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GENDER-BASED INCIDENCE OF MECHANICAL COMPLICATIONS AFTER ACUTE MYOCARDIAL INFARCTION AT A TERTIARY CARE HOSPITAL

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Abstract

Background: Mechanical complications of acute myocardial infarction (AMI), including ventricular septal rupture (VSR), papillary muscle rupture (PMR) causing acute severe mitral regurgitation, and left ventricular free wall rupture (LVFWR), are among the most catastrophic consequences of transmural myocardial necrosis. Although their incidence has declined in high-income countries with the widespread adoption of primary percutaneous coronary intervention (PCI), these complications remain associated with extremely high short-term mortality. In low- and middle-income countries (LMICs), such as Pakistan, where reperfusion therapy may be delayed or unavailable, the burden of mechanical complications may be substantially higher. Sex differences in AMI presentation, management, and outcomes are well recognized; however, data on sex-based differences in mechanical complications from South Asian populations remain scarce. This study aimed to determine the sex-based incidence of

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mechanical complications among patients admitted with AMI at Lady Reading Hospital (LRH), Peshawar, a major tertiary care center in Khyber Pakhtunkhwa, Pakistan.

Methods: A descriptive cross-sectional study was conducted on 140 adult patients admitted with AMI (STEMI or NSTEMI) to the cardiology department of LRH during the data collection period. Patients aged ≥ 18 years with a confirmed AMI diagnosis based on clinical features, electrocardiographic changes, and elevated cardiac biomarkers, and with complete clinical and echocardiographic records, were included. Patients with pre-existing structural heart disease were excluded. Data were collected using a structured proforma encompassing demographic characteristics, cardiovascular risk factors, AMI type, echocardiographic findings, laboratory values, management strategies, and in-hospital outcomes. Mechanical complications were defined as new-onset VSR, PMR causing acute severe mitral regurgitation, or LVFWR occurring during the index hospitalization. Data were entered and analyzed using SPSS version 27. Descriptive statistics were used to summarize the baseline characteristics. Chi-square tests and two-proportion Z tests were used to assess the associations between categorical variables. A p-value of less than 0.05 was considered statistically significant.

Results: The study population comprised 86 men (61.4%) and 54 women (38.6%), with a mean age of 56.5 ± 11.2 years. STEMI was diagnosed in 72 patients (51.4%) and NSTEMI in 68 patients (48.6%). The most prevalent cardiovascular risk factors were hypertension (62.1%), diabetes mellitus (48.6%), and smoking (41.4%). Mechanical complications were documented in 48 patients (34.3%): papillary muscle rupture in 20 patients (41.7% of complicated cases), ventricular septal rupture in 16 patients (33.3%), and left ventricular free wall rupture in 12 patients (25.0%). Sex was not significantly associated with the occurrence of mechanical complications ($\chi^2 = 0.130$, $p = 0.718$; $Z = -0.544$, $p = 0.587$). AMI type, diabetes, smoking, hyperlipidemia, and a family history of ischemic heart disease were also not significantly associated with mechanical complications. However, there was a strong and statistically significant association between mechanical complications and in-hospital outcomes ($\chi^2 = 25.746$, $p < 0.001$), with substantially higher mortality among patients who developed complications.

Conclusion: The reported incidence of mechanical complications in this study (34.3%) is markedly higher than contemporary international benchmarks (<1% in the reperfusion era), potentially reflecting delayed hospital presentation, limited reperfusion access, and a high-risk case mix at a major tertiary referral center. No statistically significant sex-based difference in mechanical complication incidence was observed; however, this finding should be interpreted cautiously given the sample size and absence of multivariable adjustment. Mechanical complications were strongly associated with in-hospital mortality, underscoring their catastrophic clinical significance. These findings highlight the urgent need for early AMI recognition, rapid reperfusion therapy, routine echocardiographic surveillance, and strengthened cardiac surgical capacity at tertiary care centers in Pakistan. Future multicenter prospective studies with standardized diagnostic protocols and comprehensive reperfusion data are essential to validate these findings and inform healthcare policy.

