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Effect of Partial Versus Complete Annulo-Papillary Preservation During Mitral Valve Replacement on Left Ventricular Geometry and Function Using CMR

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ABSTRACT

Background: Evaluation of left ventricular function after mitral valve surgery was always debated. Evolution of new diagnostic techniques as cardiovascular magnetic resonance imaging (CMR) may help in discovering advantages or disadvantages of different surgical techniques used during mitral valve surgery. Many comparative studies were done depending on the traditional diagnostic methods as Echocardiography.

Objective: The aim of the current work was to assess the immediate and short-term effect of partial and complete annulo-papillary preservation on left ventricular function and geometry, using CMR, in patients undergoing mitral valve replacement for predominant mitral incompetence.

Patient and methods: Prospective randomized controlled trial study, on 32 patients with mitral valve disease and predominant mitral regurgitation, mitral valve replacement was done. The study was done at different institutions (Kasr AlAiny hospitals, Sheikh Zayed specialized Hospital), with the same group of surgeons, in the period between May 2015 and Feb 2017. All patients went through preoperative, operative& early postoperative evaluation.

Results: According to our knowledge this is the first study in Egypt to use CMR in evaluating the effect of mitral valve replacement on cardiac function. Postoperative evaluation demonstrated a significant improvement in left ventricular function and dimensions in both groups using echocardiography or CMR. The study failed to quantify significant superiority of either technique in our selected patient groups. This was consistent with many trails done before using echocardiography only.

Conclusion: CMR as an available investigation should be used in a larger scale specially in debatable conditions regarding cardiac function and in tissue evaluation. Mitral valve repair is the gold standard whenever possible during surgical management of mitral valve disease, but mitral replacement is a modality may be needed in many situations. Every effort should be exerted to avoid complete separation of the annulo-papillary continuity during mitral valve replacement.

Keywords: CMR, Annulo-papillary, Mitral valve replacement, LV function, LV dimensions.

INTRODUCTION

The advent of cardiopulmonary bypass in 1953 opened the door for open cardiac surgery, but the first mitral valve replacement was not performed until 1959 by Nina Starr Braunwald, the first surgeon to perform Mitral valve replacement [(1)].

Despite the emphasis on mitral valve repair, there are circumstances when a reliable, durable result cannot be achieved. Replacement therefore, remains a necessary and viable modality [(2)].

During Mitral valve replacement, the most important issue is to preserve the continuity of mitral annulus, sub-valvular apparatus, and left ventricular chamber to maintain normal left ventricular geometry and reduce left ventricular impairment following mitral valve replacement. This target can be achieved using different techniques [(3)].

This may involve preservation of the entire leaflet tissue to the annulus using the valve sutures. Alternatively, a portion of each leaflet is excised and then the remaining leaflet with the attached chordate is fixed to the annulus [(4)].

Assessment of left ventricular geometry by Echocardiographic studies carry a higher rate of inaccurate values. Three-dimensional left ventricular geometric evaluation using CMR provides more accurate details about left ventricular geometry and function [(5)].

CMR is a highly reliable, well-validated technique for measuring heart function and analyzing the structural anatomy of the heart [(6)]. CMR is superior to other frequently used imaging modalities such as 2D echocardiography and SPECT imaging in evaluating anatomical defects, e.g. LV aneurysms. Also, MRI is a non-invasive technique without the use of radiation or radioactivity. Moreover, reproducibility of the technique is high allowing accurate detection of changes in different parameters [(7)].

The aim of the current work was to assess the immediate and short-term effect of partial and complete annulo-papillary preservation on left ventricular function and geometry, Using Cardiovascular Magnetic resonance CMR, in patients undergoing mitral valve replacement for predominant mitral incompetence.

PATIENT AND METHODS

This prospective randomized controlled trial study included a total of 32 patients with mitral valve disease and predominant mitral regurgitation, attending at Kasr AlAiny hospitals and Sheikh Zayed specialized Hospital for mitral valve replacement with the same group of surgeons. This study was conducted between May 2015 and Feb 2017. All patients went through preoperative, operative& early postoperative evaluation.

