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Article

Frequency of Left Ventricular Thrombus After Anterior Wall ST Segment Elevation Myocardial Infarction

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ABSTRACT

Background: Left ventricular thrombus (LVT) is a known complication of anterior wall ST segment elevation myocardial infarction (STEMI), associated with increased risk of thromboembolic events. Despite advances in reperfusion therapy, data on its frequency in the local population remain limited, calling for region-specific evidence to guide clinical practice. **Objective**: To decide the frequency of left ventricular thrombus formation in patients presenting with anterior wall STEMI and evaluate its association with baseline clinical variables and reperfusion strategies. **Methods**: This was a prospective observational study conducted at the Punjab Institute of Cardiology, Lahore, from September 2, 2024, to February 3, 2025. A total of 100 patients (n = 100), aged 30–80 years, presenting within 12 hours of anterior wall STEMI were enrolled. Patients with hypercoagulable states, cardiopulmonary arrest, or end-stage liver/renal disease were excluded. LVT was assessed using transthoracic echocardiography on the fourth day of admission. Data on demographics, comorbidities, and treatment modality (thrombolysis vs. primary PCI) were collected. Data was analyzed using SPSS v27.0, applying descriptive and inferential statistics (chi-square test, $p < 0.05$). **Results**: LVT was detected in 7 patients (7.0%). The mean age of LVT-positive patients was 55.4 ± 7.7 years, and the majority were male (90%). LVT was more frequent among patients undergoing thrombolysis (7.9%) than those who received PCI (5.4%), though the difference was statistically insignificant ($p = 0.632$). No significant associations were found with smoking, diabetes, or BMI. **Conclusion**: The frequency of LVT in anterior wall STEMI was 7.0%, emphasizing the need for routine echocardiographic screening post-infarction. Early detection and anticoagulation can prevent embolic complications, supporting its integration into local STEMI management protocols.

Keywords: Left Ventricular Thrombus, ST Segment Elevation Myocardial Infarction, Echocardiography, Thrombolysis, Percutaneous Coronary Intervention, Anticoagulation, Cardiovascular Complications.

INTRODUCTION

Cardiovascular diseases remain among the most significant global health concerns, accounting for substantial morbidity and mortality each year. According to the World Health Organization (WHO), non-communicable diseases are the leading causes of death worldwide, with cardiovascular conditions ranking second among them. In Pakistan, cardiovascular diseases contribute to approximately 16.49% of all deaths, underscoring their public health burden (1). Among these, acute myocardial infarction (AMI), particularly anterior wall ST segment elevation myocardial infarction (STEMI), poses a critical threat due to its association with severe complications, including left ventricular thrombus (LVT). The formation of LVT is a recognized sequela of AMI, especially in cases where significant myocardial damage occurs, leading to left ventricular systolic dysfunction and blood stasis within the ventricular cavity (2,3).

Despite significant advances in the management of AMI, particularly with the advent of primary percutaneous coronary intervention (PPCI), the risk of post-infarct complications such as LVT persists. While thrombolytic therapy has traditionally played a role in early STEMI management, PPCI has demonstrated superiority by reducing mortality and adverse events. However, studies have shown that the risk of LVT formation remains highest in the first three months following an AMI, with reported incidence rates in Western populations

ranging from 2.9% to 15% (4). The first diagnostic approach typically involves transthoracic echocardiography (TTE), but recent improvements in imaging modalities—such as contrast echocardiography, cardiac MRI, and CT—have enhanced the detection and characterization of ventricular thrombi (5). Once identified, LVT is primarily managed through anticoagulation therapy, commonly with warfarin, to prevent thromboembolic events (5).

Although international literature has explored the frequency and risk factors associated with LVT, data from local populations, particularly in South Asia, remain sparse. Solheim et al. found an LVT incidence of 15% among patients with anterior wall STEMI treated with PPCI and dual antiplatelet therapy, suggesting that even with modern interventions, the risk remains clinically relevant (6). Other studies have reported varying frequencies of LVT, ranging from as low as 2.5% to over 20%, largely influenced by diagnostic modality, timing of assessment, and patient-specific factors such as ejection fraction and infarct size (7,8). However, the extrapolation of such findings to the Pakistani population is limited by differences in healthcare access, management protocols, and patient demographics.

Given the paucity of local data and the clinical significance of early LVT detection, this study was undertaken to determine the frequency of left ventricular thrombus formation in patients presenting with anterior wall STEMI at a tertiary care cardiac center in Pakistan. By identifying the local incidence and contextualizing it within the broader literature, this research aims to enhance understanding of LVT risk and inform improvements in the management and monitoring strategies of STEMI patients in our region. The study hypothesizes that a measurable proportion of patients with anterior wall STEMI will develop LVT, emphasizing the need for routine post-infarct echocardiographic evaluation in this high-risk group.