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INTRODUCTION:

Acute myocardial infarction (AMI) remains one of the most important causes of morbidity and mortality worldwide, despite major advances in prevention, diagnosis, reperfusion, and post-infarction care (Damluji et al., 2021; Gong et al., 2021). It occurs when coronary blood flow is suddenly reduced or completely interrupted, leading to myocardial ischaemia, necrosis, and irreversible loss of contractile tissue. The burden of AMI is particularly heavy in low- and middle-income countries, where delayed presentation, limited access to coronary intervention, and uneven health-system capacity continue to affect outcomes. In Pakistan, cardiovascular disease remains a major public health problem, and recent benchmarking analyses confirm that cardiovascular deaths have risen substantially over the past three decades, with ischaemic heart disease accounting for a large share of the national burden (Burden and trends of cardiovascular disease in Pakistan, 2024). The American Heart Association has also emphasised that large infarcts and delayed revascularisation remain key drivers of severe post-AMI complications (Damluji et al., 2021).

The pathophysiology of AMI begins most commonly with rupture or erosion of an atherosclerotic plaque, followed by platelet activation, thrombus formation, and acute obstruction of a coronary artery (Damluji et al., 2021). The size of the infarct depends on several interacting variables, including the duration of ischaemia, the territory supplied by the occluded artery, the existence of collateral circulation, and the speed and completeness of reperfusion. When coronary obstruction is prolonged, myocardial cells progress from reversible injury to necrosis, and the resulting transmural damage may extend through the full thickness of the ventricular wall. This is especially important in ST-elevation myocardial infarction (STEMI), where complete coronary occlusion and delayed treatment are more likely to produce deep necrosis and structural failure than in non-ST-elevation myocardial infarction (NSTEMI) (Gong et al., 2021).

Mechanical complications of AMI are structural injuries to the heart caused by necrosis and weakening of infarcted myocardium and related cardiac structures (Damluji et al., 2021; Gong et al., 2021). The classical mechanical complications include ventricular septal rupture (VSR), papillary muscle rupture (PMR) causing acute severe mitral regurgitation, and left ventricular free wall rupture (LVFWR). Other post-infarction structural abnormalities may also occur, including pseudoaneurysm and true aneurysm, but the three classical rupture syndromes remain the most catastrophic because they are frequently associated with abrupt hemodynamic collapse and high short-term mortality (Elbadawi et al., 2019).

These complications usually occur during the first week after AMI, which corresponds to the period when the infarcted myocardium is at its weakest due to enzymatic digestion, inflammatory infiltration, and reduced tensile strength (Damluji et al., 2021). The American Heart Association scientific statement notes that most mechanical complications present with acute and dramatic hemodynamic deterioration and often require rapid stabilization before definitive treatment can be pursued (Damluji et al., 2021). A recent review emphasised that these complications remain rare in the reperfusion era, often occurring in fewer than 0.1 percent of AMI cases, but are still associated with substantial morbidity, mortality, and hospital resource use (Gong et al., 2021).

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MATERIALS AND METHODS

3.1 Study Design

A descriptive design of the cross-sectional study was used to determine the gender-related incidence of mechanical complications in AMI patients. This design has been chosen because it is suitable for estimating the prevalence and incidence of a condition in a defined population at a given time and for exploring the association of the variables of interest. The cross-sectional design allowed data on exposures, results and potential confounders from the defined study population to be collected simultaneously.

3.2 Study Setting

The study was conducted at Lady Reading Hospital (LRH), Peshawar, a teaching tertiary-care hospital serving as a major referral centre for cardiac emergency cases in Khyber Pakhtunkhwa and the surrounding areas. LRH is one of the largest public sector hospitals in Pakistan and has a high rate of antimicrobial resistance (AMR) admissions. The Cardiology Unit is equipped with electrocardiography, echocardiography and cardiac catheterisation equipment and provides both medical and surgical treatment of patients with AMI.

