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□ 임상연구 □

승모판막 성형술 후 재발의 원인에 대해 술기와 판막 요인에 대한 분석

신홍주* · 유동곤** · 이용직* · 박순익* · 주석중* · 송 현* · 정철현* · 송명근* · 이재원*

Analysis of Recurred Mitral Regurgitation after Mitral Repair according to Procedure or Valve Related Causes

Hong Ju Shin, M.D.*, Dong Gon Yoo, M.D.**, Yong Jik Lee, M.D.*, Soon Ik Park, M.D.*, Suk Jung Choo, M.D.*
Hyun Song, M.D.*, Cheol Hyun Chung, M.D.*, Meong Gun Song, M.D.*, Jae Won Lee, M.D.*

Background: Mitral valve repair (MVP) is the optimal procedure for mitral regurgitation (MR), however, failure and subsequent reoperations are the limitations. The current study assessed the procedure in relation to the primary valve related causes of recurrent MR. ***Material and Method:*** MR was treated in 493 patients undergoing MVP from January of 1994 to January of 2002. The causes of MR were degenerative (n=252, 51.5%), rheumatic (n=156, 31.6%), and others (n=85, 16.9%). Surgery comprised 446 ring annuloplasties (90.5%), 227 new chordae formations (46%), 125 quadriangular resections (25.3%), 28 chordae transfers (5.7%), and 8 Alfieri's stitches (1.6%). The mean follow up was 29.04±22.81 months. ***Result:*** There were 5 early (1.01%), and 5 late deaths (1.01%). The reoperation rate was 1.42%. There were 45 (9.1%) recurrent MR (grade III or IV). Of these, 24 were procedure related including incomplete repair (n=14), discordant new chordae length (n=8) and others (n=2). In 21 patients, the cause was valve related including rheumatic disease progression (n=10), recurrent chordae elongation or prolapse (n=5) and others (n=6). Severe MR was higher after incomplete repair ($p<0.001$), and valve related failure strongly correlated with rheumatic progression ($p<0.05$). ***Conclusion:*** Since completeness of operation is the prime risk factor that determine the repair durability, intra-operative assessment of the initial repair with trans-esophageal echocardiography is essential.

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Key words: 1. Mitral valve, repair
2. Mitral valve regurgitation
3. Risk analysis

INTRODUCTION

Mitral valve repair (MVP) has become standard procedure for treatment of mitral regurgitation (MR)[1,2]. Its advantages over mitral valve replacement (MVR) include greater freedom from reoperation and endocarditis, better preservation of left ventricular function, and improved survival[2-5]. Although MVP is a relatively durable treatment modality, failure and recurrence of MR remain as major drawbacks. The recurrence of MR is not always procedure related, as is

*서울아산병원 흉부외과, 울산대학교 의과대학
Department of Thoracic and Cardiovascular Surgery, University of Ulsan College of Medicine
**강릉아산병원 흉부외과, 울산대학교 의과대학
Department of Thoracic and Cardiovascular Surgery, Gangneung Asan Hospital, University of Ulsan College of Medicine
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책임저자 : 이재원 (138-736) 서울시 송파구 풍납동 388-1, 서울아산병원 흉부외과
(Tel) 02-3010-3580, (Fax) 02-3010-6966, E-mail: jwlee@amc.seoul.kr

Table 1. Patient characteristics

Characteristics	Mean or No.
Age (yr)	47.6±15.2 (12~82)
Male/Female	234/259 (47.5%/52.5%)
Degree of MR	
≤Grade II	56 (11.3%)
Grade III	65 (13.2%)
Grade IV	372 (75.5%)
Ejection fraction	
>40%	452 (91.7%)
≤40%	41 (8.3%)
Rhythm	
NSR	304 (61.7%)
Atrial fibrillation	180 (36.5%)
Atrial flutter	9 (1.8%)

MR=Mitral regurgitation; NSR=Normal sinus rhythm.