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Sample size calculation: Being the primary outcome, sample size calculation was done using the comparison of EF% between mitral replacement without preservation of papillary annular continuity and mitral replacement with preservation of posterior leaflet only. As reported in previous publication of Saad *et al.*, the mean ±SD of postoperative EF% in cases with mitral replacement without preservation of papillary continuity was approximately 54.83 ± 8.46% while in cases with posterior leaflet preservation, it was 63.36 ± 7.9%. Accordingly, we calculated that the minimum proper sample size was 16 patients in each arm to be able to detect a real difference of about 10% with 80% power at $\alpha = 0.05$ level using Student's t test for independent samples. Sample size calculation was done using Stats Direct statistical software version 2.7.2 for MS Windows, Stats Direct Ltd., Cheshire, UK.

Patients, males or females, different age group, with predominant mitral regurgitation, indicated for mitral valve replacement.

The included subjects were randomly divided into two equal groups; **Group 1** consisted of 16 patients undergoing mitral valve replacement with preservation of the posterior leaflet only and **Group 2** consisted of 16 patients undergoing mitral valve replacement with complete preservation of annulo-papillary continuity.

Inclusion criteria: All patients underwent mitral valve replacement for pure or predominant mitral valve incompetence with or without concomitant tricuspid valve repair.

Exclusion criteria: Associated other valve diseases requiring valve replacement, associated ischemic heart disease requiring revascularization, emergency (ie; after failed balloon valvotomy), redo cardiac surgery (re-replacement), infective Endocarditis, pregnant and lactating women were excluded from the study, patients with permanent pacemaker, and automated implantable cardiac defibrillators (ICDs), and patients with ferromagnetic cerebrovascular aneurysm clips.

All patients were studied for the following variables:

"Contemplation pamphlet used for data collection, one pamphlet for each patient carry all variables"

A. Preoperative factors:

- Diagnosis.
- History, (age, sex, history of arrhythmias, infective endocarditis, recent rheumatic activity, functional capacity according to New York Heart Association (NYHA) classification.
- Physical Examination.
- Preoperative labs: hemoglobin, hematocrit, serum creatinine.
- Echocardiography: evaluation of mitral valve lesion, evaluation of other valves, left ventricular End diastolic diameter, left ventricular End systolic diameter, Ejection fraction (EF).
- Preoperative left ventricular function and dimensions using CMR.

B. Operative Factors:

- Operative time.
- Bypass time.
- Ischemia Time.
- Modality of annulo-papillary preservation.
- Type of mitral prosthesis used.
- Need for support.
- Approach (mediansternotomy, minithoracotomy).

C. Postoperative Factors:

- Duration of postoperative mechanical ventilation.
- Duration of ICU stay.
- Postoperative complications (high drainage, reopen, chest infection).
- Postoperative CMR evaluation of left ventricular function dimensions as a geometric evaluation after 6 months of the procedure.

CMR Protocol:

All patients were imaged by a 1.5 T super conducting magnet (Gyroscan Ahieva Philips Medical systems, Best, and the Netherlands). Using 8 channel phased-array cardiac coil with ECG gating. Black blood and b-FFE in 2 chamber view. B-FFE in 4 chamber view. Short Axis on the ventricles. Volumetric measurements including EDV, ESV, SV, EF, CO, myocardial mass and thickness was recorded.

All patients included in the study were operated through left atriotomy incision. Patients in group I, resection of anterior leaflet without preservation of its sub-valvular connection and preservation of posterior leaflet was done.

Patients in group II, in addition of preservation of posterior leaflet, anterior leaflet was also preserved in different ways: (a) When the anterior leaflet is pliable, resection of most of leaflet tissue leaving only 5-10mm strip of its free margin, which still attached to the primary and secondary chordae (maintaining annulo-papillary continuity at this segment). (b) When anterior leaflet was found to be thickened or calcific, the previous strip is divided in to 2 to 4 chordal segments, each of which was trimmed in chordal button and reattached to the annulus to the corresponding commissure. Care was taken to avoid any protrusion of tissues in the LVOT.

Postoperative ICU Management

All patients were transferred to specialized intensive care unit, where adequate hemodynamic monitoring was ensured. All patients transferred intubated, mechanically ventilated.

