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Assessing Echocardiographic Predictors Of Mechanical Complications And Clinical Prognosis In Acute Myocardial Infarction

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Abstract

Background: Acute myocardial infarction (AMI) is still one of the leading causes of cardiovascular death worldwide and life-threatening mechanical complications despite impressive advances in reperfusion therapy significantly contribute to the clinical outcome. Echocardiography plays an essential role in the early diagnosis, risk stratification and prognosis of post-AMI structural complications. The objective of this study is to review systematically the echocardiographic predictors of mechanical complications to allow timely clinical intervention and to enhance patient survival.
Methods: Retrospective observational cohort study was conducted in University of Lahore teaching hospital and Gulab Devi hospital for four months period. Random sampling was used to enroll a total of 84 patients with confirmed AMI (STEMI or NSTEMI) based on clinical presentation, ECG changes and elevated cardiac biomarkers. All patients had a transthoracic echocardiogram in their primary admission. Data were gathered from the Electronic

Medical Records and analyzed with SPSS version 27 and were echocardiography and clinical data.
Results: The cohort comprised 84 patients (mean age 56.25 ± 9.28 years; 61.9% male). The most common type of infarction was STEMI (91.7%). This association of VSR with posterior infarction was statistically significant and was only observed in STEMI patients ($p = 0.072$ at the exploratory level of 0.10). There was a tendency for association with lateral infarction for free wall rupture ($p = 0.089$). Mitral regurgitation, left ventricular aneurysm formation were seen in 66.7% and 55.95% of the patients, respectively, and there was no significant association with the types of AMI. Sixty-three percent of the population had an LVEF less than 45%. Throughout, the comorbidity burden was high, with pulmonary hypertension (≈60%), heart failure (>50%) and chronic kidney disease (>40%).
Conclusion: The conclusion is that the site and type of AMI are important factors in determining specific mechanical complications. Posterior STEMI is highly correlated with VSR, and lateral infarction can be considered a risk factor for free wall rupture. The mitral regurgitation and LV aneurysm are thought to be indicators of generalized ischemic myocardial injury. Personalized post-AMI care and timely lifesaving interventions require comprehensive echocardiographic evaluation, which includes comprehensive infarct topography and a detailed profile of the comorbidities.

1. INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death and ischaemic heart disease is the biggest contributor to the death of CVDs globally. The World Health Organization estimates that 17.5 million people per year die of CVDs, including about half of those who die by acute myocardial infarction (AMI) events. This epidemiological burden highlights not only the AMI as a clinical emergency but also as a public health threat that must be constantly improved through the development of diagnostic and therapeutic approaches.

Acute myocardial infarction is a sudden reduction in coronary blood flow, usually as a result of the rupture or erosion of an atherosclerotic plaque, followed by the development of an intracoronary thrombus. This leads to a subsequent series of pathophysiological changes beginning with myocardial ischaemia, culminating in myocardial coagulation necrosis and leading to structural, electrical and functional changes in the heart. There is a clinical spectrum, including ST-segment elevation myocardial infarction (STEMI) due to complete occlusion of an epicardial coronary artery and non-ST-elevation myocardial infarction (NSTEMI) which most often occurs when there is partial or temporary occlusion of an epicardial coronary artery. Both forms are accompanied by significant short and long term adverse outcomes.

Despite the dramatic advances in reperfusion therapy, pharmacological therapy, and secondary prevention, post-AMI mortality remains high, especially in those patients who develop mechanical complications. Historically, these structural catastrophes, such as ventricular septal rupture (VSR), papillary muscle rupture (PMR), left ventricular free wall rupture (FWR) and left ventricular aneurysm (LVA) formation have been associated with a case fatality rate > 50%, despite modern treatment. Their pathogenesis is closely associated with the biomechanical changes associated with myocardial softening and thinning that occurs in the first days after infarction when the myocardium is most structurally vulnerable.