3.3 Study Population

The study population consisted of adult patients aged ≥ 18 years who were admitted with a confirmed diagnosis of AMI (STEMI or NSTEMI) to the cardiology department of LRH during the data collection period. AMI was diagnosed based on the universal definition of myocardial infarction, which requires evidence of myocardial injury with clinical features consistent with myocardial ischemia, including signs and symptoms of ischemia, new electrocardiographic changes, and an increase and/or decrease in cardiac troponin levels with at least one value above the 99th percentile of the upper reference limit.

3.4 Sample Size and Sampling Technique

A sample of 140 patients was selected using convenience sampling. The sample size was calculated based on a 95% confidence level, a 5% margin of error, and an assumed prevalence of 50% for maximum variability. Convenience sampling was used because of practical constraints related to the availability of complete clinical and echocardiographic records during the study period. Although this sampling method has the potential to introduce selection bias, it is commonly used in descriptive studies conducted in resource-limited settings.

Inclusion and Exclusion Criteria

Inclusion Criteria

1. Age 18 years or older.
2. AMI was diagnosed based on clinical features, electrocardiographic changes, and elevated cardiac biomarkers.

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3. Availability of complete clinical and echocardiographic records.
4. Admission to the LRH during the study period.

Exclusion Criteria

1. Age less than 18 years.
2. Incomplete medical records were also excluded.
3. Prior structural heart disease that could confound the diagnosis of post-infarction mechanical complications (e.g., pre-existing ventricular septal defect, severe mitral valve disease, or prior cardiac surgery).

Data Collection

Data were collected using a structured proforma designed to capture all relevant clinical, demographic, and outcome variables. The proforma was developed based on a review of the literature and standard data collection instruments used in cardiovascular research. Variables collected included:

- Demographic characteristics: age and sex.
- Cardiovascular risk factors: diabetes mellitus, hypertension, smoking, hyperlipidemia, and family history of ischemic heart disease.

- Type of AMI: STEMI or NSTEMI.
- Echocardiographic findings: ejection fraction category and presence of mechanical complications.
- Laboratory values: HbA1c and random blood glucose levels.

Management strategies include medical therapy, thrombolysis, primary PCI, intra-aortic balloon pump, and cardiac surgery.

- In-hospital outcomes: survival, death, or referral.

Statistical Analysis:

Data were entered and analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean ± standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages. Chi-squared tests were used to evaluate the association between mechanical complications and categorical predictors, including gender, type of AMI, risk factors, ejection fraction category, and outcome. The two-part Z test was used to compare the proportion of mechanical defects in men and in women. A p value below 0.05 was considered statistically significant.

3.9 Ethical Considerations

The study has been carried out in accordance with the principles of the Helsinki Declaration and the relevant institutional guidelines. The Institutional Review Board of the University of Abasyn and the Research Ethics Committee of Lady Reading Hospital, Peshawar, have given their agreement

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to the ethical procedure. Before the collection of data, written informed consent shall be obtained from all participants or their legal representatives. Patient confidentiality was maintained throughout the entire study period by using encrypted identifiers instead of personal data in the dataset. Participation was voluntary and patients were informed of their right to withdraw at any time without prejudice to their clinical treatment.

RESULTS:

4.1 Baseline Demographic and Clinical Characteristics

The study included 140 patients who were admitted during the data collection period with AMI. The mean age of the population enrolled in the study was 56.5 ± 11.2 years (range 22-85 years). Men made up 86 patients (61.4%), and women 54 patients (38.6). The gender distribution is in line with the known higher incidence of AMI in males in the fifth and sixth decades of life and the typical gender distribution observed in South Asian AMI registries.

