mitral regurgitation group, 2 patients showed significant stenosis (mitral valve area <2.0 cm^2), while moderate regurgitation was confirmed in 5 patients. Except these patients, repair was successful in 93% of degenerative mitral regurgitation group and in 92% of rheumatic mitral regurgitation group ($p>0.05$). There was no statistically significant difference of operative mortality (1% vs 0%), and of the incidence of the second-pump valve replacement (4% vs 5%).

During the follow-up, 2 patients in each group died and the incidence of reoperation was not different between 2 groups (1% vs 4%, $p>0.05$). Stroke developed in 7 patients of degenerative group, which is probably related with associated hypertension. Postoperative echocardiography was performed in all patients at 6 month intervals with the longest follow-up duration of 22 ± 20 months after repair. In degenerative mitral regurgitation group, 159 patients (86%) showed excellent post-repair status without significant mitral stenosis or regurgitation, and 66 patients (78%) of rheumatic group also showed excellent results. Development of at least moderate mitral regurgitation was confirmed in 13 patients (7%) of degenerative mitral regurgitation group and in 10 patients (12%) of rheumatic mitral regurgitation group ($p>0.05$).

Table 2. Comparison of surgical outcomes and follow-up results between degenerative and rheumatic mitral regurgitation

	Degenerative MR	Rheumatic MR	*p*
Surgical outcomes			
Successful repair	172 (93%)	78 (92%)	NS
Mitral valve replacement	7 (4%)	4 (5%)	NS
Operative mortality	2 (1%)	0 (0%)	NS
Clinical follow-up			
Follow-up duration, months	28 ± 7	34 ± 12	NS
Death	2 (1%)	2 (2%)	NS
Reoperation	2 (1%)	3 (4%)	NS
Stroke	7 (4%)	0 (0%)	NS
Echocardiographic follow-up			
At least moderate MR	13 (7%)	10 (12%)	NS
Newly developed MS	2 (1%)	2 (2%)	NS
4-yr survival rate	96 ± 2%	97 ± 2%	NS
4-yr event-free survival rate	89 ± 4%	93 ± 4%	NS
4-yr MR-free survival rate	76 ± 5%	68 ± 7%	NS

MR; mitral regurgitation, MS; mitral valve area <2.0 cm^2, NS; not significant.

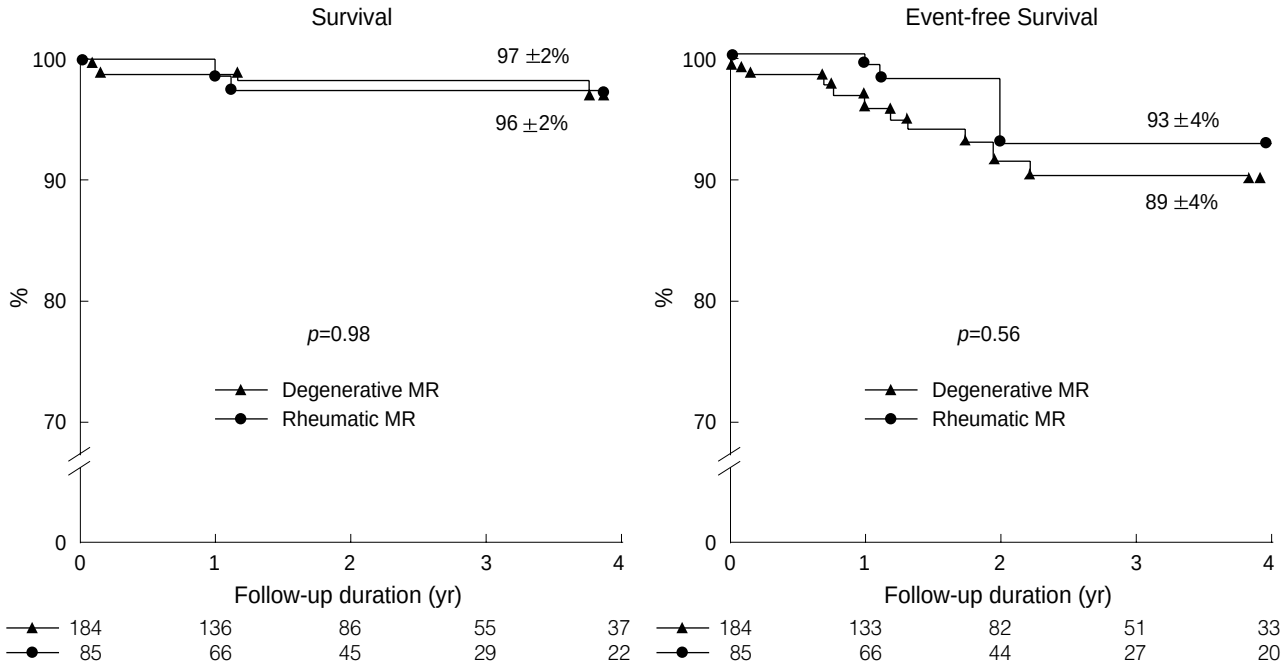

Fig. 1. Comparison of survival and event-free survival rates between patients with rheumatic mitral regurgitation (MR) and those with myxomatous degenerative MR. Numbers at bottom of each group indicate number of patients at risk for the interval.