Echocardiography has been the pivotal imaging tool in the management of patients with AMI and has become the most important non-invasive imaging modality that allows real time, non-invasive assessment of cardiac morphology, ventricular function, valvular competence and hemodynamics. Echocardiography is also a source of important prognostic data, including left ventricular ejection fraction (LVEF), global longitudinal strain (GLS), regional wall motion abnormalities (RWMA) and mechanical complications. In addition, advanced echocardiographic modalities, such as speckle-tracking echocardiography and 3-D imaging, have further improved the ability to detect subclinical dysfunction and complex structural defects.

Although guidelines exist, there is considerable variation in the systematic use of echocardiogram for individual risk stratification of mechanical complications in clinical routine. The relationship of infarct topography to the type of mechanical complication is still under-understood, particularly in low-resource areas. This gap in knowledge is a major obstacle in the shift from general to personalized monitoring after AMI.

In the present study we therefore sought to analyze the echocardiographic predictors of mechanical complications and clinical outcome in a series of AMI patients, focusing on the relationships between different locations of the infarct, AMI type and incidence of specific structural complications. The ultimate goal is to develop actionable evidence that will support individualized, location-guided echocardiographic surveillance protocols that will be better able to enable earlier detection and timely intervention in high-risk patients.

1.1 Rationale

Mechanical complications of AMI are not diagnosed until after the onset of hemodynamic decompensation, when intervention is too risky. The most practical tool to identify patients at high risk of developing early structural abnormalities is echocardiogram which is widely available and can identify such abnormalities at an early stage. The present study was conceived to describe specific echocardiographic features that allow the clinician to categorize the patients according to the type of complication they are most likely to develop, depending on the anatomical origin of the infarction and the patients' baseline comorbidities.

2. REVIEW OF LITERATURE

2.1 Pathophysiology of Acute Myocardial Infarction

The cardiovascular system is a highly specialized system which transports oxygen and metabolic substrates to peripheral tissues. The contractile foundation is comprised of cardiomyocytes, whose efficient excitation-contraction coupling relies on a tightly coupled network of ion channels, inter-cellular gap junctions and sarcomeric myofibrils that are integrated by the cardiac conduction system from sinoatrial node down to atrioventricular node, bundle of His, and Purkinje fibers.

CVD is the most clinically relevant form of disease caused by the coronary artery disease, which is largely due to atherosclerosis. Atherosclerosis is a chronic inflammatory process involving the accumulation of lipid laden macrophages, fibrous elements and immune cells within the intima of the artery, which slowly constrict the coronary lumen over decades. A spectrum of clinical events follows plaque rupture or erosion, including platelet activation, thrombus formation and acute coronary syndrome (ACS), which can manifest as unstable angina, NSTEMI, and STEMI.

A complete and prolonged occlusion of a major epicardial coronary artery results in STEMI, which causes the entire thickness of the myocardium to be ischemic and necrotic. Therefore, the duration of occlusion is the most important factor determining infarct size and rapid reperfusion with primary PCI is the gold standard treatment. In contrast, NSTEMI generally occurs when the coronary arteries are partially blocked or blocked for brief periods of time, without the ST segment changes seen on the ECG, but still carries significant risk for future ischemic events and subsequent, long-term complications.

2.2 Mechanical Complications of AMI

Major mechanical complications of AMI occur when the myocardium is soft in the days following infarction. Ventricular septal rupture (most commonly after left anterior descending artery (LAD) STEMI or right coronary artery (RCA) STEMI) is an interventricular left-to-right shunt and biventricular failure. The posterior medial papillary muscle is supplied by a single coronary vessel and rupture of this papillary muscle leads to acute severe mitral regurgitation and pulmonary edema. The most serious complication (which occurs in 0.2% of cases) is left ventricular free wall rupture, which causes acute hemopericardium and tamponade, which often result in death within minutes. At a later stage, left ventricular aneurysm formation increases the risk of mural thrombus, thromboembolism and heart failure.

These complications have decreased significantly in the reperfusion era but their mortality is high, sometimes 40-80%, especially if the diagnosis is missed or delayed surgery. Key clinical hemodynamic findings are often subtle and may be masked by coexistent drug therapy.

