Early and Intermediate Outcome of Left Atrial Plication for A Giant Left Atrium During Mitral Valve Replacement

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ABSTRACT

Giant left atrium is the end product of severe and prolonged pressure and volume overload, occurring during mitral insufficiency or stenosis. Current surgical methods for left atrial volume reduction may be classified into three categories; partial plication of inferior wall (para-annular, Mercedes plasty and triangular resection of inferior wall), partial plication of inferior and superior walls and partial heart auto-transplantation. The aim of this study was to compare the effect of left atrial plication in two groups of patients who had mitral valve replacement and had a giant left atrium. This study was a retrospective prospective, randomized, observational interventional study and included 50 patients, divided into two equal groups; group A (mitral valve replacement and left atrial plication) and group B (mitral valve replacement only). There was statistically significant difference between the 2 studied groups regarding the Left atrial diameter in the echo findings, there is statistically significant difference between the 2 studied groups in terms of the intra operative TOE, valve implant type and pacing wires used, there was statistically significant difference between the 2 studied groups in terms of 1month ECHO LAD and 6months ECHO LAD diameter. There was statistically significant difference between pre and post-operative rhythm, left atrial diameter, compression symptoms and LA thrombus among cases in group 1 but no statistically significant difference was detected in terms of rhythm, and Left atrial diameter in group 2. So, we concluded that LA reduction along with MVR has significant improvement in clinical outcome in terms of restoration of sinus rhythm, less thromboembolic complications and compression symptoms during long term follow up.

Keywords: Giant Left Atrium, Left Atrial Plication, Mitral Valve Replacement.

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INTROUDCTION

There is a strong association between chronic rheumatic mitral valve disease and a giant left atrium. About 19% of patients requiring an operation for a mitral valve disease have a giant left atrium (GLA) **[1]**.

There have been several definitions of giant left atrium ranging from 6 to beyond 10 cm in diameter. However, more recent reports follow the definition by **[2]**: GLA is characterized by the following two echocardiographic findings : (a) large left atrium depicted by M-mode ECHO with diameter >65 mm and (b) left ventricular postero-basal wall bent inward and lying between the dilated left atrial cavity, and left ventricular cavity **[3-5]**.

GLA is the end product of severe and prolonged pressure and volume overload, occurring during mitral insufficiency or stenosis **[6]**. GLA patients always have a long history of mitral valve disease and it is difficult to distinguish GLA symptoms from the conditions giving rise to initial increase in left atrial size. GLA may be asymptomatic in a minority of cases. Therefore, when symptomatic, most common manifestations are: arrhythmias including atrial fibrillation, chest pain, shortness of breath, fatigue, dyspnea, orthopnea, dysphagia, nocturnal paroxysmal dyspnea thromboembolic events and Ortner syndrome **[6, 7]**.

Chest radiography is a useful cheap initial screening tool when it shows increased cardiothoracic ratio and features characteristic of an enlarged left atrium which include double density sign, oblique measurement > 7 cm, widening or splaying of the carina (carinal angle >90 degrees) and convex left atrial appendage. Transthoracic echocardiography is the easiest, most reliable and least expensive method for diagnosing and monitoring GLA, this should be done at the time of mitral valve assessment **[8, 9]**. MRI is a more reliable tool for a precise estimation of size of the atrium and its relations with other adjacent organs. Echocardiography, particularly the trans-esophageal echocardiography (TEE) is considered to be the gold standard for the diagnosis and to exclude LA thrombus **[4]**.

Most GLA cases are managed at the time of mitral valve surgery according to some reviews. It was proved that the main indication for its surgical management is the presence of intra-cardiac or extra-cardiac compressive symptoms from

neighboring organs **[3, 6]**. The second indication is the presence of thrombus and a history of thromboembolic events. Also some authors claimed that there is an indication for size reduction of GLA even in asymptomatic patients **[10, 11]**.

Current surgical methods for left atrial volume reduction may be classified into three categories; partial plication of inferior wall (para-annular, Mercedes plasty and triangular resection of inferior wall) **[6, 12]**, partial plication of inferior and superior walls **[13]** and partial heart auto-transplantation **[14]**. So, the aim of this study was to compare the effect of left atrial plication in two groups of patients who had mitral valve replacement and had a giant left atrium regarding; post-operative thromboembolic complications, post-operative compression symptoms and post-operative cardiac arrhythmia.

PATIENTS AND METHODS

This study was a retrospective prospective, randomized, observational interventional study that was done at department of cardiothoracic Surgery at Mansoura University in Egypt with participation of department of cardiothoracic surgery at Heart and Lung center in New Cross Hospital at Wolverhampton in United Kingdom. This study took place from January 2019 to January 2021.

