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Original Article

Double valve repair for combined aortic and mitral valve regurgitation: short-term results

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Abstract

Introduction
Repair of mitral and aortic valve in double valve regurgitation is an attractive alternative to replacement, because of low incidence of valve-related complications. Standardization, reproducibility, and stable results are the three key points that will make any valve repair an established form. This study was undertaken to determine the short-term results of double valve repair for double regurgitation.

Patients and methods
Twenty-six patients had a double valve repair for aortic and mitral valve regurgitation. The mean age was 37.75 (14–53) years. There were 11 (42.3%) men and 15 (57.7%) women. The mean aortic cross-clamp time was 112 (86–135) min and cardiopulmonary bypass time was 145 (120–165) min. In aortic valve repair: subcommissural annuloplasty was done in all 26 patients, leaflet plication in six (23.1%), and pericardial patch extension in four (15.4%) patients. In mitral valve repair: Ring annuloplasty was done in all the 26 patients, quadrangular resection in four (15.4%), and triangular resection in two (7.7%) patients. Concomitant procedures were done in 10 (38.5%) patients with DeVega in seven (26.9%) patients and Maze in three (11.5%) patients.

Results
There was mortality during hospital stay or during the follow-up. New York Heart Association class was less than or equal to II. At discharge, no patient had AR greater than +2 or MR greater than +1. After 5 years, AR was less than or equal to +2 in 23 (88.5%) patients while MR less than or equal to +1 in 24 (92.3%) patients. There was no valve-related morbidity in the form of bleeding, endocarditis, or thromboembolism. Recurrent aortic regurgitation was in three (11.5%) patients. Reoperations in the form of aortic valve replacement were in two (7.7%) patients.

Conclusion
Double valve repair should be reserved for the young, women of child-bearing age, and patients with chronic renal failure due to excellent survival and freedom from valve-related morbidity with short-term results.

Keywords: Annuloplasty, double valve repair, pericardial, plication, resection, subcommissural annuloplasty

Introduction

Increasing awareness of the limitations of prosthetic valve replacement, especially in young population, forces surgeons to explore and apply more conservative procedures on valves. Standardization, reproducibility, and stable long-term results are the three key points that have made mitral valve repair an established form of surgical treatment [1].

Ten percent of patients with valvular heart disease have involvement of both aortic and mitral valves [2–4]. Most groups advocate double valve replacement for such patients [5]. However, some data suggest a survival advantage for the strategy of aortic valve replacement combined with mitral valve repair [6,7]. The results of double valve repair in patients with combined aortic and mitral valve disease still have a little documented data [8].

The primary purpose of this study was to determine the 5-year durability of combined aortic and mitral valve repair, and

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secondarily, the valve-related morbidity and overall mortality during this period. This is important, as double valve repair can be used in young patients, women of child-bearing age, and patients with chronic renal failure in whom mechanical prosthesis requiring anticoagulation is best avoided or bioprostheses are not durable due to rapid degeneration and calcification [9].

Patients and methods

Ethical committee approval was taken. Twenty-six patients had aortic and mitral valve repair for double valve regurgitation from January 2014 to June 2019 at the National Heart Institute. The mean age of patients having double valve repair was 37.75 years (range: 14–53 years); there were 11 (42.3%) men and 15 (57.7%) women. Clinical profiles of all patients are described in Table 1. Valve diseases were classified using the standard criteria based on etiology, pathophysiology, analysis of clinical information, echocardiograms, and operative reports (Tables 1 and 2).

Exclusion criteria

(1) Mild aortic or mitral regurgitation.
(2) Patients with aortic stenosis in a combined lesion.
(3) Patients with mitral stenosis in a combined lesion.
(4) Immediate repair failure and replacement of one or both valves.

Operative procedures

All operations were performed with standard bicaval cardiopulmonary bypass (CPB). Myocardial protection was achieved with cold-blood-enriched cardioplegia through the coronary ostia with moderate systemic hypothermia to 28°C and local hypothermia with cold ice slush and saline. Aortic valve repair was attempted only if the mitral valve was found to be repairable satisfactorily by intraoperative transesophageal echocardiography (TEE) and by inspection during the operation. A transverse or J-shaped aortotomy incision was made, and the aortic valve was inspected for annular dilatation, leaflet prolapse, and retracted leaflet tissue.

