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Short Term Outcome & Surgical Risk of Patients Undergoing Mitral Valve Repair vs Replacement in Severe Ischemic Mitral Regurgitation

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ABSTRACT

Background: Although severe ischemic mitral regurgitation, commonly occurring after myocardial infarction and associated with high mortality, often necessitates surgical intervention, the short-term outcome and surgical risk of patients undergoing mitral valve repair versus replacement remain uncertain, warranting comparison during concomitant coronary artery bypass grafting to assess their impact on morbidity, neurological recovery, and survival.

This study aimed to compare early surgical outcomes of mitral valve repair versus replacement with concomitant coronary artery bypass grafting (CABG) and analyze the impact on morbidity, neurological recovery and short-term survival.

Subjects and methods: In the period between March 2023 and June 2024, 100 patients (77% males, 23% females) were conducted in this study. 37 males (74%) and 13 females (26%) in group A compared to 40 males (80%) and 10 (20%) females in group B. Mean age was 59.74 ± 11.04 in group A, while that in group B was 56.88 ± 9.84 years old. The patients included in this research were CABG patients having severe ischemic mitral regurgitation & underwent surgery for MV (repair or replacement) at Kasr Al-Ainy Hospital and other affiliated hospitals. Clinical and imaging data were prospectively evaluated. Patients were divided into 2 groups depending on the procedure, group A (the repair group) & group B (the replacement group).

Result: Postoperative residual MR occurred in 21% of patients, more frequently in group A (repair, 34%) than in group B (replacement, 8%) (P=0.001), making repair a predictor of postoperative MR. Patients with residual MR had more preoperative MV morphology abnormalities (P=0.015). Multivariable analysis confirmed preoperative MV abnormalities and repair technique as independent predictors (P=0.015, P=0.001). Intraoperative TEE showed more significant MR in group A (P=0.027). Subvalvular apparatus preservation had no statistical significance (P=1). Postoperative MR did not significantly affect EF, renal, or neurological outcomes (GCS: 13.68 ± 2.09 vs. 13.50 ± 2.64; P>0.05). Mitral valve replacement was linked to higher rates of postoperative AF (P=0.001) and increased in-hospital mortality (P=0.046).

Conclusion: Mitral valve replacement is a suitable option for patients with chronic ischemic mitral regurgitation and impaired left ventricular function (over mitral valve repair). It provides better results in terms of freedom from reoperation with comparable valve-related complication rates. Although postoperative residual MR was not associated with significant morbidity and postoperative complications, significant impairment in mid-term survival could not be confirmed by the data.

Keywords: *Ischemic mitral regurgitation, mitral repair, mitral valve replacement, coronary artery bypass grafting (CABG), ejection fraction, morbidity, mortality.*

1. INTRODUCTION

Although Functional ischemic mitral regurgitation (IMR) is common after myocardial infarction, occurring in up to 50% of patients with a doubling in mortality among patients with mild or greater degrees of mitral regurgitation after myocardial infarction and heart failure and this risk increases with the severity of regurgitation.**[1]**

Severe mitral regurgitation was defined as an effective regurgitant orifice area of 0.4 cm2 or more.**[2]**

Ischemic mitral regurgitation is a consequence of adverse left ventricular remodeling after myocardial injury with enlargement of the left ventricular chamber and mitral annulus, apical and lateral migration of the papillary muscles, leaflet tethering, and reduced closing forces.**[3]**

Ischemic mitral regurgitation is associated with a substantial risk of death. Practice guidelines recommend surgery for patients with a severe form of this condition but acknowledge that the supporting evidence for repair or replacement is limited.**[3]**

The optimal management of ischemic mitral regurgitation (IMR) is controversial. The aim of this study is to examine our experience of surgical treatment in patients with IMR, and to compare outcomes of mitral valve repair versus replacement with concomitant coronary artery bypass grafting (CABG).**[4]**

A better understanding of the best way to treat the mitral regurgitation accompanied with the ischemic heart disease is needed to combat those post-operative complications and find better ways to avoid them.

The aim of this study was to compare early surgical outcomes of mitral valve repair versus replacement with concomitant coronary artery bypass grafting (CABG) and analyze the impact on morbidity, neurological recovery and short-term survival.

2. PATIENTS AND METHODS

1. Study Design:

Randomized prospective observational comparative study. Participants were randomly assigned following simple randomization procedures (computerized random numbers) to 1 of 2 treatment groups.

2. Population of Study:

The study includes 100 adult CABG patients having severe ischemic mitral regurgitation underwent surgery for MV (repair or replacement) in Kasr Al-Ainy and other affiliated hospitals in the period between March 2023 and June 2024.

3. Study Location:

Department 24, Cardio-Thoracic Surgery at Kasr Al-Ainy Hospital, Faculty of Medicine, Cairo University.

4. Inclusion Criteria:

CABG Patients with chronic severe IMR.

5. Exclusion Criteria:

1. Combined procedure e.g. other valves pathologies & aorta surgeries.
2. Re-do case.
3. Patients with chronic mild & moderate ischemic mitral regurgitation.
4. Acute ischemic mitral regurgitation.
5. Non-ischemic mitral regurgitation.

6. Primary Outcome:

The primary end-point of this study is the assessment of early surgical risk & haemodynamic stability for the 2 groups.

7. Secondary Outcome:

The secondary end-point is postoperative mortality, morbidity regarding ECHO findings such as regurgitation or paravalvular leak, neurological impairment during follow-up, complications such as renal insufficiency, tracheostomy, failure of weaning from ventilator and re-exploration due to bleeding or revision of MV or grafts.

8. Sample Size:

100 patients with chronic severe ischemic mitral regurgitation and ischemic heart disease undergoing surgery. Sample size will be calculated according to the following formula: Based on evidence from previous similar study and by considering the overall early survival rate after mitral valve repair versus replacement in patients with ischemic mitral regurgitation as a primary outcome. Epi-calc 2000 was used to calculate the sample size of this case control comparative study. Assuming 100% power, less than 0.05 level of significance, 100% proportion of cases exposed, to detect odds ratio OR=8 and with ratio of cases to controls =1. Sample size will be =100 participants (50 in each group). Considering drop-outs rate of 0%, therefore the final sample size will be 100 participants (50 in each group).

3. METHODOLOGY

A total of 100 patients were operated on in Kasr Al-Ainy and were followed up for one week postoperatively. The follow-up was conducted in the following manner:

- **Approach to the Patient Prior to Surgery (Preoperative Assessment and Data):**

History Taking:

A thorough and detailed history was taken regarding sociodemographic data such as age, sex, residency, and body surface area (BSA), along with the presence of risk factors such as diabetes mellitus (DM), hypertension (HTN), and previous myocardial infarction (MI).

Physical Examination:

Vital signs including blood pressure, pulse, and respiratory rate were measured to detect the general state of the patient and the presence of shock. Blood pressure was assessed separately. Dyspnea was assessed and graded. Cardiac auscultation was performed to detect the presence and severity of mitral regurgitation and other valvular pathologies. Chest auscultation was conducted to evaluate basal crepitations. A full neurological examination was done to assess consciousness using the Glasgow Coma Scale (GCS), motor weakness, sensory loss, and cranial nerve lesions. Urine output was monitored continuously.