The current study included 50 patients, divided into two equal groups: group A (mitral valve replacement and left atrial plication) and group B (mitral valve replacement only). A written informed consent was obtained from each patient before surgery, then we included adult patients of both sexes with left atrial diameter more than 65 mm whom underwent mitral valve replacement for the first time. Patients with rheumatic and degenerative mitral valve regurgitation or stenosis, with or without tricuspid regurgitation were also included. But we excluded patients with infective and ischemic mitral valve pathologies, patients who underwent mitral valve repair and emergency patients.

Methods

All patients referred for mitral valve surgery for rheumatic and degenerative heart diseases underwent thorough history, physical examination and review of all tests and co-morbid conditions to confirm risk stratification, and allow preoperative medical management as well as optimal surgical planning. We registered their personal Data, with history taking, that included their Present history and past history.

Cardiac medications are continued up to the time of operation with tight control of diabetes mellitus and hypertension. Warfarin was held prior to surgery for control of coagulation profile and was replaced with unfractionated heparin or low molecular weight heparin. Aspirin and clopidogrel were stopped if taken by the patients. Digoxin was stopped 48 hours before surgery if taken by the patient.

Physical examination included cardiovascular and respiratory systems assessment to assess any findings, to assess disease progression and to exclude new pathology. Clinical signs include full general and local examination for signs of mitral valve disease and signs of heart failure.

Laboratory investigations included Complete blood count, ABO and RH blood grouping, ALT, AST, bilirubin, albumin, fasting plasma glucose, creatinine, prothrombin time, INR and Pulmonary function test in selected cases. Radiological investigations included plain chest x-ray, echocardiography, carotid doppler, coronary angiography, thalim study and dobutamine stress echo if indicated.

Surgical Technique

All patients received general anesthesia under full monitoring. Both median sternotomy and minimally invasive approaches were included depending on surgeon's experience and available facilities in the operating theater. Intravenous heparin (300 IU/Kg) was given to maintain activated clotting time (ACT) greater than 480 seconds. Cardiopulmonary bypass was established using standard equipment and classical bicaval cannulation or femoral cannulation. Cardiac arrest was achieved with aortic cross clamp (ACC) and ante-grade intermittent cold hyperkalemic blood cardioplegia under moderate systemic hypothermia (28-32 C). The mitral valve was accessed through a classic left atriotomy incision and a left atrial retractor was used to expose the mitral valve and left atrium. Mitral valve replacement was done in a routine fashion with preservation of one or both leaflets using mechanical or biological prosthesis. We removed any thrombi.

In patients of group A, left atrial plication was performed by plication of left atrial appendage, plication around posterior mitral annulus (peri-annular plication), inter-pulmonary plication in the floor of left atrium extending to the roof and closure of the left atrium ensuring complete plication by performing deep sutures.

Then other concomitant cardiac procedures were performed and surgery was completed as routine. Homeostasis was checked. The patient was then finally weaned off CBP and decannulated. Good homeostasis was checked again. Operative data included; date of operation, type of mitral prosthesis, cross clamp and cardio pulmonary bypass time, type of cardioplegia, post bypass rhythm, pharmacologic support, intra-operative mortality.

Postoperative Assessment

All patients were anti coagulated post operatively. Outcome assessment included; immediate and early postoperative data that involved hospital morbidity at 30 days, pleural

effusion, pneumonia, wound infections, need for surgical re-exploration, cerebral stroke, post-operative thromboembolic complications, readmission within 30 days, ventilation duration, post-operative drainage, ICU stay in days, hospital stay in days, post-operative rhythm, use of amiodarone, beta-blockers preoperative to avoid postoperative AF and hospital mortality.

Clinical evaluation was done by; physical examination and patient symptoms were reassessed regarding tracheal and esophageal compression symptoms. Radiological evaluation was done by chest X ray, echocardiography and daily electrocardiogram (ECG) before discharge.

Statistical Analysis

Data were analyzed using SPSS (Statistical Package for Social Sciences, version 15, Chicago, USA). Qualitative data were presented as numbers and percentages). Normally distributed data were presented as mean ± SD. Comparison between groups was done by Chi-Square test. Quantitative data was tested for normality by Kolmogorov-Smirnov test. Student t-test was used to compare between two groups. $P < 0.05$ was considered to be statistically significant.

