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Severity Score for Mitral Valve Repair in Active Infective Endocarditis

Tadashi Omoto[1*], Atsushi Aoki[1], Kazuto Maruta[1] and Tomoaki Masuda[1]

[1]Department of Cardiovascular Surgery, Showa University, Shinagawa-ku, Tokyo, Japan

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***Corresponding author:** Tadashi Omoto, MD, Department of Cardiovascular Surgery, Showa University, Hatanodai 1-5-8, Shinagawa-ku, Tokyo, Japan, Tel: +81-3-3784-8588, Fax: +81-3-3784-8307; E-mail: tomoto@med.showa-u.ac.jp*

Abstract

Objectives: Whether to perform mitral valve (MV) repair is often difficult during infective endocarditis (IE), especially in patients with extensive leaflet destruction. The aim of this study was to develop scoring system to predict feasibility of mitral valve (MV) repair and select appropriate surgical candidates for repair during active IE.

Methods: Patients who underwent MV repair for active IE were retrospectively divided into two groups during average follow-up period of 81 months: if MV repair was performed without significant recurrence of MR, MV repair was defined as feasible (n=18), and MV repair was defined as non-feasible (n=7) when MV repair resulted in more than moderate MR postoperatively or required redo surgery. Extensiveness of the valvular destruction was assessed by valvular score (VS), and complexity of valve repair was assessed by technical score (TS). Severity score was defined as the sum of VS and TS. Patients with feasible and non-feasible MV repair were compared in severity score, and association between probability of feasible MV repair and severity score was evaluated.

Results: Severity score was lower in feasible MV repair than non-feasible MV repair (5.4±2.2 points vs. 10.7±1.8, respectively, Mann Whiteney U test: $p < 0.001$). The receiver operating characteristic curve revealed a cut-off value of 8 points as having the best balance of specificity and sensitivity for predicting feasible MV repair. Probability of feasible MV repair was 100% (14/14) in severity score ≤ 7 points, 67% (4/6) in severity score =8 points, and 0% (0/5) in severity score ≥ 9points.

Conclusions: Feasibility of MV repair during active IE was associated not only with extensiveness of leaflet destruction but also with surgical technique which would be taken. Probability of feasible MV repair can be categorized into high, moderate, and low probability according to severity score as ≤ 7 points, 8 points and ≥ 9points.

Keywords: Endocarditis; Mitral valve

Introduction

Because of its benefits in the preservation of left ventricular function (LV) and prevention of recurrence of infection, mitral valve (MV) repair is the preferred surgical option in degenerative MV disease. However, this is not always the case in infective endocarditis (IE). Using the Society of Thoracic Surgeons Adult Cardiac Surgery Database, Bolling et al. demonstrated that IE was associated with a decreased likelihood of MV repair and that patients with active IE were very likely to undergo MV replacement [1]. In the active-stage of IE, operative indications are (1) uncontrollable infection, (2) heart failure, and (3) large or fragile vegetation which may cause recurrent embolization. Preoperative patient condition differs from that in patients with active and healed IE; the virulence of causative bacteria is associated with difficulties in infection control, and extensive leaflet destruction often results in acute ventricular volume overload requiring urgent valve operation. Decision-making about the feasibility of MV repair is often difficult in patients with poor LV function in whom cross-clamping time would be critical issue.

By retrospective review of patients who underwent MV repair during active phase of IE, we have categorized feasible and non-feasible MV repair. And by analyzing extensiveness of valvular destruction and contents of MV repair, severity score was developed so as to assess the probability for feasible MV repair in active-stage MV endocarditis.

Patients and Methods

For the present study, patients with prosthetic endocarditis and previous cardiac operation were excluded. We reviewed 37 patients who underwent MV operation for active-stage native IE in our institution from April 2005 to February 2016. During this period, the author was engaged in all perioperative managements as a performing surgeon or an assistant, and surgical strategy and repair technique have not been changed: complete debridement of infected tissue, artificial chordae replacement for the anterior mitral leaflet repair, and use of autologous patch reconstruction in cases with extensive leaflet defect. Indications for surgery were progressive hemodynamic compromise, recurrent embolization, large vegetation (> 1cm), or uncontrollable infection with use of appropriate antibiotics or combination of these conditions. Surgery was not delayed or suspended in patients with ischemic stroke without hemorrhagic lesion. Surgery was not conducted during the acute stage of endocarditis in patients with cerebral hemorrhage. If surgical treatment was required before completion of a standard course

of antibiotics, endocarditis was defined as active-stage IE, and if no antibiotics were being given at the time of operation, other than as prophylactic medication, the infection was considered treated, and defined as *healed* stage IE [2,3]. Preoperative head, chest, abdomen, and pelvic CT imaging was performed in all patients. MV endocarditis was diagnosed based on the modified Duke criteria [4].