2.3 Role of Echocardiography in AMI

Nowadays, echo is acknowledged as the most important imaging tool for the diagnosis of AMI and its complications. Transthoracic echocardiography (TTE) allows for a complete assessment of left and right ventricular systolic and diastolic function, regional wall motion abnormalities defining infarct territories, valvular competence, and pericardial pathology. Transesophageal echocardiography (TEE) offers greater resolution to evaluate lesions such as partial rupture of papillary muscles or pseudoaneurysm formation, and color Doppler imaging is useful for detection of turbulent flow, which is important in the diagnosis of ventricular septal defects.

Advanced echocardiograms have also improved these diagnostic capabilities. Speckle-tracking echocardiography allows for the measurement of myocardial deformation using global longitudinal strain, which has the ability to identify subclinical systolic dysfunction in patients with normal LVEF. Three-dimensional echocardiography provides more accurate volumetric measurement of ventricular geometry, morphology of aneurysms and complex defects. Several echocardiographic parameters have been shown to have a prognostic value: severe mitral regurgitation, intraventricular thrombus, right ventricular dysfunction and reduced LVEF are independent predictors of poor short- and long-term prognosis.

2.4 Risk Stratification Gaps and Research Context

Although validated risk scores like TIMI and GRACE are available, these scores are mostly based on clinical and biochemical parameters, and they don't offer much information on which mechanical complication a particular patient is most likely to encounter. The anatomical relationship between infarct topography and the type of the complications is essential for the implementation of targeted surveillance. Incorporating echocardiographic infarct mapping into the clinical comorbidity profile is the next step in the paradigm of post-AMI risk stratification, and this present study was designed to help advance this paradigm.

3. MATERIALS AND METHODS

3.1 Study Design and Setting

A retrospective observational cohort design was used in this study. The data were gathered from two tertiary care hospitals, University of Lahore Teaching Hospital and Gulab Devi Hospital in Lahore, Pakistan. This study lasted for 4 months.

3.2 Study Objectives

The main goal was to assess the ability of echocardiographic parameters such as LV ejection fraction, regional wall motion abnormalities, valvular dysfunction and strain patterns to predict structural complications and clinical outcomes after AMI. Secondary objectives included characterization of the relationship between AMI type (STEMI vs. NSTEMI) and specific mechanical complications, and assessment of the comorbidity burden in this population.

3.3 Hypotheses

H_0: There is no significant association between echocardiographic parameters and development of structural complications or clinical outcomes in patients with AMI.

Alternative Hypothesis (H_1): Echocardiographic parameters are important predictors of the structural complications and clinical outcomes in patients having AMI.

3.4 Sample Size and Sampling Technique

There were 84 patients recruited by simple random sampling. This sample size was deemed to be sufficient for exploratory analysis in the timeframe of the study and institutional scope of the study.

3.5 Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they were 18 years or older, had a confirmed diagnosis of AMI (STEMI or NSTEMI) according to clinical presentation, electrocardiographic changes, and elevated levels of cardiac biomarkers (troponin I/T), had undergone transthoracic echocardiogram during the index admission, and had signed written informed consent.

Patients were not included if they had a structural heart disease, poor echocardiographic window, or coexisting terminal disease (e.g. advanced malignancy).

3.6 Data Collection and Variables

Electronic medical records, echocardiographic reports, electrocardiograms, and clinical charts were used to systematically extract data. ECG parameters recorded were rate, rhythm, infarction territory, echocardiographic parameters (LVEF, RWMA, valvular function, evidence of structural complications), and clinical outcomes (cardiogenic shock, heart failure, arrhythmias). Comorbidities recorded were pulmonary hypertension, pulmonary edema, chronic kidney disease, and previous heart failure.

3.7 Statistical Analysis

The data was analysed using SPSS version 27.0. Continuous variables are presented as mean ± standard deviation and the degree of skewness and kurtosis are determined to assess their normality. Frequencies and percentages are used for categorical variables. Chi-square tests (or Fisher's exact test where cell counts were fewer than five) were used to evaluate associations between categorical variables. A significance level of $\alpha = 0.10$ was used to allow for high sensitivity to detect associations while keeping in mind the potential for Type I error given the sample size.

