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Original Article

Complete preservation of mitral valve apparatus versus posterior leaflet preservation only during mitral valve replacement for rheumatic mitral regurgitation

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Abstract

Objectives

In the present study we investigated whether preservation of both leaflets (anterior and Posterior with subvalvular apparatus) is superior to preservation of the posterior leaflet Alone.

Patients and Methods

30 patients who underwent mitral valve replacement in our institute were divided into 2 groups: MVR-C (n=16), in whom both leaflets were preserved, and MVR-P (n=14), in Whom only the posterior leaflet was preserved. The preoperative and postoperative clinical And echocardiographic findings were evaluated.

Results

No evidence of obstruction at the left ventricular outflow tract was observed in both groups. In the MVR-C group, no deterioration was seen in left ventricular ejection fraction during the early postoperative period, whereas a mild reduction was observed in the MVR-P group (P=0.003). No changes regarding the two groups in their need for inotropic. Agents or in cross-clamp time, duration of ICU or hospital stays, new onset of atrial fibrillation, or mortality rates.

Conclusions

Bileaflet preservation allows us to avoid the decrease in left ventricular ejection fraction that occurred after preservation of the posterior leaflet alone. In spite of the fact that, posterior leaflet preservation only gives excellent results in decreasing the left ventricular diameter. Bileaflet preservation is considered to be the method of choice to avoid any decreases in ejection fraction and to decrease the incidence of death in patients who present with substantially impaired left ventricular function.

Keywords: mitral valve repair, bileaflet augmentation, mitral valve preservation

Body

In this study, we investigated whether preservation of both leaflets (anterior and posterior with the subvalvular apparatus) is superior to preservation of the posterior leaflet alone; 30 patients who underwent mitral valve replacement (MVR) in our institute were divided into two groups: mitral valve replacement–bileaflet preservation group (MVR-C) (n = 16), in whom both leaflets were preserved, and mitral valve replacement–posterior leaflet preservation group (MVR-P) (n = 14), in whom only the posterior leaflet was preserved. The preoperative and postoperative clinical and echocardiographic findings were evaluated.

No signs of left ventricular outflow tract (LVOT) obstruction were observed in either group. In the MVR-C group, no decrease was observed in the left ventricular ejection fraction (LVEF)

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during the postoperative period, whereas a significant reduction was observed in the MVR-P group ($P = 0.003$). No differences were found between the two groups in their need for inotropic agents or in cross-clamp time, duration of ICU or hospital stays, postoperative development of new atrial fibrillation, or mortality rates.

Bileaflet preservation prevented the decrease in LVEF that usually followed preservation of the posterior leaflet alone. However, posterior leaflet preservation alone yielded excellent results in terms of decreased LV diameter.

Bileaflet preservation should be the method of choice to prevent further decreases in ejection fraction and to avoid death in patients, who present with substantially impaired LV function.

Any clinical studies have shown the superiority of completely preserving subvalvular structures during MVR over the conventional valve-excising MVR technique, which involves the removal of both leaflets by cutting the chordae tendineae and the tip of the papillary muscle [1–3].

Nevertheless, bileaflet preservation has not attracted adequate attention among cardiac surgeons. Currently, most cardiac surgeons prefer to preserve the posterior leaflet alone, because bileaflet preservation is technically more difficult, prolongs surgery, requires a smaller prosthetic valve, and opens the possibilities of both LVOT obstruction and contact between the prosthetic valve and subvalvular structures [4,5]. Although many studies compare bileaflet preservation during MVR with conventional valve-excising MVR, few compare bileaflet preservation with preservation of the posterior leaflet alone. The present study aimed to investigate whether preservation of both leaflets – that is, the entire subvalvular apparatus – is superior to preservation of the posterior leaflet alone, in terms of LV function.

Patients and Methods

We follow all the rules of national heart institute. In this study, we evaluated 30 patients who underwent MVR in our clinic from March 2015 through March 2017. Written informed consent was obtained from all patients. Data obtained from patient files and outpatient follow-up were evaluated. The patients were divided into two groups: MVR-C ($n = 16$), patients in whom both leaflets were preserved and MVR-P ($n = 14$), patients in whom only the posterior leaflet was preserved. Excluded from the study were patients undergoing coronary bypass concurrent with MVR, reoperation for MVR, simultaneous aortic valve or aortic surgery, or surgical incision other than sternotomy. Patients' preoperative characteristics are summarized in Table 1.