RESULTS

The current study included 50 patients, divided into two equal groups: group A (mitral valve replacement and left atrial plication) and group B (mitral valve replacement only). Regarding the socio-demographic characteristics of the studied groups, there was statistically significant difference between the 2 studied groups regarding the age at operation and the Ethnic origin (P= 0.013 and 0.012 respectively), but no significant difference was found regarding (gender, weight, height and BMI). There was statistically significant difference between the 2 studied groups regarding the Compression Symptoms (P= 0.017) where 36% of cases in group 1 showed compression symptoms versus 8% in group 2. But no significant difference was found as regarding anginal status pre-surgery, dyspnea status pre-surgery, Diabetes mellitus, hypertension, cigarette smoking, renal dysfunction / dialysis, COPD, neurological disease, gastrointestinal disease or pre-operative heart rhythm (Table 1). Regarding medications distribution among the studied groups, there was statistically significant difference between the 2 studied groups as regard the medications intake (P= 0.04) (Table 2).

Table (1): Socio-demographic characteristics, Clinical presentation, and co-morbidities of the studied groups

	Group 1 n=25	**Group 2 n=25**	**test of significance**
Socio-demographic Characteristics			
Gender			
Male	13(52.0)	13(52.0)	p=1.0
Female	12(48.0)	12(48.0)	
Age at operation (Years)	55.28±15.22	64.88±10.85	t=2.56 p=0.013*
Ethnic origin			
White British	13(52)	21(84)	MC=11.03
Black	0	1(4)	P=0.012*
Asian	4(16)	3(12)	
Arab	8(32)	0	
Height/cm	166.96±11.77	168.88±8.72	t=0.655 p=0.515
Weight/kg	77.86±14.20	80.83±16.29	t=0.688 p=0.496
BMI (kg/m^2)	27.95±4.18	28.29±5.09	t=0.259 p=0.796
Clinical Presentation and Co-morbidities			
Anginal status pre-surgery (CCS)			
No angina	21(84)	21(84)	MC=1.33
No limitation of physical activity	2(8)	2(8)	p=0.721
Marked limitation of ordinary physical activity	0	1(4)	
Symptoms at rest or minimal activity	2(8)	1(4)	
Dyspnea status pre-surgery (NYHA)			
No limitation of physical activity	1(4)	0	MC=2.39
Slight limitation of ordinary physical activity	6(24)	10(40)	P=0.495
Marked limitation of ordinary physical activity	13(52)	10(40)	
Symptoms at rest or minimal activity	5(20)	5(20)	
Diabetes mellitus			
No	20 (80)	20(80)	MC=2.50
Yes	5 (20)	5 (20)	P=0.287

Hypertension			
No	17(68)	15(60)	□2=0.347
Yes	8(32)	10(40)	p=0.556
Cigarette smoking			
Never smoked	13(52)	7(28)	
Ex- smoker	8(32)	13(52)	□2=3.11
Current smoker	4(16)	5(20)	p=0.212
Renal dysfunction / Dialysis			
No	25(100)	24(96)	FET=1.02
Yes	0	1(4)	P=1.0
COPD			
No	21(84)	22(88)	FET=0.166
Yes	4(16)	3(12)	p=1.0
Neurological disease			
No history of neurological disease	20 (80)	19 (76)	MC= 0.892
CVA with full recovery	2 (8)	4 (16)	P= 0.640
CVA with residual deficit	3 (12)	2 (8)	
Gastrointestinal disease			
No	22(88)	21(84)	MC=2.35
Yes	3 (12)	4 (16)	P=0.502
Compression Symptoms			
No	16(64)	23(92)	□2=5.71
Yes	9(36)	2(8)	P=0.017*
Pre-operative heart rhythm			
Atrial fibrillation/flutter	18(72)	11(44)	MC=4.27
Complete heart block/pacing	1(4)	1(4)	P=0.118
Sinus rhythm	6(24)	13(52)	

Parameters described as mean ±SD, number and percentage.
t: Student t test, MC: Monte Carlo test, Chi-Square test, FET: Fischer exact test *statistically significant

Table (2): Medications distribution among the studied groups

	Group 1 n=25	**Group 2 n=25**	**test of significance**
NO	7(28)	14(56)	MC=11.56
Warfarin & Digoxin	3(12)	0	P=0.04*
Warfarin& BB	5(20)	0	
DOACS&BB	8(32)	10(40)	
DOACS	1(4)	1(4)	
Digoxin	1(4)	0	

Parameters described as mean ±SD, number and percentage.
MC: Monte Carlo test, Chi-Square test, FET: Fischer exact test *statistically significant

