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Factors determining early mortality in ischemic mitral regurgitation surgery

İskemik mitral yetmezlik cerrahisinde erken mortaliteyi belirleyen faktörler

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ABSTRACT

Background: This study aims to identify the causes of early mortality in patients undergoing mitral valve surgery performed in combination with coronary artery bypass grafting for the treatment of ischemic mitral regurgitation.

Methods: Between January 2017 and January 2023, a total of 411 patients (272 males, 139 females; mean age: 63.1±9.1 years; range, 32 to 92 years) who underwent coronary artery bypass grafting and mitral valve surgery due to ischemic mitral regurgitation were retrospectively analyzed. The primary outcome measure of the study was in-hospital mortality. The patients were divided into two groups as those with and without in-hospital mortality. Variables affecting mortality were identified.

Results: In-hospital mortality was observed in 13.6% (n=56) of the patients. Elective surgery was performed in 308 patients (74.9%), while priority surgery was performed in 103 patients (25.1%). Mortality rate was 9.1% in elective cases and 27.1% in priority cases. Independent risk factors for mortality included age (p=0.001), female sex (p<0.001), priority surgery (p=0.005), low left ventricular ejection fraction (p=0.005), high creatinine levels (p=0.002), the presence of extracardiac arteriopathy (p=0.042), and prolonged cardiopulmonary bypass time (p<0.001). In priority cases, a waiting period of ≤9 days was associated with higher mortality (area under the curve: 0.781, sensitivity: 75%, specificity: 72%, p<0.001).

Conclusion: A comprehensive preoperative evaluation is crucial for optimizing outcomes in patients with ischemic mitral regurgitation. In high-risk cases, the use of less invasive approaches, such as percutaneous interventions, can be considered potential alternatives. In priority cases, if hemodynamic stability can be achieved, waiting nine days after the index event before performing surgical intervention may significantly reduce perioperative and in-hospital mortality rates.

Keywords: Coronary artery bypass grafting, mitral valve regurgitation, postoperative mortality, risk factors.

ÖZ

Amaç: Bu çalışmada iskemik mitral yetmezlik tedavisi amacıyla koroner arter baypas greftleme ile birlikte gerçekleştirilen mitral kapak cerrahisi yapılan hastalarda erken dönem mortalite nedenleri belirlendi.

Çalışma planı: Ocak 2017 - Ocak 2023 tarihleri arasında iskemik mitral yetmezlik nedeniyle koroner arter baypas greftleme ve mitral kapak cerrahisi yapılan toplam 411 hasta (272 erkek, 139 kadın; ort. yaş: 63.1±9.1 yıl; dağılım, 32-92 yıl) retrospektif olarak incelendi. Çalışmanın birincil sonuç ölçümü hastane içi mortalite idi. Hastalar, hastane içi mortalitesi olan ve olmayanlar şeklinde iki gruba ayrıldı. Mortalite üzerine etki eden değişkenler belirlendi.

Bulgular: Hastaların %13.6'sında (n=56) hastane içi mortalite gözlendi. Elektif cerrahi 308 (%74.9) hastada, öncelikli cerrahi ise 103 (%25.1) hastada uygulandı. Mortalite oranı elektif olgularda %9.1, öncelikli olgularda ise %27.1 idi. Mortalitenin bağımsız risk faktörleri arasında yaş (p=0.001), kadın cinsiyeti (p<0.001), öncelikli cerrahi (p=0.005), düşük sol ventrikül ejeksiyon fraksiyonu (p=0.005), yüksek kreatinin düzeyleri (p=0.002), ekstrakardiyak arteriopati varlığı (p=0.042) ve uzun kardiyopulmoner baypas süresi (p<0.001) yer aldı. Öncelikli olgularda, bekleme süresinin ≤9 gün olması daha yüksek mortalite ile ilişkilendirildi (eğri altında kalan alan: 0.781, duyarlılık: %75, özgüllük: %72, p<0.001).

Sonuç: İskemik mitral yetmezlik olan hastalarda, kapsamlı bir ameliyat öncesi değerlendirme, sonuçları optimize etmek için önem arz etmektedir. Yüksek riskli olgularda, perkütan girişimler gibi daha az invaziv yaklaşımlar muhtemel alternatifler olarak düşünülebilir. Öncelikli olgularda, hemodinamik stabilite sağlanabilirse, cerrahi girişim için başlangıçtaki olaydan sonra dokuz gün beklenmesi perioperatif ve hastane içi mortaliteyi anlamlı ölçüde azaltabilir.

