Journal of Medicine in Scientific Research

Volume 3 | Issue 2 Article 6

Subject Area:

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Maged M. A. Kisho
National Heart Institute, magedkisho@yahoo.com

Recommended Citation

A. Kisho, Maged M. (2020) "Bileaflet augmentation for repair of rheumatic mitral valve disease in Egyptian patients," *Journal of Medicine in Scientific Research*: Vol. 3: Iss. 2, Article 6.
DOI: https://doi.org/10.4103/JMISR.JMISR_44_20

Original Article

Bileaflet augmentation for repair of rheumatic mitral valve disease in Egyptian patients

Maged M.A. Kisho
Department of Cardiac Surgery, National Heart Institute, Cairo, Egypt

Abstract

Objectives
Mitral valve (MV) repair in rheumatic patients is a challenging procedure and carries high incidence of early and late failure. We aimed in this study to evaluate the mid-term results of MV bileaflet augmentation to increase the depth of coaptation and achieve satisfactory results of repair.

Patients and methods
Between January 2015 and December 2018 at the National Heart Institute of Egypt, 24 rheumatic patients had leaflet augmentation with glutaraldehydetreated autologous pericardium as part of their mitral repair procedure. Their clinical and echocardiographic data were prospectively analyzed.

Results
The mean age of the rheumatic patients was 34.2 ± 14.7 years, range 20–50 years. Overall, 72.4% patients had predominant mitral regurgitation (MR), whereas 27.6% had mixed mitral stenosis and MR. Leaflet augmentation was performed in the posterior, anterior, and both leaflets in 5, 3, and 16 of patients, respectively. Additional repair procedures included commissurotomy and papillary muscle splitting. All repairs were stabilized with annuloplasty rings. The follow-up was complete in all patients with a mean follow-up of 22.4 ± 13.6 months. There was no mortality in this series. At the latest follow-up, the MR grade was none/trivial in eight of patients, mild in four, moderate in six, moderately severe in three, and severe in three patients. Two patients had redo mitral surgery. At 3 years postoperatively, the estimated rates of freedom from reoperation and valve failure were 95.8 and 90.6%, respectively.

Conclusion
Repair with leaflet augmentation in rheumatic disease resulted in good early and mid-term outcomes. A wider use of this technique may improve the success rate and prognosis of repair in complex rheumatic MV disease.

Keywords: Mitral valve, Rheumatic heart disease, Bileaflet Augmentation

Introduction

Mitral valve (MV) repair is better than replacement owing to its great value of preserving the ventricular function, decreasing operative mortality, long-term survival, and avoidance of anticoagulation [1–3]. MV repair has good durability in patients with mitral valve regurgitation (MR) caused by degenerative disease [4,5] and is indeed the method of choice in the correction of MR whenever feasible. However, valve repair for rheumatic MR is still controversial, as it shows an inferior feasibility of repair [6] and is less stable with inferior durability when compared with a degenerative MV repair [7]. Carpentier type IIIa MR owing to rheumatic leaflet restriction makes valve repair difficult and may predict a less successful repair [8]. However, the use of leaflet mobilization and augmentation technique with a pericardial patch to increase the leaflet area and depth of coaptation may achieve satisfactory results [9–11]. In this study, we reviewed our experience of MV repair with leaflet augmentation in rheumatic disease and the mid-term durability of the repaired valve.

Access this article online

Quick Response Code:

Website: www.jmsr.eg.net

DOI: 10.4103/JMISR.JMISR_44_20

Correspondence to: Maged M.A. Kisho, MD, Department of Cardiac Surgery, National Heart Institute, Cairo 12651, Egypt, Tel: +20 106 916 8429; Fax: +20 23479893. E-mail: magedkisho@yahoo.com

Submitted: 11-May-2020 **Revised:** 11-May-2020 **Accepted:** 16-May-2020 **Published:** 24-Aug-2020

How to cite this article: Kisho MM. Bileaflet augmentation for repair of rheumatic mitral valve disease in Egyptian patients. J Med Sci Res 2020;3:117-21.

