Band annuloplasty for ischemic mitral valve regurgitation; was it effective?

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Received:3-7-2023 **Accepted:17-7-2023** **Published:30-7-2023**

ABSTRACT:

Background: Chronic ischemic mitral regurgitation (CIMR) represents one of the most vexing problems for cardiac surgeons. Band annuloplasty offers a simple and inexpensive method for such conditions. However, its efficacy is still debatable.

Objective: In this study, we investigated the efficacy and safety of band annuloplasty in controlling CIMR. Between January 2019 and June 2023, 192 patients who underwent combined Coronary artery bypass grafting (CABG) and mitral valve repair for CIMR at Kasr Al-Ainy and Fayoum University Hospitals were assigned into two groups: group A, which included 100 patients with ring annuloplasty, and group B, which included 92 patients with band annuloplasty.

Results: Over the mean follow-up duration (21.02+9.76 months), post-operative severe MR mandating reintervention occurred in 7 patients. 4 (4%) of which belonged to group A, and 3 (3.3%) were among the other groups that denoted a statistically insignificant difference (P value = 0.7970). Cerebrovascular strokes (CVS) ,Infectious Endocarditis (IE) and early postoperative Heart Block (HB) were lower in group B (2 vs. 5, 2 vs. 6 and 1 vs 3 patients, respectively). However, the differences were not statistically significant (P > 0.05).

Conclusion: short and mid-term outcomes of band annuloplasty were satisfying regarding postoperative morbidity and mortality denoting its efficacy and safety for managing CIMR especially when annuloplasty rings are deficient or better avoided as in cases with preoperative heart block.

Key Words: Chronic ischemic mitral regurgitation, Coronary artery bypass grafting and mitral annuloplasty.

DOI: 10.48047/ecb/2023.12.Si8.775

Abbreviation:

CIMR	Chronic ischemic mitral regurgitation
CABG	Coronary artery bypass grafting
CVS	Cerebrovascular strokes
IE	Infectious Endocarditis
HB	Heart Block

INTRODUCTION:

CIMR affects about one-fifth of patients with ischemic heart disease (IHD)[1,2]. The Process of LV remodeling and distortion following myocardial infarctions may explain why CIMR worsens the prognosis after re-perfusion independent of the ejection fraction[3].

Retortion of mitral annulus configuration allows for proper leaflet coaptation preventing regurgitation which in many cases leads to low cardiac output syndrome and may be lethal[4].

Downsizing ring-annuloplasty aiming to decrease the anteroposterior dimension of the mitral annulus along with coronary revascularization is currently the conventional approach for the surgical treatment of CIMR[5].However, artificial rings are not always available and have their well-known drawbacks regarding failure, increasing incidence of posterior leaflet tethering, post-operative heart block and infective endocarditis[6,7].

We aimed to study the efficacy and safety of Band annuloplasty (with or without strut chord transection) as a simple, inexpensive surgical option for controlling CIMR.

MATERIALS AND METHODS

Study design:

Data on 192 candidates for on-pump CABG and mitral valve repair were collected from Kasr Al-Ainy and Fayoum University Hospitals and studied in the period between January 2019 and June 2023. Patients were assembled into 2 groups: Group A (the control group, including 100 patients where conventional downsizing ring annuloplasty was used for mitral repair) and Group B (the band annuloplasty group, including 92 patients).

Definitions:

- Ischemic heart disease mandating CABG was defined regarding the European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS) [8].
- CIMR was defined and graded regarding the ESC/EACTS Guidelines for the management of valvular heart disease[9].

Exclusion criteria: patients with Acute, rheumatic or coexistent stenotic mitral lesions, preoperative HB, low ejection fraction <30%, other cardiac problems rather than CIMR demanding surgical intervention and mitral valve replacement.