Monitoring: 5 lead ECG, pulse oximetry for O2 saturation, invasive blood pressure, central venous pressure, body temperature, urine output, and drainage (chest tubes).All monitoring data were collected in specific charts (hemodynamic, fluid chart).

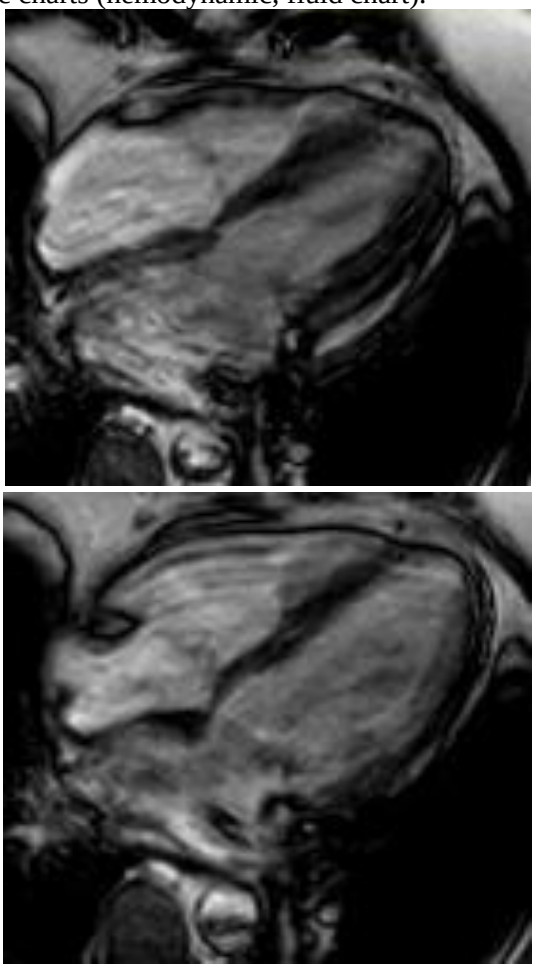

Figure (1): 4 chamber steady state free precession images for patient with mitral incompetence in end systolic (A) and end diastolic (B) phases showing dilated left atrium and left ventricle.

Mechanical ventilation: Patients were transferred on mechanical ventilation, and gradual weaning was adopted if the patient is candidate for extubation. Criteria for extubation: Adequate conscious level. Adequate motor power. Good hemodynamics on accepted doses of inotropes. Accepted drainage and decreased possibility of reopen. Adequate minute ventilation. Accepted blood gases and acid /base balance, and accepted pressure support for extubation.

***Ethical Consideration*:**

An approval of the study was obtained from Cairo University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. 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.

Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data were presented as number and percentages while the quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric. The comparison between groups with qualitative data were done by using Chi-square test and/or Fisher exact test when the expected count found less than 5. The comparison between two independent groups with quantitative data and parametric distribution was done by using Independent t-test. The comparison between two paired groups with quantitative data and parametric distribution was done by using Paired t-test. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: $P > 0.05$: Non-significant. $P < 0.05$: Significant. $P < 0.01$: Highly significant

RESULTS

The difference in the mean age between both groups was statistically insignificant (P Value >0.05). The difference in Gender distribution and spectrum of age between both groups was statistically insignificant (P Value >o.o5) (Table 1).

Table (1): Age, male & female distribution between both groups.

		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
Age (years)	Mean±SD	30.63±6.76	31.75±7.08	-0.460	0.649
	Range	21–45	22–44		
Sex	Male	6(37.5%)	5(31.3%)	0.139*	0.710
	Female	10(62.5%)	11(68.8%)		
	Redo surgery	2(12.5%)	1(6.3%)		

*:Chi-square test

Echo-cardiographic evaluation was done routinely for every patient, where the differences between both groups regarding EF, LVED, LVES and LA, were found to be statistically insignificant (Table 2).