Laboratory Investigations:

Complete blood count (CBC) was performed. Liver function tests including total and direct bilirubin, liver enzymes (AST and ALT), serum albumin, and prothrombin time and concentration were assessed. Kidney function tests including serum urea and creatinine were performed, as high kidney function may indicate involvement of renal arteries and may limit the use of intravenous contrast. Coagulation profile, serum electrolytes, fasting blood sugar, serum triglycerides, and arterial blood gases (ABG) were also evaluated.

Imaging:

Carotid duplex (bilateral) and lower limb arterial and venous duplex (bilateral) examinations were performed. A plain chest X-ray in a postero-anterior view and erect position was obtained to evaluate the cardiothoracic ratio, lung congestion, and pleural collection. CT chest imaging was performed as needed. Cardiac catheterization was conducted to assess coronary anatomy. Echocardiography was performed to assess cardiac contractility, mitral regurgitation and its severity, other valvular pathologies, cardiac dimensions, resting wall motion abnormalities, and estimated pulmonary artery systolic pressure (ePASP). An ECG was done to evaluate arrhythmias and ischemic changes.

Preoperative Counseling:

Prior to surgery, a brief explanation of the operative steps, expected postoperative events, and intensive care unit (ICU) stay was discussed with the patient.

Preoperative Preparation:

Upon arrival in the preparation room, a 14-gauge peripheral venous cannula was inserted under local anesthesia. Sedation was optimized using midazolam at a dose of 0.03–0.07 mg/kg. A 20-gauge non-dominant radial artery cannula was inserted under local anesthesia. Two blood samples were withdrawn from the arterial line: the first for preoperative baseline activated clotting time (ACT) and the second for baseline arterial blood gas (ABG) analysis. Monitoring was initiated preoperatively using five-lead ECG, direct arterial blood pressure, and pulse oximetry.

Intraoperative Procedures

- **Anesthetic Technique:**

All patients were managed with a standardized anesthetic protocol. Induction was achieved with fentanyl at a dose of 5–10 µg/kg, and tracheal intubation was facilitated using pancuronium at 0.02 mg/kg. Additional fentanyl doses of 100–200 µg were administered as needed to maintain analgesia. After achieving full muscle relaxation, the trachea was intubated orally with an appropriate-sized single-lumen endotracheal tube. Anesthesia was maintained using inhaled isoflurane at a concentration of 0.5–1%. Following induction, a triple-lumen central venous catheter was inserted into either the right or left internal jugular vein for central monitoring.

Additional monitoring devices included a radial arterial cannula for invasive blood pressure monitoring, a urinary catheter for urine output measurement, and a nasopharyngeal temperature probe for temperature regulation. Continuous intraoperative monitoring included five-lead ECG, arterial pressure tracing, and transesophageal echocardiography (TEE), which was performed routinely by an anesthesiologist to guide cardiac function assessment and valve evaluation.

- **Surgical Technique:**

All patients underwent combined coronary artery bypass grafting (CABG) with either mitral valve repair or replacement via a standard median sternotomy. After hemostasis of the sternum and incision of the pericardium, the left internal mammary artery (LIMA) was harvested, and saphenous vein grafts were obtained when required. Central arterial cannulation of the ascending aorta was performed using a purse-string suture technique, and bicaval venous cannulation was achieved either

directly through the superior and inferior vena cava or indirectly via the right atrium. A left ventricular vent was placed via the right superior pulmonary vein to facilitate decompression. Cardiopulmonary bypass (CPB) was initiated, and systemic cooling to 28–32°C was employed. Myocardial protection was provided using antegrade cold blood cardioplegia delivered after aortic cross-clamping, with an initial dose of 15 ml/kg, supplemented every 20–30 minutes during the cross-clamp period. In selected cases, topical ice slush was applied for additional myocardial protection.

Distal coronary anastomoses were performed first with 7-0 polypropylene sutures, typically in the sequence of the right coronary system, followed by lateral coronaries (obtuse marginal and diagonal branches), and finally, the LIMA-to-LAD anastomosis was completed after the mitral valve procedure.

❖ **Mitral Valve Procedures:**

The left atrium was approached through an incision parallel to the interatrial groove or via a transseptal approach when necessary. Systematic evaluation of the mitral valve was performed to assess annular dilatation, leaflet motion, chordal integrity, and papillary muscle status.

- **Mitral Valve Repair:** Annuloplasty was performed by downsizing the annulus, typically using a Carpentier ring two sizes smaller than the annulus (most commonly size 28). The adequacy of repair was confirmed using the saline injection test.
- **Mitral Valve Replacement:** Replacement was undertaken when a competent repair was deemed unachievable. Mechanical prostheses were used in all cases, with annular sizing typically at 29 mm. Valve implantation was performed using 2-0 pledgeted, everting Ethibond sutures passed from the atrial to the ventricular side and then through the sewing ring of the prosthesis. Preservation of the subvalvular apparatus was prioritized whenever feasible to maintain ventricular geometry. The left atrium and septum were closed with 3-0 polypropylene sutures.

Following the valve procedure, the LIMA-to-LAD anastomosis was performed using 7-0 or 8-0 polypropylene sutures during rewarming and de-airing. Before aortic unclamping, de-airing was completed with manual lung inflation, and prophylactic administration of 100 mg lidocaine and 2 g magnesium was given. Proximal anastomoses were constructed using a side-biting clamp on the aorta with 6-0 polypropylene sutures.

Gradual weaning from CPB was carried out with stepwise reduction in pump flow while monitoring systemic blood pressure, central venous pressure, pulmonary artery pressure, and cardiac rhythm in coordination with the anesthesiology team. Inotropic support was introduced when indicated, and an intra-aortic balloon pump (IABP) was inserted selectively. TEE was used to assess the adequacy of mitral valve repair or prosthetic function, checking for residual regurgitation, pressure gradients, and coaptation depth (acceptable coaptation depth >8 mm). Revisions were performed if moderate or severe residual MR was detected.

Heparin was reversed using protamine sulfate to normalize ACT. Aortic and venous cannulae were removed, surgical sites inspected for hemostasis, and mediastinal and pleural drainage tubes were inserted. Temporary pacing wires were positioned. The sternum was closed using six to nine stainless steel wires, and layered closure of fascia, subcutaneous tissue, and skin was performed.

Postoperative Evaluation

Patients were transferred to the ICU for comprehensive monitoring. Mechanical ventilation was continued postoperatively and weaned gradually using CPAP and pressure support modes, reducing support in 1–2 cmH_2O increments. Extubation was considered once patients achieved full consciousness, adequate respiratory effort, stable hemodynamics, good ABG parameters, minimal chest drainage, FiO_2 ≤40%, and minimal or no inotropic support.

❖ **Hemodynamic and Rhythm Monitoring:**

Continuous arterial blood pressure and heart rate monitoring were maintained. ECG was repeated routinely and on demand to detect arrhythmias or ischemia.