MATERIAL AND METHODS

This prospective, observational study was conducted at the Department of Cardiology, Punjab Institute of Cardiology, Lahore, from September 2, 2024, to February 3, 2025, after approval from the hospital's ethical review board. The study aimed to determine the frequency of left ventricular thrombus (LVT) formation in patients presenting with anterior wall ST segment elevation myocardial infarction (STEMI). The study included adult patients aged between 30 and 80 years, of either gender, who were admitted through the emergency department with a confirmed diagnosis of acute anterior wall STEMI within 12 hours of symptom onset. Diagnosis was established based on clinical presentation, electrocardiographic findings, and cardiac biomarkers in accordance with standard STEMI criteria. Exclusion criteria included patients with known hypercoagulable states (e.g., protein C or S deficiency, Factor V Leiden mutation), those who had experienced cardiopulmonary arrest or electrical cardioversion, and individuals with end-stage renal or hepatic disease, as these conditions could independently predispose to thrombus formation and confound the results.

Participants were recruited consecutively upon presentation to the emergency department. Written informed consent was obtained from all patients prior to their inclusion in the study. Confidentiality of participant data was strictly maintained, Ethical approval for the study was granted by the institutional review board Patients were managed according to standard hospital protocols for STEMI, including thrombolytic therapy or primary percutaneous coronary intervention (PPCI), as clinically indicated.

The primary outcome of interest was the detection of LVT on transthoracic echocardiography (TTE), performed routinely on the fourth day of admission. This timing was selected based on existing literature that suggests LVT typically forms within the first week following myocardial infarction (4). A two-dimensional TTE was performed using a standardized protocol and interpreted by experienced cardiologists blinded to the clinical details. Secondary variables collected included patient demographics (age, sex), body mass index (BMI), history of smoking, hypertension, diabetes mellitus (defined as random blood sugar ≥186 mg/dL), and the type of reperfusion therapy administered. Patients were monitored during their in-hospital stay and re-evaluated in the outpatient department one week after discharge for clinical status and echocardiographic follow-up, where applicable.

Data was entered and analyzed using IBM SPSS Statistics for Windows, Version 27.0. Quantitative variables such as age and BMI were expressed as mean ± standard deviation. Categorical variables like gender, smoking status, diabetes, hypertension, and presence of LVT were summarized as frequencies and percentages. Chi-square test was applied to assess associations between categorical variables, and a p-value <0.05 was considered statistically significant. Stratification was performed to examine the influence of potential confounders such as age, gender, and comorbidities on the frequency of LVT. No imputation was carried out for missing data as all required assessments were completed for the enrolled cohort. Sensitivity analysis was not applicable due to the descriptive nature of the study.

RESULTS

Smoking status and diabetes were also examined as potential risk factors. LVT was observed in 4 of 43 smokers (9.3%) and 3 of 36 diabetic patients (8.3%). However, no significant associations were found between LVT and smoking ($p = 0.431$) or diabetes ($p = 0.518$). Similarly, hypertension status did not significantly correlate with LVT development ($p = 0.342$).

Patients undergoing thrombolytic therapy showed a slightly higher incidence of LVT (7.9%) compared to those who did not receive thrombolysis (5.4%), but this difference was not statistically significant ($\chi^2 = 0.229$, $p = 0.632$). Likewise, patients treated with primary PCI had an LVT rate of 5.7%, whereas 15.4% of those not undergoing PCI developed LVT ($\chi^2 = 1.614$, $p = 0.204$). Although not statistically significant, the higher incidence of LVT among non-PCI patients may suggest a clinical trend toward protective benefit from early revascularization.

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Table 1 Baseline Characteristics of Patients with and Without LVT

Variable	With LVT (n = 7)	Without LVT (n = 93)	Total (n = 100)	p-value
Mean Age (years) ± SD	55.43 ± 7.7	52.48 ± 10.2	52.94 ± 9.9	0.069
Male, n (%)	6 (85.7%)	84 (90.3%)	90 (90.0%)	0.643
Mean BMI (kg/m²) ± SD	24.91 ± 2.8	24.50 ± 3.6	24.54 ± 3.49	0.742
Smokers, n (%)	4 (57.1%)	39 (41.9%)	43 (43.0%)	0.431
Diabetics, n (%)	3 (42.9%)	33 (35.5%)	36 (36.0%)	0.518
Hypertensives, n (%)	4 (57.1%)	40 (43.0%)	44 (44.0%)	0.342

A total of 100 patients diagnosed with anterior wall ST segment elevation myocardial infarction (STEMI) were enrolled in the study. The mean age of the study population was 52.94 ± 9.9 years. Among these, 90 patients (90.0%) were male and 10 (10.0%) were female. Left ventricular thrombus (LVT) was identified in 7 patients (7.0%) based on transthoracic echocardiography performed on day four of admission.

