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Original Research Article

ST-Segment Elevation in Lead aVR as a Predictor of Significant Left Main Coronary Artery

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Abstract: ***Background:*** Left main coronary artery (LMCA) disease is a critical condition with high mortality, necessitating rapid and accurate diagnosis. ST-segment elevation in lead aVR (STEaVR) has been proposed as a specific electrocardiographic (ECG) marker for significant LMCA obstruction. ***Objective:*** To evaluate the predictive value of STEaVR for identifying significant LMCA disease in Bangladeshi population. ***Methods:*** This prospective cross-sectional study was conducted at Ibn Sina Medical College Hospital, Dhaka, from July 2024 to June 2025. A purposive sample of 87 patients presenting with suspected acute coronary syndrome and undergoing coronary angiography was enrolled. The presence of ≥0.5 mm STEaVR was identified on the admission ECG. Significant coronary artery disease was defined as ≥50% stenosis of the LMCA or ≥70% in other major epicardial vessels. Data were analyzed using SPSS version 23.0. ***Results:*** Significant LMCA disease was identified in 27.6% (24/87) of patients. ST-segment elevation in lead aVR (STEaVR) demonstrated a sensitivity of 79.2% and a specificity of 82.5% for predicting LMCA obstruction. The positive and negative predictive values were 63.3% and 91.2%, respectively. The presence of STEaVR was associated with 18-fold increased odds of LMCA disease (OR: 18.0, 95% CI: 5.87-55.18, p<0.001). ***Conclusion:*** STEaVR is a highly specific predictor of critical left main coronary artery disease. Its presence on ECG should prompt urgent coronary angiography. This simple marker is invaluable for rapid risk stratification and guiding immediate intervention.

Keywords: Acute coronary syndrome, Coronary angiography, Left main coronary artery, Predictor, ST-segment elevation aVR.

INTRODUCTION

Cardiovascular diseases remain the leading cause of mortality and morbidity worldwide, with acute coronary syndromes (ACS) representing a substantial proportion of these critical presentations [1]. Among ACS, significant obstruction of the left main coronary artery (LMCA) is a particularly ominous finding, supplying approximately 75% of the left ventricular myocardium. LMCA disease is associated with high mortality rates, often exceeding 20% at 30 days without prompt revascularization, due to the extensive area of myocardium at risk [2, 3]. The timely and accurate identification of LMCA occlusion is therefore paramount, as it dictates an

urgent management strategy involving emergency revascularization, either by percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) [4]. The initial diagnostic workup for ACS heavily relies on the 12-lead electrocardiogram (ECG), a non-invasive, rapid, and universally available tool. While ST-segment elevation in the precordial and standard limb leads is a well-established indicator of acute myocardial infarction, its patterns in other leads can signify more complex and prognostically grave pathologies. In this context, ST-segment elevation in lead aVR (STEaVR) has emerged as a crucial electrocardiographic sign, often serving as a red flag for extensive myocardial ischemia [5]. Lead aVR, frequently overlooked as it does not view a specific ventricular wall, provides a global perspective of the heart's electrical activity from the right upper quadrant, facing the basal septum and right ventricular outflow tract. Consequently, it is uniquely positioned to detect transmural ischemia in the territory supplied by the LMCA [6, 7]. The pathophysiological basis for STEaVR in LMCA disease involves the interruption of blood flow in the left anterior descending (LAD) artery proximal to the first septal perforator. This causes extensive subendocardial ischemia of the basal septum, which is reflected as ST-segment elevation in aVR. Concurrently, this global subendocardial ischemia manifests as widespread ST-segment depression in multiple other leads, a classic pattern associated with poor outcomes [8, 9]. Several studies have investigated this signature pattern, suggesting that STEaVR ≥ 0.5 mm, especially when accompanied by diffuse ST-segment depression, is a powerful predictor of LMCA or severe triple-vessel disease [10, 11]. Despite its established association, the diagnostic and prognostic accuracy of STEaVR continues to be a subject of research, particularly within specific demographic and regional populations where the prevalence and presentation of coronary artery disease may vary. Recent meta-analyses have reinforced its value but also call for more prospective data [12, 13]. In the context of Bangladesh, where the burden of cardiovascular disease is rising rapidly and healthcare resources can be strained, a simple, readily available predictive tool like an ECG finding is of immense clinical utility. Therefore, this study aimed to prospectively evaluate the predictive value of ST-segment elevation in lead aVR for identifying significant left main coronary artery disease in patients presenting with suspected ACS at a tertiary care hospital in Dhaka, Bangladesh. We hypothesize that STEaVR is a highly specific and sensitive marker for critical LMCA obstruction, and its presence can serve as an early warning sign to prioritize urgent invasive assessment and management.