Methodology:

- All patients received the same anesthesia and surgical preparation protocols. All patients had routine preoperative investigations such as an electrocardiogram, a chest X-ray, hemoglobin, urea, electrolytes, serum creatinine, echocardiography, and post-operative follow-up echocardiographic studies on a trimonthly basis for 2 years following the operation.
- Mitral valve was approached through trans-septal incision in only 31(16.15%) patients for small left atrium that halted sufficient surgical exposure, while the conventional left atriotomy incision was used in the remaining majority of cases.

Ethical approval:

The ethical committee of Fayoum University hospitals approved the study protocol, Fayoum University, Egypt. Ethical Approval Number: R 485. Every patient signed an informed written consent for acceptance of the operation. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans[10].

Surgical Technique:

Conventional median sternotomy incision was used to access coronaries and mitral valve. The aorta was cross-clamped after heparinization and the start of cardiopulmonary bypass through aorto-bicaval cannulation. Cardiac arrest was achieved by administration of antegrade cold blood-based cardioplegic solution at moderate hypothermia (range 28 to 32 °C).

When a trans-septal approach was preferred (16.15% of cases), tapes were snared around both vena cava, and we accessed the mitral valve through an atrial septectomy incision that extended between the entrance of the superior vena cava and the front of the coronary sinus. Otherwise, the traditional left atriotomy incision that runs parallel to the interatrial groove was used.

Following exposure, the mitral valve is evaluated for repair feasibility and the precise cause of valve failure using a pair of hooks or by injecting saline into the left ventricular (LV) cavity. In situations with dilated annulus, minor leaflet prolapses, and/or restricted motility, pericardial strip annuloplasty was first performed.

After injecting saline into the LV cavity, the repair was deemed sufficient based on adequate opposition of the two leaflets further towards the posterior annulus and ballooning of the anterior mitral leaflet. In case of inadequate repair, commissural stitches may be added. Strut chordal cutting was used in cases with tethered posterior mitral leaflet for better mobility. Patients who underwent mitral valve replacement because of failed repair were eliminated from our research.

Technique of CABG:

After repair, the distal anastomoses were then performed using continuous polyproline 7/0 or 8/0 sutures using the previously prepared conduits, closure of cardiotomy incisions, rewarming and deairing.

Side aortic occluder was used allowing for the proximal end-to-side anastomosis that was done using a continuous suture of 6/0 polypropylene.

Technique of posterior mitral reduction annuloplasty:

In patients with annular disfigurement and/or leaflet prolapse, we aimed to reduce the anteroposterior dimension of the mitral annulus to a proper extent that makes the valve competent but nor stenotic.

Following annular sizing, 8-10 horizontal mattress, non-pledgetted braided sutures (2-0 or 3-0 Ethibond) were threaded clockwise into the posterior mitral annulus between the fibrous trigones,

and then through the annuloplasty band strip. Sutures are then secured when the strip is lowered into place.

Band strip used was commonly made of fashioned Dacron tube, pericardial strip or even a properly constructed saphenous vein graft. After annuloplasty, testing with saline is done and sutures can be used to close the gaps or reduce the areas of prolapse in the localized regurgitation area. Strut chord transection (chordal cutting) was used as adjunctive procedure to alleviate excess tethering of the mitral leaflets and restore sufficient coaptation length.

At the end of the operation, Trans-esophageal echocardiographic (TEE) studies were done by a trained operator to re-check for the repair adequacy. Then, patient is weaned from the bypass and sternotomy incision was closed in layers after inserting chest drains and proper hemostasis. Inotropic support was used according to the hemodynamic state of each patient.

Statistical analysis:

Sampling method:

A convenient sample size (92 patients with more patients in the control group) was properly calculated from total patient population of 120 cases. This size was adopted using the Medcalc 19 program by setting an alpha error of 5%, 95% confidence level, and 80% power sample (Equations are described by Machin D et al.; 2009[11]).

