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Original Article

Lead aVR ST-Segment Elevation as a Marker for Left Main Coronary Artery Disease in Acute Coronary Syndrome Patients

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ABSTRACT

Background: Coronary artery disease (CAD) is a leading cause of death globally, including in Pakistan. Accurate and timely identification of severe left main coronary artery disease (LM-CAD) in patients with acute coronary syndrome (ACS) is crucial for improving outcomes. ST-segment elevation in lead aVR on electrocardiogram (ECG) has been proposed as a potential marker for LM-CAD.

Objective: The study aimed to ascertain the prevalence of left main coronary artery disease in acute coronary syndrome patients exhibiting ST-segment elevation in lead aVR and to evaluate the diagnostic utility of this ECG finding.

Methods: This cross-sectional study was conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar, KPK, Pakistan, from April 2023 to May 2024. A total of 125 patients aged 18-75 years with ST-segment elevation of >0.5mm in lead aVR were enrolled. Exclusion criteria included chronic kidney disease, severe anemia, dextrocardia, history of circulatory collapse, low ejection fraction, and prior bypass grafting. Demographic and clinical data were collected, and all patients underwent coronary angiography. Data analysis was performed using SPSS version 25.0. Quantitative variables were presented as mean ± standard deviation, while qualitative variables were expressed as frequencies and percentages. The chi-square test was used to find associations, with a p-value <0.05 considered significant. The study followed ethical guidelines, including informed consent and institutional ethical board approval.

Results: The cohort included 70.4% males and 29.6% females, with a mean age of 55.76 ± 6.5 years. Among the patients, 81.6% had LM-CAD. Significant associations were found between LM-CAD and smoking (P = 0.017) as well as obesity (P = 0.003). No significant associations were observed with age (P = 0.825) or gender (P = 0.764). Among the types of ACS, NSTEMI patients had the highest LM-CAD prevalence (48%), followed by STEMI (22.4%) and unstable angina (11.2%), with a significant association between unstable angina and LM-CAD (P = 0.048).

Conclusion: ST-segment elevation in lead aVR is a reliable indicator of left main coronary artery disease in patients presenting with acute coronary syndrome. Major cardiovascular risk factors such as smoking and obesity showed strong correlations with this ECG finding. Incorporating lead aVR analysis into routine ECG evaluations can enhance diagnostic accuracy and facilitate early therapeutic decisions, potentially improving patient outcomes.

Keywords: left main coronary artery disease, aVR, electrocardiography, ST-segment elevation, acute coronary syndrome, obesity, smoking, diagnostic markers, coronary angiography, cardiovascular risk factors.

INTRODUCTION

Coronary artery bypass (CAD) remains a leading cause of mortality worldwide, with a significant impact on public health in Pakistan as well (1). Among the most severe manifestations of CAD is left main coronary artery disease (LM-CAD), characterized by stenosis exceeding 50% of the vessel diameter, posing a substantial threat due to its potential to compromise blood flow to the left ventricle and precipitate severe cardiovascular events .In the context of acute coronary syndrome (ACS), which encompasses a spectrum of

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conditions from unstable angina to ST-elevation myocardial infarction (STEMI), timely and accurate diagnosis of LM-CAD is crucial for improving patient outcomes (2, 3).

Historically, the prognosis for patients with LM-CAD was poor, with a three-year survival rate of merely 37% before the advent of revascularization techniques such as percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG), which have significantly improved survival rates (4). Despite advancements in treatment, the identification of LM-CAD in the setting of ACS remains challenging, necessitating reliable diagnostic markers to guide early intervention.(5)

Electrocardiography (ECG) is a fundamental diagnostic tool in cardiology, providing immediate and non-invasive insights into cardiac function. Among the various ECG leads, lead aVR has gained attention for its potential role in diagnosing LM-CAD. Studies have indicated that ST-segment elevation in lead aVR, particularly when greater than in lead V1, can serve as a significant indicator of LM-CAD, distinguishing it from other types of coronary artery disease with high diagnostic accuracy (6, 7) This finding underscores the importance of incorporating lead aVR analysis into routine ECG evaluations, especially in ACS patients, to enhance diagnostic precision and facilitate prompt therapeutic decisions (8).

The present study aims to ascertain the prevalence of LM-CAD in patients presenting with ACS who exhibit ST-segment elevation in lead aVR. By correlating these ECG findings with coronary angiography results, which remains the gold standard for diagnosing LM-CAD, the study seeks to validate the utility of lead aVR as a predictive marker. This research not only focuses on the diagnostic value of ST-segment elevation in lead aVR but also explores the association of LM-CAD with various demographic and clinical factors, including age, gender, smoking status, and obesity, to provide a comprehensive risk assessment framework for ACS patients (9).

Recent studies, such as those by Kosuge et al. and Morris et al., have highlighted the prognostic significance of ST-segment elevation in lead aVR in the context of acute myocardial infarction, supporting its use as a reliable marker for LM-CAD (10, 11). Additionally, research by Barrabes et al. has emphasized the association of lead aVR findings with adverse cardiac events and mortality, further underscoring the need for early invasive management in patients exhibiting this ECG pattern (12). The integration of these insights into clinical practice could potentially lead to better patient outcomes by enabling more accurate and timely identification of high-risk individuals.