Table 2 Association Between Thrombolysis and LVT Formation

Thrombolysis	LVT Present, n (%)	LVT Absent, n (%)	Total, n	χ^2	p-value
Yes (n = 63)	5 (7.9%)	58 (92.1%)	63	0.229	0.632
No (n = 37)	2 (5.4%)	35 (94.6%)	37		

The mean age of patients who developed LVT was slightly higher (55.43 ± 7.7 years) compared to those without LVT (52.48 ± 10.2 years), though this difference did not reach statistical significance (p = 0.069). The average BMI in the overall cohort was 24.54 ± 3.49 kg/m², and no statistically significant relationship was found between BMI and LVT occurrence.

Table 3 Association Between Primary PCI and LVT Formation

PCI Performed	LVT Present, n (%)	LVT Absent, n (%)	Total, n	χ^2	p-value
Yes (n = 87)	5 (5.7%)	82 (94.3%)	87	1.614	0.204
No (n = 13)	2 (15.4%)	11 (84.6%)	13		

Although the statistical tests did not yield significant associations, the trend observed suggests a potential clinical implication: patients who did not undergo PCI had more than double the LVT frequency compared to those who did. This reinforces the role of early and effective revascularization in limiting myocardial injury and reducing thrombus formation risk. Unexpectedly, a slightly higher LVT incidence was seen in patients who received thrombolysis compared to those who did not, possibly due to suboptimal reperfusion outcomes in thrombolytic therapy.

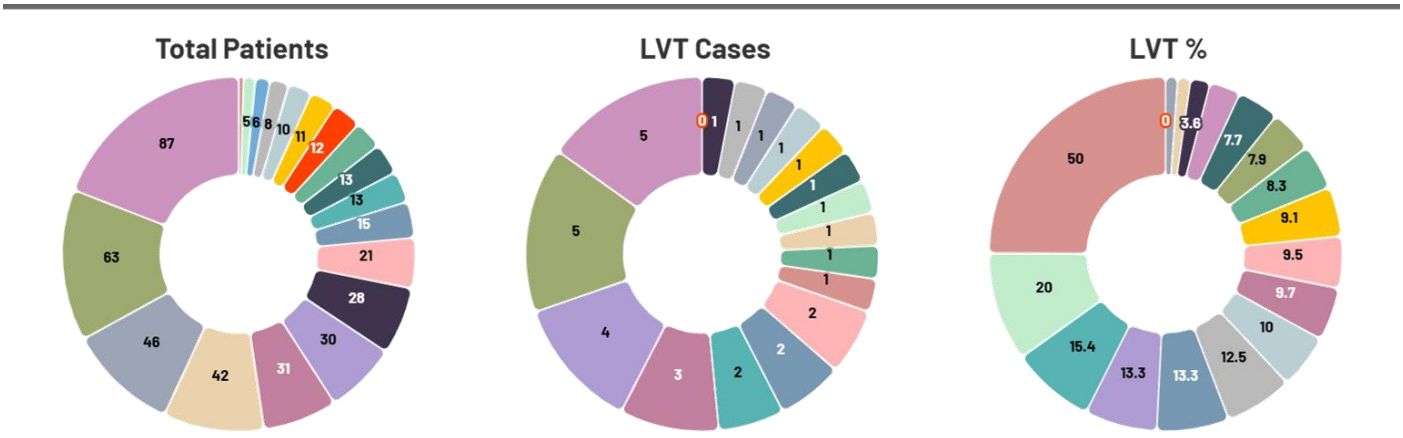

Figure 1 Subgroup Insights on LVT Frequency

The overall frequency of LVT in this cohort (7.0%) is within the lower to mid-range of values reported in global studies, supporting the relevance of early echocardiographic screening in anterior wall STEMI. These findings, though limited by sample size and single-center design, have meaningful clinical implications, suggesting that routine post-infarct imaging may enhance detection of subclinical thrombus and optimize secondary prevention strategies.