Table (2): Preoperative echocardiography comparison between both groups

Pre-operativeEcho		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
LVED"mm"	Mean±SD	60.94 ± 4.70	59.50 ± 2.99	1.033	0.311
	Range	52 – 68	56 – 68		
LVES "mm"	Mean±SD	37.31 ± 3.38	37.31 ± 3.16	0.000	1.000
	Range	31 – 42	32 – 42		
EF % simpson	Mean±SD	63.24 ± 3.92	61.38 ± 5.20	1.144	0.262
	Range	57.8 – 70.5	54 – 71		
LA cm	Mean±SD	5.36 ± 0.49	5.53 ± 0.51	-0.960	0.345
	Range	4.6 – 6.2	4.8 – 6.3		
	Atrial fibrillation	14 (87.5%)	16 (100.0%)		

**:Chi-square test*

The traced mitral valve lesions in our study was pure or predominant mitral regurgitation. Associated functional tricuspid regurgitation was included. Any other valve lesion was excluded. Pure mitral regurgitation patients were 4 (25%) in group I, 8 (50%) in group II, where mixed stenosis & regurgitation with predominant regurgitation were 12 (75%) in group I, 8(50%) in group II. The distribution of mitral valve lesions between both groups was found to be statistically insignificant (Table 3).

Table (3): Preoperative data

Pre-operative data		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
Mitral valve lesion	Pure MR	4 (25.0%)	8 (50.0%)	2.133*	0.144
	Mixed Stenosis & regurgitation with predominant MR	12 (75.0%)	8 (50.0%)		
Tricuspid	Mild	10 (62.0%)	9 (56.0%)	0.253*	0.881
	Moderate	2 (13.0%)	3 (19.0%)		
	Severe	4 (25.0%)	4 (25.0%)		
PAPs mmHg	Mean SD	56.25 ± 11.90	53.75 ± 11.62	0.601	0.552
	Range	40 – 75	40 – 75		
Rhythm	Sinus	2 (12.5%)	0 (0.0%)	2.133*	0.144
	Atrial fibrillation	14 (87.5%)	16 (100.0%)		

Evaluation of tricuspid valve:

Regarding tricuspid valve lesions: group I, there were 10 patients with mild tricuspid regurgitation (62.0%), 2 patients with moderate tricuspid regurgitation (13.0%), 4 patients with severe tricuspid regurgitation (25.0%). In group II, there were 9 patients with mild tricuspid regurgitation (56.0 %), 3 patients with moderate tricuspid regurgitation (19.0%), 4 patients with severe tricuspid regurgitation (25.0%). The distribution of tricuspid valve lesions between both groups was found to be statistically insignificant.

Pulmonary pressure: The mean SD values of pulmonary pressure between both groups were statistically insignificant, with the same range.

Rhythm: There were only 2 cases with sinus rhythm in group I, compared to group II where all patients were in atrial fibrillation. Still this distribution was statistically insignificant.

Preoperative CMR evaluation of left ventricular function:

Indexed EDV (ml/m^2): The mean ± SD of indexed EDV (ml/m2) in group I was 118.30 ± 20.75 with range of (89-154 ml/m2), where in group II the mean ± SD was 124.31±16.87 with range of (98- 156 ml/m2).there was statistically insignificant difference between both groups.(P-value :0.376)

Indexed ESV (ml/m^2): The mean ± SD of indexed ESV (ml/m2) in group I was 38.76 ± 12.53 with range of (23.1-72 ml/m2), where in group II the mean ± SD was 43.38±16.12 with range of (25- 75 ml/m2).there was statistically insignificant difference between both groups.(P-value: 0.374)

Indexed SV (ml/m^2): The mean ± SD of indexed SV (ml/m2) in group I was 79.54 ± 13.76 with range of (57-104 ml/m2), where in group II the mean ± SD was 80.94±8.93 with range of (60- 91 ml/m2).there was *statistically insignificant* difference between both groups.(P-value: 0.736)

EF (%): The mean ± SD of EF (%) in group I was 67.53 ± 6.53 with range of (53.2-78.9 %), where in group II the mean ± SD was 67.56±7.73 with range of (52- 77%). There was *statistically insignificant* difference between both groups. (P-value: 0.736) (Table 4).