❖ **Postoperative Parameters and Complications:**

Chest tube output was recorded, and blood transfusions were administered to maintain hematocrit ≥25–30%. Neurological status was assessed regularly with the Glasgow Coma Scale (GCS), and brain CT was obtained for patients with delayed recovery (>48 hours). Laboratory assessments included daily CBC, liver and kidney function tests, and coagulation profiles.

❖ **Imaging and Functional Assessment:**

Transthoracic echocardiography was performed on day 7 to evaluate mitral valve competence or prosthetic function, ventricular contractility, and detect pericardial collections.

❖ **Outcome Measures:**

The duration of ICU stay, total hospital stay, and incidence of in-hospital mortality were documented, along with

complications such as renal insufficiency, arrhythmias, re-exploration for bleeding, and neurological events.

Statistical Analysis

Statistical method: Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using unpaired t test in normally distributed quantitative variables while non-parametric Mann-Whitney test was used for non-normally distributed quantitative variables. For comparing categorical data, Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5. P-values less than 0.05 were considered as statistically significant.

4. RESULTS

Preoperative Data

1. Sociodemographic Data:

The mean age was 59.74 ± 11.04 years in the repair group and 56.88 ± 9.84 years in the replacement group, with no statistical significance (P = 0.175) as shown in **Table 1**; sex distribution showed 77 males and 23 females overall (74% vs. 80% males, P = 0.476) as shown in **Table 1**, and the mean body surface area was 1.93 ± 0.26 m² in the repair group versus 1.90 ± 0.17 m² in the replacement group (P = 0.522) as shown in **Table 1**.

2. Clinical Data:

Diabetes mellitus was present in 50 patients (50%), with 23 patients (46%) in group A and 27 patients (54%) in group B (P = 0.424), while hypertension was reported in 46 patients (46% in group A vs. 54% in group B, P = 0.229), and dyspnea in 78 patients (76% vs. 80%, P = 0.629); angina pectoris occurred in 84 patients (90% in group A vs. 78% in group B, P = 0.102), and all patients (100%) were fully conscious (**Table 1**). The mean systolic blood pressure was 124.40 ± 16.68 mmHg in group A and 127.20 ± 16.42 mmHg in group B (P = 0.400), while the mean diastolic pressure was 74.20 ± 13.11 mmHg versus 76.30 ± 9.30 mmHg (P = 0.358), and the mean pulse rate was 82.46 ± 12.85 bpm versus 84.46 ± 11.64 bpm (P = 0.417); all hypertensive patients were on antihypertensive medications (**Table 1**). Rhythm disturbances (AF) were observed in 3 patients (6%) in group A and 1 patient (2%) in group B (P = 0.617), while ECG ischemic changes were present in 77 patients (80% in group A vs. 74% in group B, P = 0.476) (**Table 1**).

Table 1: Showing the sociodemographic & clinical variables in both groups

	Repair (n=50)			Replacement (n=50)		P value
	Mean	SD		Mean	SD	
Age (years)	59.74	11.04		56.88	9.84	0.175
BSA (m2)	1.93	0.26		1.90	0.17	0.522
SBP	124.40	16.68		127.20	16.42	0.400
DBP	74.20	13.11		76.30	9.30	0.358
Pulse	82.46	12.85		84.46	11.64	0.417
	Repair			**Replacement**		
	Count		**%**	**Count**	**%**	
Sex	**M**	37	74.0%	40	80.0%	0.476
	F	13	26.0%	10	20.0%	
DM	**Yes**	23	46.0%	27	54.0%	0.424
	No	27	54.0%	23	46.0%	
HTN	**Yes**	20	40.0%	26	52.0%	0.229
	No	30	60.0%	24	48.0%	

Rhythm disturbance (preoperative)	**Yes**	3	6.0%	1	2.0%	0.617
	No	47	94.0%	49	98.0%	
Dyspnea	**Yes**	38	76.0%	40	80.0%	0.629
	No	12	24.0%	10	20.0%	
Angina	**Yes**	45	90.0%	39	78.0%	0.102
	No	5	10.0%	11	22.0%	
Consciousness	**Yes**	50	100.0%	50	100.0%	------
ECG ischemic changes	**Yes**	40	80.0%	37	74.0%	0.476
	No	10	20.0%	13	26.0%	

3. Echocardiographic Findings

Regarding mitral valve (MV) morphology, 29 patients (29%) showed normal morphology: 20 patients (40%) in group A and 9 patients (18%) in group B. Conversely, 71 patients (71%) exhibited abnormal morphology (including features such as tethering, increased tenting depth, and anterior leaflet angle): 30 patients (60%) in group A and 41 patients (82%) in group B. This difference was statistically significant (P = 0.015) as shown in **Table 2** and illustrated in **Figure 1**.

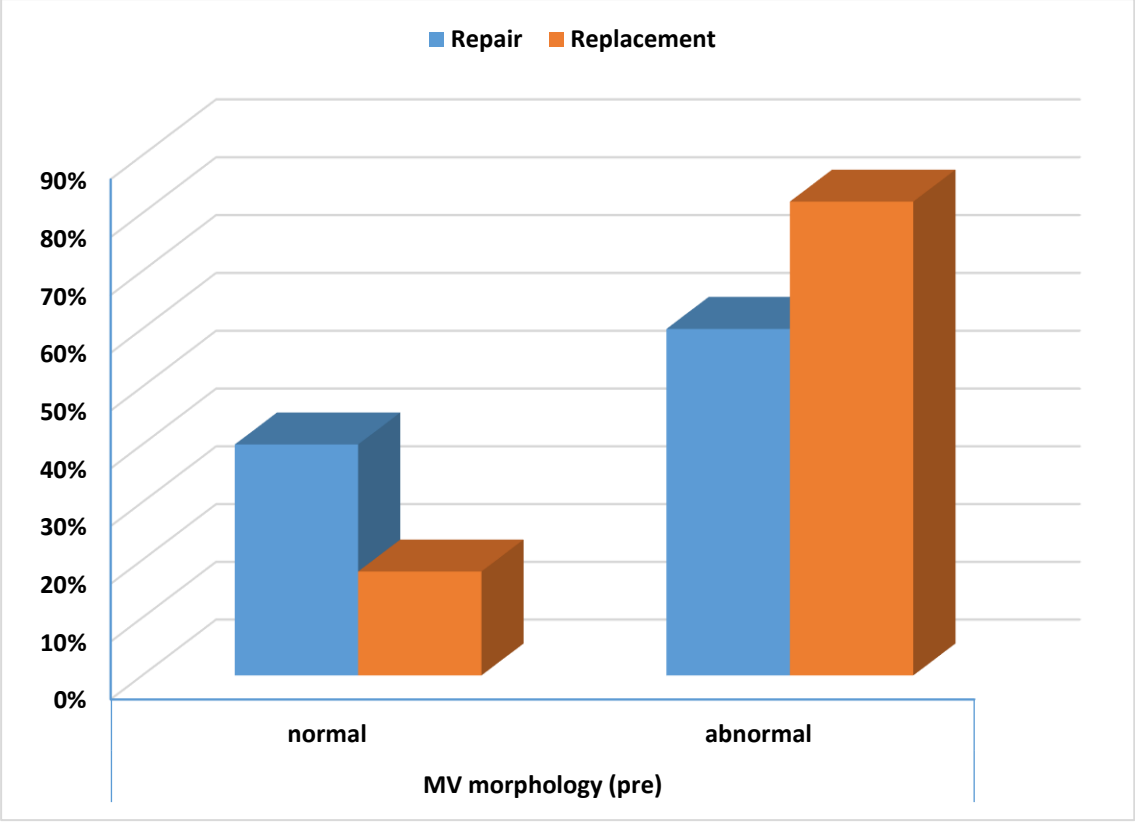

Fig. 1: Showing the difference between both groups concerning MV morphology preoperatively