Table 1: Preoperative characteristics of the groups

Variables	MVR-C ($n=16$)	MVR-P ($n=14$)	*P*
Age (years)	46.5±12.1	42.55±12.9	0.311
Female/male	9/7	8/6	0.218
Preoperative atrial fibrillation	4 (25)	6 (42)	0.252
NYHA functional class III/IV	9/7	9/5	0.238

Data are presented as mean±SD or as *n* (%). MVR-C, mitral valve replacement-bileaflet preservation group; MVR-P, mitral valve replacement-posterior leaflet preservation group; NYHA, New York Heart Association. $P<0.05$ was considered statistically significant.

Surgical technique

All patients underwent median sternotomy, aorto-bicaval cannulation, and antegrade or retrograde cold hyperkalemic cardioplegia. In all, 30 bileaflet mechanical heart valves (St. Jude) were used. The transseptal approach was used in nine patients in whom both mitral and tricuspid valve intervention were performed.

In the other 21 patients, the mitral valve was exposed through a left atriotomy performed parallel to the interatrial groove. In patients whose posterior leaflets alone were preserved, the anterior leaflet was excised 2–3 mm from the annulus by cutting the tip of the papillary muscle together with the attached chordae tendineae. The posterior leaflet and its attached chordae were completely preserved. In the MVR-C group, the anterior leaflet was excised 2–3 mm from the annulus. Thereafter, the anterior leaflet was divided into two parts, lengthwise in the middle. Each of these parts was attached to a point on the annulus close to the commissure, on the same side, in order to prevent LVOT obstruction. While these tissues were attached, redundant tissues were excised. The posterior leaflet was also completely preserved together with its chordae tendineae. Pledgeted sutures were placed in such a manner that they passed from the atrium to the ventricle. After completion of all sutures, we measured the valve and selected the correct valve size. The sutures were tied by passing them through the prosthetic valve annulus.

After ligation, the valve was cautiously examined to determine whether there was contact with subvalvular structures; then the procedure was completed.

Echocardiographic examination

Echocardiographic findings on all patients were evaluated preoperatively and then echocardiography was repeated before discharge from the hospital, and again at the sixth postoperative month. On each of these occasions, left atrial diameter, interventricular septal thickness, LV end-systolic diameter (LVESD) and LV end-diastolic diameter (LVEDD), LVEF, and pulmonary arterial pressure were compared.

Valvular function and the presence of LVOT obstruction, pericardial effusion, and intracardiac thrombus were evaluated at postoperative echocardiographic examinations. When the patient files were reviewed, we compared data regarding cross-clamp time, postoperative need for inotropic agents, amount of postoperative drainage, and duration of ICU and hospital stays. Functional capacity and cardiac rhythm of the patients were recorded at the sixth postoperative month visit.

Statistical analysis

We collected preoperative demographic and echocardiographic data, together with operative and postoperative in-hospital data. Postoperative outpatient visits were also evaluated. In the event that patients had missed their follow-up appointments, they

were contacted by telephone for outpatient clinical information. Collected data were analyzed with SPSS statistical software. Continuous variables were expressed as mean ± SD. Fisher's exact test was used to analyze differences between the two groups with regard to inotropic agent support, atrial fibrillation incidence, and mortality rates. Preoperative and postoperative continuous variables of the groups were compared with the use of the t test. Preoperative and postoperative values within and between groups were compared with repeated-measures testing in a general linear model. A *P* value of less than 0.05 was considered to be statistically significant.

Results

No death occurred during the 6-month follow-up period. No signs of LVOT obstruction were observed on the intraoperative or postoperative echocardiograms in any of the groups. All valve functions were normal (Table 2).

In the MVR-C group, no decrease was observed in LVEF in the postoperative period, whereas a reduction in ejection fraction from a mean of 0.59–0.56 was observed in the MVR-P group ($P = 0.003$). Significant decreases were observed in interventricular septal thickness, left atrial diameter, and pulmonary arterial pressure in both groups. In the MVR-P group, significant decreases were noted in LVESD and LVEDD. Moreover, a significant decrease was found in LVEF. In the MVR-C group, decreases in LVESD and LVEDD were observed; however, these were not significant. The LVEF remained almost unchanged in the MVR-C group. No differences were found between the groups in terms of postoperative need for inotropic agents, cross-clamp time, duration of ICU or hospital stay, postoperative development of new atrial fibrillation, or mortality rates (Table 3, Fig. 1).