Table (4): Preoperative CMR

Pre-operative CMR		Group I	Group II	Independent t-test	
		No.=16	No.=16	t	P-value
EDV ml / m2	Mean±SD	118.30 ± 20.75	124.31 ± 16.87	-0.899	0.376
	Range	89 – 154	98 – 156		
ESV ml / m2	Mean±SD	38.76 ± 12.53	43.38 ± 16.12	-0.904	0.374
	Range	23.1 – 72	25 – 75		
SV ml / m2	Mean±SD	79.54 ± 13.76	80.94 ± 8.93	-0.341	0.736
	Range	57 – 104	60 – 91		
EF%	Mean±SD	67.53 ± 6.53	67.56 ± 7.73	-0.012	0.990
	Range	53.2 – 78.9	52 – 77		

There was statistically significant difference between preoperative EF evaluation using CMR and preoperative EF evaluation using echocardiography in group I (P-value: 0.019). The mean SD of echocardiography was 63.24±3.92 with range of (57.8-70.5), where mean SD of CMR EF mean was 67.53±6.53 with range of (53.2-78.9) (Table 5).

Table (5): Postoperative EF comparing Echocardiography and CMR

Post-Operative EF		Echo	CMR	Paired t-test	
				t	p-value
EF (%)	Mean SD	59.29±6.25	61.09±3.60	1.095	0.291
	Range	50.1–72.2	55–67.6		

There was statistically significant difference between postoperative EF evaluation using CMR and postoperative EF evaluation using echocardiography in group II (P-value: 0.018). The mean SD of echocardiography was 61.38±5.20 with range of (54-71), where mean SD of CMR EF mean was 67.56±7.73 with range of (52-77) (Table 6).

Table (6): Preoperative EF comparing echocardiography and CMR

Preoperative		Echo	CMR	Paired t-test	
				t	p-value
EF (%)	Mean±SD	61.38 ± 5.20	67.56 ± 7.73	2.666	0.018
	Range	54 – 71	52 – 77		

The difference in the number of redo-surgeries between both groups was statistically insignificant (P Value >0.05) (Table 7).

Table (7): Showing number and distribution of redo-surgeries between both groups."

		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
Redo surgery	1st go surgery	14 (87.5%)	15 (93.8%)	0.368*	0.544
*:Chi-square test	Redo surgery	2 (12.5%)	1 (6.3%)		

Incision and approach: Group I: 15 patients were done through median sternotomy, while only 1 patient were done through mini thoracotomy. All patients in group II were done through sternotomy. There was insignificant difference between both groups.

Operative data: there were insignificant differences between both groups regarding operative time, CPB time and ischemia time. (Table:8)

Table (8): Operative data:

		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
Op. Time (min)	**Mean ±SD**	223.75 ± 37.04	211.88 ± 25.88	1.051	0.302
	Range	180 – 280	180 – 270		
CPB Time (min)	**Mean± SD**	101.25 ± 22.47	104.88 ± 16.78	-0.517	0.609
	Range	70 – 150	85 – 145		
Ischemic .Time (min)	**Mean± SD**	60.31 ± 14.61	69.00 ± 16.11	-1.082	0.288
	Range	35 – 110	45 – 120		

Postoperative course: there were insignificant differences between both groups regarding ICU course and stay, mechanical ventilation and postoperative complications (Tables 9, 10).

Table (9): Postoperative complications:

		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
Post-operative Complications	Chest inf.	0 (0.0%)	0 (0.0%)	2.370*	0.306
	Wound infection	0 (0.0%)	0 (0.0%)		
	Reopen	1 (6.3%)	0 (0.0%)		
	High drainage	2 (12.5%)	2 (12.5%)		
	Embolic	0 (0.0%)	0 (0.0%)		
	Valve malfunction &Paravalvular leak	0 (0.0%)	0 (0.0%)		
	Non	13 (81.2%)	14 (87.5%)		

Table (10): ICU stay:

		Group I	Group II	Independent t-test	
		No.=16	No.=16	t/X²*	P-value
ICU Stay (hrs)	Mean±SD	43.63 ± 9.38	41.31 ± 5.31	0.858	0.399
	Range	35 – 66	35 – 50		

There was insignificant difference between both groups regarding postoperative CMR after 6 months of the operation (Table 11).