Table 2. Etiology of mitral regurgitation

Etiology	No.
Degenerative	252 (51.1%)
Rheumatic	156 (31.6%)
Ischemic	28 (5.7%)
Infective endocarditis	26 (5.3%)
Congenital	23 (4.7%)
Myxoma	7 (1.4%)
Iatrogenic	1 (0.2%)

Table 3. Valve pathology

Pathology	No.
Annular dilatation	199 (40.4%)
Chorda elongation	190 (38.5%)
Chorda rupture	182 (36.9%)
Commissural fusion	104 (21.1%)
Leaflet tethering	89 (18.1%)
Chorda fusion	58 (11.8%)
Leaflet perforation	17 (3.4%)
Cleft	11 (2.2%)

usually thought to be the case. We assessed the results of MVP in our experience and further analyzed those patients with severe MR comprising repair failure. The patients were divided by underlying cause of valve failure, either procedure or primary valve related. The aim of the present study was to assess for risk factors of repair failure, in order to enhance long-term results by taking necessary preventive measures.

MATERIALS AND METHODS

1) Patients

From January 1994 to January 2002, 493 patients undergoing MVP with or without concomitant cardiac procedures were included in the present study. Patients with pure mitral stenosis were excluded. The mean age was 47.6±15.2 years ranging from 12 to 82 years, and there were 234 men and 259 women. Preoperative Echocardiogram revealed grade III MR in 65 patients, and grade IV in 372 (Table 1). The etiology was degenerative in 252 patients, rheumatic in 156, ischemic in 28, endocarditis in 26, congenital in 23 and myxoma in 7 (Table 2).

2) Surgical details

Median sternotomy was performed, with bicaval cannulation and cardiopulmonary bypass (CPB) under moderate hypothermia. The mitral valve was exposed through left atriotomy. Myocardial protection was achieved via intermittent antegrade or retrograde cold cardioplegia. The mean CPB and aortic cross clamp times were 134±56 min and 95±41 min, respectively. The mitral pathology was determined by direct visual inspection at the time of operation and later confirmed by histologic examination of the submitted specimens (Table 3). Among the surgical findings annular dilatation was the single most common cause of MR followed by chordal elongation and rupture. However the incidence of chordal elongation and rupture combined comprised the largest incidence of MR (Table 3). The operative technique and types of concomitant surgery performed in addition to mitral repair are summarized in Table 4. The most frequent mitral repair technique was annuloplasty performed in 90.5% patients, followed by new chordae formation in 46.0%, and quadriangular resection in 25.3%. The types of rings used in decreasing order of frequency were Carpentier-Edwards ring (n=314, 70.4%), Duran ring (n=119, 26.7%), and the Physio-

Table 4. Surgical procedures

Procedures	No.
Mitral valve repair	
Ring annuloplasty	446 (90.5%)
New chorda formation	227 (46.0%)
Quadriangular resection	125 (25.3%)
Commissuroplasty	42 (8.5%)
Chorda transfer	28 (5.7%)
Alfieri stitch	8 (1.6%)
Concomitant procedures	
Tricuspid valve repair	117 (39.4%)
Maze operation	90 (30.3%)
CABG	44 (14.8%)
Aortic valve surgery	23 (7.7%)
ASD patch closure	15 (5.1%)
Ascending aorta replacement	8 (2.7%)

ASD=Atrial septal defect; CABG=Coronary artery bypass grafting.

ring (n=13, 2.9%). Tricuspid valve repair was performed in 39.4% patients, the maze procedure in 30.3%, and CABG in 14.8%.

3) Clinical Analysis and Follow-up Techniques

The mean follow up was 29.04±22.81 months and the follow up was complete in 96.6% with 17 patients lost to follow-up. Medical records were reviewed and the patient, family, or referring physician was contacted for data collection. Echocardiography was performed in the early post-operative period prior to discharge and later during the follow-up. Recurred MR was defined as greater than 3+ MR on a scale of 0 to 4+ on the last follow up echocardiogram. Incomplete repair was defined as greater than 2+ MR on immediate follow up echocardiography, and we consider that it involve early MR after no use of intra-operative trans-esophageal echocardiogram (TEE), cases of no more chance of repair because of poor patient condition at operation room, the cases in that there were no intra-operative MR, but early progression of MR, and cardiologist's underestimation of intra-operative TEE. Disease progression was defined according to etiology as rheumatic motion limitation, commissural MR, valve prolapse or chordae elongation, and functional MR separate from procedural failure[3].