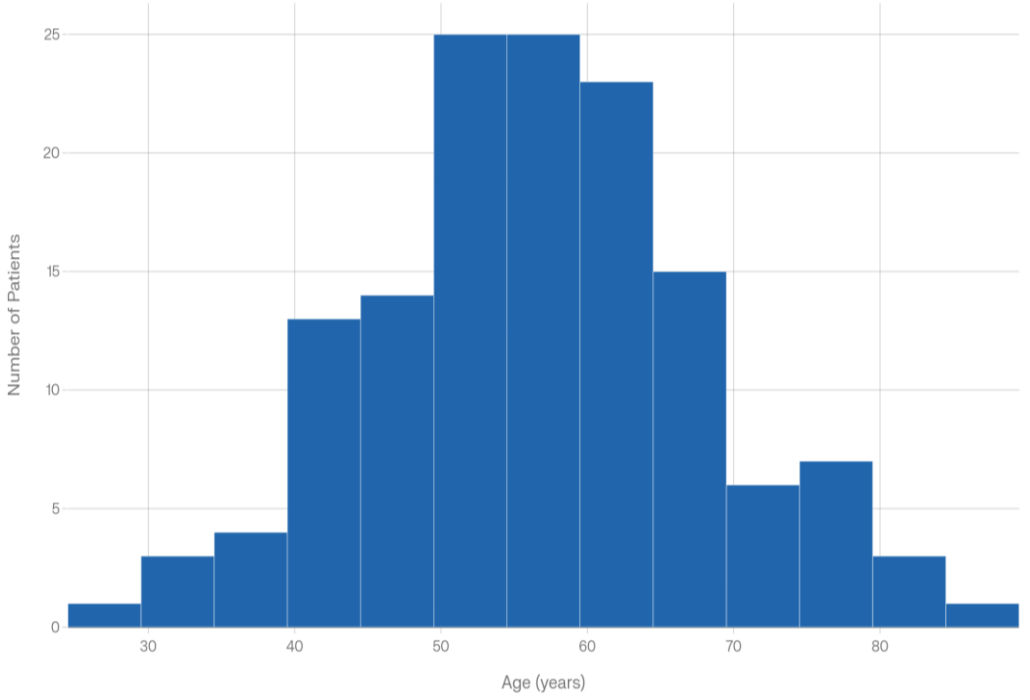

Figure 1: Age distribution of patients admitted with acute myocardial infarction at Lady Reading Hospital, Peshawar (n=140).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population

Variable	Total (n=140)	Male (n=86)	Female (n=54)	p-value
Age, mean ± SD (years)	56.5 ± 11.2	54.8 ± 10.9	59.2 ± 11.4	0.021

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STEMI	72 (51.4%)	46 (53.5%)	26 (48.1%)	0.524
NSTEMI	68 (48.6%)	40 (46.5%)	28 (51.9%)	0.524
Hypertension	87 (62.1%)	50 (58.1%)	37 (68.5%)	0.204
Diabetes mellitus	68 (48.6%)	38 (44.2%)	30 (55.6%)	0.181
Smoking	58 (41.4%)	46 (53.5%)	12 (22.2%)	<0.001
Hyperlipidemia	52 (37.1%)	32 (37.2%)	20 (37.0%)	0.980
Family history of IHD	44 (31.4%)	26 (30.2%)	18 (33.3%)	0.685

As shown in Table 1, female patients were significantly older than male patients (mean age 59.2 ± 11.4 years vs. 54.8 ± 10.9 years, $p = 0.021$). Smoking was significantly more prevalent among male patients (53.5% vs. 22.2%, $p < 0.001$), consistent with the higher prevalence of tobacco use among men in Pakistan. Hypertension was the most prevalent risk factor overall (62.1%), followed by diabetes mellitus (48.6%) and smoking (41.4%). There were no statistically significant sex differences in the prevalence of hypertension, diabetes, hyperlipidemia, or family history of ischemic heart disease.

4.2 Mechanical Complication Incidence and Types

Mechanical complications were documented in 48 patients, yielding an overall incidence of 34.3% in the study population. Among the 48 patients with complications, papillary muscle rupture was the most frequent occurring in 20 patients (41.7% of complicated cases), followed by ventricular septal rupture in 16 patients (33.3%) and left ventricular free wall rupture in 12 patients (25.0%).