Data analysis:

Continuous data were expressed as mean and standard deviation or median with the interquartile range and categorical data as percentages. All reported P values are two-sided, and P values of $\leq$ 0.05 were considered statistically significant. The Kaplan-Meier method was used to assess survival, freedom from atrial arrhythmias, thromboembolic events and hospitalization for heart failure. All statistical analyses were performed with SPSS version 22.0 (SPSS, Inc., Chicago, IL, USA). All statistical analyses were done with the help of a departmental statistician.

RESULTS: [Data presented as mean± SD, mean (interquartile range), or n (%)]

Demographic and pre-operative variables; Table 1-3

A total of 192 patients (72 females) were divided into two groups: Group A (control group of 100 patients with ring annuloplasty) and Group B (band annuloplasty group of 90 patients). Our sample's mean age was 51.88 (+9.456) years old. There was no significant difference between both groups regarding all demographic and clinical baseline characteristics; p>0.05.

Intraoperative variables; Table 4

Mitral valve was approached trans-septally in 31 (16.15%) of patients. Despite shorter aortic cross clamp and total bypass times in Group B for simpler repair techniques, differences were not statistically significant (p >0.05).

Postoperative variables; Table 5

Post-operative severe MR necessitating reintervention occurred in 7 patients throughout the course of the average follow-up (21.02+9.76 months). 4 (4%) belonged to group A, while 3 (3.3%) belonged to one of the other groups, with a statistically insignificant difference (P value = 0.7970). Cerebrovascular strokes (CVS), infective endocarditis (IE), and early postoperative heart block (HB) were all lower in group B (2 vs. 5, 2 vs. 6, and 1 vs. 3 patients, respectively). The differences, however, were not statistically significant (P > 0.05).

Table 1; Demographic data:

	All patients (192)	Group A (100)	Group B (92)	P value (significant<0.05)
Age	51.88 (±9.456)	51.18 (±9.22)	50.81 (±9.11)	P = 0.7803
Female sex	72 (37.5%)	40 (40%)	32 (34.78%)	P = 0.4566
Previous HF	71 (36.98%)	30 (60%)	41 (44.56%)	P = 0.0328
Previous MI	24 (12.5%)	10 (10%)	14 (15.22%)	P = 0.2759
Dyspnea	119 (61.98%)	63(63%)	56 (60.87%)	P = 0.7619
Chest pain	58 (30.20%)	32 (32%)	26 (28.26%)	P = 0.5739
Lower limb edema	85 (44.27%)	41 (41%)	44 (47.82%)	P = 0.3431
Palpitations	29 (15.10%)	16 (16%.)	13 (14.13%)	P = 0.7184
Syncope	15 (7.8%)	8 (8%)	7 (7.60%)	P = 0.9180
AF	48 (25%)	28 (28%)	20 (21.74%)	P = 0.3182

HF; Heart Failure, MI; Myocardial Infarction, AF; Atrial Fibrillation.

Table 2; Preoperative Comorbidities:

	All patients	Group A	Group B	P value
Hypertension	117 (60.93%)	63 (63%)	54 (58.70%)	P = 0.5429
Hyperlipidemia	81 (42.18%)	39 (39%)	42 (45.65%)	P = 0.3525
COPD	25 (13%)	14 (14%)	11 (11.96%)	P = 0.6756
Peripheral vascular disease	29 (15%)	13 (13%)	16 (17.39%)	P = 0.3973
Diabetes mellitus	35 (18.2%)	17 (17%)	19 (20.65%)	P = 0.5185
High Creatinine level (>1.3mg/dl)	7 (3.65%)	4 (4%)	3 (3.26%)	P = 0.7852

COPD; chronic obstructive pulmonary disease.