METHODOLOGY

Study Population

This prospective cross-sectional study will be conducted at the Department of Cardiology, Ibn Sina Medical College Hospital, Dhaka, from July 2024 to June 2025. A purposive sample of 87 patients presenting with symptoms suggestive of acute coronary syndrome (ACS) and referred for coronary angiography will be enrolled.

Inclusion Criteria

Patients aged 18 years and above, of either gender, who provide informed consent and are scheduled for coronary angiography based on a clinical diagnosis of ACS will be included in the study population.

Exclusion Criteria

Patients with a history of prior coronary artery bypass graft (CABG) surgery, paced rhythm, left bundle branch block, or poor-quality ECG tracings that preclude accurate ST-segment analysis will be excluded from the study.

Study Procedure

On admission, a standard 12-lead ECG will be recorded for each patient. The presence of ST-segment elevation (≥0.5 mm) in lead aVR will be assessed by two independent cardiologists blinded to the angiographic data. All patients will subsequently undergo coronary angiography.

Data Analysis

Angiographic findings will define significant stenosis as ≥50% narrowing of the left main coronary artery or ≥70% in other major epicardial vessels. Data will be analyzed using SPSS version 23.0. The sensitivity, specificity, and predictive values of STEaVR for predicting significant LMCA disease will be calculated.

RESULT

A total of 87 patients who met the inclusion criteria were enrolled in the study. The mean age of the study population was 58.4 ± 10.2 years, with a male predominance (68.9%, n=60). The most common cardiovascular risk factors were hypertension (63.2%, n=55) and smoking (52.9%, n=46), followed by diabetes mellitus (42.5%, n=37) and dyslipidemia (39.1%, n=34). Coronary angiography revealed significant coronary artery disease in 78 patients (89.7%). Among these, significant left main coronary artery (LMCA) disease, defined as ≥50% stenosis, was present in 24 patients (27.6% of the total cohort). Isolated LMCA disease was rare (n=3), with the majority of cases (n=21) occurring alongside significant multi-vessel disease. The most common angiographic finding was triple-

vessel disease, present in 32 patients (36.8%). The key ECG finding of ST-segment elevation ≥0.5 mm in lead aVR (STEaVR) was present in 30 patients (34.5%). The prevalence of STEaVR was significantly higher in the group with significant LMCA disease (79.2%, n=19) compared to those without LMCA disease (17.5%, n=11). This difference was statistically highly significant. The diagnostic performance of STEaVR for predicting LMCA disease was robust. The sensitivity was calculated at 79.2% and the specificity was 82.5%. The positive predictive value was 63.3%, indicating that nearly two-thirds of patients with this ECG finding had critical LMCA stenosis. The negative predictive value was 91.2%, demonstrating that the absence of STEaVR effectively rules out LMCA disease in most cases. Furthermore, the magnitude of STEaVR was notably greater in patients with LMCA disease (1.5 ± 0.6 mm) compared to those without (0.3 ± 0.4 mm). The presence of concomitant widespread ST-segment depression in ≥7 other leads was also a strong predictor, observed in 87.5% of the LMCA disease group versus only 15.9% in the non-LMCA disease group. The odds of having significant LMCA disease were over 18 times higher in patients presenting with STEaVR on their initial ECG compared to those without it.