Anahtar sözcükler: Koroner arter baypas greftleme, mitral kapak yetmezliği, ameliyat sonrası mortalite, risk faktörleri.

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The surgical management of ischemic mitral regurgitation (IMR) combined with coronary artery disease (CAD) has garnered increasing attention in recent years, driven by significant advancements in diagnostic imaging techniques and surgical interventions. Ischemic mitral regurgitation is not merely a secondary complication of ischemic heart disease but rather a distinct clinical entity characterized by its multifactorial pathophysiology. This condition involves structural and functional alterations of the mitral valve apparatus, changes in ventricular geometry, and global myocardial dysfunction. These complexities make the management of IMR particularly challenging, requiring an integrated approach to address both coronary and valvular pathologies.[1]

Patients with IMR often present with unique clinical characteristics, including advanced age, multiple comorbidities, and varying degrees of ventricular dysfunction. These factors are strongly associated with high surgical risk and contribute to persistently elevated morbidity and mortality rates, even in the modern era of cardiac surgery. Despite notable advancements in cardiopulmonary bypass (CPB) techniques, myocardial protection strategies, and postoperative care, the outcomes of combined coronary artery bypass grafting (CABG) and mitral valve intervention remain suboptimal in this patient population.[2]

A significant limitation in the current literature is the scarcity of large-scale studies specifically focused on the IMR population. While general outcomes of cardiac surgery are well-documented, the unique challenges and complexities associated with IMR are often underrepresented. Identifying the risk factors contributing to mortality in this subgroup is critical for refining surgical strategies and improving clinical outcomes. Furthermore, identifying patient-specific predictors of adverse outcomes may facilitate tailored surgical planning, risk stratification, and decision-making processes.[3,4]

In the present study, we aimed to identify the causes of early mortality in patients undergoing mitral valve surgery performed in combination with CABG for the treatment of IMR and to improve outcomes in this challenging patient population.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, Department of Cardiovascular Surgery between January 2017 and January 2023. A total of 411 patients (272 males, 139 females; mean age: 63.1±9.1 years; range, 32 to 92 years) who underwent CABG and mitral valve surgery due to IMR were included. Inclusion criteria were as follows: having a diagnosis of IMR as Carpentier classification type 3b using transthoracic echocardiography (TTE), transesophageal echocardiography (TEE), and/or cardiac magnetic resonance imaging (cardiac MRI) and undergoing CABG and mitral valve surgery. Patients with a history of redo cardiac surgery, tricuspid valve replacement (TVR), combined aortic valve procedures, carotid artery surgical interventions, or emergency cases were excluded from the study. Patient data were retrieved from the hospital database. A written informed consent was obtained from each patient. The study protocol was approved by the İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital Ethics Committee (date: 20.02.2023, no: 2023.02-21). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients presenting with ischemic heart disease, evaluated, and scheduled for surgery within the first 24 h were classified as emergency cases. Patients who could not be discharged due to hemodynamic instability or had severe coronary artery lesions but were not operated on within the first 24 h and remained hospitalized while awaiting surgery were classified as priority cases. Patients who were hemodynamically stable and had non-emergent coronary lesions were discharged to await surgery and were classified as elective cases. For priority cases, the waiting period was defined as the time between the onset of acute symptoms and the operation.

Patients with preoperative glycated hemoglobin (HbA1c) levels ≥6.5% or those receiving treatment for diabetes mellitus (DM) were considered diabetic. Patients using antihypertensive medications or those with blood pressure >140/90 mmHg despite not using medication were considered hypertensive. Active smokers or those who quitted smoking within the past two years were classified as smokers. Patients with a forced expiratory volume in 1 sec (FEV1)/forced vital capacity (FVC) ratio <70% on pulmonary function tests or those receiving treatment for chronic obstructive pulmonary disease (COPD) were considered to have COPD. Extracardiac arteriopathy was defined based on the European System for Cardiac Operative Risk Evaluation II (EuroSCORE II) criteria.