Patients and methods

Patients

Between January 2015 and December 2018, 24 rheumatic patients underwent leaflet augmentation using autologous pericardium treated with 0.6% glutaraldehyde as part of their repair procedure. The data were prospectively collected from the patient data of our National Heart Institute. Patients who underwent concomitant cardiac surgery for the aorta, cardiac tumor, pericardial diseases, or CABG were excluded. Patients with concomitant repair or replacement for aortic and tricuspid valvular lesions were not excluded. The mean age for our study group was 34.2 ± 11.7 years. A total of 17 (70.8%) patients were type III (leaflet restriction) and seven (29.2%) were type IIa/IIIp (a combination of prolapse of the anterior leaflet with retraction of the posterior leaflet). Predominant MR was present in 18 (75%) patients, and mixed stenotic and regurgitant lesions in six (25%). Atrial fibrillation was present in seven (29.1%) patients. Shortness of breath on exertion was the predominant symptom, and 21 (87.5%) patients were in New York Heart Association functional class II and higher (Table 1 and Figs. 1 and 2).

Preoperative assessment

Preoperative echocardiography was performed on all patients within 2 weeks before surgery. The morphology of the valve was documented to further substantiate the diagnosis of rheumatic MV disease with leaflet restriction. Of the 62 patients, 17 (70.8%) were further classified into type III (leaflet restriction) and seven (29.2%) into type IIa/IIIp (a combination of prolapse of the anterior leaflet with retraction of the posterior leaflet), as described by Chauvaud *et al.* [10]. The degree of severity of MR was quantified by the regurgitant fraction (RF) obtained by two-dimensional echocardiography with Doppler, and graded as mild (1 + MR, RF <15%), moderate (2 + MR, RF 15–30%), moderately severe (3 + MR, RF 35–50%). and severe (4 + MR, RF >50%). The classification of the severity of rheumatic mitral stenosis primarily relied on the MV area assessed by two-dimensional echocardiogram, using the planimetry and/or pressure half-time methods. Mitral stenosis was graded as mild (valve area >1.5 cm^2), moderate (1.0–1.5 cm^2), or severe (<1.0 cm^2). In addition, all patients underwent intraoperative transesophageal echocardiography.

Surgical procedures

A median sternotomy approach and conventional ascending aorta and bicaval cannulation were used for all patients. Moderately hypothermic (28–32°C) cardiopulmonary bypass was performed, and myocardial protection was achieved with cold-blood cardioplegia. The MV was approached through a left atrial incision parallel to the interatrial groove. After careful analysis of the MV leaflets and subvalvular apparatus, the reconstruction procedure was planned [12]. We usually perform a step-wise repair to mobilize the restricted mitral leaflet. The initial step was to free the fused commissures and subvalvular apparatus by a commissurotomy, and splitting of the fused chords and papillary muscles. Shortened secondary chords are often cut to further free the leaflets. The leaflets themselves were made more pliable by peeling off the inflammatory fibrotic layer (leaflet shaving, leaflet peeling, or cusp thinning) and decalcification. Next, when the leaflet and subvalvular mobilization were not enough to compensate for tissue retraction and leaflet hypoplasia, leaflet augmentation

Table 1: Baseline demographic and clinical characteristics

Variables	Leaflet augmentation (*n*=24)
Female	17 (7.8)
Male	7 (29.1)
Age (year)	32±12
Median age (year)	32.5
Range (year)	20-45
Diabetes mellitus	2 (8.3)
Hypertension	3 (12.5)
Congestive cardiac failure	1 (4.1)
Pulmonary hypertension	5 (20.8)
Atrial fibrillation	7 (29.1)
NYHA I	3 (12.5)
NYHA II	14 (58.4)
NYHA III	5 (20.8)
NYHA IV	2 (8.3)
Median ring size (mm)	28

Data presented as mean±SD or median for continuous variables and *n* (%) for categorical variables. NYHA, New York Heart Association.

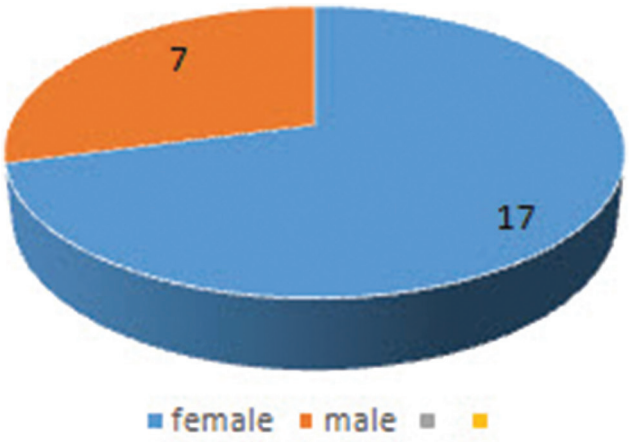

Figure 1: Male to female ratio.