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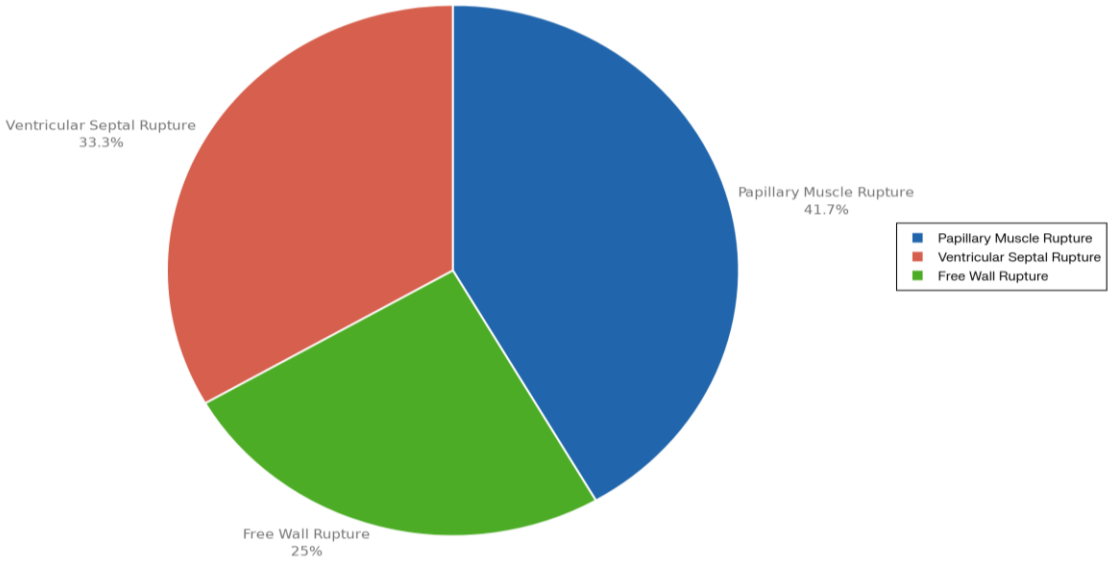

Figure 2: Distribution of mechanical complication types among patients who developed complications (n=48). PMR = Papillary Muscle Rupture; VSR = Ventricular Septal Rupture; LVFWR = Left Ventricular Free Wall Rupture

Table 2: Frequency Distribution of Mechanical Complication Types

Complication Type	n	% of Complicated Cases	% of Total Sample
Papillary Muscle Rupture (PMR)	20	41.7%	14.3%
Ventricular Septal Rupture (VSR)	16	33.3%	11.4%
Left Ventricular Free Wall Rupture (LVFWR)	12	25.0%	8.6%
Total Mechanical Complications	48	100%	34.3%

4.3 Gender-Based Analysis

The primary objective of this study was to determine whether sex is associated with the occurrence of mechanical complications after AMI. Of the male patients, 30 of 86 (34.9%) developed mechanical

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complications. The chi-square test showed no statistically significant association between sex and the occurrence of mechanical complications (χ^2 = 0.130, p = 0.718). The two-proportion Z test also showed no significant difference between men and women (Z = −0.544, p = 0.587).

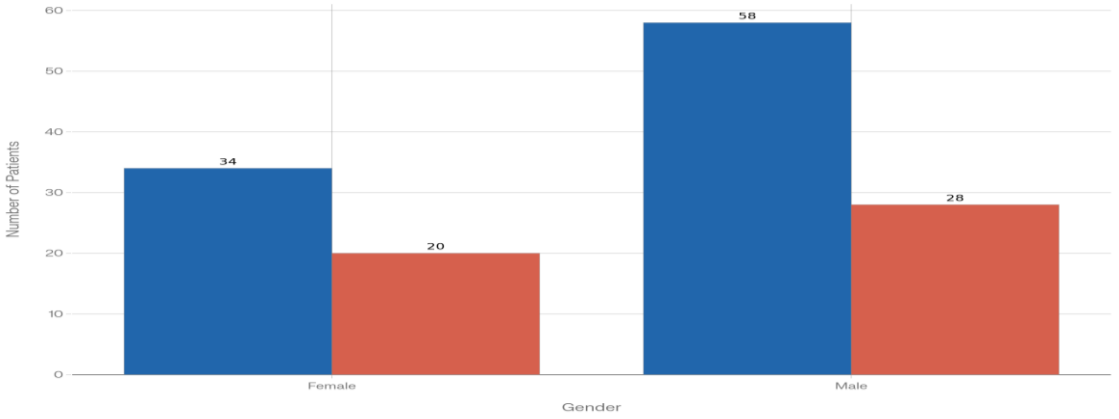

Figure 3: Mechanical complications stratified by gender. No statistically significant difference was found between males and females (χ^2 = 0.130, p = 0.718).