Mortality was defined as in-hospital death occurring from the operation until discharge. The patients were divided into two groups based on whether in-hospital mortality occurred. Demographic data, preoperative imaging and laboratory findings, and operative data were compared to identify factors affecting in-hospital mortality.

Surgical technique

All patients were thoroughly evaluated in the Cardiac Council. The decision to perform mitral valve replacement (MVR) or mitral valve ring annuloplasty (MVr) was made by the Council by jointly assessing the imaging findings and measurements obtained

Table 1. Demographic and preoperative data of patients (n=411)

	n	%	Mean±SD	Median	Min-Max
Age (year)			63.1±9.1		
Sex					
Female	139	33.8			
Male	272	66.2			
Height (cm)			166.1±8.4		
Weight (kg)			76.6±13.3		
Body surface area (m^2)			1.8±0.2		
Smoking status					
None	162	39.4			
Ex-smoker	149	36.3			
Active	100	24.3			
Diabetes mellitus	256	62.3			
Hypertension	238	57.9			
Hyperlipidemia	195	47.8			
FEV_1/FVC (%)				78.0	41.0-100.0
Creatinine (mg/dL)				0.9	0.5-10.0
Dialysis	19	4.6			
Hematocrit			38.3±5.5		
Troponin (ng/mL)				32.0	3.0-8804.0
Presenting complaint					
Angina	253	61.6			
Dyspnea	158	38.4			
Extracardiac arteriopathy					
No	341	82.8			
Yes	70	17.2			
Echocardiographic findings					
LVEF (%)				45.0	25.0-65.0
LVEDD (mm)				54.0	39.0-95.0
LVESD (mm)				38.0	21.0-64.0
IVS thickness (mm)				11.0	5.0-20.0
LAD (mm)			45.2±7.0		
VC (mm)				0.5	0.2-9.0
PISA (cm^2)				0.9	0.4-1.8
EROA (mm^2)				0.3	0.1-1.6
RV (mL)				52.0	25.0-167.0
PAP (mmHg)				40.0	16.0-95.0

SD: Standard deviation; FEV_1/FVC: Forced expiratory volume in 1 sec/forced vital capacity; LVEF: Left ventricular ejection fraction; LVEDD: Left ventricular end-diastolic diameter; LVESD: Left ventricular end-systolic diameter; IVS: Interventricular septum; LAD: Left atrium diameter; VC: Vena contracta; PISA: Proximal isovelocity surface area; EROA: Effective regurgitant orifice area; RV: Regurgitant volume; PAP: Pulmonary artery pressure.

through imaging modalities, along with the areas requiring coronary revascularization. In patients undergoing MVR, the type of prosthetic valve was determined based on the patient's age and preference. In patients over 65 years of age, biological prostheses were predominantly preferred. In all MVr procedures, routine undersized ring annuloplasty was performed, and additional repair techniques were applied based on the condition of the valve.

In all patients, distal anastomoses were performed under cross-clamp, antegrade cardioplegia was administered, and a sump cannula was placed in the pulmonary vein to decompress the heart. The type of cardioplegia, atriotomy technique, use of retrograde cardioplegia in addition to routine antegrade cardioplegia, and whether proximal anastomoses were performed under cross-clamp or side-clamp varied depending on the surgical team's expertise and experience. All surgeries were performed by a surgical team with at least five years of experience.

Statistical analysis

Statistical analysis was performed using the Jamovi project version 2.3.24.0 (https://www.jamovi.org) and JASP version 0.17.1 software (https://jasp-stats.org). Continuous variables were presented in mean ± standard deviation (SD) or median (min-max), while categorical variables were presented in number and frequency. The normality of continuous variables was assessed using the Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests. Categorical variables were compared using the Pearson chi-square test, Fisher exact test, or the Fisher-Freeman-Halton test, depending on the data distribution. Univariate