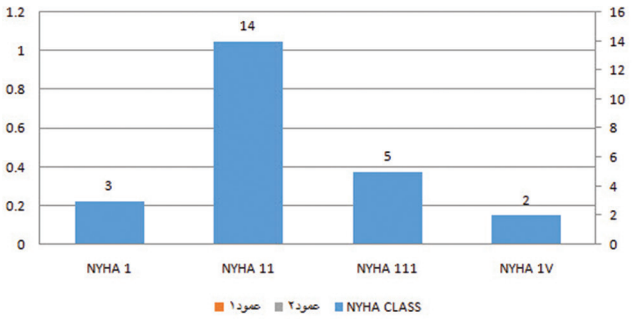

Figure 2: NYHA classification of the patient. NYHA, New York Heart Association.

techniques were adopted to increase the surface area of the leaflet, providing increased mobility and surface for leaflet coaptation. The leaflet augmentation technique further allows for the insertion of a larger annuloplasty ring, thereby reducing the risk of stenosis [10,12]. All mitral reconstructions were completed by the placement of an annuloplasty ring. Following repair, MV competency was assessed by injecting cold saline with a bulb syringe into the left ventricle directly through the MV. Intraoperative TE was routinely used to objectively assess the repair following termination of cardiopulmonary bypass.

The commonest concomitant procedure performed was tricuspid annuloplasty in 11 (45.8%) patients and aortic valve replacement in four (16.6%).

The leaflet augmentation procedure

An autologous pericardial patch was harvested at the beginning of the operation before the injection of heparin, cleared of fatty tissue, trimmed, and soaked in 0.6% glutaraldehyde-buffered solution at room temperature for 5–10 min and then rinsed with normal saline solution for 15 min in three separate baths. Annuloplasty sutures were applied around the posterior circumference of the mitral annulus. This initial step improves valve exposure for accurate analysis and in addition avoids pericardial patch dehiscence owing to needle-hole perforation if the larger annuloplasty sutures were to be inserted after the patch had been sewn into place. An anterior leaflet augmentation was performed when it was determined that the area of the leaflet was smaller than the 26-mm annuloplasty sizer, which is the smallest adult prosthetic ring. Alternatively, leaflet augmentation was also undertaken when the vertical height of the anterior leaflet was less than 26 mm, as this was associated with the failure of repair [13]. An incision was carried out on the anterior leaflet 2 mm away from the annulus and extended to both commissures. The size of the pericardial patch was made so that the newly augmented leaflet could fit the size of at least a 28-mm annuloplasty template. The width of the pericardial patch was also made to be of generous size covering the defect created from commissure to commissure. The posterior leaflet augmentation was undertaken when it was determined to be retracted and/or when the leaflet tissue was insufficient. The patch usually had an ovoid shape, and the height and the width of the patch were designed to create a curtain-like posterior leaflet to allow for free and generous coaptation against the anterior leaflet. The reconstructed posterior leaflet usually had a height of ~ 16–20 mm and a breadth that spanned from commissure to commissure. An effort was made to maintain the height ratio of the repaired anterior and posterior leaflet to 2/3 and 1/3, respectively. The patch was sutured using two continuous 5/0 nonabsorbable monofilament sutures (polypropylene) with fixations at three or four points to prevent a purse-string effect. The patch was oriented so that the smooth surface of the pericardium faces the left atrial side to reduce the potential of thrombogenesis. In this series, 20.8% of patients had posterior leaflet augmentation and 12.5% had anterior leaflet augmentation, whereas 66.6% had both leaflets extended (Fig. 3).