Discussion

Mitral valve repair is in general superior to MVR; however, replacement is the only option in some cases.

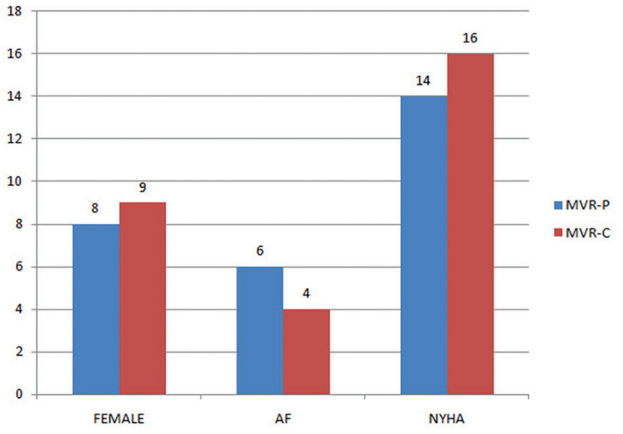

Figure 1: Comparison between both groups regarding female ratio, preoperative atrial fibrillation, and preoperative NYHA class.

Many studies have shown the superiority of bileaflet preservation during MVR over the standard MVR technique [6–9]. However, bileaflet preservation has failed to gain adequate support among surgeons for the reasons mentioned above. Currently, the more frequently accepted and performed technique is MVR that preserves only the posterior leaflet. Although the superiority of bileaflet preservation over conventional valve-excising MVR has been shown by many studies, there are to the best of our knowledge few MVR studies that compare bileaflet preservation with posterior-leaflet-only preservation [1–3].

The study conducted by Yun *et al*. [6], one of the rare comparisons of bileaflet preservation and posterior-leaflet-only preservation, showed no differences between the two techniques in terms of LV diameter and LVEF. In their study, Hennein *et al*. [10] compared bileaflet preservation,

Table 2: Cross-clamp and postoperative evaluation of both groups

	MVR-C	MVR-P	*P*
Aortic cross-clamp time (min)	79.75±34	78.12±37.3	0.877
Postoperative bleeding (ml)	365±250	356±234	0.888
Positive inotropic agent support	9 (56)	10 (71)	1
ICU stay (days)	1.31±0.6	1.12±0.3	0.154
Hospital stay (days)	7.12±2.2	6.92±2.3	0.767
Postoperative atrial fibrillation	4 (12)	5 (14)	1

Data are presented as mean±SD or as *n* (%). MVR-C, mitral valve replacement-bileaflet preservation group; MVR-P, mitral valve replacement-posterior leaflet preservation group. $P<0.05$ was considered statistically significant.

Table 3: Echographic evaluation of groups

Variables	Preoperative	Postoperative	*P*
LVEF			
MVR-C	0.48±0.14	0.48±0.12	0.936
MVR-P	0.59±0.10	0.56±0.07	0.003
LVESD (mm)			
MVR-C	43.6±9	43.5±8	0.027
MVR-P	37.1±8	35.7±7	<0.001
LVEDD (mm)			
MVR-C	61.3±7	57.5±6	0.089
MVR-P	58.9±8	51.8±7	<0.001
IVS thickness (mm)			
MVR-C	11.3±1	10.4±0	0.028
MVR-P	11.4±1	11.1±1	0.027
LA diameter (mm)			
MVR-C	54.1±1	48.8±1	<0.001
MVR-P	53±1	47.1±0	<0.001
PAP (mmHg)			
MVR-C	47.6±9	35.8±6	<0.001
MVR-P	46.4±1	37.6±8	<0.001

Data are presented as mean±SD. IVS, interventricular septal thickness; LA, left atrial; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; MVR-C, mitral valve replacement-bileaflet preservation group; MVR-P, mitral valve replacement-posterior leaflet preservation group; PAP, pulmonary arterial pressure.

posterior-leaflet-only preservation, and total resection. When they performed echocardiography during the sixth and ninth postoperative months, they found bileaflet preservation and posterior leaflet-only preservation to be superior over total resection in terms of exercise capacity, systolic dimensions, and fractional shortening. However, they observed no significant difference between their bileaflet preservation and posterior-leaflet-only preservation groups.