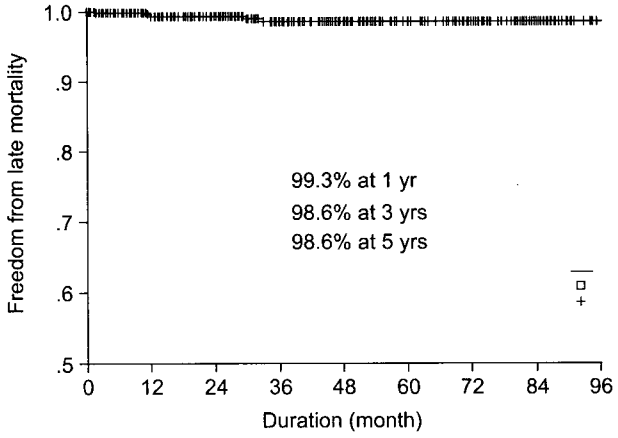

Fig. 1. Freedom from late mortality.

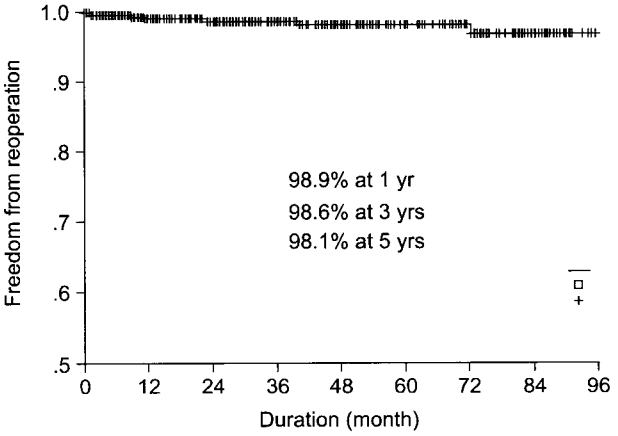

Fig. 2. Freedom from reoperation.

4) Statistical analysis

Univariate analysis was performed to identify the independent risk factors for recurrent MR. The relationship between etiology of MR, operative and valve related risk factors were analyzed by univariate analysis (χ^2test). A p value of less than 0.05 was considered significant. The cumulative survival and freedom from reoperation were assessed by the Kaplan-Meier method.

RESULTS

There were 5 (1.01%) hospital deaths. The causes included

Table 5. Postoperative echocardiogram data

Variables	Mean
EF (%)	57±10.26
MR (grade)	1.0±1.40
MV area (cm^2)	2.7±1.63
Peak pressure gradient (mmHg)	9.4±5.35

EF=Ejection fraction; MR=Mitral regurgitation; MV=Mitral valve.

Table 6. Causes of recurred MR

Causes	No.
Procedure related	24 (53.3%)
Incomplete repair*	14 (31.1%)
New chorda formation	8 (31.1%)
Suture dehiscence	1 (2.2%)
Leaflet perforation	1 (2.2%)
Valve related	21 (46.7%)
Progression of disease†	20 (44.5%)
Infective endocarditis	1 (2.2%)
Total	45

*Incomplete repair means more than grade 2 MR by immediate follow-up echocardiogram; †Progression of disease includes rheumatic motion limitation, commissural MR, valve prolapse or elongation of chorda in degenerative disease, functional MR.

sepsis (n=3), low cardiac output (n=1), and tracheal bleeding (n=1). There were also 5 late deaths (1.01%). The freedom from late mortality is shown in Fig. 1. Reoperation was required in 7 patients (1.42%) as shown in Fig. 2, among which 2 of them underwent MVP, and 5 of them underwent MVR. The postoperative echocardiographic data are summarized in Table 5. The mean postoperative ejection fraction was 57±10.3%. The mean postoperative MR grade was 1.0 ±1.4. Recurred MR occurred in 45 patients. The characteristic findings according to underlying cause of MR, either procedure or valve related are summarized in Table 6. Procedure related recurred MR was seen in 24 (53.3%) patients, of which incomplete repair was seen in 14 (31.1%) patients, too short or too long new chorda formation in 8 (17.7%) patients, suture dehiscence in 1 (2.2%), and leaflet perforation in 1 (2.2%) patient. Recurred MR due to valve

Table 7. Relationship between etiologies and recurred MR

Etiology	No. of total	No. of recurred MR	p-value
Degenerative	252	20 (7.9%)	0.348
Rheumatic	156	15 (9.6%)	0.798
Ischemic	28	4 (14.3%)	0.329
Infective endocarditis	26	3 (11.5%)	0.661
Congenital	23	2 (8.7%)	0.941
Myxoma	7	1 (14.3%)	0.633
Iatrogenic	1	0 (0.0%)	0.751