Table 2. Intraoperative data of patients (n=411)

	n	%	Median	Min-Max
Timing of operation				
Elective	308	74.9		
Priority	103	25.1		
Cardioplegia				
Del Nido	94	22.9		
Isothermic blood	288	70.1		
Hypothermic blood	29	7.1		
Temperature (°C)			28.0	28.0-32.0
CPB time (min)			144.0	60.0-373.0
Cross-clamp time (min)			92.0	41.0-233.0
Number of distal anastomoses			2.0	1.0-6.0
Operation				
MVR	274	66.7		
MVr	37	9.0		
MVR and TVr	93	22.6		
MVr and TVr	7	1.7		
Approach to the mitral valve				
Transseptal	315	76.6		
Left atriotomy	96	23.4		
Mitral prosthesis type				
Mechanical	256	62.2		
Biological	111	27.0		
Ring	44	10.8		
Tricuspid valve intervention				
None	304	74.0		
Ring annuloplasty	74	18.0		
Kay annuloplasty	19	4.6		
DeVega annuloplasty	7	1.7		

CPB: Cardiopulmonary bypass; MVR: Mitral valve replacement; MVr: Mitral valve repair; TVr: Tricuspid valve repair.

and multivariate logistic regression analyses were performed to identify predictors of mortality. To evaluate the effectiveness of various variables in mortality differentiation among priority cases, the receiver operating characteristic (ROC) curve analysis was performed. The analysis was conducted using the DeLong method, and the optimal cut-off value for each variable was determined using Youden's index. The area under the curve (AUC), 95% confidence interval (CI), and p-values were calculated for each variable. The AUC, sensitivity, and specificity values were used to determine the effectiveness of each variable in differentiating mortality. A *p* value of <0.05 was considered statistically significant.

RESULTS

Of a total of 411 patients, 308 (74.9%) underwent elective surgery, while 103 (25.1%) underwent priority surgery. Demographic and preoperative data of the patients are presented in Table 1.

Mitral valve replacement was performed in 274 (66.7%) patients, MVr in 37 (9%) patients, MVR combined with tricuspid valve repair (TVr) in 93 (22.6%) patients, and MVr combined with

Table 3. Comparison of demographic data and preoperative clinical variables in terms of mortality

	Mortality										
	Absent (n=355)					Present (n=56)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			62.2±8.9					68.5±8.6			**<0.001**
Sex											**<0.001**
Female	108	30.4				31	55.4				
Male	247	69.6				25	44.6				
Height (cm)			166.6±8.3					162.4±8.4			**0.001**
Weight (kg)			77.3±13.1					71.8±13.3			**0.005**
Body surface area (m²)			1.9±0.2					1.8±0.2			**0.001**
Smoking status											0.218
None	134	37.7				28	50.0				
Ex-smoker	132	37.2				17	30.4				
Active	89	25.1				11	19.6				
Diabetes mellitus	219	61.7				37	66.1				0.631
Hypertension	199	56.1				39	69.6				0.077
Hyperlipidemia	163	46.3				32	57.1				0.173
FEV_1/FVC (%)				78.0	41.0-100.0				78.0	59.0-100.0	0.701
Creatinine (mg/dL)				0.9	0.5-7.0				1.0	0.5-10.0	**0.028**
Dialysis	13	3.7				6	10.7				**0.032**
Hematocrit (%)			38.7±5.4					35.4±5.1			**<0.001**
Troponin (ng/mL)				28.0	3.0-8360.0				112.0	7.0-8804.0	**<0.001**
Presenting complaint											0.137
Angina	213	60.0				40	71.4				
Dyspnea	142	40.0				16	28.6				
Extracardiac arteriopathy											**0.008**
No	303	85.3				38	67.8				
Yes	52	14.7				18	32.2				
Echocardiographic findings											
LVEF (%)				45.0	25.0-65.0				40.0	25.0-65.0	**0.001**
LVEDD (mm)				54.0	39.0-95.0				52.0	43.0-64.0	0.178
LVESD (mm)				39.0	21.0-64.0				37.0	23.0-56.0	0.107
IVS thickness (mm)				11.0	5.0-20.0				11.0	8.0-16.0	0.298
LAD (mm)			45.4±7.1					43.6±6.2			**0.041**
VC (mm)				0.5	0.2-9.0				0.6	0.3-1.0	0.184
PISA (cm²)				0.9	0.4-1.8				0.9	0.6-1.3	0.737
EROA (mm²)				0.3	0.1-0.9				0.3	0.1-1.6	0.600
PAP (mmHg)				40.0	16.0-95.0				45.0	17.0-88.0	**0.012**

SD: Standard deviation; FEV_1/FVC: Forced expiratory volume in 1 sec/forced vital capacity; LVEF: Left ventricular ejection fraction; LVEDD: Left ventricular end-diastolic diameter; LVESD: Left ventricular end-systolic diameter; IVS: Interventricular septum; LAD: Left atrium diameter; VC: Vena contracta; PISA: Proximal isovelocity surface area; EROA: Effective regurgitant orifice area; PAP: Pulmonary artery pressure.