Table (11): Postoperative CMR

Postoperative CMR 6month		Group I	Group II	Independent t-test	
		No.=16	No.=16	t	P-value
EDV(ml/m²)	Mean±SD	70.75±6.35	71.13±6.84	-0.161	0.873
	Range	60–82	60–81		
ESV (ml/m²)	Mean±SD	27.44±2.76	27.38±2.45	0.068	0.946
	Range	22–32	24–34		
SV (ml/m²)	Mean±SD	43.31±5.30	43.75±5.41	-0.231	0.819
	Range	33–51	34–52		
EF%	Mean±SD	61.09±3.60	61.38±2.78	-0.253	0.802
	Range	55–67.6	57–67		

Both groups postoperative stage, after valve replacement, there was in significant difference between echocardiography and CMR evaluation (Tables 12, 13).

Table (12): Comparing postoperative EF evaluation using both modalities. Comparison between EF (%) of Echo and CMR postoperative in group I

Post Operative (Group I)		Echo	CMR	Paired t-test	
				t	p-value
EF (%)	Mean±SD	59.29±6.25	61.09±3.60	1.095	0.291
	Range	50.1–72.2	55–67.6		

In Group II postoperative stage, after valve replacement, there was in significant difference between echocardiography and CMR evaluation (Table 13).

Table (13): Comparing postoperative EF evaluation in Group II Comparison between EF (%) of Echo and CMR post-operative in group II

Post Operative (Group II)		Echo	CMR	Paired t-test	
				t	p-value
EF (%)	Mean±SD	60.44±2.68	61.38±2.78	1.332	0.203
	Range	57–67	57–67		

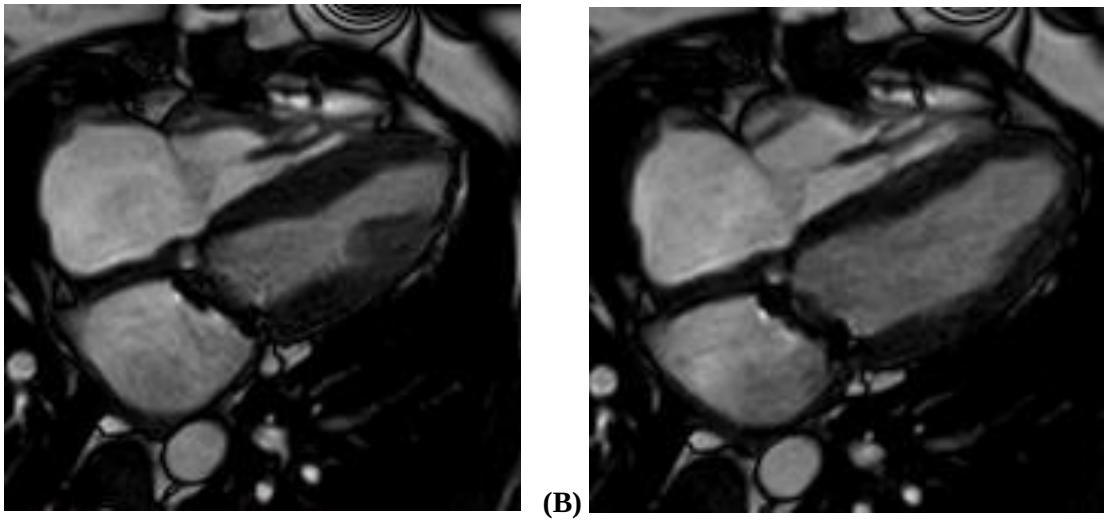

Figure (2): 4 chamber steady state free precession images for patient with mitral replacement with single leaflet preservation in end systolic (A) and end diastolic (B) phases showing improvement of the ventricular and atrial size after the operation.