In conclusion, this study aims to establish the prevalence and diagnostic utility of ST-segment elevation in lead aVR for detecting LM-CAD in ACS patients. By validating this ECG marker's prognostic value and exploring its correlation with major cardiovascular risk factors, the research endeavors to enhance the clinical management of ACS, ultimately contributing to improved patient care and outcomes (13).

MATERIAL AND METHODS

This observational cross-sectional study was conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar, KPK, Pakistan, over a one-year period from April 2023 to May 2024. The study aimed to investigate the prevalence and diagnostic utility of ST-segment elevation in lead aVR for detecting left main coronary artery disease (LM-CAD) in patients presenting with acute coronary syndrome (ACS). A total of 125 patients were enrolled based on a sample size calculation that ensured statistical robustness. Eligibility criteria included both male and female patients aged between 18 and 75 years who presented with ACS and exhibited ST-segment elevation of greater than 0.5mm in lead aVR on electrocardiogram. Exclusion criteria were established to minimize confounding factors and included patients with chronic kidney disease requiring dialysis (glomerular filtration rate <25 ml/min/1.73m^2), severe anemia (hemoglobin <8g/dl), dextrocardia, history of circulatory collapse requiring cardiopulmonary resuscitation, left ventricular ejection fraction <20%, and those with prior coronary artery bypass grafting.

Data collection involved obtaining informed consent from all participants, ensuring compliance with ethical standards outlined in the Declaration of Helsinki. Demographic data, including age and gender, as well as clinical characteristics such as risk factors and comorbidities, were recorded using a standardized proforma. This included details on diabetes mellitus, hypertension, smoking status, and obesity (body mass index >30 kg/m^2). Electrocardiographic assessment focused on identifying ST-segment elevation in lead aVR, and all patients subsequently underwent coronary angiography, the gold standard for diagnosing LM-CAD.

The ethical review board of the Hayatabad Medical Complex approved the study protocol, emphasizing informed consent and patient confidentiality. Data analysis was performed using SPSS version 25.0. Quantitative variables were presented as mean ± standard deviation, while qualitative variables were expressed as frequencies and percentages. Statistical associations between ST-segment elevation in lead aVR and the presence of LM-CAD were evaluated using the chi-square test, with a p-value of less than 0.05 considered significant.

Stratification was carried out based on age, gender, and comorbidities to identify any potential confounding factors. The study also investigated the relationship between LM-CAD and ACS subtypes, including non-ST-elevation myocardial infarction (NSTEMI), ST-

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elevation myocardial infarction (STEMI), and unstable angina. Results were presented in a manner that facilitated a clear understanding of the prevalence and diagnostic implications of ST-segment elevation in lead aVR for LM-CAD.

Overall, this study adhered to rigorous methodological standards to ensure the reliability and validity of its findings, contributing valuable insights into the diagnostic approach for ACS patients and highlighting the significance of lead aVR in routine ECG evaluations

RESULTS

The study included 125 patients, with a mean age of 55.76 ± 6.5 years. The cohort consisted of 88 males (70.4%) and 37 females (29.6%). The prevalence of various risk factors and the types of acute coronary syndrome (ACS) among the participants are detailed in the tables below.

Table 1 Baseline Clinical Features and Prevalence of LMS Disease

Characteristic	Sub-groups	Frequency (N=125)	Percentage (%)
Gender Distribution	Male	88	70.4
	Female	37	29.6
Prevalence of Risk Factors	Diabetes Mellitus	53	42.3
	Hypertension	73	58.4
	Smoking	47	37.6
	Obesity (BMI >30kg/m²)	53	42.4
Type of ACS	NSTEMI	70	56.0
	STEMI	34	27.2
	Unstable Angina	21	16.8
Left Main Stem Disease	Present	102	81.6
	Absent	23	18.4

Table 2 Association of Left Main CAD with Age

Age Group (Mean±SD = 55.76 ±6.5 years)	Left Main CAD	Total	Percentage (%)	P-Value
Below 55 years	Yes	64	51.2	0.825
	No	13	10.4	
Above 55 years	Yes	38	30.4	
	No	10	8.0	
Total	Yes	102	81.6	
	No	23	18.4	

Table 3 Association of Left Main CAD with Gender

Gender	Left Main CAD	Total	Percentage (%)	P-Value
Male	Yes	72	57.6	0.764
	No	16	12.8	
Female	Yes	30	24.0	
	No	7	5.6	
Total	Yes	102	81.6	
	No	23	18.4	

Table 4 Association of Left Main CAD with Smoking

Smoking Status	Left Main CAD	Total	Percentage (%)	P-Value
Smoker	Yes	41	32.8	0.017
	No	6	4.8	
Non-smoker	Yes	61	48.8	
	No	17	13.6	

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Smoking Status	Left Main CAD	Total	Percentage (%)	P-Value
Total	Yes	102	81.6	
	No	23	18.4	