All patients (100%) in both groups had severe mitral regurgitation (**Table 2**). The mean preoperative ejection fraction (EF) was 45.10 ± 11.69% in group A and 47.12 ± 9.80% in group B, with no statistical significance (P = 0.351), while the mean estimated pulmonary artery systolic pressure (ePASP) was significantly higher in group B (35.00 ± 12.57) compared to group A (29.50 ± 7.78) (P = 0.010), with all symptomatic patients controlled by medications (**Table 2**, **Figure 2**).

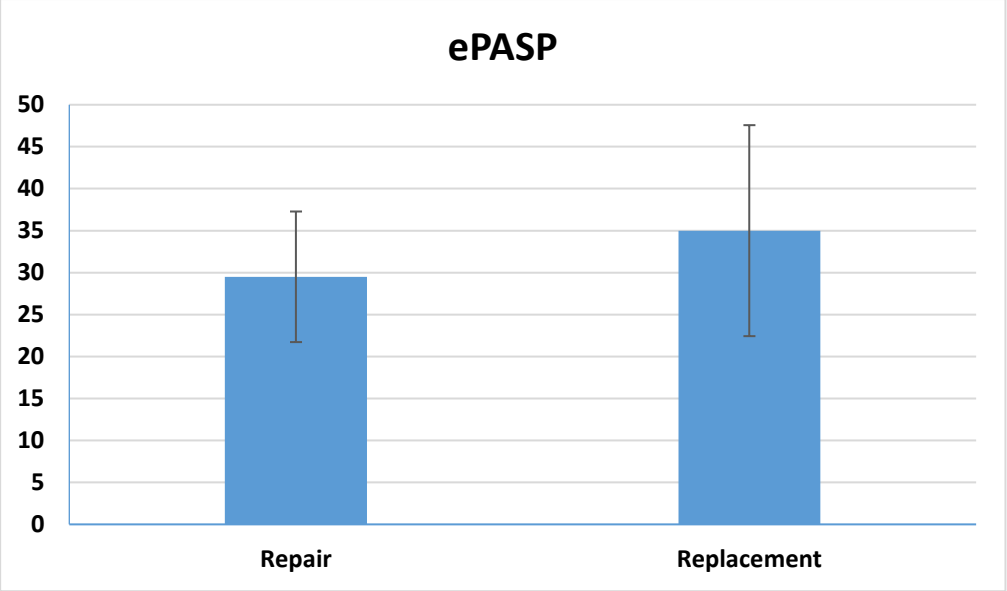

Fig. 2: Showing the difference between both groups concerning ePASP preoperatively

As regard the LA dimensions (pre-operatively) in cm, out of the total 100 patients, patients of group A showed mean value of 4.63 ± 0.73 while patients of group B showed mean value of 4.69 ± 70. (P=0.675) as shown in **(Table 2)**

Table 2: Showing the echocardiographic data preoperatively in both groups

		Repair (n=50)		Replacement (n=50)		P value
		Count	%	Count	%	
MV morphology (pre)	normal	20	40.0%	9	18.0%	0.015
	abnormal	30	60.0%	41	82.0%	
MR degree (pre)	severe	50	100.0%	50	100.0%	------
	Repair			Replacement		
	Mean		SD	Mean	SD	
EF % (pre)	45.10		11.69	47.12	9.80	0.351
ePASP (pre)	29.50		7.78	35.00	12.57	0.010
LA dimensions (pre) (cm)	4.63		0.73	4.69	0.70	0.675

4. Operative Data:

As regard the mitral valve attack, among 100 patients, 45 patients in group A underwent mitral valve repair using a rigid, complete ring (down-sized by 2 measurements, most frequently size 28), and 5 patients had posterior annuloplasty with a band, while all patients in group B underwent mitral valve replacement with a mechanical prosthesis (most commonly size 29). The mean number of grafts was significantly higher in the repair group (2.40 ± 0.83) compared to the replacement group (1.96 ± 0.88) (P = 0.012), favoring the repair group (**Table 3**, **Figure 3**).

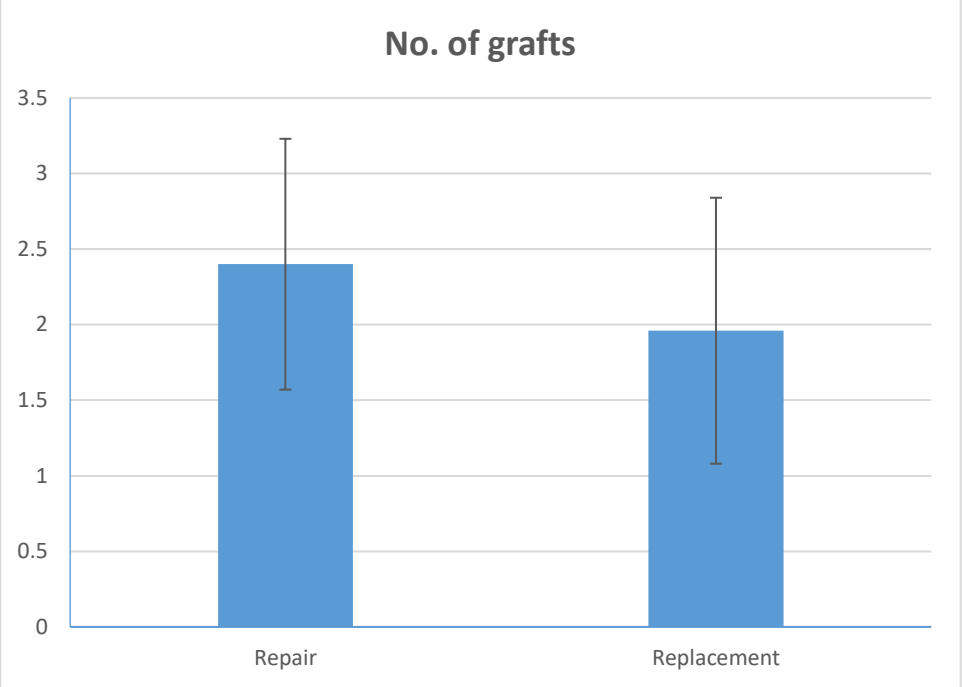

Fig. 3: Showing the difference in No. of grafts in both groups

As regard the CPB time in mins, out of the total 100 patients, patients of group A showed mean value of 141.40 ± 31.15 while patients of group B showed mean value of 173.74 ± 32.08 with statistical significance. (P < 0.001) as shown in **(Table. 3) (Fig. 4)**