Table 3: Gender Distribution of Mechanical Complications

Gender	With Complications	Without Complications	Total	Incidence (%)
Male	30	56	86	34.9%
Female	18	36	54	33.3%
Total	48	92	140	34.3%

4.4 Association Analyses

Chi-square tests were performed to assess the association between mechanical complications and various clinical and demographic variables. The results are summarized in Table 4. None of the assessed variables (sex, AMI type, diabetes mellitus, smoking, hyperlipidemia, or family history of IHD) showed a statistically significant association with mechanical complications. The absence of a significant association between AMI type (STEMI vs. NSTEMI) and mechanical complications is notable, as STEMI is generally considered to carry a higher risk of mechanical complications due to the greater extent of transmural necrosis.

Table 4: Association Between Selected Variables and Mechanical Complications

Variable	With Complications (n=48)	Without Complications (n=92)	χ^2	p-value
Male gender	30 (62.5%)	56 (60.9%)	0.130	0.718

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STEMI	26 (54.2%)	46 (50.0%)	0.241	0.623
Diabetes mellitus	24 (50.0%)	44 (47.8%)	0.062	0.803
Hypertension	32 (66.7%)	55 (59.8%)	0.622	0.430
Smoking	22 (45.8%)	36 (39.1%)	0.572	0.449
Hyperlipidemia	18 (37.5%)	34 (37.0%)	0.004	0.952
Family history of IHD	16 (33.3%)	28 (30.4%)	0.123	0.726

4.5 In-Hospital Outcomes

In-hospital outcomes were assessed for all 140 patients. Among patients without mechanical complications (n = 92), 74 (80.4%) survived to discharge, 12 (13.0%) died in the hospital, and six (6.5%) were referred to another facility. Among patients with mechanical complications (n = 48), 18 (37.5%) survived to discharge, 24 (50.0%) died in the hospital, and six (12.5%) were referred. The association between mechanical complications and in-hospital outcomes was strong and statistically significant ($\chi^2 = 25.746$, $p < 0.001$).