Regarding echo findings among the studied groups, there was statistically significant difference between the 2 studied groups regarding the Left atrial diameter in the echo findings (P= 0.001), but no significant difference was found regarding left ventricular function, PA systolic, MV area, mean MV gradient, mitral valve hemodynamic pathology, severity of stenosis, severity of regurgitation and LA thrombus). Regarding pre-operative findings among the studied groups, there was a statistically significant difference regarding pre-operative findings between the 2 studied groups in terms of intravenous inotropes prior to anesthesia, ventilation (pre-operation), cardiogenic shock (pre-operation), pre-op support devices used. Regarding operative findings there was statistically significant difference between the 2 studied groups in terms of the intra operative Transesophageal echocardiography (TOE), valve implant type and pacing wires used (P= 0.009, 0.018 and 0.006 respectively), but no significant difference was found regarding incision, cardioplegia solution, cardioplegia temperature, cardioplegia infusion mode, by pass time, cross clamp time, filtration, Intra-aortic balloon pump used, post bypass cardiac rhythm, sternum closure and duration of operation.. Regarding inotropic support, there was no statistically significant difference apart from the excessive use of Noradrenaline in the studied group 2 (Table 3).

Table (3): Echo findings, pre-operative findings, and operative findings among the studied groups

	Group 1 n=25	**Group 2 n=25**	**test of significance**
Echo findings			
Left ventricular function	51.96±13.32	52.76±9.38	t=0.245 p=0.807
PA systolic	44.60±17.08	42.08±16.21	t=0.535 p=0.595
MV area	1.28±0.57	1.37±0.57	t=0.424 p=0.675
Mean MV gradient	13.32±3.89	10.32±5.0	t=1.77 p=0.09
Mitral valve hemodynamic pathology Stenosis Regurgitation Mixed	 3(12) 13(52) 9(36)	 9(36) 13(52) 3(12)	 MC P=0.05
Severity of stenosis NA Mild (MVA > 2.5cm) Moderate (MVA 1.5- 2.5cm) Severe (MVA <1.5cm)	 11(44) 2(8) 3(12) 9(36)	 12(48) 1(4) 5(20) 7(28)	 MC P=0.771
Severity of regurgitation NA Mild (Vena contracta < 3mm) Moderate (Vena contracta 3-7 mm) Severe (Vena contracta > 7mm)	 1(4) 2(8) 5(20) 17(68)	 2(8) 6(24) 1(4) 16(64)	 M=5.03 P=0.170
Left atrial diameter (cm)	7.55±1.07	6.73±0.55	t=3.37 p=0.001*
LA thrombus No Yes	 19(76) 6(24)	 18(72) 7(28)	 χ^2=0.104 p=0.747
Pre-operative findings			
Intravenous inotropes prior to anesthesia No Yes	 24(96) 1(4)	 23(92) 2(8)	 FET=0.355 P=0.552
Ventilated (pre-operation) No Yes	 24(96) 1(4)	 24(96) 1(4)	 FET P=1.0
Cardiogenic shock (pre-operation) No Yes	 25(100) 0	 23(92) 2(8)	 FET P=0.490
Pre-op support devices used Intra-aortic balloon pump None	 1(4) 24(96)	 0 25(100)	 FET=1.02 P=1.0
Operative Finding			
Incision Median sternotomy Thoracotomy	 25(100) 0	 24(96) 1(4)	 FET=1.02 P=1.0
Intra-operative TOE No Yes	 6(24) 19(76)	 0 25(100)	 χ^2=6.82 p=0.009*
Cardioplegia solution Blood Crystalloid	 25 (100) 0	 24 (96) 1 (4)	 FET=1.06 P=0.490
Cardioplegia temperature Cold	 25(100)	 25(100)	
Cardioplegia infusion mode			

Antegrade	25(100)	25(100)	
Bypass time	174.0±50.45	151.48±54.87	t=1.51 p=0.137
Cross clamp time	132.04±30.56	112.08±49.65	t=1.71 p=0.093
Filtration No Yes	 21(84) 4(16)	 18(72) 7(28)	 □2=1.05 p=0.306
Valve implant type Mechanical Biological	 20(80) 5(20)	 12(48) 13(52)	 □2=5.56 p=0.018*
Post bypass cardiac rhythm Sinus rhythm (1) Atrial fib/flutter (2) Nodal rhythm (3) Heart block (4) Other (5)	 14(56) 8(32) 1(4) 1(4) 1(4)	 12(48) 7(28) 2(8) 0 4(16)	 MC=3.35 P=0.500
Pacing wires used None Atrial Ventricular Dual-chamber	 10(40) 1(4) 5(20) 9(36)	 1(4) 7(28) 8(32) 9(36)	 MC=12.56 P=0.006*
Intra-aortic balloon pump used no pre -operative Intra-operation	 23(92) 1(4) 1(4)	 25(100) 0 0	 MC=2.08 p=0.353
Inotropes used Adrenaline Vasopressin Milrinone Noradrenaline Dopamine/Dobutamine	 11(44) 2(8) 7(28) 16(64) 7(28)	 5(20) 2(8) 11(44) 23(92) 4(16)	 p=0.069 p=1.0 p=0.239 p=0.017* p=0.306
Sternum closure Routine Modified	 23 (92) 2 (8)	 24 (96) 1 (4)	 FET P=1.0
Duration of operation	265(130-465)	240(100-480)	p=0.098