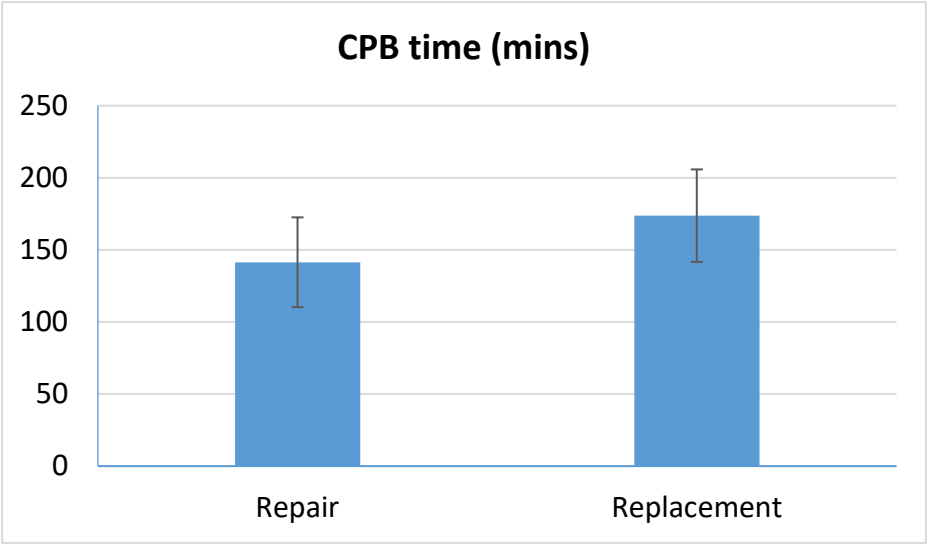

Fig. 4: Showing the difference in CPB time (mins) in both groups

As regard the cross clamp time in mins, out of the total 100 patients, patients of group A showed mean value of 104.72 ± 24.51 while patients of group B showed mean value of 134.38 ± 24.92 with statistical significance. (P < 0.001) as shown in **(Table. 3) (Fig. 5)**

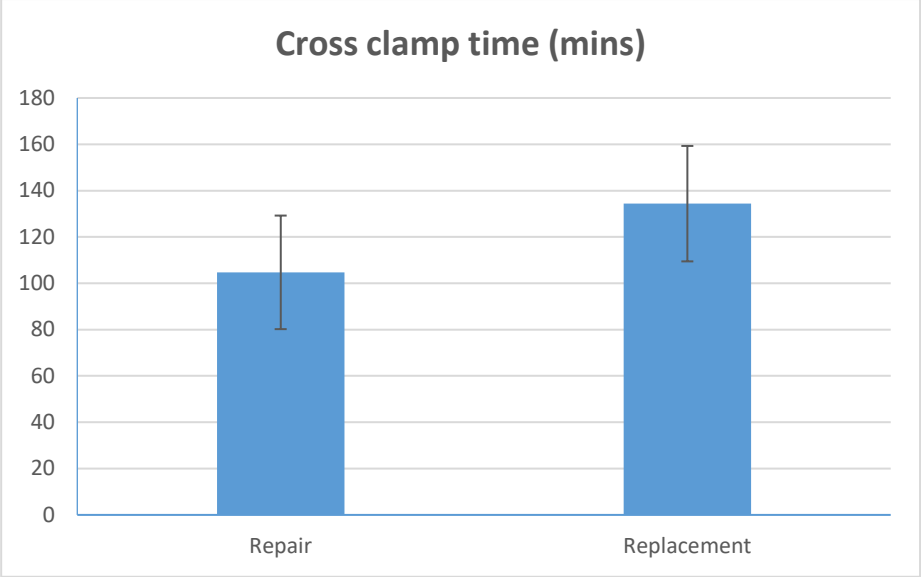

Fig. 5: Showing the difference in cross clamp time (mins) in both groups

The surgical approach was inter-atrial in 87 patients (86% in group A vs. 88% in group B) and trans-septal in 13 patients (14% vs. 12%), with no statistical significance (P = 0.766) **(Table 3).**

Preservation of the subvalvular apparatus (posterior leaflet) was achieved in 91 patients (91%), including 46 patients (92%) in group A and 45 patients (90%) in group B, with partial preservation in 4 cases of group A and removal in 5 cases of group B due to prosthetic obstruction, without statistical significance (P = 1) **(Table 3).**

Smooth weaning from bypass occurred in 47 patients (47%), including 26 patients (52%) in group A and 21 patients (42%) in group B, with no statistical significance (P = 0.316) **(Table 3).**

Two patients (both in group B) were transferred to the ICU without inotropic support, 58 patients (58%) were transferred with single support (30 patients [60%] in group A and 28 patients [56%] in group B), 37 patients (37%) were transferred with double supports (20 patients [40%] in group A and 17 patients [34%] in group B), and 3 patients (3%, all in group B) were transferred with triple supports, with adrenaline being the most frequently used drug, and no statistical significance (P = 0.173) **(Table 3).**

Intra-aortic balloon (IAB) was used in 21 patients (21%), including 12 patients (24%) in group A and 9 patients (18%) in group B, with no statistical significance (P = 0.461) **(Table 3).**

Intra-operative TEE revealed significant MR in 6 patients (12%) of group A, who underwent revision of repair with a smaller ring, while all group B patients had well-seated and well-functioning prostheses without paravalvular leak, with statistical significance (P = 0.027) **(Table 3, Figure 6).**

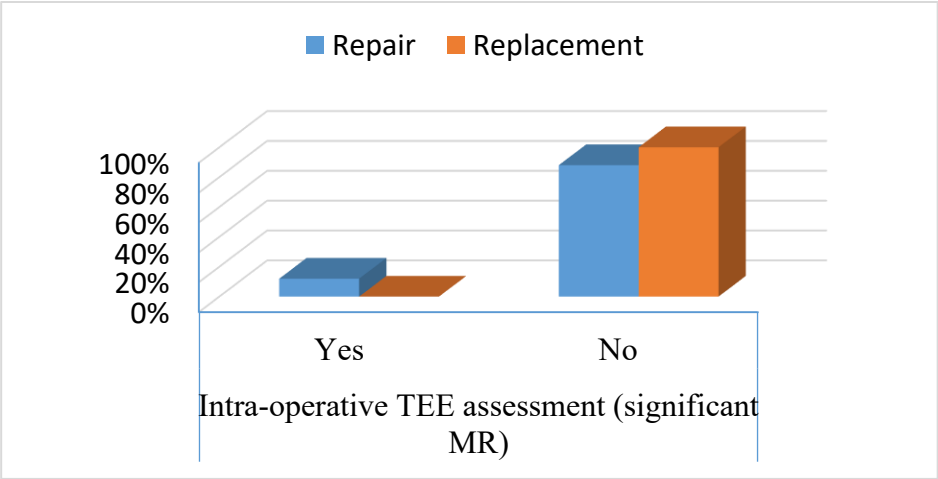

Fig. 6: Showing the difference in intra-operative TEE assessment (significant MR) in both groups