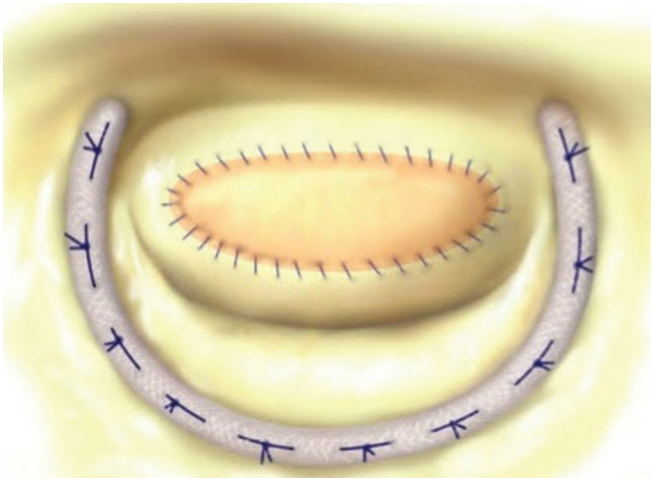

Figure 3: Leaflet augmentation and annuloplasty ring is applied.

Postoperative management

We gave warfarin for anticoagulation for all patients with prosthetic annuloplasty rings. We gave anticoagulation for 6 weeks postoperatively, with a target international normalized ratio of 2.0–3.0. We continued anticoagulation for those with atrial fibrillation.

Follow-up

The mean follow-up was 22.4 ± 13.6 months, and the maximum was 36 months. We defined early mortality as patient death within 30 days of surgery or in-hospital death. The main points of interest in our study were detection and recording of early death, late mortality, the need for redo surgery, and/or valve failure. Valve failure was defined as recurrent significant regurgitation more than moderate MR (2 + MR) and/or reoperation. All survivors were evaluated with echocardiography before discharge, at 3 months, 6 months, and annually after surgery.

Statistical analysis

Data were presented as frequencies and percentages for categorical variables and medians or means with SDs for continuous variables. Statistical tests were performed using SPSS, version 20.0 (SPSS Inc., Chicago, Illinois, USA).

Results

General outcomes

The patients in the study group with leaflet augmentation were young, with a mean age of 34.2 ± 11.7 years. The mean size of MV annuloplasty rings was 28 ± 2 mm, and the median size was 28 mm. The annuloplasty ring used in the study group was Carpentier Edwards Physio ring.

Early outcomes

There were no major postoperative morbidity or hospital deaths. Minor complications included re-exploration for bleeding in two (8.3%) patients and pericardial effusion in three (12.5%).

Late outcomes

Follow-up was complete in all patients. The mean follow-up for the leaflet augmentation group was 22.4 ± 13.6 months. There

were no late deaths reported in both groups. No complications related to anticoagulations or infections were seen.

Recurrent mitral regurgitation, reoperation, and valve failure

At the end of the follow-up period, the MR grade was trivial in eight of the patients, mild in four, moderate in six, moderately severe in three, and severe in three patients. Two patients had redo mitral surgery. At 3 years postoperatively, the estimated rates of freedom from reoperation and valve failure were 95.8 and 90.6%, respectively. Two (3.2%) patients had redo MV surgery. The reasons for redo surgery were recurrent MR from inadequate initial repair in one patient and progression of rheumatic disease with mitral stenosis in the other patient. At redo surgery, MV replacement was performed in the two patients. At 3 years postoperatively, the estimated rate of freedom from reoperation was 91.6% (Fig. 4).

Discussion

MV repair in rheumatic patients is a difficult procedure and shows a high incidence of early or late failure of repair [14,15]. The rheumatic disease affects the MV in up to 50% of cases and results in MR, mitral stenosis, or both [11]. Replacement of the diseased valve with a prosthesis is associated with a decrease of ventricular function and anticoagulation-related complications [1–3]. Moreover, patient growth, rapid bioprosthetic degeneration, and complications of pregnancy remain important items in young patients, particularly in developing countries. MV repair is the operation of choice for valves with degenerative regurgitation. However, valve repair in patients with rheumatic MV disease remains controversial because many studies show that repair is inferior to replacement in rheumatic patients [6,7]. Chauvaud *et al.* [9,10] had explained good results with MV repair in diseased rheumatic MVs using Carpentier's reconstruction techniques.

The diseased rheumatic valve is more difficult to repair owing to the young age of the patient, the progress of rheumatic activity and the complicated nature of the pathology, which frequently needed numerous repair techniques in one patient. In the rheumatic disease, Carpentier's type III leaflet restriction is the commonest type [10]. The most difficult lesions to repair are patients who had induced fibrotic retraction of the leaflets and the subvalvular apparatus. Usually the rheumatic leaflet is thickened, and the fibrosis may affect all parts of the leaflet, causing transverse or vertical retraction, making repair very difficult. Carpentier had outlined the main principles of mitral reconstruction [12]. Many techniques have been mentioned to correct leaflet restriction, like opening the fused commissures, releasing chords and papillary muscles [10], cusp thinning [16], leaflet augmentation [9], and putting of a small-sized annuloplasty ring.