Parameters described as mean ±SD t: Student t test *statistically significant
MC: Monte Carlo test, Chi-Square test, FET: Fischer exact test *statistically significant

Regarding post-operative findings, no significant difference was found in terms of chest drainage 1st 24 hours, re-operation for bleeding or tamponade, arrhythmias requiring intervention, intervention for AF and heart block, pulmonary complications requiring re-intubation and ventilation, infective complications, chest infection, deep sternal wound infection, new hemofiltration or dialysis, peak post op creatinine, gastro-intestinal complications, new neurological complications (Stroke), pre-discharge Hb, pre-discharge creatinine, in-patient mortality, ICU stay and postoperative stay (Table 4)

Table (4): Post-operative findings of the studied groups

	Group 1 n=25	**Group 2 n=25**	**test of significance**
Chest drainage 1st 24 hours	450(200-1630)	380(200-1150)	p=0.524
Re-operation for bleeding or tamponade No Yes	 24(96) 1(4)	 23(92) 2(8)	 FET=0.355 P=1.0
Arrhythmias requiring intervention None A fib/flutter Heart block	 18(72) 6(24) 1(4)	 19(76) 4(16) 2(8)	 MC=0.760 P=0.684

Intervention for AF or HB	N=7	N=6	
Pharmacological	5(71.4)	1(16.7)	
Permanent pacemaker	1(14.3)	2(33.3)	MC=3.95
Pharmacological + Electrical cardioversion	1(14.3)	3(50)	P=0.139
Pulmonary complications requiring re-intubation and ventilation			
No	23(92)	24(96)	FET
Yes	2(8)	1(4)	P=1.0
Infective complications			
Pneumonia	3(12)	1(4.0)	MC=2.0
none	21(84)	21(84)	P=0.368
pleural infection	1(4)	3(12)	
Deep sternal wound infection			
No	23(92)	24(96)	FET
Yes	2(8)	1(4)	P=1.0
New hemofiltration or dialysis			
No	22(88)	23(92)	FET=0.222
Yes	3(12)	2(8)	P=0.637
Peak post op creatinine (µmol/L)	130(66-420)	105(61-306)	p=0.482
Gastro-intestinal complications			
No	25(100)	22(88)	FET=3.19
Yes	0	3(12)	P=0.074
New neurological complications (Stroke)			
No	24(92)	21(88)	FET
Yes	1(8)	4(12)	p=0.157
Pre-discharge Hb (gm/dl)	9.66±1.37	10.01±1.29	p=0.365
Pre-discharge creatinine (µmol/L)	88.5(60-190)	88(49-193)	p=0.687
In-patient mortality			
No	24(96)	24(96)	FET=0.0
Yes	1(4)	1(4)	P=1.0
ICU stay	3(1-15)	2(1-59)	p=0.627
Postoperative stay	9(5-24)	8(4-59)	p=0.325

Parameters described as mean ±SD, number and percentage
MC: Monte Carlo test, Chi-Square test, FET: Fischer exact test *statistically significant

Regarding post-operative follow up at 1 month and 6 months, there was statistically significant difference between the 2 studied groups in terms of 1month ECHO LAD and 6months ECHO LAD diameter (P<0.001), But no differences in terms of 1month ECHO LVEF, 6month ECHO LVEF, Rhythm after 6 months, 6months post op compression symptoms and 6months post op thromboembolic complications (Table 5). Regarding Outcomes of surgeries, there is statistically significant difference between pre and post-operative rhythm, left atrial diameter, compression symptoms and LA thrombus among cases in group 1 (P<0.001, p<0.001, p=0.0009 and p =0.01 respectively), but no statistically significant difference was detected regarding neurological complications. Regarding cases in group 2, there is statistically significant difference between pre and post-operative LA thrombus (P=0.005), but no statistically significant difference was detected in terms of rhythm, Left atrial diameter, compression symptoms and neurological complications (Table 6).