Table 4. The effect of operative variables on mortality

	Mortality								
	Absent (n=355)				Present (n=56)				
	n	%	Median	Min-Max	n	%	Median	Min-Max	*p*
Timing of operation									**<0.001**
Elective	280	78.9			28	50.0			
Priority	75	21.1			28	50.0			
Waiting time in priority cases (days)			14.0	3.0-28.0			7.0	2.0-16.0	**<0.001**
Cardioplegia									0.394
Del Nido	85	23.9			9	16.1			
Isothermic blood	246	69.3			42	75.0			
Hypothermic blood	24	6.8			5	8.9			
Temperature (°C)			28.0	28.0-32.0			28.0	28.0-32.0	0.544
CPB time (min)			141.0	60.0-274.0			164.5	96.0-373.0	**<0.001**
Cross-clamp time (min)			91.0	41.0-180.0			99.0	59.0-233.0	**0.004**
Number of distal anastomoses			2.0	1.0-6.0			2.0	1.0-4.0	0.843
Operation									0.800
MVR	238	67.0			36	64.3			
MVr	33	9.3			4	7.1			
MVR and TVr	78	22.0			15	26.8			
MVr and TVr	6	1.7			1	1.8			
Tricuspid valve intervention									0.318
None	273	76.9			38	67.9			
Ring annuloplasty	62	17.5			12	21.4			
Kay annuloplasty	16	4.5			3	5.4			
DeVega annuloplasty	4	1.1			3	5.4			

CPB: Cardiopulmonary bypass; MVR: Mitral valve replacement; MVr: Mitral valve repair; TVr: Tricuspid valve repair.

TVr in seven (1.7%) patients. Intraoperative data are presented in Table 2. The overall in-hospital mortality rate was 13.6%. Mortality rates stratified by case type were 9.1% for elective cases and significantly higher at 27.1% for priority cases.

Univariate logistic regression analysis identified that advanced age, female sex, the presence of priority surgery, reduced left ventricular ejection fraction (LVEF), decreased hematocrit (HCT), elevated pulmonary artery pressure (PAP), elevated troponin levels, elevated blood urea nitrogen (BUN), elevated creatinine levels, the presence of extracardiac arteriopathy, the absence of left atrial diameter (LAD) enlargement, prolonged CPB time, and prolonged cross-clamp time were associated with an increased risk of mortality (Tables 3 and 4). However, operative data analysis showed that the type of cardioplegia, choice of MVR or MVr, and the addition of TVr did not significantly influence hospital mortality (Table 4).

In the multivariate logistic regression analysis, only age, female sex, the presence of priority surgery, LVEF, creatinine, extracardiac arteriopathy, and CPB time were identified as independent predictors of mortality ($p<0.05$ for all) (Table 5).

For priority cases, the diagnostic value of waiting time for mortality was calculated with an AUC of 0.781, a sensitivity of 75%, and a specificity of 72% ($p<0.001$). The cut-off value for waiting time was determined as ≤9 days. Additionally, cut-off values for other variables affecting mortality were identified as age >65 years, HCT <35.2%, LVEF <45%, cross-clamp time >86 min, and PAP >50 mmHg (Table 6, Figures 1 and 2).

DISCUSSION

The present study constitutes one of the largest cohorts of patients undergoing combined mitral valve intervention and coronary artery revascularization specifically for IMR, offering a