Table 3: Showing the operative data in both groups

		Repair (n=50)		Replacement (n=50)		P value
		Count	%	Count	%	
Surgical approach	**trans-septal**	7	14.0%	6	12.0%	0.766
	inter-atrial	43	86.0%	44	88.0%	
Preservation of subvalvular apparatus (posterior mitral leaflet)	**Yes**	46	92.0%	45	90.0%	1
	No	4	8.0%	5	10.0%	
Weaning off bypass	**smooth**	26	52.0%	21	42.0%	0.316
	difficult	24	48.0%	29	58.0%	
IAB	**Yes**	12	24.0%	9	18.0%	0.461
	No	38	76.0%	41	82.0%	
Intra-operative inotropic supports number	**no**	0	0.0%	2	4.0%	0.173
	single	30	60.0%	28	56.0%	
	double	20	40.0%	17	34.0%	
	triple	0	0.0%	3	6.0%	
Intra-operative TEE assessment (significant MR)	**Yes**	6	12.0%	0	0.0%	0.027
	No	44	88.0%	50	100.0%	
	Repair			**Replacement**		
	Mean	**SD**		**Mean**	**SD**	
No. of grafts	2.40	0.83		1.96	0.88	0.012
CPB time (mins)	141.40	31.15		173.74	32.08	< 0.001
Cross clamp time (mins)	104.72	24.51		134.38	24.92	< 0.001

5. Postoperative Results:

There is no correlation between haemodynamic stability and the type of MV surgery; out of the total 100 patients, 75 patients (75%) were vitally stable, 39 patients (78%) were in group A and 36 patients (72%) were in group B, with no statistical significance (P = 0.488) as shown in (**Table 4**).

As regard MR, out of the total 100 patients, 21 patients (21%) had mild to moderate MR; 17 patients (34%) were in group A and 4 patients (8%) were in group B (due to malfunctioning MV), which was statistically significant (P = 0.001) as shown in (**Table 4**, **Figure 7**).

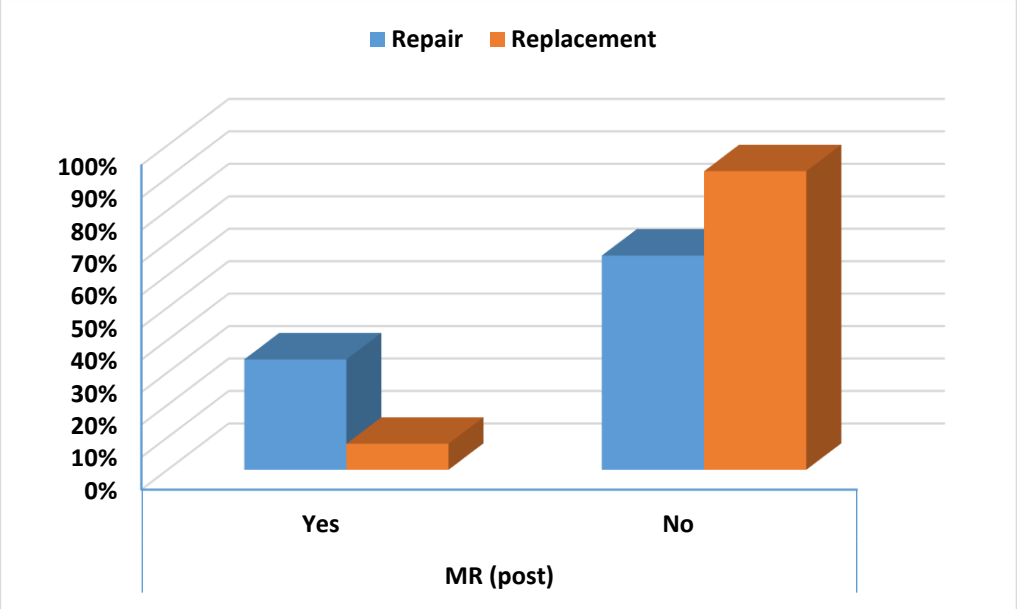

Fig. 7: Showing the difference in MR (post) in both groups

Table 4: Showing the postoperative results in both groups

		Repair (n=50)		Replacement (n=50)		P value
		Count	%	Count	%	
Haemodynamic stability	Yes	39	78.0%	36	72.0%	0.488
	No	11	22.0%	14	28.0%	
MR (postoperative)	Yes	17	34.0%	4	8.0%	0.001
	No	33	66.0%	46	92.0%	
Rhythm disturbance	Yes	9	18.0%	12	24.0%	0.461
	No	41	82.0%	38	76.0%	
Renal functions (postoperative)	normal	43	86.0%	40	80.0%	0.424
	compromised	7	14.0%	10	20.0%	
Mortality	Yes	2	4.0%	8	16.0%	0.046
	No	48	96.0%	42	84.0%	
EF (postoperative)	improved	15	30.0%	17	34.0%	0.896
	the same	7	14.0%	6	12.0%	
	deteriorated	28	56.0%	27	54.0%	
	Repair			Replacement		
	Mean	SD		Mean	SD	
Time for extubation (hrs)	19.69	20.82		25.00	27.88	0.747
Neurological status (GCS (postoperative))	13.68	2.09		13.50	2.64	0.706

The relationship between DM and the number of grafts was as follows: patients who were diabetic had a mean number of grafts of 2.27 ± 0.87, while non-diabetic patients had a mean number of grafts of 2.12 ± 0.90, with no statistical significance (P = 0.498) as shown in (**Table 5**).

Table 5: Describing the relationship between DM and No. of grafts in all patients

	DM				
	Yes		No		P value
	Mean	Standard Deviation	Mean	Standard Deviation	
No. of grafts	2.24	0.87	2.12	0.90	0.498

The relationship between preservation of the subvalvular apparatus (posterior mitral leaflet) and rhythm disturbance postoperatively did not reach statistical significance; however, a large number of patients who had their subvalvular apparatus preserved did not show postoperative arrhythmias (P = 0.680) as shown in (**Table 6**).

Table 6: Describing the relationship between preservation of subvalvular apparatus (posterior mitral leaflet) and occurrence of rhythm disturbance postoperatively in all patients

		Preservation of subvalvular apparatus (posterior mitral leaflet)				
		Yes		No		P value
		Count	%	Count	%	
Rhythm disturbance (postoperative)	**Yes**	20	22.0%	1	11.1%	0.680
	No	71	78.0%	8	88.9%	

The relationship between No. of grafts & residual MR (post-operative) was not statistically clear with the No. of grafts had mean value of 2.33 ± 0.86 in the patients who had residual MR postopertaively while it was 2.14 ± 0.89 in the patients who did not have residual MR with no statistical significance. (P= 0.372) as shown in **(Table. 7)**

Table 7: Describing the relationship between No. of grafts and occurrence of MR postoperatively in all patients

	MR (post)				
	Yes		No		P value
	Mean	Standard Deviation	Mean	Standard Deviation	
No. of grafts	2.33	0.86	2.14	0.89	0.372