Table (5): Follow up at 1 month and 6 months post-operative of the studied groups

	Group 1 n=24	**Group 2 n=24**	**test of significance**
1month ECHO LVEF (%)	53(21-69)	50(26-60)	p=0.628
1month ECHO LAD diameter (cm)	4.4(3.5-6.7)	6.3(5.5-7.8)	p<0.001*
6month ECHO LVEF (%)	58(29-65)	48(30-66)	p=0.084
6month ECHO LAD diameter (cm)	4.25(3.5-6.8)	6.5(5.9-7.6)	p<0.001*
Rhythm after 6 months			
Atrial fibrillation/ Flutter	2(8.3)	5(20.8)	MC=1.93
Sinus rhythm	20(83.3)	16(66.7)	P=0.381
complete heart block/pacing	2(8.3)	3(12.5)	

6months post op compression symptoms	0	3 (12.5)	FET=3.19 P=0.235
6month post op thromboembolic complications	1 (4.2)	5 (20.8)	FET P=0.189

Parameters described as mean ±SD, number and percentage
MC: Monte Carlo test, Chi-Square test, FET: Fischer exact test *statistically significant

Table (6) : Outcomes of surgeries in each studied group

	Group 1 n=25		**test of significance**	**Group 2 n=25**		**test of significance**
	Pre	Post		Pre	Post	
Rhythm Atrial fibrillation Complete heart block Sinus rhythm	n=25 18(72) 1(4) 6(24)	n=24 2(8.3) 2(8.3) 20(83.3)	p<0.001*	n=25 11(44) 1(4) 13(52)	n=24 5(20.8) 3(12.5) 16(66.6)	p=0.17
Left atrial diameter	7.54±1.09	4.57±0.90	t=10.41 p<0.001*	6.64±0.25	6.58±0.500	t=0.694 p=0.495
Compression symptoms No Yes	16(64) 9(36)	24(100) 0	p=0.0009*	23(92) 2(8)	21(87.5) 3(12.5)	p=0.637
LA thrombus No Yes	19(76) 6(24)	24(100) 0	p=0.01*	18(72) 7(28)	24(100) 0	p=0.005*
Neurological complications No Yes	22(88) 3(12)	22(91.6) 2(8.3)	p=1.0	24(96) 1(4)	21(87.5) 3(12.5)	0.297

Parameters described as mean ±SD, number and percentage
MC: Monte Carlo test, Chi-Square test, FET: Fischer exact test *statistically significant

DISCUSSION

Left Atrium (LA) is far from being a simple passive transport chamber. It is highly dynamic and responds to stretching with the secretion of atrial natriuretic peptides. Enlargement of the LA has been shown to be a reliable predictor of adverse cardiovascular outcomes **[15]**. The prognostic implication of LA size has been shown in high-risk subgroups, such as patients with acute myocardial infarction, atrial arrhythmia, LV dysfunction, or dilated cardiomyopathy, and patients undergoing valve replacement for aortic stenosis and mitral regurgitations **[16]**. Mitral valve surgery alone mostly does not restore sinus rhythm or prevent recurrence of AF after surgery. The idea that mitral valve surgery alone will result in remodeling and atrial size reduction is considered wrong by most studies **[17]**.

After atrial size reduction, sinus rhythm was restored in 77.3% of patients, whereas in the group without reduction it was restored only in 61.1% of patients. Addition of LA size reduction to mitral valve surgery is effective in 63% of patients with chronic AF in reducing the risk of stroke and thromboembolic complications **[18]**. Therefore, the current study aimed to compare the effect of left atrial plication in patients who underwent mitral valve replacement and had a giant left atrium. The current study included 50 patients, divided into two equal groups: group A (mitral valve replacement and left atrial plication) and group B (mitral valve replacement only).

The current study showed that there was statistically significant difference between the 2 studied groups regarding age at operation and ethnic origin (P= 0.013 and 0.012 respectively), but no significant difference was found regarding gender, weight, height and BMI. The discrepancy between the 2 studied groups regarding the age at operation and ethnic origin is explainable by the fact that all group 2 patients had their operations in UK and the most common cause of mitral valve disease in developed countries is degenerative which is more common in older age group. Nevertheless, the most predominant ethnic group in UK is White British. The current study showed that there was statistically significant difference between the 2 studied groups as regarding compression symptoms (P= 0.017) where 36% of cases in group 1 shows compression symptoms versus 8% in group 2. However, no significant difference was found regarding anginal status pre-surgery, dyspnea status pre-surgery, Diabetes mellitus, hypertension, cigarette smoking, renal dysfunction/dialysis, COPD, neurological disease,

gastrointestinal disease or pre-operative heart rhythm.