Table 5. Univariate and multivariate logistic regression analysis results

	Univariate LR			Multivariate LR		
	OR	95% CI	*p*	OR	95% CI	*p*
Age	1.09	1.05-1.13	**<0.001**	1.07	1.03-1.11	0.001
Sex						
Female	0.35	0.20-0.63	**<0.001**	0.31	0.16-0.62	<0.001
Male						
Hematocrit	0.89	0.84-0.94	**<0.001**			
Creatinine	1.40	1.09-1.81	**0.010**	1.67	1.21-2.3	0.002
Troponin	1.01	1.01-1.02	**0.003**			
Extracardiac arteriopathy						
None	2.46	0.97-6.21	0.058			
Present	4.17	1.62-10.71	**0.003**	3.15	1.04-9.48	**0.042**
Timing of operation						
Priority	3.73	2.09-6.68	**<0.001**	2.69	1.35-5.33	**0.005**
Elective						
LVEF	0.95	0.93-0.98	**0.001**	0.95	0.92-0.98	**0.005**
LAD	0.96	0.92-1.00	0.062			
PAP	1.03	1.01-1.05	**0.008**			
CPB time	1.02	1.01-1.03	**<0.001**	1.02	1.01-1.03	**<0.001**
Cross-clamp time	1.02	1.01-1.03	**<0.001**			

LR: Logistic regression; OR: Odds ratio; CI: Confidence interval; LVEF: Left ventricular ejection fraction; LAD: Left atrium diameter; PAP: Pulmonary artery pressure; CPB: Cardiopulmonary bypass.

Table 6. Results of ROC analysis for diagnostic values of certain variables in predicting mortality

	AUC	Sensitivity	Specificity	Cut-off	95% Cl	*p*
Waiting time in priority cases (days)	0.781	75.00	72.00	≤9	0.689-0.857	**<0.001**
Age (year)	0.691	71.43	61.69	>65	0.644-0.735	**<0.001**
Hematocrit (%)	0.669	53.57	73.52	≤35.2	0.622-0.715	**<0.001**
LVEF (%)	0.632	82.14	43.66	≤45	0.583-0.678	**0.000**
Cross-clamp time (min)	0.621	76.79	42.82	>86	0.572-0.668	**0.003**
PAP (mmHg)	0.604	35.71	81.97	>50	0.554-0.651	**0.014**
Creatine (mg/dL)	0.592	50.00	69.58	>1.05	0.542-0.640	**0.043**

ROC: Receiver operating characteristic; AUC: Area under the curve; CI: Confidence interval; LVEF: Left ventricular ejection fraction; PAP: Pulmonary artery pressure.

substantial contribution to the body of literature on surgical management of this condition. Our comprehensive analysis identified advanced age, female sex, impaired renal function (including elevated creatinine levels and dialysis dependency), the presence of extracardiac arteriopathy, reduced LVEF, and prolonged CPB time as independent predictors of in-hospital mortality. These findings underscore the multifactorial nature of perioperative risk in this patient population. Although operative strategies, such as the choice between MVR and MVr, were not significantly associated with differences in mortality rates, our results suggest that other procedural factors, including the

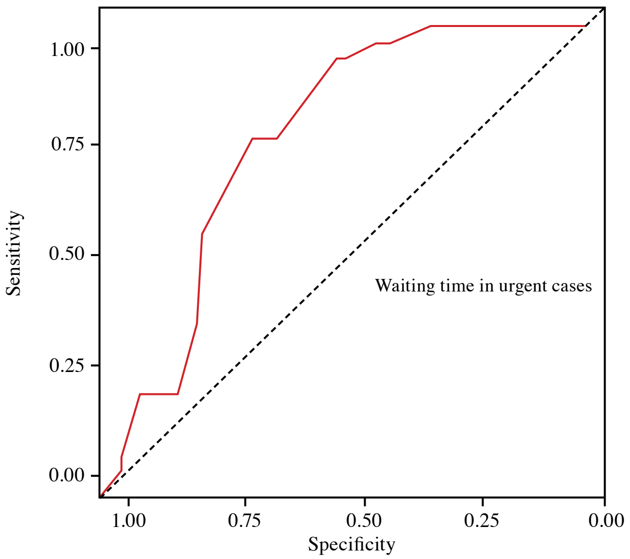

Figure 1. Evaluation of waiting time in priority cases using ROC curve.

ROC: Receiver operating characteristic.