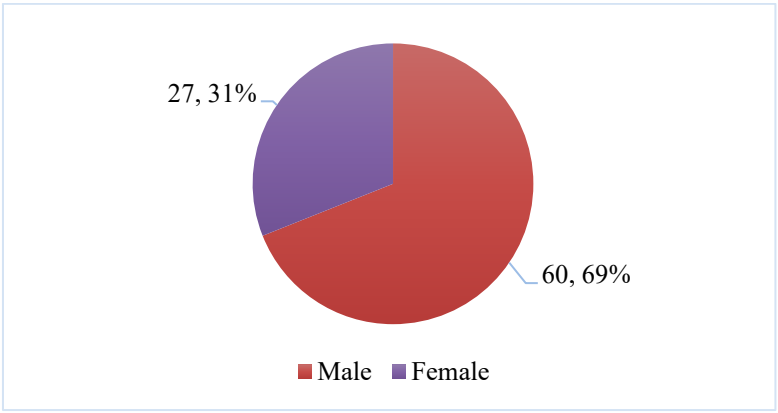

Figure 1: Gender distribution

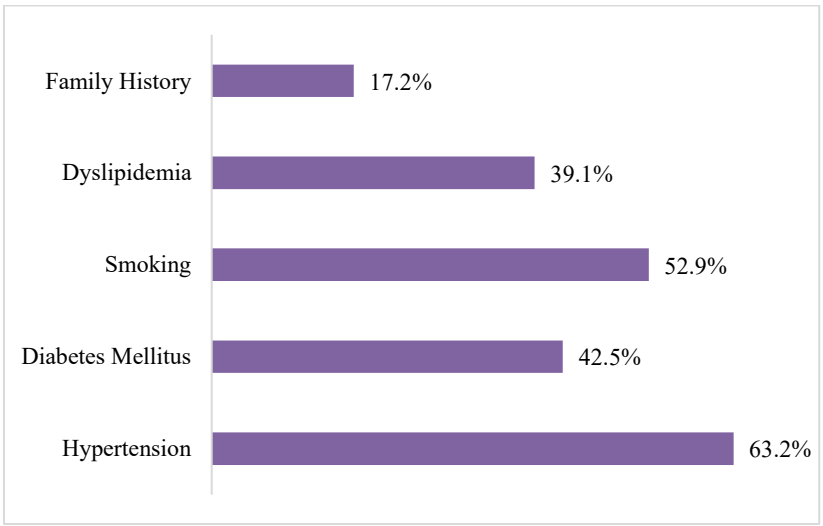

Figure 2: Cardiovascular risk factors distribution

Table 1: Angiographic findings distribution (N=87)

Findings	n	%
No significant CAD	9	10.3%
Single-vessel disease	17	19.5%
Double-vessel disease	20	23.0%
Triple-vessel disease	32	36.8%
Significant LMCA disease	24	27.6%
Isolated LMCA	3	3.4%
LMCA + MVD	21	24.1%

CAD: Coronary Artery Disease; LMCA: Left Main Coronary Artery; MVD: Multi-Vessel Disease

Table 2: Prevalence of STEaVR stratified by angiographic outcome

Group	STEaVR	
	Present	Absent
LMCA (n=24)	19 (79.2%)	5 (20.8%)
No LMCA (n=63)	11 (17.5%)	52 (82.5%)
Total (N=87)	30 (34.5%)	57 (65.5%)

Data presented as n (%). p-value < 0.001 (Chi-square test)

Table 3: Diagnostic performance of STEaVR for predicting significant LMCA disease

Parameter	Value	95% CI
Sensitivity	79.2%	60.5% - 90.8%
Specificity	82.5%	71.5% - 90.0%
PPV	63.3%	45.7% - 78.1%
NPV	91.2%	81.4% - 96.3%
Accuracy	81.6%	72.2% - 88.5%

PPV: Positive predictive value, NPV: Negative predictive value

Table 4: Comparison of ECG and angiographic parameters

Parameter	LMCA disease	
	Yes	No
	(n=24)	(n=63)
	%/Mean ± SD	
Magnitude of STEaVR (mm)	1.5 ± 0.6	0.3 ± 0.4
Widespread STD (≥7 leads)	87.5%	15.9%

p-value < 0.001; STD: ST-Segment Depression, p-values calculated using the Independent Samples t-test for magnitude and the Chi-square test for widespread STD