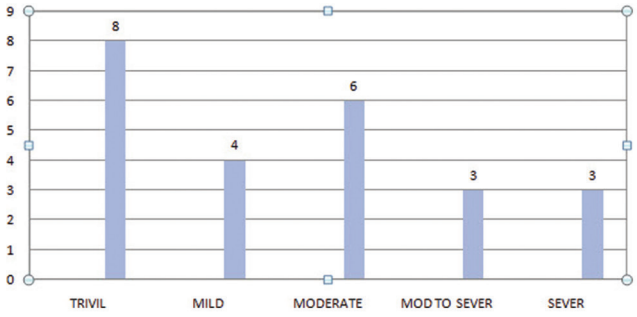

Figure 4: Postoperative mitral regurgitation.

In our study, we used autologous pericardium to treat type III rheumatic MV disease. Leaflet augmentation using autologous pericardium is helpful in treating leaflet retraction or perforation. The use of autologous pericardium was first described by Chauvaud *et al.* [9]. It is easy to get and prepare, as well as easy to handle. We compared autologous pericardium with commercial bovine pericardium. Autologous pericardium is non-antigenic and avoids the risk of xenograft viral transmission. The autologous pericardium was treated with 0.6% glutaraldehyde solution for 5–10 min. The glutaraldehyde is important as it renders it easy to handle.

Which leaflet is more suitable for augmentation in restrictive rheumatic disease is debatable. A lot of studies mentioned that augmentation of the anterior leaflet is a gold standard repair procedure, explaining the benefits as we can insert a larger prosthetic ring to avoid mitral stenosis [17–19]. Some recent studies have focused on patch augmentation of the posterior leaflet [20–23], and depending on Carpentier, the most important mechanism in rheumatic MR is the retraction of the posterior leaflet (type III) [12]. In our study, posterior leaflet augmentation was done when it is clear that the leaflet tissue is insufficient. We use ovoid-shaped patch, and the height and the width of the patch is adjusted to create a curtain-like posterior leaflet. We take care to avoid excessive height or width of the augmented posterior leaflet and the use of an undersized prosthetic ring to prevent systolic anterior motion and LVOTO. We did not record any case with systolic anterior motion complication following rheumatic MV repair in our practice. This is may be owing to the fact that there is severe fibrosis in the rheumatic leaflets.

The most important item for repair is that the width of the pericardial patch to be of enough size to cover the defect created from commissure to commissure. This is to be sure that mobilization of the all retracted leaflet is completed, and sufficient depth of coaptation between the opposing leaflet edges. The use of a prosthetic annuloplasty ring is important for complete repair of rheumatic MR. We apply prosthetic annuloplasty rings for all patients. We implant annuloplasty rings where the mean and median sizes of rings were 28 ± 2 and 28 mm, respectively. This observation reinforces the important benefit of the patch augmentation technique that allows for the implantation of larger size annuloplasty rings, regardless of whether the anterior or the posterior leaflet was extended. Leaflet augmentation increases the surface area of leaflet and depth of coaptation.

There is no clear information about the durability of autologous-treated pericardium in repairing rheumatic MV.

Chauvaud *et al.* [9] reported a free rate from reoperation of 70% at 6 years, whereas Omeruglu *et al.* [20] reported free from redo surgery rate of 85% at 7.5 years. In our study, the rate of freedom from reoperation was 91.6% at 3 years. Two patients in our leaflet augmentation study needed redo surgery: one for early failure owing to failure of repair and the second after 3 years for mitral stenosis as the patient had progression of rheumatic disease.

Conclusion

In conclusion, leaflet augmentation is feasible for rheumatic MV and complements the criteria of Carpentier's valve reconstruction methods. The technique is promising and offers excellent early and mid-term outcomes. The follow-up will detect the durability of this technique. More use of this technique may improve the success rates for repair in complicated rheumatic MV disease, especially in children and young adults.

Limitations

Limited group of patients and single surgeon experience were the limitations of the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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