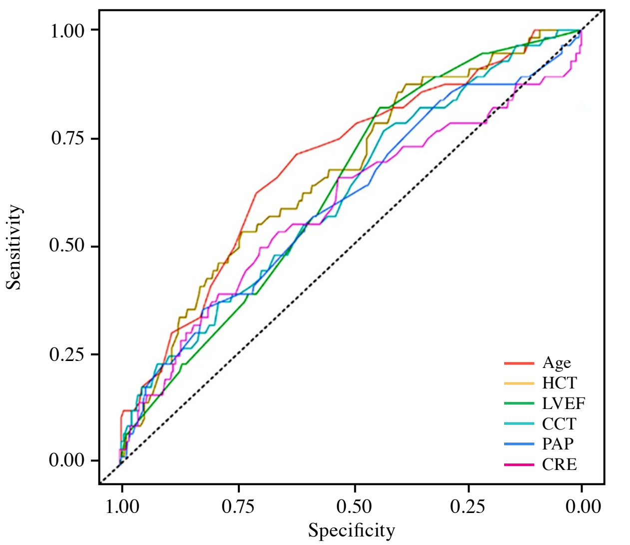

Figure 2. Evaluation of the use of variables in mortality prediction with ROC curve.

HCT: Hematocrit; LVEF: Left ventricular ejection fraction, CCT: Cross clamp time; PAP: Pulmonary artery pressure; CRE: Creatine; ROC: Receiver operating characteristic.

type of cardioplegia administered and the type of atriotomy performed, also did not influence mortality outcomes. However, optimizing the timing of surgical intervention may play a critical role in improving outcomes, particularly in priority cases. In particular, a waiting period of more than nine days following the index event appears to be associated with a reduction in perioperative and in-hospital mortality. These findings emphasize the need for a tailored, multidisciplinary approach in the perioperative management of IMR patients, focusing not only on surgical technique but also on preoperative optimization and timing of intervention to minimize the risk and enhance patient survival.

The most comprehensive data on IMR-related mortality comes from the 2018 Society of Thoracic Surgeons (STS) report, which analyzed open-heart surgery outcomes.[1] This national study reported early mortality rates of 8% for MVR+CABG and 4% for MVr+CABG. In comparison, the overall in-hospital mortality rate in our study was 13.6%, with 9.1% for elective cases and 27.1% for priority cases. The inclusion of priority cases in our cohort likely accounts for this higher mortality rate. Furthermore, the STS database does not specify the underlying etiologies for MVR+CABG or MVr+CABG, limiting direct comparisons.

A recent study by D'Agostino et al.[2] is most comparable to our cohort, as it focused specifically on IMR patients. Their reported mortality rate was 9.7%. Literature on MVR and MVr demonstrates variability in outcomes. Magne et al.[1] and Daneshmand et al.[5] suggested that MVR was associated with lower operative mortality than MVr in IMR patients, while Dufendach et al.[3] reported higher mortality for MVR, attributing this to prolonged CPB and cross-clamp times in cases where MVR followed unsuccessful MVr. Our findings revealed no significant differences in mortality, CPB duration, or cross-clamp time between MVR and MVr. These results indicate that both approaches yield comparable outcomes when appropriately selected for the patient, contributing to the ongoing debate regarding surgical strategy in IMR patients.[3,6]

The timing of revascularization following myocardial infarction (MI) remains a subject of debate. Weiss et al.[7] reported increased mortality in patients undergoing CABG within two days of MI compared to those operated on after two days. Similarly, Assmann et al.[8] demonstrated significantly higher mortality in frail patients undergoing surgery within 10 days of MI. Conversely, Naylor et al.[9] concluded that while patients awaiting CABG had a higher mortality risk than the general population, their risk was similar to or lower than that of other CAD patients. The 2021 American College of Cardiology/ American Heart Association/Society for Cardiovascular Angiography and Interventions

(ACC/AHA/SCAI) coronary artery revascularization guidelines advocate for early revascularization, although evidence suggests that delaying CABG after MI may improve outcomes.[10] A critical unanswered question is the optimal waiting period for IMR patients requiring priority surgery. Our findings indicate that waiting less than nine days for priority surgery was associated with higher mortality rates. Based on this finding, we recommend a minimum waiting period of nine days for such patients, provided their clinical condition allows. These findings highlight the importance of patient-specific factors in determining the optimal timing and surgical strategy for IMR management. Further research with multi-center, larger cohorts is needed to refine these recommendations and improve outcomes for this high-risk patient population.