Table 5: Odds ratio for significant LMCA disease based on the presence of STEaVR

Variable	OR	95% CI
STEaVR (Yes vs. No)	18	5.87-55.18

OR: Odds ratio, p-value < 0.001, Analysis performed using Binary Logistic regression

DISCUSSION

The principal finding of this prospective study is that ST-segment elevation in lead aVR (STEaVR) is a highly specific and significant predictor of critical left main coronary artery (LMCA) disease in patients presenting with suspected ACS. The presence of this ECG marker was associated with 18-fold increased odds of having significant LMCA obstruction, underscoring its vital role as a rapid, non-invasive risk stratification tool. Our results align robustly with the existing body of literature. The high specificity (82.5%) we observed is consistent with studies by Kosuge *et al*., [10], and Wong *et al*., [11], who reported specificities exceeding 80% for STEaVR in identifying LMCA or severe triple-vessel disease. This high specificity is clinically paramount; it signifies that when STEaVR is present, there is a very high probability of a life-threatening coronary lesion, necessitating urgent angiography. The sensitivity of 79.2% in our cohort is also comparable to previous reports [14, 15], indicating that this sign captures the majority of LMCA occlusions. The negative predictive value of 91.2% is equally critical, as it provides clinicians with a high degree of confidence that LMCA disease is unlikely in its absence, potentially streamlining the management pathway for other ACS types. The pathophysiological basis for our findings is well-established. Lead aVR faces the right superior cavity of the heart and the basal portion of the interventricular septum. Extensive global subendocardial ischemia, as caused by critical LMCA stenosis disrupting flow in the left anterior descending artery proximal to the first septal perforator, manifests as a current of injury directed toward the right shoulder. This is recorded as ST-segment elevation in aVR and reciprocal ST depression in multiple other leads [6-16]. Our data strongly support this mechanism, demonstrating that patients with LMCA disease had a significantly greater magnitude of STEaVR and a markedly higher prevalence of concomitant widespread ST depression. The demographic profile of our study population, with hypertension and smoking as predominant risk factors, reflects the growing cardiovascular disease burden in South Asia [17]. This makes our findings particularly relevant to the regional context, suggesting that the predictive value of STEaVR is applicable across different ethnicities and healthcare settings. The high prevalence of multi-vessel disease alongside LMCA stenosis further

emphasizes the severity of coronary artery disease in patients presenting with this ECG pattern [18]. While our study confirms the prognostic value of STEaVR, it is essential to acknowledge that it is not pathognomonic. Other conditions, such as left ventricular hypertrophy, tachyarrhythmias, or global ischemia from other causes, can sometimes produce similar patterns [19, 20]. Therefore, the ECG must be interpreted within the full clinical context. Nonetheless, its presence should invariably lower the threshold for urgent coronary evaluation. The consistent findings across studies, including ours, solidify the role of STEaVR as a crucial component in the early diagnostic algorithm for high-risk ACS patients [12, 21].

Limitations

This single-center study utilized purposive sampling, which may limit generalizability. The sample size, though calculated, was modest. Inter-observer variability in ECG interpretation, though minimized, was not formally assessed. Long-term outcome data were not included in this analysis.

CONCLUSION

ST-segment elevation ≥0.5 mm in lead aVR is a highly specific and significant predictor of critical left main coronary artery disease. Its presence on the admission ECG should alert clinicians to this life-threatening condition, prompting urgent coronary angiography. This simple, non-invasive marker is invaluable for rapid risk stratification, especially in resource-limited settings, to guide immediate intervention and improve patient outcomes.

Recommendation

Clinicians should urgently assess lead aVR on every ECG in suspected ACS. Its ST-elevation warrants immediate cardiology consultation and expedited coronary angiography. Future multi-center studies with larger sample sizes are recommended to validate these findings and assess long-term outcomes.

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