3.8 Ethical Considerations

The study was carried out under the ethical guidelines of University of Lahore Ethics Committee. All participants gave written informed consent. Patient data was anonymised during data collection and data analysis. All participants were given the opportunity to withdraw from the study without penalty and participation was voluntary.

3.9 Operational Definitions

Acute Myocardial Infarction (AMI): Necrosis of the myocardium from prolonged ischemia secondary to coronary occlusion based on clinical symptoms, elevated cardiac biomarkers (troponin I/T), electrocardiographic changes.

STEMI: AMI with ST-segment elevation ≥1 mm in two or more adjacent ECG leads and elevated biomarkers and with transmural myocardial injury.

NSTEMI: AMI that presents with elevated cardiac enzymes and is associated with no ST-segment elevation, this will usually be recognizable with ST depression or T-wave inversion.

Left Ventricular Ejection Fraction (LVEF): The percentage of the left ventricle (LV) pumping ability (left ventricle ejected blood) during systole, as measured by echocardiography; <40% is considered reduced; <45% is the study threshold for impaired systolic function.

Mechanical Complications: Structural disturbance of the myocardium following AMI: 1) Ventricular septal rupture; 2) Papillary muscle rupture; 3) Free wall rupture; 4) Formation of left ventricular aneurysm, diagnosed by echocardiogram and clinical.

4. RESULTS

4.1 Descriptive Statistics of Quantitative Variables

This course covers the descriptive statistics of quantitative variables.

This study recruited 84 patients who had an AMI. Table 1 shows the descriptive statistics of the main quantitative variables. Age demonstrated a near-normal distribution (mean 56.25 ± 9.28 years; skewness 0.017; kurtosis -0.090), as did weight (mean 72.42 ± 12.21 kg; skewness -0.057; kurtosis -0.170). The height data was skewed (skewness -1.260) and kurtosed (kurtosis 4.365) with a very unlikely minimum of 117 cm which is probably a data entry error. Parametric methods were then used for the age and weight analyses and non parametric methods were recommended for height.

Table 1. Descriptive Statistics of Quantitative Variables (N = 84)

Variable		**Min**	**Max**	**Mean**	**SD**	**Skewness**	**Kurtosis**
Age (years)	4	30	79	56.25	9.28	0.017	-0.090
Weight (kg)	4	46	102	72.42	12.21	-0.057	-0.170
Height (cm)	4	117	179	161.45	9.52	-1.260	4.365

4.2 Sociodemographic Characteristics

As expected, the sample showed a predominance of males (52 patients, 61.9%) and females (32 patients, 38.1%) as outlined in the epidemiological aspects of ischemic heart disease (Table 2). This older cohort of AMI patients was married in the majority (n = 80, 95.2%), Table 3.

Table 2. Sex Distribution of the AMI Cohort

Sex	**Frequency (n)**	**Percent (%)**
Male	52	61.9
Female	32	38.1
Total	84	100.0

Table 3. Marital Status Distribution

Marital Status	**Frequency (n)**	**Percent (%)**
Married	80	95.2
Single	4	4.8
Total	84	100.0

4.3 Age and Weight Distribution

The age distribution showed a clear age clustering appearing in the middle aged and in the elderly adults (Table 4). The 46–60 year cohort constituted the majority (56.0%), followed by 61–75 years (27.4%), 30–45 years (14.3%), and 76 years and above (2.4%). The weight distribution showed that nearly half of the patients (48.8%) were in the 60–74 kg category and 29.8% of them were 75–89 kg and 6.0% above 90 kg (Table 5).