Valve inspection:

(1) Annular dimension (by Hegar dilator or valve sizer).
(2) Commissural height.
(3) Coaptation height.
(4) Geometric height.
(5) Type of valve.
(6) Cusp fusion pattern, as in bicuspid aortic valve (BAV), if present.

The technique most frequently used was subcommissural annuloplasty (SCA) for annular dilatation, central leaflet plication for leaflet prolapse, and pericardial leaflet extension for leaflet retraction. Testing of the repaired aortic valve is done with a saline test while the left ventricular vent is on maximum suction (as a first initial step, if competent = good repair). Then the aortotomy is closed and another testing dose of cardioplegia was given through the cardioplegia cannula and the aorta was observed for inflation with cardioplegia denoting good coaptation of the aortic valve leaflets under pressure (as a second initial step, if competent = good repair). Then mitral valve was repaired either with ring annuloplasty in the dilated annulus only or combined with quadrangualr or triangular resection of the prolapsed posterior leaflet. Saline test infusion was done (as a first initial step, if competent = good repair). If the patient had AF, a left-modified Maze was done at the end of the procedure, followed by closure of the left atrium. After deairing, the aortic cross clamp (ACC) is released and the heart was beating spontaneously. The tricuspid valve

Table 1: Clinical profile of all patients

Number of patients	26
Age (years)	
Mean	37.75
Range	14-53
Sex [*n* (%)]	
Male	11 (42.3)
Female	15 (57.7)
Echocardiography (preoperative)	
EDD (mm)	55
ESD (mm)	36
EF%	62%
MR	
+2	3 (11.5)
+3	3 (11.5)
+4	20 (77)
AR	
+2-3	21 (80.8)
+3	2 (7.7)
+4	3 (11.5)

AR, aortic regurgitation; EDD, end-diastolic diameter; EF, ejection fraction; ESD, end-systolic diameter; MR, mitral regurgitation.

Table 2: Operative data

Et mitral valve repair	
Etiology	
Rheumatic	11 (42.3)
Degenerative	9 (34.6)
Posterior leaflet prolapse	6 (23.1)
Ring annuloplasty	26 (100)
Alone	20 (76.9)
Quadrangular resection	4 (15.4)
Triangular resection	2 (7.7)
Aortic valve repair	
SCA	26 (100)
Leaflet plication	6 (23.1)
Pericardial patch extension	4 (15.4)
Concomitant procedure	10 (38.5)
DeVega	7 (26.9)
Maze	3 (11.5%)
CPB time (range) (min)	145 (120-165)
ACC time (range) (min)	112 (86-135)

ACC, aortic cross-clamp; CPB, cardiopulmonary bypass; SCA, subcommissural annuloplasty).

was repaired if needed on a beating heart using DeVega sutures. After coming out of bypass, intraoperative TEE was used to assess the success of double valve repair in all the 26 patients (as a final step = good repair). After completion of repair, AR was less than +2, while MR was less than or equal to +1. The mean time of myocardial ischemia (ACC time) was 112 min (range: 86–135 min), and the mean time of CPB was 145 min (range: 120–165 min). All patients were evaluated before discharge at the fifth postoperative day, then at regular intervals of 3, 6, and 12 months after operation and then annually by echocardiography. All patients received oral anticoagulant for 3 months and aspirin for life after operation. The completeness of follow-up during the closing interval was 100%, with a follow-up of 5 years.

In aortic valve repair, all the 26 (100%) patients had SCA for dilated annulus and as a part of repair for other etiologies. Central plication for leaflet prolapse was performed in six (23.1%) patients and pericardial patch extension for retracted leaflet was done in four (15.4%) patients. In mitral valve repair, all 26 patients had ring annuloplasty for dilated annulus and as a part of repair for other etiologies. The ring was used alone in 20 (76.9%) patients and combined with leaflet resection for posterior leaflet prolapse in six (23.1%) patients, four patients with quadrangular (15.4%) and two patients with triangular (7.7%) resection. There were 11 patients with rheumatic heart disease and nine patients with degenerative mitral valve disease had ring annuloplasty, while patients with posterior leaflet prolapse (six patients) were treated with quadrangular or triangular resection of the prolapsed segment combined with ring annuloplasty. Concomitant procedures were done in 10 (38.5%) patients. DeVega annuloplasty for tricuspid valve was done in seven (26.9%) patients and Maze (left-modified) for AF was done in three (11.5%) patients.