Patients with feasible MV repair were defined as MV repair without significant postoperative recurrence of MR during the follow up period. Patients with non-feasible MV repair were defined as follows: MV repair was converted to MV replacement intraoperatively, MV repair required reoperation postoperatively, or MV repair resulted in recurrence of more than moderate mitral regurgitation (MR) during the follow up period (Figure 1).

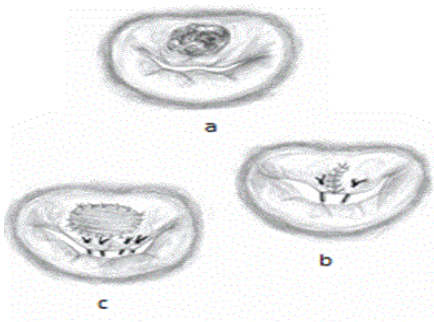


Figure 1: Mitral valve repair for A2 lesion. a) Vegetation involving A2 lesion. b) Repair by leaflet resection and artificial chordae. C) Repair by autologous patch reconstruction and artificial chordae.

During the retrospective review of each operative record, extensiveness of leaflet destruction and complexity of repair technique was assessed by valvular score (VS) and technical score (TS) as shown in Table 1. Severity score was defined as the sum of VS and TS. We defined VS of the MV according to intraoperative assessment of leaflet destruction. Artificial chordae implantation was not scored additionally.

Table 1: Severity score

	Score
Valvular Score	
P1-P3	1
Commissure leaflet (anterior/posterior)	1
A1-A3	2
Preexisting lesion (restrictive or rheumatic)	2
Abscess	2
Technical Score	
Leaflet resection/ one scallop	1
Leaflet resection/ two scallop	2
Leaflet resection/ A2	3
Patch reconstruction/ one scallop	1
Patch reconstruction/ two scallop	2
Patch reconstruction/A2	3

For example, if the valve lesion was P1-P2 and leaflet resection was one-scallop size, VS was 1+1 and TS was 1, therefore, severity score was 3 points; VS was reflected by the location of the vegetation, so even if the size of the vegetation is the same, vegetation of P1 counted as 1 point of VS, and vegetation of P1-2 is counted as two points of VS. If the valve lesion was A3-posterior commissure-P3 and leaflet resection was two-scallop size with the edge-to-edge repair, VS was 2+1+1, and TS was 2, thus, severity score was 6 points (Figure 2a and 2b). However, if MV repair required patch reconstruction, TS was 2+2 and severity score was 8 points (Figure 2c).

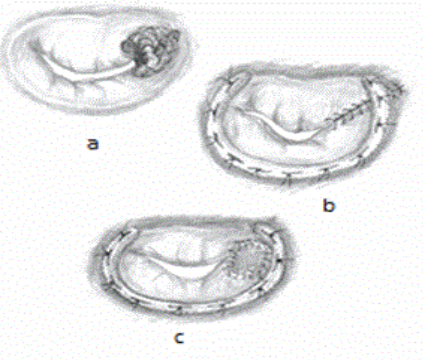


Figure 2: Mitral valve repair for A3-posterior commissure-P3 lesion. a) Vegetation involving A3-posterior commissure-P3 lesion. b) Repair by leaflet resection. C) Repair by leaflet resection and autologous pericardial patch reconstruction.

Association between severity score and feasibility of MV repair was evaluated. The receiver operating characteristic (ROC) curve was used to identify the most appropriate cut-off value to define the feasibility of MV repair [5]. The data were summarized as mean ± standard deviation or number (percentage). Baseline differences in categorical variables were tested using the Pearson $\chi 2$ test, while continuous variables were tested using the Student t-test and non-parametric data were analyzed using Mann Whiteney U test. Values of $p < 0.05$ were considered statistically significant.