The relationship between preservation of subvalvular apparatus (posterior mitral leaflet) & residual MR (post-operative) was not obvious and did not match the statistical significance yet a large number of patients who had their subvalvular apparatus (posterior mitral leaflet) preserved did not show postoperative arrhythmias. (P= 0.680) as shown in **(Table. 8)**

Table 8: Describing the relationship between preservation of subvalvular apparatus (posterior mitral leaflet) and occurrence of MR postoperatively in both groups

		Preservation of subvalvular apparatus (posterior mitral leaflet)				
		Yes		No		P value
		Count	%	Count	%	
MR (postoperative)	**Yes**	20	22.0%	1	11.1%	0.680
	No	71	78.0%	8	88.9%	

As regard the relationship between preservation of subvalvular apparatus & EF (post-operative), we found no statistically significant relationship in all patients. (P= 0.546) LVEF was higher in patients with total mitral apparatus preservation than in patients with no leaflet preservation, although the difference did not reach statistical significance as shown in (**Table. 9)**

Table 9: Describing the relationship between preservation of subvalvular apparatus (posterior mitral leaflet) and EF postoperatively in both groups

	Preservation of subvalvular apparatus (posterior mitral leaflet)				
	Yes		**No**		**P value**
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
EF % (postoperative)	43.82	9.43	41.78	12.04	0.546

5. DISCUSSION

Nowadays, performing mitral valve surgery for patients with severe (3+ or 4+) ischemic mitral regurgitation (IMR) during coronary artery bypass grafting (CABG) has become a widely accepted practice **[5].**

According to the **AHA 2020 guidelines**, chordal-sparing mitral valve replacement (MVR) is recommended over repair in patients with impaired left ventricular (LV) function due to three main reasons: high recurrence rate of MR after repair, better durability of replacement, and strong evidence support from trials and registry data. The CTSN trial, for example, demonstrated that patients undergoing repair experienced more frequent recurrence of MR and higher rates of reoperation compared to those who had chordal-sparing MVR **[6].**

Identifying the risk factors and predictors for postoperative residual MR remains crucial to improving outcomes and preventing persistent LV remodeling. The present study aimed to evaluate the surgical techniques currently employed to address this complex pathology. We included 100 patients with ischemic heart disease and severe ischemic MR between March 2023 and June 2024. The mean age was 58.31 ± 10.50 years. Patients were divided into two groups:

- Group A (n=50): CABG with mitral valve repair (MVP).
- Group B (n=50): CABG with mitral valve replacement (MVR).

Both groups were similar preoperatively, with no significant differences in demographics, risk factors, or clinical status, aligning with observations in other studies **[7].**

A) Pre-operative Data

The mean age was 59.74 ± 11.04 years in Group A and 56.88 ± 9.84 years in Group B, with 77 males (77%) overall. These findings were consistent with **Maltais et al.**, who reported a mean age of 70.1 ± 9.1 years and male predominance (67%) among patients undergoing CABG with concomitant MV surgery. In their cohort, 78% underwent MVP and 22% MVR The slightly older age in their study may reflect longer life expectancy in developed countries **[8].**

Regarding risk factors, diabetes mellitus (DM) was present in 50% of our cohort (23 patients in Group A and 27 in Group B). In comparison, **Maltais et al.** reported DM in 34.4% of repair patients and 25.9% of replacement patients **[8].**

This discrepancy may relate to regional differences in lifestyle and metabolic risk factors. Preoperative rhythm showed no significant difference between groups in our study (6% AF in Group A vs. 2% in Group B), similar to findings by **Lorusso et al.** and **Magne et al.**, who reported AF prevalence of 10.8% and 13.3% in repair and replacement groups, respectively **[9].**

Dyspnea was prevalent in both groups (76% in Group A and 80% in Group B), comparable to **Lam et al.**, who noted 60% of patients were NYHA Class III [66], and **Tolis et al.**, who observed 75% in NYHA II–III **[10].**

The mean ejection fraction (EF) was 45.10% in Group A and 47.12% in Group B, similar to **Chan et al.**, who reported 40.5% in repair and 42.4% in replacement patients **[11].**

B) Operative Data

Surgical approach was primarily via median sternotomy, using intermittent antegrade cold blood cardioplegia for myocardial protection. Distal anastomoses were completed first, followed by left atrial access for MV exposure in most cases due to LA dilation in MR. Proximal anastomoses were performed after cross-clamp release. These protocols are widely practiced and consistent with published literature Variations in operative techniques may reflect differences in surgeons' experience and patients' anatomical characteristics **[12].**

Among our patients, MVP was performed in 50 cases using rigid, complete Carpentier–Edwards annuloplasty rings, typically downsized by two sizes (commonly size 28). Five patients underwent posterior annuloplasty with a band. The remaining 50

patients had MVR, most frequently with a size 29 mechanical prosthesis. **Nantsios et al.** reported higher mortality risk with mitral valve replacement (HR 1.87) and restrictive annuloplasty (HR 2.73) compared with mild undersizing annuloplasty. Similarly, **Gillinov et al.** documented a 98% use of annuloplasty rings, with 79% being ≤30 mm in their Cleveland Clinic series **[13].**

The Leiden group emphasized systematic downsizing using semirigid Carpentier–Edwards rings, reporting sustained LV reverse remodeling and no residual MR immediately post-surgery **[14].**

Although randomized trials comparing rigid versus flexible rings are lacking, evidence favors rigid or semirigid complete rings due to lower recurrence and minimal mitral stenosis risk **[15].**

Subvalvular apparatus preservation was achieved in 91% of our patients, primarily preserving the posterior leaflet. Complete preservation was avoided in cases where prosthesis function was at risk. Literature strongly supports chordal-sparing MVR for maintaining LV function. **Qiu et al.** reported 88.7% posterior leaflet preservation and 11.3% bileaflet preservation in their series **[16].**

Another technique, **Chan et al.,** described but we didn't imply in our study to preserve the AML as his study compared 65 patients who underwent mitral valve replacement for IMR between 2001 and 2010 with 65 patients who underwent mitral repair during the same period on the basis of age, concomitant coronary bypass grafting, gender, left ventricular function, preoperative pulmonary hypertension, and urgency of operation. Mitral replacement involved preservation of the subvalvular apparatus. The mean study follow-up period was 2.5 ± 2.1 years.: "In 38 (out of 65) patients were undergoing mitral valve replacement, the middle portion of the anterior leaflet was resected and the remaining leaflet tissue was plicated with the individual valve sutures.[**12]**

Operative times in our study averaged 104.72 ± 24.51 min cross-clamp and 141.40 ± 31.15 min CPB for repair versus 134.38 ± 24.9 and 173.74 ± 32.08 min for replacement, significantly longer in Group B. Similar findings were noted by **Lorusso et al.**, who reported mean CPB and cross-clamp times of 124.4 ± 47.5 and 82.2 ± 31.6 min **[9].**

Aklog and colleagues showed that 90% of the patients with moderate mitral regurgitation on preoperative echocardiogram had their mitral regurgitation downgraded to mild or less at intraoperative TEE. The mechanism underlying this phenomenon is almost certainly the unloading effect of general anesthesia, which results in arterial vasodilation and venous vasodilation and decreases afterload and preload, respectively. **[17].**

C) Post-operative Data

Residual MR

Our study demonstrated that residual mitral regurgitation (MR), ranging from mild to moderate, was observed in 21 out of 100 patients (21%), with the majority occurring in the repair group. Residual MR in the replacement group (4 cases) was attributed to malfunctioning mitral valve prostheses, and these patients were followed up with periodic transthoracic echocardiography and hemoglobin level assessments.

