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Original Article

Electrocardiogram (ECG) Pattern of Left Anterior Descending Coronary Artery Occlusion in Acute Anterior Myocardial Infarction Cases

Zeeshan Ishaq, Asif Nadeem, Nisar Ahmed*, Iftikhar Ahmed, Zahid Mumtaz, Naseem Azad, Fasih Ullah, Atif Ghafoor

Department of Cardiology, Armed forces Institute of Cardiology/National Institute of Heart Diseases/National University of Medical Sciences (NUMS) Pakistan, *Department of Cardiology, Combined Military Hospital Sargodha/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To assess blockage site in left anterior descending coronary artery by means of Electrocardiogram (ECG).
Study Design: Prospective longitudinal study.
Place and Duration of Study: Armed forces Institute of Cardiology & National Institute of Heart Diseases, Pakistan from Aug to Feb, 2024.
Methodology: This study was conducted on 101 patients with acute anterior wall myocardial infarction (AWMI). Included patients had chest pain in last 12 hours. ECG was done in all patients upon presentation. Localization of occlusion site in LAD territory was identified using pre-specified algorithm. Afterwards, each patient underwent coronary angiography to make sure the findings of ECG for occlusion site in LAD territory. Sensitivity, specificity, positive and negative predictive value and accuracy for ECG patterns were also calculated by taking angiographic findings as gold standard for occlusion site detection.
Results: A total of one hundred and one study participants were comprised of 85(84.2%) male and 16(15.8%) female patients and mean age was 61.87±10.39 years. Among patients with anterior wall myocardial infarction (AWMI), 28 (27.7%) showed blockage in LAD before origin of both 1st septal(S1) and 1st diagonal(D1) branch. For occlusions before origin of S1 and after D1, after S1 and before D1, and after both S1 and D1, the numbers were 7(6.9%), 8 (7.9%), and 58(57.4%), respectively.
Conclusion: ECG is not only useful in guiding the timely administration of reperfusion therapy but also in offering insights into the severity and site of blockage in individuals diagnosed with AWMI before encountering angiography.

Keyword: Anterior wall myocardial infarction, coronary angiography, electrocardiogram, left anterior descending artery, ST-elevation myocardial infarction.

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INTRODUCTION

Coronary artery disease is the leading global reason of mortality,[1] and electrocardiogram (ECG) is a consistent diagnostic instrument to identify myocardial infarction (MI).[2-4] Electrocardiograms (ECGs) determine the nature and site of acute myocardial infarction (AMI).[5] Three main vessels, the coronary arteries supplies the myocardium, however there may be variations in terms of their beginning, path, number, and supply.[6] Left anterior descending (LAD) coronary artery had a major contribution in supplying blood to the left ventricular myocardium.[6] Blockage of LAD artery causes various types of MI, such as apical-anterior, mid-anterior or septal infarctions, based on the specific location of the blockage.[7] Occlusion in early part of LAD can independently predict unfavorable effects such as higher mortality and recurrent myocardial infarction MI, however occlusion in the distal LAD results in more favorable outcomes.[8] The requirement for early reperfusion therapy is broadly detected by how proximal is the blockage area to the beginning of the coronary artery. In anterior myocardial infarction(AWMI), the blockage point in the LAD coronary artery is directly correlated to the amount of dead myocardium and subsequent prognosis.[9,10]

In this study, we focused on predetermined criteria for the identification of blockage in the blood vessels. In our population, so far limited research has been conducted for the characterization of infarct-related coronary artery, and our research aims to fulfill that gap. Thus, ECG is a valuable source to point out the location of blockage in coronary artery in acute AWMI, by predicting the extent of at-risk myocardium and help in making decisions about the serious need of revascularization, also can help in early referral or thrombolysis decision in non-tertiary care hospitals.

Correspondence: Dr Zeeshan Ishaq, Department of Cardiology, AFIC/NIHD Rawalpindi Pakistan
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METHODOLOGY

The prospective longitudinal study was conducted on 101 individuals having acute anterior wall MI. Patients were recruited via consecutive sampling technique during a study period of 6-months (Aug, 2023 to Feb, 2024). Ethical approval was sought from Institutional Ethical Review Board (IERB) of Armed Forces Institute of Cardiology & National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi Pakistan (IERB Ltr# 9/2/R&D/2022/224). Sample size of one hundred and one was calculated by using WHO sample size calculator with reference to the 93.0% prevalence of acute anterior wall myocardial infarction.[2]

Inclusion Criteria: Both male and female patients, aged between 20 to 80 years, having anterior myocardial infarction and indicating their symptoms within 12 h from the onset were appropriate for inclusion.

Exclusion Criteria: Participants with signs of previous MI on ECG, complete Left bundle branch block, previous history of PCI or CABG, non-ST elevation MI (NSTEMI) patients were excluded. Furthermore, patients with severe STEMI but not agree for coronary angiogram, allergic to contrast medium, known case of congenital heart disease, implanted pacemaker and left ventricular hypertrophied patients were also excluded.