Kim *et al.* [19] evaluated 116 patients with a giant LA who underwent surgical AF ablation during MV surgery divided into 28 patients received aggressive LA volume reduction procedure (reduction group) while the other 88 patients received the surgery without LA volume reduction (non-reduction group). Their study found no statistically significant difference between the two groups regarding age (years), male predominance, hypertension, Diabetes mellitus, Dyslipidemia, CAD, Respiratory problems, Renal insufficiency, Hepatobiliary problems, Rheumatic origin and Mitral valve disease.

The current study showed that there was statistically significant difference between the 2 studied groups regarding the medications given (P= 0.04). Interestingly, the current study found statistically significant difference between the 2 studied groups regarding the left atrial diameter in the echo findings (P= 0.001), but no significant difference was found regarding left ventricular function, PA systolic, MV area, Mean MV gradient, mitral valve hemodynamic pathology, severity of stenosis, severity of regurgitation and LA thrombus.

Conversely, **Kim *et al*, [19]** found no statistically significant difference between the two groups as regard LA dimension (mm), LVEF (%), LV dysfunction, PA pressure (mmHg), severe PHT and Cardiothoracic ratio. Our study showed no statistically significant difference regarding pre-operative findings between the 2 studied groups in terms of intravenous inotropes prior to anesthesia, ventilation (pre-operation), cardiogenic shock (pre-operation), pre-op support devices used. Interestingly, the current study evaluated the operative findings among the studied groups and showed that there was statistically significant difference between the 2 studied groups regarding the availability of intra-operative TOE**,** valve implant type and pacing wires used (P=0.009 0.018 and 0.006 respectively), but no significant difference was found regarding incision, cardioplegia solution, cardioplegia temperature, cardioplegia infusion mode, bypass time, cross clamp time, filtration, intra-aortic balloon pump used, post bypass cardiac rhythm, sternum closure and duration of operation. Regarding inotropic support, there was no statistically significant difference apart from the excessive use of Noradrenaline in the studied group 2.

TOE has been one of the standards set up in mitral valve surgery for the studied group 2. However, TOE was not available in the department till recently for some patients in the studied group 1. The discrepancy between the 2 groups regarding valve implant type is due to the younger median age of the studied group 1 where the patients choose the mechanical valves over the biological valves due to better longevity of the mechanical valves over biological valves. The difference between the 2 studied groups as regard the use of pacing wires in mainly due to the surgeon's preference and the different protocols in the 2 different operating centers where only 1 patient in the studied group 2 (single operating center) had no pacing wires used in contrast of 10 patients in the studied group 1 where patients had their operations in 2 different centers. The discrepancy between the 2 studied groups in terms of the excessive use of Noradrenaline in the studies group 2 is due to the different inotropic use protocol in the 2 different operating centers where the Noradrenaline is the inotrope of first choice in New Cross hospital, UK.

As regard post-operative findings, the current study found that, no significant difference was found in terms of chest drainage 1st 24 hours, re-operation for bleeding or tamponade, arrhythmias requiring intervention, intervention for AF and heart block, pulmonary complications requiring re-intubation and ventilation, infective complications, chest infection, deep sternal wound infection, new hemofiltration or dialysis, peak post op creatinine, gastro-intestinal complications, new neurological complications (Stroke), pre-discharge Hb, pre-discharge creatinine, in-patient mortality, ICU stay and postoperative stay.

On the other hand, **Yalcinkaya *et al*.,** evaluated 60 patients who were scheduled for mitral valve replacement allocated into two groups: (Group 1; received left atrial size reduction); (Group 2; not received left atrial size reduction). The study found no statistically significant difference between the two studied groups as regard Operative and postoperative variables (Cardiopulmonary bypass time (min), Time of cross-clamping (min), CABG, Time of mechanic ventilation (min) 24-h bleeding (mL), Use of inotropes, Time of ICU stay (d), Time of postoperative stay (d) and Sinus rhythm (until discharge)) **[20]**.