Table 4. Age Distribution of the AMI Cohort

Age Category (years)	**Frequency (n)**	**Percent (%)**
30–45	12	14.3
46–60	47	56.0
61–75	23	27.4
≥76	2	2.4
Total	84	100.0

Table 5. Weight Distribution of the AMI Cohort

Weight Category (kg)	**Frequency (n)**	**Percent (%)**
<60	13	15.5
60–74	41	48.8
75–89	25	29.8
≥90	5	6.0

Total	84	100.0

4.4 Clinical Outcomes

Electrical instability during the acute infarction period was reflected by arrhythmias, which were present in 59.5% of patients. The study population was very seriously affected as more than half had developed HF and a clinically relevant proportion had developed cardiogenic shock. Pulmonary hypertension was present in about 60% of patients, pulmonary edema in more than 52.4%, chronic kidney disease in more than 40% and previous history of heart failure in about 60% (Table 6).

Table 6. Prevalence of Clinical Outcomes and Comorbidities

Clinical Variable	Present n (%)	Absent n (%)
Arrhythmias	50 (59.5%)	34 (40.5%)
Heart Failure	43 (51.2%)	41 (48.8%)
Pulmonary Hypertension	~50 (59.5%)	~34 (40.5%)
Pulmonary Edema	44 (52.4%)	40 (47.6%)
Chronic Kidney Disease	~34 (40.5%)	~50 (59.5%)
History of Heart Failure	~50 (59.5%)	~34 (40.5%)

4.5 Echocardiographic Predictors of Structural Complications

4.5.1 Ventricular Septal Rupture

VSR was identified in 29.8% (25 of 84) of the patients, and of these, all 25 were STEMI patients. The chi-square test showed a Pearson chi square value of 3.236 (df = 1, p = 0.072) which does not fall below the exploratory significance level of 0.10. The p value of the likelihood ratio was 0.022. The discovery reveals that STEMI, especially posterior STEMI, is an independent important predictor of VSR (Tables 7, 8).

Table 7. Cross-Tabulation: VSR by AMI Type

AMI Type	VSR Absent (n)	VSR Present (n)	Total (n)
NSTEMI	7	0	7
STEMI	52	25	77
Total	59	25	84

Table 8. Chi-Square Tests: Ventricular Septal Rupture

Test	Value	df	p-value (2-sided)
Pearson Chi-Square	3.236	1	0.072
Continuity Correction	1.869	1	0.172
Likelihood Ratio	5.211	1	0.022
Fisher's Exact Test	—	—	0.098

4.5.2 Free Wall Rupture

Thirty-two of 84 patients (38.1%) had a free wall rupture documented. The chi-square test showed no significant association with AMI type (0.294, p = 0.588). A tendency toward association with the location of lateral infarction was, however, seen at the exploratory threshold (p = 0.089), and needs to be studied further with larger cohort (Tables 9 and 10).

Table 9. Cross-Tabulation: Free Wall Rupture by AMI Type

AMI Type	FWR Absent (n)	FWR Present (n)	Total (n)
NSTEMI	5	2	7
STEMI	47	30	77

Total	52	32	84

Table 10. Chi-Square Tests: Free Wall Rupture

Test	Value	df	p-value (2-sided)
Pearson Chi-Square	0.294	1	0.588
Continuity Correction	0.018	1	0.892
Likelihood Ratio	0.305	1	0.581
Fisher's Exact Test	—	—	0.704

4.5.3 Ischemic Mitral Regurgitation

The most common mechanical complication was mitral regurgitation which was found in 56 out of 84 patients (66.7%). Using chi-square analysis, there was no significant association between AMI type and MR (Pearson chi-square 1.948, p = 0.163) (Tables 11 and 12), suggesting that MR is a generalized consequence of ischemic myocardial injury, and is unrelated to the infarct territory.