Table 8. Relationship between procedural risk factors and recurred MR

Risk factor	No. of total	No. of recurred MR	p-value
Incomplete repair	44	14 (31.8%)	<0.001
New chorda formation	227	22 (9.7%)	0.899
Ring annuloplasty	446	40 (9.0%)	0.343
Q-resection	125	7 (5.6%)	0.082
Chorda transfer	28	2 (7.1%)	0.619
Alfieri's stitch	8	2 (25.0%)	0.151

Q-resection=Quadriangular resection.

related causes were seen in 21 (46.7%) patients, of which progression of rheumatic disease was seen in 10 (22.2%), recurrent chordae elongation or prolapse in 5 (11.1%), incomplete coaptation due to cardiac dilatation in 3 (6.7%), commissural regurgitation in 2 (4.4%), recurred bacterial endocarditis in 1 (2.2%) patient. The relationship between MR recurrence and etiology of MR are summarized in Table 7. There was no single etiological factor significantly affecting the incidence of MR recurrence. The relationship between recurred MR and procedure related causes are summarized in Table 8. Incomplete repair was found to be a major risk factor for MR recurrence ($p<0.001$). The recurrence of MR per procedure related and valve related causes are summarized in Table 9. A significant difference was seen only among the rheumatic patients (n=156)

DISCUSSION

MVP is associated with low early and late mortality and

Table 9. Relationship between etiology and repair failure

Etiology	Cause of repair failure		p-value
	Procedure related	Valve related	
Degnerative (n=252)	13	7	0.161
Rheumatic (n=156)	4	11	<0.05
Ischemic (n=28)	3	1	0.363
Infective endocarditis (n=26)	1	2	0.472
Congenital (n=23)	2	0	0.176
Myxoma (n=7)	1	0	0.344

has the advantage of avoiding many of the complications associated with prosthetic valve replacement. Therefore, valve repair is the procedure of choice whenever possible[6]. The present study demonstrated satisfactory and acceptable early and late results for MVP with the early and late operative deaths at 1.01% and 1.01%, respectively. The reoperation rate was 1.42%. These results were comparable to other series in which the incidence of operative mortality ranged between 1.3% and 5.5% [2,4,6,7]. Furthermore, the reoperation rate was significantly lower than other reported series[3,8,9]. Although the follow-up duration in this study was relatively short, according to the hazard phase as reported by Cleveland clinic[9] our long-term results were satisfactory. Nonetheless, MR recurrence is an important consideration and many studies have investigated the relationship between the etiology of MR, repair technique and the durability of the repaired mitral valve[2-4,6,7]. The assessment of the 493 patients in whom MVP was performed according to etiology showed degenerative and rheumatic causes to be the most common. According to Lessana the results of MVP depended on the underlying disease, in which their findings showed a tendency for degenerative etiology to show less recurrence than rheumatic but no significant difference[8]. Duran also showed relatively better results after MVP with degenerative or ischemic valve dysfunction than rheumatic disease[10,11]. In the presence of severe calcification and extensive fibrosis, mitral valve repair is not recommended[8]. However, in select rheumatic patients, good results were seen after MVP. On the other hand, assessment of surgical technique showed incomplete repair to be a significant risk factor for MR recurrence. According to Gillinov[3] incomplete repair in patients with degenerative etiology was associated with a low recurrence rate of 7%, contrasting even further with our data of 31.8% (Table 8) in which our data included assessment of the influence of operative procedure on MR recurrence, making simple comparison difficult. However, according to the earlier description of incomplete repair, it has been shown that completeness of repair at the time of surgery is an important factor in preventing further recurrence. As reported in earlier studies, intra-operative TEE is essential in detecting immediate failure[12-14]. According to Saiki et al, intra- operative TEE matched well with early and late postoperative TTE findings in measuring residual MR, indicating its usefulness in reliably predicting early and late postoperative mitral valve dysfunction. In the past, fluid filling test was used to assess the success of MR correction. However, this method has been shown to be inaccurate as the spatial arrangement of the mitral apparatus is different from the contracting ventricle [8,15]. In our experience, we also relied on intra-operative TEE for the assessment of residual MR to decide whether to repeat cardiopulmonary bypass to correct the residual MR. Stewart et al, showed that post pump grade 1+ or 2+ MR on intra-operative TEE did not increase morbidity or mortality, but it did lead to a significantly higher incidence of significant MR recurrence that required reoperation, stressing the importance of completeness of repair the first time[12]. Likewise, to ensure good long term results it is essential to make sure that there is no residual MR on intra-operative TEE and per this standard even 1+ or 2+ MR may necessitate a second pump run to completely correct the residual defect. Gillinov et al divided the causes of failed mitral valve repair into procedure-related (rupture of previously shortened chordae, suture dehiscence, incomplete initial operation) and valve-related (progressive disease, endocarditis) causes[3]. They already showed a high proportion of procedure-related repair failures in patients with degenerative disease[16]. However there was a greater proportion of valve related mitral repair failure of 57% versus procedure related failure of 30% and this may be related to modifications in the operative technique[3]. In the present study, there was a greater procedure related failure of 53.3%