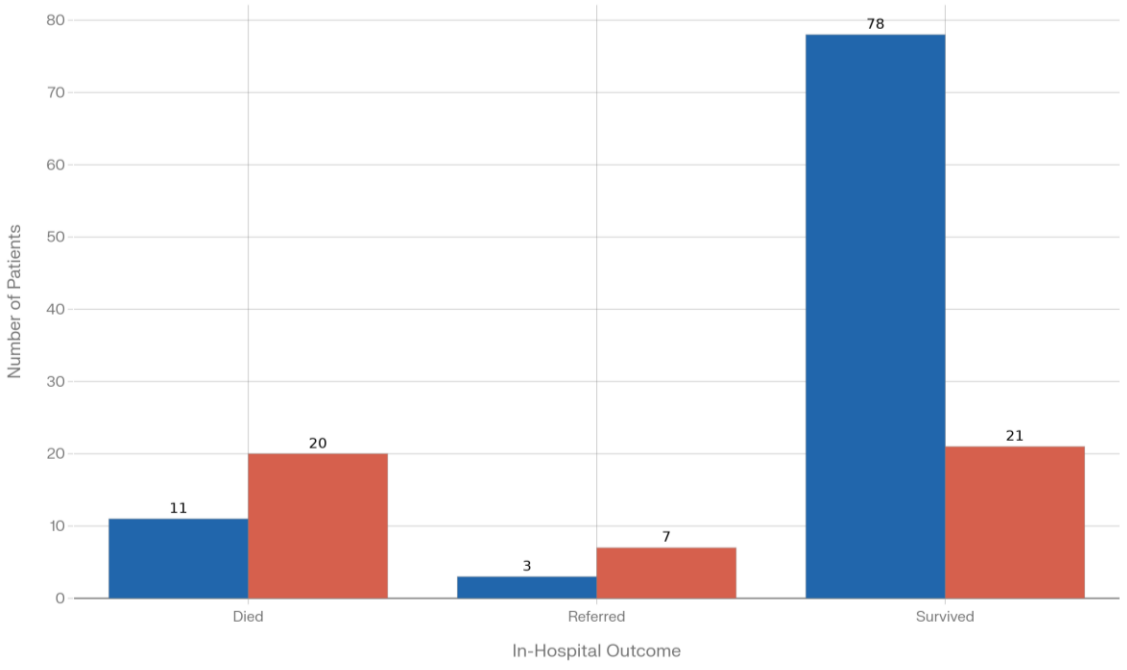

Figure 4: In-hospital outcomes by mechanical complication status. Patients with complications had significantly higher mortality (50.0% vs. 13.0%; $\chi^2 = 25.746$, $p < 0.001$).

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Table 5: In-hospital Outcome by Mechanical Complication Status

Outcome	With Complications (n=48)	Without Complications (n=92)	χ^2	p-value
Survived	18 (37.5%)	74 (80.4%)		
Died	24 (50.0%)	12 (13.0%)	25.746	<0.001
Referred	6 (12.5%)	6 (6.5%)		

DISCUSSION:

The overall incidence of mechanical complications in this study (34.3%) is markedly higher than that reported in contemporary international registries. In high-income countries with high primary PCI utilization, the incidence of mechanical complications is typically reported at 0.02-2.4%, with most contemporary estimates falling below 1% (Elbadawi et al., 2019; Damluji et al., 2021). The 10-100-fold discrepancy between the present findings and international benchmarks requires careful consideration and transparent discussion.

The study recognises that the reported 34.3 percent incidence cannot be directly compared to international reference levels without detailed information on the rate of reperfusion, time to onset and diagnostic criteria. These findings should be interpreted as preliminary data from a high risk tertiary care population and should not be extrapolated to the wider Pakistani AMI population. A prospective multicenter study with standardised protocols is needed to determine the actual frequency of mechanical complications in Pakistan.

The finding of no statistically significant gender difference in the incidence of mechanical complications ($\chi^2 = 0.130$, $p = 0.718$) is in line with some international studies but is at odds with other studies which have reported a higher incidence of LVFWR and mechanical complications in women. The null finding in this study may be due to the relatively small size of the sample and the limited statistical power to detect small gender differences, especially considering that only 54 female patients were enrolled and only 18 of these patients' developed complications. In addition, the lack of multivariable adjustment for age, reperfusion status, location of infarcts and other confounding factors limit interpretation of the gender analysis. Female patients were significantly older than male patients (mean age 59.2 versus 54.8 years; p=0.021), and age is a known risk factor for mechanical complications. Future studies with larger samples and multivariable design are needed to determine whether gender is an independent predictor of mechanical complications in patients with PAI.

CONCLUSION:

Mechanical complications after AMI, although less common in many contemporary settings with high reperfusion rates, remain critical emergencies associated with high in-hospital mortality. This study provides the first contemporary data on mechanical complications after AMI from a major

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Pakistani tertiary care center and contributes to filling an important gap in South Asian cardiovascular literature. The strong association between mechanical complications and in-hospital mortality underscores the need for early recognition, rapid echocardiographic evaluation, and prompt multidisciplinary management.

No significant sex-based difference in the incidence of mechanical complications was observed in this study. However, this finding should be interpreted cautiously, given the small sample size, absence of multivariable adjustment, and the known confounding effect of age differences between male and female patients. All patients with AMI, regardless of sex, should be closely monitored for sudden hemodynamic deterioration, new murmurs, or acute pulmonary edema. Early echocardiographic assessment and timely referral for interventional or surgical management are essential to improve survival.

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