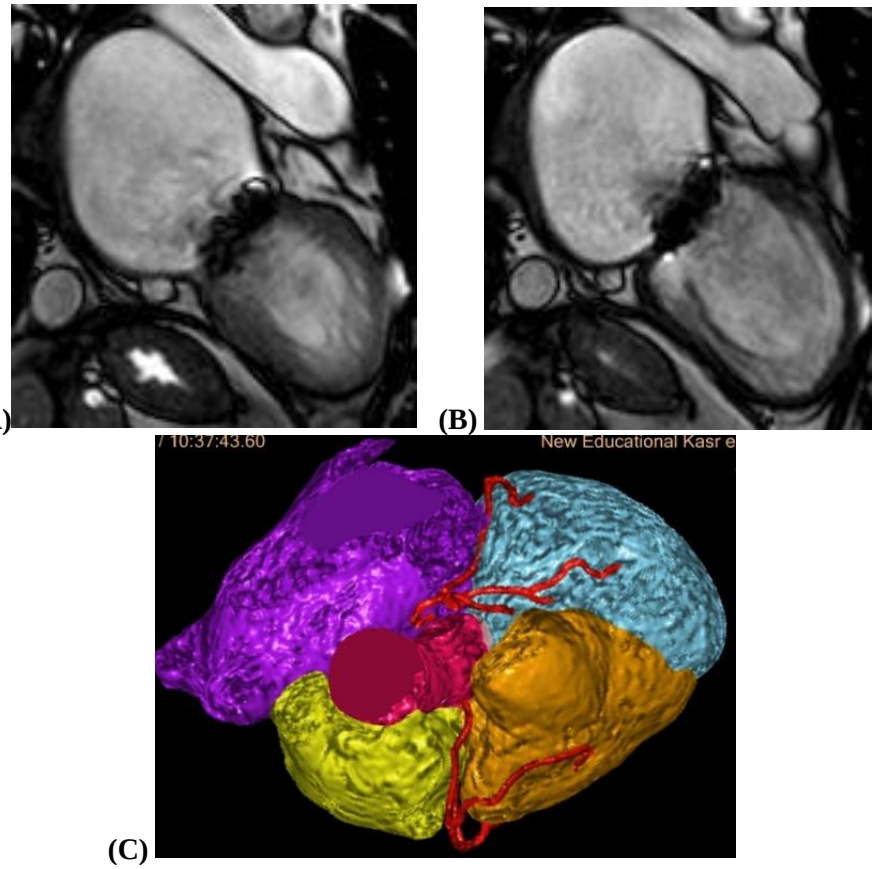

Figure (3): 2 chamber steady state free precession images for patient with mitral replacement with bileaflet preservation in end systolic (A) and end diastolic (B) phases showing dilated left atrium and left ventricle, image (C) shows 3 D reconstructions of the cardiac chambers and coronary arteries for the same patient.

DISCUSSION

Our study was conducted on 32 patients. They were randomized between both groups. Each group includes 16 patients, with total 11 male patients and 21 female patients with insignificant difference between both groups regarding gender distribution, where group I offered posterior preservation only and group II offered complete preservation.

We decided to include patients with predominate mitral regurgitation, as their ventricles supposed to be much more affected by the volume overload. And also, these ventricles are also debatable in the concern of left ventricular evaluation, and CMR will be of more value during the evaluation [8].

There were insignificant differences between both groups regarding preoperative data. The plan was to evaluate all patients using transthoracic echo and CMR preoperative and postoperative.

It was not a surprise to find a significant difference between preoperative evaluation data gathered from echocardiography and that from CMR, in spite it was not within the scope of our study to compare both techniques, this data was not to be neglected.

Unfortunately, specific techniques of evaluation were not available at the time of the study like sphericity, conicity indices and global longitudinal strain. This would add more value in the further analysis of left ventricular behavior after mitral valve replacement [9-10].

Operative technique in our study was not strict enough, because of different techniques used to preserve the anterior leaflet due to different intraoperative anatomical findings and also because patients were operated with different surgeons. This heterogenicity in the operative technique was a common observation in many studies as mentioned in meta-analysis of 1535 patient by **de Oliveira Sá *et al.*** [11] to overcome this observation we should do subgroup analysis of a very large group of patients where we can find a volume of patients in each technique large enough to do statistical analysis.

Postoperative evaluation demonstrated a significant improvement in left ventricular function and dimensions in both groups using echocardiography or CMR. But the study also failed to quantify significant superiority of either technique in our selected patient groups. This was consistent with many trails done before using echocardiography only.

This was comparable to what was reported by **Katewa *et al.*** [12]**,** in his report. He studied 40 patients with rheumatic mitral incompetence using Echocardiography only. Ashish report has the same limitation that we faced in our study as he didn't use the same technique during anterior leaflet preservation.