Table 3; Preoperative Echocardiographic related data:

	All patients	Group A	Group B	P value
Dilated LA (> 5 mm)	147 (76.56%)	81 (81%)	66 (71.74%)	P = 0.1312
Severe MR (VC > 7mm)	139 (72.40%)	71 (71%)	68 (73.91%)	P = 0.6531
Low EF (30-50%)	37 (19.72%)	18 (18%)	19 (20.65%)	P = 0.6427
PHT (PAP > 1/3 ABP)	73 (38.02%)	38 (38%)	35 (38.04%)	P = 0.9955

LA; Left Atrium, MR; Mitral Regurge, VC; Vena Contracta, EF; ejection Fraction, PHT; Pulmonary Hypertension, PAP; Pulmonary Artery Pressure, ABP; Arterial Blood Pressure.

Table 4: Intraoperative data:

	All patients	Group A	Group B	P Value
Trans-septal Mitral approach	31 (16.15%)	18 (9.38%)	13 (6.77%)	P = 0.3486
Aortic clamp time	124.8±33.6	124.8±23.9	120.8±20.18	P = 0.2120
Cardio-pulmonary bypass time	195.4±38.4	190.4±40.2	193.5±39.5	P = 0.5893

Table 5: postoperative data:

	Total	Group A	Group B	P value
Follow up duration (months)	21.02+9.76	22.05± 5.31	21.91±5.27	P = 0.8542
Reintervention	7 (3.65%)	4 (2.08%)	3 (1.56%)	P = 0.7035
CVS	7 (3.65%)	5 (2.60%)	2 (1.04%)	P = 0.2535
Postoperative IE	8 (4.17%)	6 (3.13%)	2 (1.04%)	P = 0.1523
postoperative HB	4 (2.08%)	3 (1.56%)	1 (0.52%)	P = 0.3158

CVS; cerebrovascular stroke, IE; Infective Endocarditis, HB; Heart Block.

DISCUSSION:

CIMR is a complex disorder that commonly demands concomitant surgical management along with coronary artery grafting[12]. Surgical mitral valve repair is always preferred over replacement being less hazardous with lower postoperative morbidities[13].

Different repair strategies are now available; in this study, we sought to prove the effectiveness of the simple band annuloplasty repair technique in controlling such a serious problem in patients with ischemic heart disease.

Francesco Formica et.al. discovered in 2007 that trigone-to-trigone semirigid band annuloplasty had excellent early and midterm results, with a significant reduction in CIMR after repair (P 0.0001) and no documented thromboembolic events or late mitral valve reoperation. This is consistent with our findings, which revealed no early postoperative MR and only 3.3% late MR requiring surgical intervention in the mitral annuloplasty group [14].

In 2020, Muhammad Aqeel Kunwar et.al, found 93.1% success rate among 335 patients who underwent concomitant Posterior mitral annuloplasty along with two- and three-vessel CABG. This also matches well with our results (96.7% of patients among the band annuloplasty group needed no re-operation)[15].

In addition, Mehmet Adnan Celkan et al. reported in 2018 that mitral band annuloplasty performed in conjunction with CABG is an effective approach with low mortality that prevents future mitral regurgitation and the need for repeat surgery [16].

On comparing incidence of recurrence of MR after surgical repair in CIMR using band annuloplasty to ring annuloplasty, Edwin C McGee et.al. found statistically higher incidence in the band annuloplasty cases (60% vs. 25%) that doesn't pair well with our results that proved similar effectiveness of both methods in controlling CIMR[17].

Surprisingly, a multi-center retrospective analysis including 362 patients with IHD and moderate CIMR published in 2023 by Kaoru Matsuura et al. claimed that Additional mitral repair to CABG did not increase long-term survival, independence from heart failure, or cerebrovascular incidents in patients with moderate ischemic MR[18].

CONCLUSION:

Many local and international studies have proved similar outcomes comparing MV replacement and repair along with CABG in patients with CIMR[19-21]. However, only a little data is available about the least expensive feasible method of repair in such conditions. In this study, simple posterior mitral band annuloplasty was proved to be an effective repair method for CIMR in short and mid-term follow up.

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