Results

Feasible and non-feasible MV repair

Out of 37 patients with active IE of the MV, 12 patients underwent MV replacement; we reviewed total number of 25 patients who underwent MV repair. Follow-up data of 25 patients (100%) were obtained from patients charts, with mean length of follow-up was 81.1±33.4 months (maximum 126 months). Feasible MV repair was performed in 18 patients and non-feasible MV repair was performed in 7 patients. There was no statistical significance between patients with feasible and non-feasible MV repair in age, preoperative c-reactive protein, preoperative left ventricular end-diastolic dimension, preoperative left ventricular ejection fraction, preoperative left atrial dimension, length of preoperative administration of antibiotics, cardiopulmonary bypass time and aortic cross-clamping time (Table 2).

Table 2: Patient's profile of feasible and non-feasible MV repair. MVP: mitral valve repair, ns: non significant, LVEF: left ventricular ejection fraction, LAD: left atrial dimension, CPB: cardiopulmonary bypass time, ACC: aortic cross clamp time. *: length of preoperative administration of antibiotics

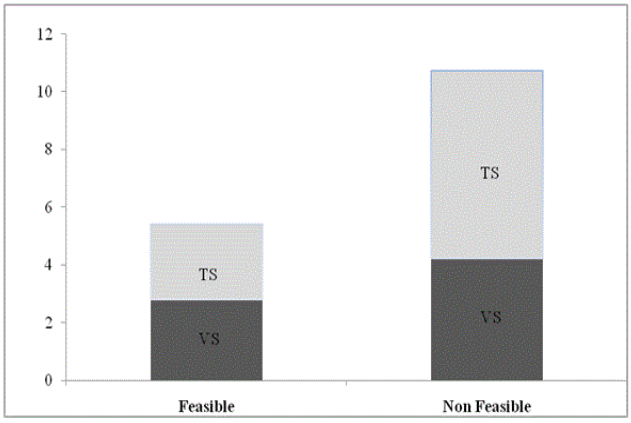
	Feasible MVP	Non-Feasible MVP	p-value
Number of Patients	18	7	
Age (year)	53.0±14.4	50.1±20.6	ns
C-reactive protein (mg/dl)	5.2±5.4	3.5±3.8	ns
LVEF (%)	63.6±6.7	61.4±6.0	ns
LAD (mm)	42.3±7.9	41.4±5.0	ns
Antibiotics (days)*	17.3±16.6	9.0±5.7	ns
CPB (minutes)	162.8±53.5	183.3±34.7	ns
ACC (minutes)	122.5±45.9	147.9±52.4	ns
LVDD	55.8±6.0	56.8±8.5	ns
LVEF	63.5±6.9	61.4±6.0	ns
LAD	42.5±8.1	41.1±5.0	ns
NYHA class IV	37%	71%	ns
MR III-IV	100%	100%	ns

LVDD: left ventricular end-diastolic dimension, LVDS: left ventricular end-systolic dimension, LVEF: left ventricular ejection fraction, LAD: left atrial dimension, NYHA: New York Heart Association, MR: mitral regurgitation

Perioperative Outcomes

In-hospital mortality was 13% (n=3). Both occurred in feasible MV repair and the cause of death was non-cardiac; pneumonia in two patients and peritonitis in one patients. Major complications were renal failure requiring new hemodialysis in one patient, new postoperative cerebral infarction in one, subdural hematoma, mycotic aneurysm of the ulnar artery in one (feasible MV repair), and complete AV block in one (non-feasible MV repair).

In long-term follow up, 15 patient who underwent feasible MV repair are doing well with New York Heart Association Class I (n=12) and II (n=3). In 7 patients with non-feasible MV repair, one patient died during follow up (pancreatic cancer), and one patient developed intracranial hemorrhage6 years after the operation, other 5 patients are doing well with New York Heart Association Class I (n=3) and II (n=2).



VS: valvular score, TS: technical score

Table 3: Severity score in feasible mitral valve repair and non-feasible mitral valve repair.