Regarding post-operative follow up at 1 month and 6 months, there was statistically significant difference between the 2 studied groups in terms of 1month ECHO LAD and 6months ECHO LAD diameter (P<0.001), But, no differences in terms of 1month ECHO LVEF, 6month ECHO LVEF, Rhythm after 6 months, 6months post op compression symptoms and 6months post op thromboembolic complications. The significant reduction of the left atrium size can be explained by the technique of plication performed in our study which allowed reduction of the left atrial size in more than one diameter. Despite increased number of atrial fibrillation/flutters after 6 months as well as incidence of post-operative thromboembolic complications and compression symptoms in group

2 (without plication) as compared with group 1 (with plication), there was no statistically significance.

In harmony with our results, **Kim *et al.* [19]** who conducted his study on 116 patients with a giant LA (antero-posterior dimension ≥70 mm) who underwent surgical AF ablation during MV surgery were retrospectively reviewed. Among these, 28 patients received an aggressive LA volume reduction procedure (reduction group) while the other 88 patients received the surgery without LA volume reduction (non-reduction group). Mean follow-up duration was 6.8±3.0 years, reported that in group A, a significant decrease in LA size was noted postoperatively which was not observed in group B. The LA reduction technique used included extending the inferior end of the left atriotomy, aiming it to the left inferior pulmonary vein. The other end of the left atriotomy was extended superiorly across the LA dome, and this finally met the inferior extension of the atriotomy. After making another incision, parallel to the mitral annulus leaving about a 2 cm margin from the annulus, a strip with a width of 2–4 cm was resected circumferentially, and this included the LA appendage.

Tonguç *et al*., [21] reported that the possibility of spontaneous echo contrast or thrombosis is still high after mitral valve surgery in patients with giant LA and AF. The size of the LA is one of the strongest independent predictors of thromboembolism. Plication techniques decrease the incidence of postoperative low cardiac output syndrome and respiratory dysfunction.

After all, the current study showed that there was statistically significant difference between pre and post-operative (rhythm, left atrial diameter, compression syndrome and LA thrombus) among cases in group A ($P<0.001$, $p<0.001$, $p=0.0009$ and $p=0.01$ respectively), but no statistically significant difference was detected as regard neurological syndrome. Regarding cases in group B, there is statistically significant difference between pre and post-operative (LA thrombus) ($P=0.005$), but no statistically significant difference is detected as regard rhythm, left atrial diameter, compression syndrome and neurological syndrome. These results could denote that LA plication might have positive outcome on the rhythm, left atrial diameter, compression syndrome and LA thrombus.

Kim *et al.* [19] reported that following LA reduction, 2 patients reverted from AF to sinus rhythm postoperatively while the rest continued to be in AF in group A. During follow up at six months one more patient reverted to sinus rhythm in this group (reduction group). In group B (non-reduction group), sinus rhythm was not restored. There was difference in conversion to sinus rhythm in both groups. During the early postoperative period, the persistence of AF in group B patients was more apparent than in group A.

Scherer *et al.* [5] reported that left atrial size reduction affects cardiac rhythm in patients with chronic AF undergoing mitral valve surgery. The addition of left atrial size reduction to mitral valve surgery was effective in restoring sinus rhythm in 19% at discharge and in 63% of patients with chronic AF, restoring predominant SR at one year postoperatively.

Özerdem *et al.* in their study on left atrial reduction by posterior wall plication combined with mitral valve replacement, observed an important statistically significant reduction in the LA diameters after reduction. When the postoperative sixth-day and sixth-month measurements were compared, no significant differences were found **[22]**.

Conversely, **Tonguç *et al*, 2001** study was conducted on patients with giant left atrium which divided into 2 groups retrospectively. Group 1 comprised 10 patients with compression symptoms who received left atrial plication after mitral valve replacement. Group 2 comprised 31 patients without symptoms of compression who did not receive plication and reported no significant difference in left atrial size between the 2 groups. Therefore he concluded that, in cases of giant left atrium with a left atrial diameter below 80 mm, plication might not be necessary. **[21]**.

The discrepancies in findings of the above-mentioned studies can be explained by a number of factors including the type of the surgical plication, the efficacy of the surgical procedure, dissimilar populations, selection of patients and limited sample size.

CONCLUSION

This study added evidence for the contribution of left atrial size reduction in patients undergoing mitral valve surgery for mitral valve disease with left atrial enlargement on clinical outcome and echocardiographic parameters. LA reduction along with MVR has significant improvement in clinical outcome in terms of restoration of sinus rhythm, less thromboembolic complications and compression symptoms during long term follow up. So, LA reduction is advisable in patients with enlarged LA along with MVR.

LIMITATIONS

The study group was small. The follow up was of six months only. Finally, the detection of AF, based on the routine or spot electrocardiogram obtained during the follow-up visits could have been underestimated the real incidence of AF.

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