Cardiovascular disease remains a critical health concern in aging populations, with advanced age identified as an independent risk factor for increased mortality. Several studies have demonstrated that additional factors commonly associated with aging, including frailty, obesity, and diabetes, further exacerbate these risks.[11] Mahesh et al.[12] highlighted age as a major determinant of postoperative mortality, while Friedrich et al.[13] reported significantly higher mortality rates in patients over 65 years compared to younger individuals. Consistent with these findings, our study demonstrated a significant association between advanced age, particularly over 65 years, and increased mortality.

Female sex has also been linked to elevated mortality rates in numerous studies.[14,15] Similarly, our findings indicate that female patients experienced higher mortality, suggesting sex as a contributing factor in postoperative outcomes.

Renal dysfunction, known for its systemic effects, has been strongly associated with increased mortality risk, particularly due to its role in predisposing patients to postoperative acute kidney injury.[16,17] Our results corroborate these findings, showing that elevated preoperative creatinine and blood urea nitrogen levels are predictors of mortality. Moreover, dependence on dialysis emerged as a significant risk factor, emphasizing the need for careful renal function management in these patients.

Prolonged CPB time and cross-clamp times are well-documented contributors to increased mortality in cardiac surgery. Al-Sarraf et al.[18] and Suri et al.[19] demonstrated that cross-clamp times exceeding 90 min significantly increased both mortality and morbidity. In our study, cross-clamp duration was identified as an independent risk factor, with a cut-off value of >86 min. Furthermore, each unit increase in ischemia duration was associated with a 1.02-fold increase in mortality risk, aligning with existing literature.

Furthermore, LVEF is another critical factor influencing mortality. Moreira et al.[20] reported worse outcomes in patients with reduced LVEF (<50%), while Yapıcı[21] and Pieri et al.[22] observed higher mortality rates in cases with LVEF <55% and ≤40%, respectively. Our findings support these observations, with a cut-off value of 45% for LVEF in our cohort. A 5-unit decrease in LVEF was associated with a 5% increase in mortality risk, underscoring the importance of preoperative LVEF assessment.

Extracardiac arteriopathy, a component of the widely used EuroSCORE II risk assessment tool, has been identified as a predictor of early mortality in cardiac surgery. Birkmeyer et al.[23] reported peripheral arterial occlusive disease as a significant independent risk factor for in-hospital mortality in CABG patients. However, van Straten et al.[24] suggested that while extracardiac arteriopathy did not impact early mortality, it affected long-term outcomes. In our study, extracardiac arteriopathy was significantly associated with early mortality, reinforcing its inclusion in risk stratification models.

Our study revealed no significant difference in mortality between the use of Del Nido and blood cardioplegia types (normothermic or hypothermic), consistent with previous literature.[25] However, subgroup analyses examining intraoperative variables such as cross-clamp time and CPB duration were not performed, limiting further insight into their potential interactions with cardioplegia type.

Taken together, these findings highlight the multifactorial nature of mortality risk in IMR patients undergoing cardiac surgery, emphasizing the importance of personalized preoperative evaluation and intraoperative management to improve outcomes. Further studies are needed to refine risk stratification tools and optimize surgical strategies in this high-risk population.

While our study includes one of the largest series of patients undergoing cardiac surgery for IMR, it is of utmost importance to acknowledge certain limitations. First, the single-center and retrospective design of the study inherently limits the generalizability of the findings. Second, due to the lack of a standardized protocol for monitoring troponin levels at our institution, the troponin values analyzed in the study were either peak levels or the values recorded at the time of admission. This variability in data collection represents another limitation. We believe that further multi-center, large-scale, prospective studies may provide more robust and conclusive insights on this topic.

In conclusion, the type of mitral valve intervention did not significantly influence early mortality. However, several preoperative factors were associated with an increased risk of mortality, including advanced age, female sex, impaired renal function, extracardiac arteriopathy, and reduced left ventricular ejection fraction. In the light of these findings, a thorough preoperative evaluation remains essential to optimizing patient outcomes in ischemic mitral regurgitation. In high-risk cases, the use of less invasive approaches, such as percutaneous interventions, can be considered potential alternatives. Additionally, in priority cases, if hemodynamic stability can be achieved, delaying surgical intervention for nine days after the index event may significantly reduce perioperative and in-hospital mortality rates.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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