versus valve related failure of 46.7%, but as this may be attributed to multiple causes, a simple comparison to the series reported by Gillinov et al may be difficult (Table 6). According to Table 9, although the procedure related failure of 65% was greater than the 35% valve related failure in the degenerative patients, this may be attributed in part to the fact that we experienced a greater incidence of procedure related failures in the earlier part of our series (1994～1997), which improved significantly with more experience over time. In the rheumatics, valve related failure of 73.3% was significantly higher than that of the procedure related failures of only 26.7%. However, this is only to be expected as the natural course of the disease in the rheumatics is progressive in nature[8]. Therefore, care is warranted in the selection of candidates for MVP in the rheumatics.

CONCLUSION

MVP is a relatively safe procedure with a recurrence rate of 9.1% and reoperation rate 1.4%. In the rheumatics, disease progression was the more important cause of failure than the surgical procedure itself.

Because completeness of initial operation is the most important risk factor in predicting failure of repair, intra-operative TEE is crucial for ensuring good long-term results.

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=국문 초록=

배경: 승모판막 성형술은 승모판막 폐쇄부전증에서 적절한 치료이지만 승모판막 폐쇄부전의 재발과 그에 따른 재수술이 제한점이다. 본 연구는 승모판막 성형술 후 재발의 원인에 대해 술기와 판막 요인에 대하여 분석하였다. **대상 및 방법**: 1994년 1월부터 2002년 1월까지 승모판막 폐쇄부전증으로 승모판막 성형술을 받은 493명을 대상으로 하였다. 승모판막 폐쇄부전의 원인으로는 퇴행성이 252예(51.5%), 류마티스성이 156예(31.6%), 다른 원인이 85예(16.9%)였다. 성형술은 링을 사용한 판막륜성형술이 446예(90.5%), 신건삭 재건술이 227예(46%), 사각 절제술이 125예(25.3%), 건삭 전이술이 28예(5.7%), Alfieri 방법이 8예(1.6%)였다. 평균 추적 관찰 기간은 29.04±22.81개월이었다. **결과**: 5예의 조기 사망(1.01%)과 5예의 만기 사망(1.01%)이 있었다. 재수술율은 1.42%였다. 승모판막 폐쇄부전의 재발은 45예(9.1%)에서 있었다. 24예에서 술기와 동반된 재발이 발생하였는데, 불완전한 성형술로 인한 재발이 14예, 신건삭 길이의 부적합으로 인한 재발이 8예, 기타 원인으로 인한 재발이 2예 있었다. 21예에서 판막 요인에 의한 재발이 발생하였는데, 류마티스성 질병 진행으로 인한 재발이 10예, 건삭의 연장이나 탈출로 인한 재발이 5예, 기타 원인으로 인한 재발이 6예 있었다. 심한 승모판막 폐쇄 부전은 불완전한 성형술 후 많이 나타났으며($p<0.001$), 판막 요인에 의한 재발은 류마티스성 진행과 강한 상관관계를 보였다($p<0.05$). **결론**: 승모판막 성형술의 내구성을 결정하는 위험 인자로 수술의 완전성이 가장 중요하므로, 초기 성형술 후 수술장에서 경식도 초음파로 검사하는 것이 필수적이다.

중심 단어 : 1. 승모판 성형술
2. 승모판 폐쇄부전
3. 위험인자 분석