Another study [7] compared bileaflet preservation and posterior-leaflet-only preservation with conventional MVR, in which total resection was performed, and examined patients in terms of ventricular volume, wall stress, and ejection fraction. Although there was no change in LV end-diastolic volume in the conventional group, the study showed significant increases in LV end-systolic volume and stress, and a significant decrease in LVEF. On the other hand, significant decreases in LV end-diastolic and end-systolic volumes and a reduction in wall stress were observed in the preservation groups; no change was observed in LVEF. A meta-analysis of bileaflet preservation reviewed investigations of different preservation techniques but failed to show the superiority of bileaflet preservation over posterior-leaflet-only preservation [11]. The results of this study are similar to those of the studies mentioned above.

However, we found no decrease in LVEF in the MVR-C group, whereas LVEF decreased from 0.59 to 0.56 in the MVR-P group ($P = 0.003$). This study was not a prospective randomized study, and bileaflet preservation was performed mostly in patients with lower LVEF and with higher LVESD and LVEDD.

There is an opinion that residual subvalvular tissue after bileaflet preservation in patients with disease of rheumatic origin might lead to aggravation of recurrent rheumatic fever and thus worsen the results of surgery. However, this issue has not yet been clarified [12].

Both techniques (bileaflet preservation and posterior leaflet-only preservation) result in significant decreases in LVES and LVED dimensions during the postoperative period. Such a decrease in LV size introduces the possibility, in cases of bileaflet preservation, of contact between subvalvular structures and the mechanical prosthetic valve leaflets, and of consequent LVOT obstruction. Therefore, if bileaflet preservation is to be performed, an appropriate preventive measure should be taken. Many such methods have been published [8,9,13–15].

In the present instance, we divided the anterior leaflet into two parts and attached each to a point on the annulus close to the commissure, on the same side, in order to prevent LVOT obstruction. Thus, the subvalvular structures were moved away from the prosthetic valve leaflets. In addition, we reduced the likelihood of contact between subvalvular structures and prosthetic valve leaflets by positioning the leaflets with their hinges close to the atrial side of the valvular orifice.

Bileaflet mechanical valves were oriented in a vertical 12–6-o'clock plane.

There have been many studies of the adverse sequelae of bileaflet preservation. These sequelae include LVOT obstruction or subvalvular tissue impairment of prosthetic valve function, either of which usually necessitates repeat surgery. In this study, bileaflet preservation yielded almost perfect results, except for a very small improvement in postoperative LVEFs. In addition, the preservation of the posterior leaflet alone yielded successful results, except for a statistically significant decline in postoperative LVEFs. Despite lack of complications associated with bileaflet preservation in the present study, there are many reports of LVOT obstruction and hindered prosthetic-valve-leaflet function [4,5,12]. Bileaflet preservation should be chosen to prevent further decrease in LVEF in patients who present with substantially impaired LV function, on the condition that the technical difficulties and postoperative risks of bileaflet preservation are considered.

In this manner, the risk of adverse sequelae to bileaflet preservation can be reduced.

Study limitations

Limitations of this study should be taken into consideration. First, our patients were not randomized into the study groups. The study groups also lack similarity. There was a difference between the groups in terms of preoperative LVEF and LVESD; ideally, LVEF and postoperative decrease in LV size should be evaluated in patients, who present with similar preoperative LVEFs. Because of the small sample size, especially for MVR-C patients, our findings are inconclusive. Moreover, the present study investigated the results of only one of the bileaflet preservation techniques. Different results might be obtained with the use of other preservation techniques, particularly in regard to LVOT obstruction and contact between mechanical valve leaflets and subvalvular structures.

Conclusion

In light of the studies we conclude that conventional MVR, in which subvalvular structures are removed together with both leaflets, should not be performed unless absolutely necessary. Bileaflet preservation successfully prevents postoperative decrease in LVEF in comparison with preservation of the posterior leaflet alone.

Moreover, posterior-leaflet-only preservation yields excellent results in terms of LV diameter.

Large-scale prospective, randomized studies are needed to obtain a more detailed information on this subject.

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Conflicts of interest

There are no conflicts of interest.

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