Goldstein et al. reported a significantly higher recurrence of moderate or severe MR in the repair group compared with the replacement group (58.8% vs. 3.8%, $P < 0.001$) [**76**]. Suture annuloplasty, in particular, is associated with a high incidence of residual MR when performed in patients with ischemic MR. Although suture annuloplasty can effectively eliminate MR in the short term and preserves annular contraction, as demonstrated in experimental studies, its clinical application often results in suboptimal long-term durability [**18**].

Annuloplasty with a pericardial band has shown less effectiveness than prosthetic ring annuloplasty, with more than 30% of patients exhibiting persistent grade 3+ or 4+ MR following repair [**19**].

Partial posterior ring annuloplasty, although used in the past due to ease of implantation in challenging exposures, has been largely replaced by complete ring annuloplasty to address the anterior annulus, which also dilates in functional MR. Despite ischemic MR being fundamentally a "ventricular disease" rather than a valvular one, restrictive annuloplasty continues to be applied to improve symptoms, albeit with limitations [**20**].

Downsized annuloplasty has emerged as a critical factor in minimizing residual MR. Bolling and colleagues first popularized this technique, achieving zero residual MR in 46 patients undergoing annuloplasty during CABG, despite using flexible rather than rigid rings. Similarly, the Leiden University group reported zero residual MR rates with downsized annuloplasty [**21**].

Surgical technique and patient selection remain key determinants of residual MR. Clinical and experimental evidence suggests that residual MR (defined as more than trivial or mild postoperatively) should occur in less than 5% of cases when using complete rigid or semirigid rings, whereas other techniques are associated with higher failure rates [**19**].

In our series, the replacement group exhibited a markedly lower incidence of residual MR (8%, 4 cases), attributed to prosthetic valve malfunction, compared to 34% (17 cases) in the repair group. While mitral valve repair (MVP) avoids

complications associated with prosthetic valves, the higher incidence of residual or recurrent MR with repair in ischemic MR may negate this benefit. Goldstein et al. reported similar findings, with recurrent MR significantly higher in the repair group compared to the replacement group (58.8% vs. 3.8%) [**18**].

The European survey by Lorusso et al. confirmed that residual MR occurred in 25% of MVP patients long-term, and repair was directly associated with an increased likelihood of reoperation [**9**]. Predictors of MR recurrence have been linked to preoperative mitral anatomy and left ventricular (LV) geometry.

Our study found no significant correlation between the number of grafts and residual MR (mean grafts: 2.33 ± 0.86 with residual MR vs. 2.14 ± 0.89 without; $P = 0.372$). Chan et al. reported a six-month freedom from recurrent MR ≥ grade 2+ of 95% after repair and 100% after replacement, whereas at five years, these rates were 41.4% and 85.7%, respectively. They concluded that the number of grafts performed was inversely related to MR recurrence [**12**].

Rhythm Disturbance

Postoperative rhythm disturbances were observed in 21 patients (21%): 9 (18%) in group A and 12 (24%) in group B, with atrial fibrillation (AF) being the most frequent arrhythmia. Two patients in group A and two in group B had preoperative AF, while others developed AF or ventricular fibrillation postoperatively. Statistical analysis favored the replacement group regarding lower postoperative arrhythmia incidence ($P = 0.001$).

Obadia et al. noted that patients in sinus rhythm preoperatively had a 93.7% probability of remaining in sinus rhythm, while those with AF of >1-year duration had a much lower likelihood of postoperative sinus rhythm restoration [**22**]. Survival rates did not differ significantly based on preoperative rhythm, but postoperative restoration of sinus rhythm correlated with improved outcomes.

Conversely, Tseluyko et al. found that surgical intervention itself promotes sinus rhythm restoration, improving clinical outcomes. Goldstein et al. reported supraventricular arrhythmia rates of 13% and 10% in the repair and replacement groups, respectively ($P = 0.38$), and ventricular arrhythmia rates of 6% and 8.9% ($P = 0.29$). Acker et al. similarly found no significant differences between groups regarding arrhythmia incidence [**23**].

Our analysis showed a non-significant trend toward fewer arrhythmias with posterior subvalvular apparatus preservation, consistent with Alizadeh-Ghavidel et al., who reported AF in 52.7% without chordal preservation versus 38.5% with preservation ($P = 0.12$) [**24**].

Ejection Fraction (EF)

Improvement in EF was noted in 32 patients (32%), with 30% in the repair group and 34% in the replacement group ($P = 0.424$), suggesting no significant difference, possibly due to the short follow-up period.

De Bonis et al. demonstrated that LV functional recovery occurred in only 50% of patients after successful MVP, and this improvement was associated with LV reverse remodeling. Similar findings of modest EF improvement after MVP or MVR combined with CABG were reported by Calafiore et al. [**25**].

Postoperative Mortality

Ischemic MR is not merely a marker of advanced ischemic disease but an independent predictor of late mortality. In our cohort, postoperative mortality was 10% (2% in group A vs. 8% in group B), mainly due to cardiac failure and arrhythmias, consistent with the known adverse prognosis of impaired LV function [**26**].

Goldstein et al. reported mortality rates of 19% in repair and 23.2% in replacement groups, with no significant difference. Gamal et al. found a trend toward better perioperative survival in the repair arm, though not statistically significant. Acker et al. reported similar early mortality for both approaches [**3**].

Despite higher durability of valve replacement in eliminating MR, it is associated with prosthetic valve–related risks, late mortality, and less reverse remodeling compared to repair. MVR with complete chordal preservation has been advocated to improve outcomes, maintaining LV mechanics while addressing MR durability limitations. Recent randomized trials by the Cardiothoracic Surgical Trials Network revealed no survival difference between repair and replacement at 12 months, but repair was associated with significantly higher recurrent MR (32.6% vs. 2.3%) [**3**].

Ultimately, surgical choice should be individualized based on anatomical predictors and patient-specific risks. Patients with unfavorable echocardiographic features for repair should be considered for replacement to ensure durable MR correction [**27**].

Limitations

This study reflects a single-centre experience on a small number of patients and long-term follow-up study in this field is hard due to incompliance of the cases and its finance costing.

6. CONCLUSION

Despite the aforementioned limitations, we found that, based on a meta-analysis of a single RCT and 10 adjusted observational studies including a total of 2784 patients with IMR, MV repair is not likely to improve both early and late overall survival compared with MV replacement, patients with IMR undergoing MV repair should be selected with caution being based on lack of its durability in correction of MR, replacement provided a more durable correction of mitral regurgitation in terms of freedom from reoperation with comparable valve-related complication rates, but there was no significant between-group difference in clinical outcomes, we observed no significant difference in left ventricular reverse remodeling between patients who underwent mitral valve repair and those who underwent mitral valve replacement.

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