Severity Score

Severity score was lower in feasible MV repair than in non-feasible MV repair (5.4±2.2 points vs. 10.7±1.8, respectively: Mann Whiteney U test, $p < 0.0001$, Table 3). ROC of severity score revealed a cut-off value of 8 points as having the best balance of specificity and sensitivity for predicting the feasibility of MV repair with a sensitivity of 100% and specificity of 78%. Probability of feasible MV repair was 100% (14/14) in SS ≤ 7points, 67% (4/6) in SS=8 points, and 0% (0/5) in SS ≥ 9points.

Discussion

Surgical principle of MV operation for active-stage IE is complete debridement of the infective tissue under the consideration of prevention from re-infection and cerebral embolization. Even though MV repair has been reported as the preferred therapy than MV replacement in IE [6-8], there are marked variability in the frequency of MV repair, and the influence of both patient-surgeon level factors on the likelihood of MV repair [6]. A multivariable model utilizing The Society of Thoracic Surgeons Adult Cardiac Surgery Database showed that MV repair was performed for 60.6% of degenerative mitral regurgitation (MR), 41.0% of treated IE, and 20.8% of active IE [7,8]. Even though there are potential benefits in MV repair in active-stage IE, namely the preservation of left ventricular (LV) function and avoidance of a prosthetic valve, the line between which patients should be recommended for MV repair has been unclear.

In previous studies, if vegetation is localized in one scallop MV repair is generally recommended and performed, however, cases with debridement of more than half of the PML or with destruction of more than one segment of the AML remained controversial [9]. Aggressive surgical techniques for the reconstruction of large leaflet defects using patch reconstruction, the sliding technique, and artificial chordae are available [10-12], but concerns have been raised about the durability of complex MV repair, particularly during the active-stage of IE. An aggressive approach to repair may render the recurrence of MR a long-term problem.

Surgical score is useful for intraoperative surgical decision-making for active IE. Because suture stress of the AML was supposed to be higher than the PML, we decided to double the score between the PML and AML. If one scallop is removed without patch reconstruction, that means surgery was rather simple, however if patch reconstruction was necessary, that mean surgery was more complex and suppose to have an additional postoperative risk of recurrence of MR. In case with P1-P2 involvement (first example in method section), which VS is 2, however there is significant difference between a case with two scallop size resection which requires annular reconstruction (TS=2), and a case with only one scallop size resection (TS=1); Severity Score system would characterize the difference by adding one or two points of TS .In this study we did not add score in patients with annuloplasty and artificial chordae replacement, which supposed to have less influence on durability than patch reconstruction.

Good candidate for MV repair during active IE are patients with severity score ≤ 7. If severity score is more than 9, MV repair should be abandoned because possibility of feasible MV repair is low. In patients with severity score of 8 points, MV repair is only recommended in patients who would have great benefit in selecting MV repair. One example of severity score of 8 points is; A2 lesion which repaired by leaflet resection and patch repair (VS as 2, TS 3+3), or A3-posterior commissure-P3 lesion which repaired by leaflet resection of two scallop size and patch reconstruction (VS as 2+1+1, TS as 2+2, Figure 2c). In order to secure long-term durability after MV repair, advancements in surgical technique will be necessary for patients with severity score ≥ 8 points.

Several limitations of our study warrant mention. The sample size is small, and the ability to draw definitive conclusions is limited. The scoring system was based on our own surgical experiences, and arbitrary nature might be inevitable. However, we believe, data based on single surgical group which have performed same repair technique with same surgical strategy may be representative for current surgical therapy: 25 MV repair in active IE in 11 years might not be too small experience for a single surgeon. TS added to VS might seem redundant, which involved same segment/scallop scored twice. However, TS was added in order to differentiate between simple and complex repair in patients with same VS: A2 lesion with simple leaflet resection and patch reconstruction should have different potential durability. Actually, repair techniques in active IE, such as leaflet resection, annuloplasty, artificial chordae reconstruction, or autologous patch reconstruction have been currently standardized. We believe that our scoring system is simple, easy to reproduce in other institutes and effective in surgical decision-making in MV operation during active IE.

Conclusion

Severity score provides a guide for surgical strategy in patients undergoing MV operation in active IE. If severity score is less than 7, MV repair is recommended, however, more than 9, MV repair should be abandoned. In patients with severity score =8 points, MV repair is only recommended in patients who would have great benefit in selecting MV repair.

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