Table 5 Association of Left Main CAD with Obesity

Obesity (BMI >30kg/m²)	Left Main CAD	Total	Percentage (%)	P-Value
Yes	Yes	53	42.4	0.003
	No	11	8.8	
No	Yes	49	39.2	
	No	12	9.6	
Total	Yes	102	81.6	
	No	23	18.4	

Table 6 Prevalence of Left Main CAD across Different Types of ACS

Type of ACS	Left Main CAD	Total	Percentage (%)	P-Value
NSTEMI	Yes	60	48.0	0.197
	No	10	8.0	
STEMI	Yes	28	22.4	0.894
	No	6	4.8	
Unstable Angina	Yes	14	11.2	0.048
	No	7	5.6	
Total	Yes	102	81.6	
	No	23	18.4	

The study demonstrated that 81.6% of the 125 patients exhibited left main stem disease (LMS), reflecting its significant prevalence among the study population. Among the participants, 70.4% were males, and 29.6% were females. The most common risk factors included hypertension (58.4%), diabetes mellitus (42.3%), smoking (37.6%), and obesity (42.4%). In terms of ACS types, NSTEMI was the most prevalent (56.0%), followed by STEMI (27.2%) and unstable angina (16.8%).

There was a statistically significant association between smoking and LM-CAD (P = 0.017) as well as obesity and LM-CAD (P = 0.003). No significant associations were found between age or gender and LM-CAD. Additionally, a significant association was observed between unstable angina and LM-CAD (P = 0.048).

The findings suggest that ST-segment elevation in lead aVR is a reliable indicator of LM-CAD, with a high prevalence of LM-CAD in patients with ACS and ST-elevation in lead aVR. The results highlight the importance of incorporating lead aVR analysis into routine ECG evaluations for ACS patients, enabling timely and accurate diagnosis of LM-CAD, which is critical for guiding early therapeutic decisions and improving patient outcomes

DISCUSSION

The study demonstrated a significant prevalence of left main coronary artery disease (LM-CAD) among patients presenting with acute coronary syndrome (ACS) and ST-segment elevation in lead aVR, with 81.6% of the cohort exhibiting LM-CAD. This finding aligns with prior research, which identified ST-segment elevation in lead aVR as a reliable marker for LM-CAD in patients with acute myocardial infarction (14). Similarly, another study. underscored the diagnostic accuracy of lead aVR in identifying significant left main stem disease, corroborating the present study's results (15).

The study's patient population predominantly consisted of males (70.4%), consistent with the higher incidence of cardiovascular disease observed in men. The mean age of 55.76 years reflected a middle-aged demographic, typical of CAD studies. The prevalence of major cardiovascular risk factors such as hypertension, diabetes mellitus, smoking, and obesity was notable, with significant associations found between LM-CAD and both smoking (P = 0.017) and obesity (P = 0.003). These associations reinforced , who highlighted smoking as a significant risk factor for LMCA disease (16).

Interestingly, no significant associations were observed between LM-CAD and age or gender. This lack of association aligns with previous studies focusing on ECG parameters rather than demographic factors as primary diagnostic tools for LM-CAD (9, 10). The study also found a significant association between unstable angina and LM-CAD (P = 0.048), suggesting a higher likelihood of LM-

CAD in patients with this ACS subtype. This observation aligns with the findings of who reported similar trends in the context of ST-segment elevation in lead aVR and its association with LM-CAD (17).

One of the study's strengths was its comprehensive approach, incorporating both demographic and clinical factors alongside detailed ECG analysis. This allowed for a nuanced understanding of the interplay between risk factors and the diagnostic utility of lead aVR in predicting LM-CAD. Furthermore, the use of coronary angiography as the gold standard for diagnosing LM-CAD ensured the reliability of the results (18).

However, the study had limitations. The single-center design might limit the generalizability of the findings to other settings. Additionally, the sample size, while adequate, could be expanded in future studies to enhance the robustness of the conclusions. Potential selection bias, inherent in the study's design, could have influenced the results, though efforts were made to minimize this through strict inclusion and exclusion criteria (19).

The findings underscored the critical role of lead aVR in the routine ECG evaluation of ACS patients. By incorporating lead aVR analysis, clinicians can enhance diagnostic accuracy, enabling timely and effective therapeutic interventions for patients at high risk of LM-CAD. Future research should focus on larger, multicenter studies to validate these findings further and explore the underlying mechanisms linking ST-segment elevation in lead aVR with LM-CAD. Additionally, investigating the impact of incorporating lead aVR analysis into clinical practice on patient outcomes would provide valuable insights into its practical applications (20, 21)

CONCLUSION

In conclusion, this study reinforced the significance of ST-segment elevation in lead aVR as a reliable indicator of LM-CAD among ACS patients. The strong correlation with major cardiovascular risk factors like smoking and obesity highlighted the importance of comprehensive risk assessment in managing ACS. By integrating lead aVR analysis into routine clinical practice, healthcare providers can improve diagnostic precision and optimize patient care, ultimately enhancing outcomes for those with acute coronary syndromes

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