If you leave the operating room with any degree of regurgitation after repair, durability is jeopardized. So, the ideal patient has bilateral regurgitant, degenerative or rheumatic valve, and gets a repair that is perfect with trivial or mild double valve regurgitation. That will give the optimal durability for double valve repair.

Durability of valve repair was assessed by the event valvular reoperation, and by results of late echocardiograms of the presence of valve failure. Analysis of reoperation focused on mitral or aortic valve replacement after double valve repair. Indications for valvular reoperation and etiology of recurrent valve regurgitation were determined by a review of echocardiograms. Aortic valve and mitral valve failures were analyzed separately in order to determine the risk factors for recurrent dysfunction at each valvular position.

Time-related events were analyzed, including endocarditis, thromboembolism, and bleeding using the same criteria as if valve replacement had been performed [10]. However, for these events, follow-up extended to 5 years or to the date of replacement of one or more valves.

Consent

The study data and information were taken after approval by patients. Informed consent was obtained from patients to do this procedure and for data publication.

Results

Aortic valve repair in patients with AR included SCA in all the 26 (100%) patients, plication in prolapsed cusp in six (23.1%) patients, and pericardial patch augmentation for retracted leaflets in four (15.4%) patients.

Mitral valve repair with ring annuloplasty was done in all the 26 (100%) patients, while resection of the prolapsed posterior leaflet was done in six patients. Quadrangular resection was done in four (15.4%) patients and triangular resection in two (7.7%) patients. The mean CPB time was 145 min (range: 120–165 min) and the ACC time was 112 min (86–135 min).

Survival after operation was 100%. No mortality occurred during hospitalization or during the 5-year follow-up. All patients were alive at follow-up and were in New York Heart Association functional class II or lower. The TTE after the follow-up study was performed in all patients and showed + 1 AR in 17 (65.4%) patients, +2 AR in six (23.1%) patients, +3 AR in one (3.8%) patient, and + 4 AR in two (7.7%) patients. No aortic valve stenosis occurred. All patients were free from valve-related events including bleeding, endocarditis, and thrombosis.

Repair durability required reoperations for valvular dysfunction. This included two (7.7%) patients with aortic valve reoperations who had aortic valve replacement, one of them due to recurrent rheumatic changes at the aortic valve, as he stopped all medications including long-acting penicillin prophylaxis. There were neither mitral valve reoperations nor patients requiring a third operation. Freedom from valvular reoperation after initial double valve repair was 92.3% after 5 years (92.3% for aortic and 100% for mitral).

Although recurrent aortic regurgitation occurred in only three patients (≥+3 AR), reoperations occurred in only two (7.7%) patients with rheumatic disease which was not *per se* a risk factor for reoperation. There was no death at reoperation, AR less than or equal to +2 in 23 (88.5%) patients and MR less than or equal to +1 in 24 (92.3%) patients (Tables 2 and 3).

Discussion

In this study, patients with double valve disease of varying etiology and pathophysiology were treated by a strategy of combined aortic and mitral valve repair. Survival after double valve repair was good. The 5-year survival was 100% which is similar to that reported for patients having double valve replacement [2–5].

Risk factors for mitral valve reoperation after double valve repair were chordal transfer, bovine pericardial annuloplasty, and the presence of pure aortic regurgitation accompanying

Table 3: Follow-up postoperative echocardiography and results

EDD (mm)	54.6
ESD (mm)	35.8
EF%	62.2
MR [*n* (%)]	
Trivial	13 (50)
+1	11 (42.3)
I+2	2 (7.7)
AR	
+1	17 (65.4)
I+2	6 (23.1)
II+3	1 (3.8)
+4	2 (7.7)
Mortality	0
Redo	2 (7.7)
Recurrent aortic regurgitation (III-IV)	3 (11.5)

AR, aortic regurgitation; EDD, end-diastolic diameter; EF, ejection fraction; ESD, end-systolic diameter; MR, mitral regurgitation.

pure mitral stenosis [8]. In this study, there were no mitral reoperation at all in the 5-year follow-up, as ring annuloplasty was placed in all patients and there was no bovine pericardial annuloplasty used for dilated annulus. Quadrangular and triangular resections were done for prolapsed posterior leaflets with no chordal transfer. Also, there were no mitral stenosis in mitral valve disease or accompanied with aortic regurgitation in this study.