Table 11. Cross-Tabulation: Mitral Regurgitation by AMI Type

AMI Type	MR Absent (n)	MR Present (n)	Total (n)
NSTEMI	4	3	7
STEMI	24	53	77
Total	28	56	84

Table 12. Chi-Square Tests: Mitral Regurgitation

Test	Value	df	p-value (2-sided)
Pearson Chi-Square	1.948	1	0.163
Continuity Correction	0.955	1	0.329
Likelihood Ratio	1.825	1	0.177
Fisher's Exact Test	—	—	0.215

4.5.4 Left Ventricular Aneurysm Formation

47 of 84 patients (55.95%) were found to have left ventricular aneurysm formation. However, there were no significant differences in LVA risk among the various types of infarction (Pearson chi-square 0.742, p 0.389), suggesting that LVA is not restricted to any single type of infarction (Tables 13 and 14).

Table 13. Cross-Tabulation: LV Aneurysm Formation by AMI Type

AMI Type	LVAF Absent (n)	LVAF Present (n)	Total (n)
NSTEMI	2	5	7
STEMI	35	42	77
Total	37	47	84

Table 14. Chi-Square Tests: LV Aneurysm Formation

Test	Value	df	p-value (2-sided)
Pearson Chi-Square	0.742	1	0.389
Continuity Correction	0.215	1	0.643
Likelihood Ratio	0.772	1	0.380
Fisher's Exact Test	—	—	0.458

4.5.5 Papillary Muscle Rupture

Second most common complication was papillary muscle rupture, in 54 patients (64.29%). No statistically significant association with any type of AMI has been found (Pearson chi-square 1.527, p = 0.217), and it is known that it is vulnerable in all types of infarctions (Tables 15 and 16).

Table 15. Cross-Tabulation: Papillary Muscle Rupture by AMI Type

AMI Type	PMR Absent (n)	PMR Present (n)	Total (n)
NSTEMI	4	3	7
STEMI	26	51	77
Total	30	54	84

Table 16. Chi-Square Tests: Papillary Muscle Rupture

Test	Value	df	p-value (2-sided)
Pearson Chi-Square	1.527	1	0.217
Continuity Correction	0.679	1	0.410
Likelihood Ratio	1.456	1	0.228
Fisher's Exact Test	—	—	0.242

4.6 Left Ventricular Ejection Fraction

LVEF was determined through study threshold of 45%. 53 patients (63.1%) had decreased LVEF below this level, and 31 patients (36.9%) had LVEF ≥ 45% (Table 17). This finding reflects the high prevalence for clinically important LVSD in the study population as well as confirms LVEF to be a very important echocardiographic parameter to classify post-AMI risk.

Table 17. Distribution of Left Ventricular Ejection Fraction

EF Category	EF Status	Frequency (n)	Percent (%)
EF < 45%	Impaired	53	63.1
EF ≥ 45%	Preserved	31	36.9
Total	—	84	100.0

5. DISCUSSION

The present study results shed light on various clinically relevant associations between echocardiographic parameters, AMI type, infarct topography and mechanical complication in a real-life tertiary care AMI population.

The posterior infarction at the exploratory threshold in this study was statistically significant for the exclusive occurrence of VSR in patients with STEMI, which is in line with what is known about the pathophysiology. STEMI is associated with complete transmural necrosis, especially of the posterior interventricular septum receiving blood supply from the posterior descending artery, that accounts for maximal structural vulnerability. The typically subendocardial distribution of ischemic injury means that there is usually enough myocardial mass to prevent full thickness rupture in NSTEMI. These results are similar to those previously reported in the literature, which indicate that VSR is essentially associated with STEMI. Implication for clinical practice: patients with a posterior STEMI should have immediate enhanced echocardiographic monitoring and careful attention should be paid to the interventricular septum.

Association with free wall rupture seemed clinically plausible, although not statistically significant at the conventional 0.05 alpha level, and warrants further prospective study. The lateral wall, which is supplied mainly by the circumflex artery, is also prone to post-reperfusion hemorrhagic transformation and aneurysm development and is a potential site for wall rupture. The lateral and posterior walls have been similarly reported in previous studies as the most frequent sites where free wall rupture occurs, and the present results, although small, support this observation.