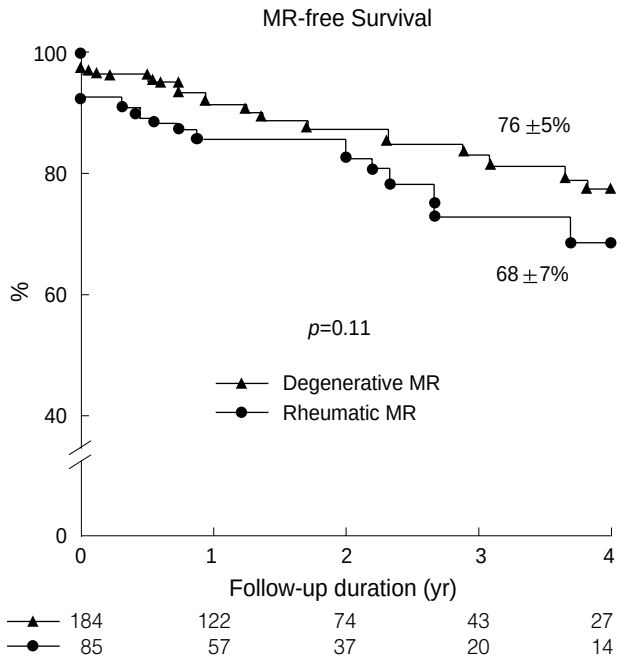

Fig. 2. Comparison of development rate of at least moderate mitral regurgitation (MR) on follow-up echocardiography after repair surgery. Numbers at bottom of each group indicate number of patients at risk for the interval.

The 4-yr survival, 4-yr event-free survival, and 4-yr mitral regurgitation-free survival rates in degenerative mitral regurgitation group were 96 ±2%, 89 ±4%, and 76 ±5%, respectively, and the rates were not significantly different from those in rheumatic mitral regurgitation group (97 ±2%, 93 ±4%, and 68 ±7%, $p>0.05$, Fig. 1, 2). In multivariate analysis, independent determinants of development of at least moderate regurgitation in degenerative mitral regurgitation group were no use of ring annuloplasty (hazards ratio 6.6, 95% CI 2.0 to 21.5) and new chordae formation (hazards ratio 3.5, 95% CI 1.4 to 8.7). In rheumatic mitral regurgitation group, no use of ring annuloplasty (hazards ratio 15.3, 95% CI 3.5 to 66.7) was also independent predictor.

DISCUSSION

We have proven that valve repair is highly feasible in selected patients with predominant mitral regurgitation of rheumatic etiology, and clinical course after repair surgery is not significantly different from that of patients with degenerative mitral regurgitation. Patient selection based on the preoperative echocardiography and the use of specific surgical procedures to repair the individual components contributing to the development of mitral regurgitation might explain the favorable results of this study.

Despite relatively early attempt of valve repair in rheumatic mitral regurgitation, higher rates of failure and late re-operation compared to the degenerative mitral regurgitation group made most physicians and surgeons believe that etiology plays an important role in the results of repair (9, 10, 14, 16). Unlike the previous clinical reports, our study shows different results of valve repair for rheumatic mitral regurgitation. The subjects in the most previous reports were the patients with mixed disease; those with predominant mitral regurgitation comprised of less than 50% of the total patients (11-13). It is well known that the repair for mixed rheumatic lesions does not give gratifying results because these valves frequently become stenotic a few years postoperatively (17). The higher mean age of the patients with predominant rheumatic mitral regurgitation in our study (39 ±14 yr) needs to be re-emphasized. In a few studies on predominant rheumatic mitral regurgitation, the mean age of the subjects was between 11 to 27 yr (14, 15, 18). Duran and other investigators reported that young age with high chance of active rheumatic carditis is an important predisposing factor of re-operation (7, 8, 13, 14, 16), which has been challenged recently by another group (18). The most important difference, we believe, is that all patients underwent preoperative echocardiographic screening for feasibility of repair surgery in our study. Patients with unfavorable morphology, such as significant stenosis (valve area <2.0 cm^2) or subvalvular calcification, underwent a straight valve replacement, and, during the study period, about 80% of the total patients with significant rheumatic mitral regurgitation were selected for repair after the echocardiographic screening. This may explain the relatively higher rate of successful repair of rheumatic mitral regurgitation in our study (92%) compared to 67% reported by others (19).

Another interesting finding in this study is that recent improvements of surgical techniques with understanding of the mechanisms of mitral regurgitation contributed to the better postoperative results. Specifically in patients with degenerative mitral regurgitation, new chordae formation has been accepted as a prerequisite procedure to repair prolapse or chordae rupture of anterior or both leaflets (20-22), which lesions were once regarded as a poor candidate for repair. The findings that no use of new chordae formation and ring annuloplasty are important determinants of progressive mitral regurgitation after repair reinforce that use of multiple surgical interventions to repair the individual mechanisms of mitral regurgitation in 3 different levels (subvalvular, valvular and annular) are necessary not only for successful repair but also for long-term durability.

The mean clinical and echocardiographic follow-up duration of less than 3 yr is a main limitation of our study, as development of significant mitral regurgitation and re-operation after repair increase with longer follow-up. Long-term follow-up results are necessary to prove the durability of mitral valve repair in rheumatic mitral regurgitation and to answer the question if valve repair should be the favored approach for all patients with rheumatic mitral regurgitation using

echocardiographic screening (23).

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