The real issues of double valve repair are the durability and patient selection. Freedom from events generally considered valve related, such as endocarditis, thromboembolism, and hemorrhage, were excellent and generally superior to double valve replacement [2–5]. In this study, 5-year freedom from valve-related complication was 100%. The most common indication for reoperation was aortic valve dysfunction, and the primary cause of recurrent valve dysfunction was progressive native valve disease, which was rheumatic in most of the patients. Correspondingly, the most common reoperative procedure was aortic valve replacement.

The advantages of mitral valve repair over mitral valve replacement are well documented [1,11]; however, the durability of mitral valve repair is not 100% [1,8]. While the 15-year freedom from mitral valve reoperation in patients with degenerative disease is 93% and only 76% for patients with rheumatic disease [1], in this study, there were 100% freedom from mitral valve reoperation in both rheumatic and degenerative diseases after 5 years.

Similarly, degenerative mitral valve disease affecting the anterior leaflet, which was treated by chordal transfer, was associated with decreased durability when examined in the context of the durability of single valve repair. In this study, there were no anterior mitral leaflet pathology and there were no chordal transfer at all, as to decrease the variability of mitral valve dysfunction.

Durability of aortic valve repair has been less satisfying. In patients with aortic valve regurgitation, 5-year freedom from reoperation is 87% after repair of bicuspid aortic valves [12]. In this study, 5-year freedom from reoperation is 92.3%.

Duran and colleagues had the same results as our study. They found that the repair of rheumatic aortic valves is associated with 30-month freedom from reoperation of 77–94% [13].

Bernal *et al*.[14] documented 25% of 22-year freedom from aortic valve reoperation and 21% of 22-year freedom from mitral valve reoperation in patients with rheumatic disease. In contrast, there was 92.3% 5-year freedom from aortic valve reoperation and 100% 5-year freedom from mitral valve reoperation in this study.

Kalangos *et al*.[15] have demonstrated good durability of aortic valve repair in children and young adults with severe rheumatic disease. Although follow-up is short, a strategy of double valve repair in younger rheumatic patients with severe aortic valve disease may be appropriate. This study reports the results of double valve repair in this type of patients.

Q: Who benefits from the strategy of double valve repair?

Double valve repair should not be abandoned; there are important advantages with respect to freedom from bleeding, thromboembolism, and endocarditis. The ideal patient for double valve repair is a young patient who desires to avoid Coumadin, woman in a child-bearing age, and a patient with chronic renal failure on dialysis in whom mechanical valve prosthesis requiring anticoagulation is best avoided or even bioprosthesis is not durable due to rapid degeneration and calcification[9] and, overall, has the most favorable anatomy for combined aortic and mitral valve repair. Such favorable anatomy includes degenerative mitral valve disease affecting the posterior leaflet and a repairable aortic valve regurgitation at the same time.

Repair should be guided by intraoperative TEE, and a ring annuloplasty should always be used as a part of mitral valve repair and SCA should always be used as a part of aortic valve repair. Before considering double valve repair, patients must be informed of the possibility of reoperation for recurrent valve dysfunction.

Conclusion

Double valve repair should be reserved for the young, women of child-bearing age, and for patients with chronic renal failure due to the excellent survival and freedom from valve-related morbidity with short-term results.

Limitations

The decision to repair the aortic and mitral valves was made by the operating surgeon after consideration of patient desires, operative findings, and echocardiography, as repair was not attempted in unsuitable patients. Serial echocardiographic assessment of valve function is an assessment of durability based on both reoperation, recurrent valve dysfunction and mortality.

There is a learning curve, as the primary outcomes analyzed were death, reoperation, and valve-related complications. No attempt was made to compare outcomes after double valve repair to those obtained after double valve replacement or aortic valve replacement with mitral valve repair. The relatively small number of patients in the study with respect to valve etiology and pathophysiology may be responsible for the inability to identify a larger number of risk factors for valve-related reoperation.

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Conflicts of interest

There are no conflicts of interest.

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