Another comparable result was reported by **Ozdemir *et al.*** [13]**,** where 70 patients studied using echocardiography. He used the same technique during anterior leaflet preservation with relatively larger sample size. His sample size distribution was also different in terms of predominance of degenerative mitral valve pathology in group one where only 2 out 16 patients was suffering rheumatic mitral valve disease, and in his second group rheumatic mitral valve disease was 16 out 54.

Another report by **Wang *et al.*** [14]**,** reported that the bi-leaflet preservation technique for MVR in patients with rheumatic mitral regurgitation and LVESD ≥50mm is superior to posterior leaflet only preservation technique. Complete preservation of mitral valve apparatus significantly prevents the postoperative decrease in LVEF, and improves LVESD, LVEDD, LA diameter, IVS-Thickness and severity of pulmonary artery hypertension. However, this report was also limited by the absence of intergroup similarity. There was a difference between the groups in terms of preoperative LVEF and LVESD. Additionally, though this is a randomized prospective study, the sample groups were small for long term follow up study. Moreover, **Wang** investigated the results of only one of the bi-leaflet preservation techniques. Different results might be obtained with the use of other preservation techniques [14].

A more recent report published in 2019, **Guo *et al.*** [15] reported the superiority of bileaflet preservation over posterior leaflet only, he used single technique during anterior mitral leaflet preservation, but this was a retrospective, non-randomized study with no multivariate analysis performed and failed to avoid heterogeneity between groups.

Regarding meta-analysis, there are inherent limitations with meta-analyses, including the use of cumulative data from summary estimates. Patient data were gathered from published data, not from individual patient follow-up. we would like to discuss two reports. The 1st one by **de Oliveira Sá *et al.*** [16]. In spite that he was studying preservation versus non preservation, the importance of that report was in term of highlighting the difficulty of studying mitral valve replacement techniques. Among the studies used in this meta-analysis, they identified 10 different techniques of bileaflet and/or posterior leaflet preservation used in 3835 cases. This aspect may influence the results.

The second meta-analysis report is that was published also by **Ghosh *et al.*** [17] about complete versus incomplete preservation of mitral valve in 1535 patients. They found evidence that argues against any superiority of complete preservation of the mitral valve apparatus during mitral valve replacement in comparison with posterior preservation only. In this report there were only two studies oriented with mitral regurgitation. Another limitation is the heterogeneity of the strategies across the studies. Among the studies used in this meta-analysis, they identified many different techniques of bi-leaflet and/or posterior leaflet preservation. This aspect may influence in the results.

Limitations: In our study, we tried to offer a new diagnostic modality that has a powerful validation in the evaluation of left ventricular function specially in the presence of mitral valve regurgitation and considered as the gold standard in LV function evaluation. This was not enough to get specific and reliable outcome. During our work and literature review, we found some limitations better to be avoided in next trials like: (1) Study was done on patients operated by different surgeons and different techniques of complete sub-valvular preservation. (2) The unavailability of more specific techniques such as longitudinal strain analysis of the ventricles. This may give much more accurate evaluation of left ventricular performance. (3) At the time of studying the patients there were limited number of centers and professionals who are qualified to offer CMR.

However, our study was targeting specific group of patients with predominant mitral incompetence, where the rule of conventional echocardiography is declining and new techniques together with CMR offers a better evaluation of left ventricular function.

CONCLUSION

1. CMR as an available investigation should be used in a larger scale specially in debatable cases regarding cardiac function and in tissue evaluation.
2. Mitral valve repair is the gold standard whenever possible during surgical management of mitral valve disease.
3. If mitral valve replacement is mandatory, every effort should be done to preserve annulo-papillary continuity, without affecting the left ventricular outflow tract. And conventional complete excision should be avoided.
4. Furthermore, prospective studies are needed, using as much specific data and as much advanced technique of evaluation the effect of different techniques on left ventricular performance.
5. Establishment of a detailed national registry will give a lot of data that when subjected to analysis would help in improving surgical practice and outcome.

RECOMMENDATIONS

Large-scale prospective randomized studies using more specific group selection criteria, more specific surgical techniques and more specific evaluation techniques are needed to assess the superiority of bi-leaflet preservation over posterior leaflet only. A well-organized national registry would be of great value in this concern and many others.

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Author contribution: Authors contributed equally in the study.

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