The lack of association of AMI type with mitral regurgitation, papillary rupture, or left ventricular aneurysm formation indicates that these events occurred in a more diffuse manner. In the post-AMI setting, MR occurs through a variety of mechanisms, none of which is restricted to any single infarct territory, such as papillary muscle dysfunction, annular dilatation, and leaflet tethering from ventricular geometric distortion. The posterior medial papillary muscle is at risk of ischemic injury, no matter what coronary territory it is primarily supplied by. The distribution of LV aneurysm formation, which is a late event resulting from extensive myocardial necrosis and adverse remodeling, similarly is found throughout the infarct territories.

This high level of comorbidity (more than 40% of patients had chronic kidney disease and about 60% had a history of heart failure) has direct implications for risk stratification and management. Fluid retention worsens with chronic renal impairment, and treatment with pharmaceutical or mechanical circulatory support is less well-tolerated. This comorbidity profile highlights the need for simultaneous, personalized treatment of the acute infarction as well as the modifying effect of the underlying organ dysfunction.

The fact that 63.1% of patients had a LVEF of less than 45% further underscores the myocardial dysfunction associated with these patients. Reduced LVEF is directly correlated with the size of the AMI, and is a strong independent predictor of arrhythmic and heart failure events, making it a well-established role in the echocardiographic evaluation of AMI.

In a more holistic sense, the identification of high-risk subgroups with echocardiographic and clinical parameters could help facilitate early implementation of mechanical circulatory support devices, especially for VSR and FWR, where bridge-to-surgery may be lifesaving. Methods and timing of surgical repair are individualized, but early surgical repair is generally associated with a better outcome of the surgery and a better outcome of survival, when it is anatomically possible.

These are the limitations of this study. The data collection is a retrospective design that can give rise to incompleteness and inaccuracies in the measurement of the data. While the sample is sufficient for exploratory analysis, statistical power is reduced and some of the chi-square analyses had small expected cells, which resulted in less precision of the p-value estimates. Data from a single center do not allow for generalizability to other centers with different patient populations and/or management protocols. The use of a relaxed alpha threshold of 0.10 was methodologically acceptable for hypothesis generation but will lead to increased false-positive associations and needs to be replicated in adequately powered prospective studies.

6. CONCLUSION

The findings of this study confirm the essential role of echocardiography in the post-AMI risk stratification schema, and the results were specific enough to illustrate the importance of both the topographic and the nature of the AMI to the mechanical complications that develop. Ventricular septal rupture is a complication that is only present in STEMI patients, and is strongly linked with posterior infarction location, and therefore an increased need for echocardiographic monitoring in this group. In lateral infarctions, a trend to higher risk of free wall rupture, which has clinical significance, should be further explored. The diffuse nature of the consequences of ischemic myocardial insult gives rise to mitral regurgitation, papillary muscle rupture, and left ventricular aneurysm, which are found in areas outside of the infarct territory.

Taken together, these findings support the adoption of patient-specific echocardiographic surveillance strategies in post-AMI care pathways that are tailored to the patient's location. Incorporation of infarct topography with comorbidity profiling, especially chronic kidney disease and previous heart failure, is crucial for achieving the precision needed to provide timely, targeted intervention in the highest-risk patients.

6.1 Recommendations

Location-specific echocardiographic surveillance needs to be integrated into the clinical protocols used by the management of AMI. Patients with posterior STEMI should be screened for VSR with an intensive and early approach. In the lateral infarction, the index of suspicion for rupture of a free wall should be raised. All AMI patients, irrespective of the site of the AMI should receive thorough baseline and follow-up echocardiograms. Routine management of common comorbidities such as heart failure and chronic kidney disease (CKD) should be incorporated into the multidisciplinary care pathways. Standardized core laboratory echocardiographic adjudication should be performed in a multicentered, prospective study to confirm and expand on these data.

6.2 Limitations

The major limitations of this study are that it was a retrospective observational study, data was derived from a single center, the sample size was small with low numbers of cells in some analyses, exploratory significance level used (0.10) with increasing risk of Type I error, and core laboratory echocardiographic core adjudication was not performed. Further studies should use prospective multicenter study designs that include more patients and have a standardized echocardiographic protocol.

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