DISCUSSION

The development of left ventricular thrombus (LVT) following anterior wall ST segment elevation myocardial infarction (STEMI) remains a clinically significant complication with implications

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for patient prognosis, particularly due to the risk of systemic embolization, including stroke. In this prospective study, the frequency of LVT was found to be 7.0%, aligning with the lower end of the incidence spectrum reported in international literature, which ranges between 2.9% and 15% depending on study design, patient selection, diagnostic methods, and timing of assessment (4). This observed rate is comparable to the 7.9% reported in a study by Solheim et al., where patients with anterior wall STEMI were treated with percutaneous coronary intervention (PCI) and dual antiplatelet therapy (6). The similarity in findings reinforces the contemporary understanding that prompt reperfusion and evidence-based pharmacotherapy may contribute to a reduced thrombus burden (7-16).

However, earlier studies, particularly from the pre-PCI era or those utilizing delayed or non-contrast echocardiography, have reported markedly higher LVT frequencies. For instance, Iqbal et al. documented a 27% LVT rate in their cohort, which may reflect differences in population characteristics, extent of myocardial damage, or limitations in early revascularization strategies (6). Conversely, studies reporting significantly lower rates of LVT, such as 2.5% and 4.3%, often used stricter diagnostic thresholds or included mixed infarct locations, which typically carry a lower thrombus risk (9,10). These variations emphasize the influence of infarct size, anterior wall involvement, and regional differences in access to timely and effective cardiac care (17-19).

The pathophysiological basis of LVT formation involves Virchow's triad: endothelial injury, hypercoagulability, and stasis of blood flow. In the context of large anterior wall infarcts, especially those involving the apical region, impaired contractility and akinesis promote blood pooling, creating an environment conducive to thrombus formation. While our study did not evaluate ejection fraction or wall motion abnormalities in detail, these factors are well-established predictors of thrombus development and should be integrated into future risk stratification tools (8). The lack of association between thrombolytic or PCI-based reperfusion strategies and LVT in our study, although not statistically significant, suggests that residual infarct burden and timing of intervention may be more critical determinants than the modality of reperfusion itself (18-21).

Clinically, the presence of LVT necessitates careful management with anticoagulation to prevent thromboembolic complications. The current standard involves initiation of warfarin therapy upon detection of LVT, but future studies may explore the role of novel oral anticoagulants (NOACs) in this setting, given their growing use in other thromboembolic conditions. From a diagnostic standpoint, while this study employed conventional two-dimensional transthoracic echocardiography, modalities like contrast echocardiography and cardiac MRI offer superior sensitivity and specificity, potentially leading to earlier and more accurate detection (5). Incorporating advanced imaging protocols may refine diagnostic accuracy in future local studies (22).

This study contributes to the limited body of literature on LVT in South Asian populations, offering region-specific insights into its incidence and clinical context. Its prospective design, use of standardized protocols, and real-world setting enhance its relevance. However, several limitations must be acknowledged. The relatively small sample size (n=100) limits statistical power, and the single-center design may affect the generalizability of findings to broader populations. Additionally, echocardiographic assessments were limited to a single time point (day 4), potentially missing thrombi that form later during the recovery phase. Lack of detailed imaging parameters such as ejection fraction or infarct size further constrains mechanistic interpretations. Moreover, the absence of long-term follow-up precludes evaluation of thrombus resolution or embolic outcomes.

Future research should focus on larger multicenter cohorts with extended follow-up and integration of advanced imaging modalities to better delineate the temporal profile and clinical predictors of LVT. Incorporating quantitative measures of infarct size, ventricular function, and inflammatory markers may also enhance risk stratification. Furthermore, interventional studies assessing the efficacy and safety of newer anticoagulants in managing post-STEMI thrombus would offer valuable clinical direction. In conclusion, the present study highlights a measurable frequency of LVT in anterior wall STEMI within the local population and underscores the importance of early echocardiographic evaluation. These findings support the continued refinement of management protocols to minimize the risk of thromboembolic complications in this high-risk subgroup.

CONCLUSION

This study identified a 7.0% frequency of left ventricular thrombus (LVT) formation in patients with anterior wall ST segment elevation myocardial infarction (STEMI), highlighting its continued relevance as a post-infarct complication despite advancements in reperfusion strategies. These findings underscore the importance of routine echocardiographic screening in the early post-STEMI period to enable timely diagnosis and anticoagulation, thereby reducing the risk of thromboembolic events. The results emphasize the need for context-specific clinical protocols in resource-limited settings and contribute to the limited local data on LVT prevalence. Future research should focus on larger, multicenter studies incorporating advanced imaging modalities and exploring optimized therapeutic strategies to further improve outcomes in this high-risk patient population (19-22).

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