Prior to data collection study participants were asked to sign the consent form to ensure their voluntary participation. Demographic (age, gender) and risk factor profile (diabetes, smoking, hypertension) was recorded. The enrolled patients were grouped based upon their age, gender and risk factors. All patients who presented at the emergency department within 12 hours of symptom onset were recruited. Acute ST-Elevation myocardial infarction was diagnosed according to following criteria, a) Ischemic symptoms, and b) New ST-elevation at the J-point in two contiguous leads with the cut-off points: ≥ 0.2 mV in men or ≥0.15 mV in women in leads V2–V3 and/or ≥0.1 mV in other leads.

Patients were categorized based on the occlusion site in the left anterior descending (LAD) artery, whether the occlusion occurred before the origin of the first diagonal (D1) and first septal (S1) branches, after D1 but before S1, after S1 but before the D1 branch, or after both D1 and S1 branches. Twelve lead ECG was performed in all patients. Prespecified criteria was used to localize the blockage site in LAD territory. Afterword, coronary angiography was performed to make sure the electrocardiographic prediction of the blockage site in LAD territory. Greater than 70% stenosis in the coronary artery or total blockage, acute thrombosis or dissected plaque were considered significant for revascularization.

Statistical Package for Social Sciences (SPSS) version 21.00 was utilized for data management and analysis. Frequencies & percentages and means & standard deviations of categorical and numerical data were calculated and presented. The specificity, sensitivity, negative predictive value (NPV), positive predictive value (PPV), and accuracy of individual ECG parameters to detect the occlusion site, were calculated.

RESULTS

Overall one hundred and one study participants with Anterior Wall Myocardial Infarction were included, out of which patients having male gender were 85(84.2%) and 16(15.8%) patients had female gender. The mean age was 61.87±10.39 years. Hypertension 46(45.5%) was most common risk factor, among others smoking 35(34.7%) and diabetes mellitus 33(32.7%). Maximum patients suffered from single vessel coronary artery disease 49(48.5%), followed by double and triple vessel CAD [35(34.7%), 17(16.8%) respectively].

Blockage before origin of first septal (S1) and first diagonal(D1) branch was noted in 28(27.7%) of AWMI patients, the corresponding estimates for blockages before S1 and after D1, after S1 and before D1, and after origin of both S1 and D1 were 7(6.9%), 8(7.9%), and 58(57.4)%, respectively. Seven ECG patterns were measured to localize blockage in Left anterior descending artery before origin of S1 and D1 branch. Amongst which the commonly observed was ST depression ≥1mm in II, III aVF , 45(44.6%). Four ECG patterns were measured for blockage before S1 but after origin of D1, and complete RBBB was most common, 13(12.9%). Four ECG patterns were considered to identify blockage after origin of S1 but before D1, of which ST elevation in aVL 51(50.5%) was the commonest. For identifying blockage after origin of both S1 and D1 branch, among four ECG criteria, the most common pattern observed was ST-Elevation in V3-V6, 87(86.1%) (Table-I).

Before origin of S1 and D1: ST depression ≥1mm in II, III, aVF was most sensitive (75.0%). ST depression in V5 had 97.2% specificity followed by ST-depression≥1mm in II, III, aVF, complete RBBB, and

ST-elevation≥2.5mm in V1 which had (94.5%),(93.1%) and (93.1%) specificity, respectively. The pattern with highest accuracy was complete RBBB (75.2%) (Table-II).

Table-I: Electrocardiogram (ECG) Parameters Considered for Identifying Blockage Site in Left Anterior Descending Artery (n=101)

Variables	Frequency (%) (Total=101)
Before origin of S1 and D1	28(27.7)
Complete RBBB	13(12.9)
ST-elevation ≥ 2.5 mm in Vl	10(9.9)
ST-depression ≥ l mm in II, III, aVF	45(44.6)
ST-elevation aVR	8(7.9)
ST-depressionV5	4(4.0)
Q in aVL	10(9.9)
ST-elevation in aVL, Vl	25(24.8)
Before S1 and after D1	7(6.9)
Complete RBBB	13(12.9)
ST-elevation aVR	8(7.9)
ST-depression V5	4(4.0)
ST-depression aVL	8(7.9)
After S1 and before D1	8(7.9)
Q wave in V4-V6	20(19.8)
Q wave in aVL	11(10.9)
ST-elevation aVL	51(50.5)
ST-depression III >II	25(24.8)
After origin of both S1 and D1	58(57.4)
Q wave in V4-V6	20(19.8)
ST-elevation in II, III, aVF	8(7.9)
ST-elevation in V3-V6	87(86.1)
ST-depression aVL	8(7.9)

RBBB=Right Bundle Branch Block; S1=1st Septal Branch; D1=1st Diagonal Branch

patterns was equal (89.1%) except complete RBBB (86.1%) (Table-III).

After S1 and before D1: To identify blockage after origin of S1 and before D1, ST-elevation in aVL was highly sensitive (75.00%) while Q wave in aVL had highest specificity as well as accuracy (89.2%, 83.1% respectively) (Table-IV).

After origin of both S1 and D1: High sensitivity of 87.9% was observed in ST-elevation in V3-V6, after that Q wave in V4-V6 had 20.6%, and ST elevation in II,III,aVF had 12.0% sensitivity, while corresponding specificities were 16.2%, 81.4% and 97.67% respectively. ST-depression in aVL had (6.9%) sensitivity and 90.7% specificity along with highest accuracy, 57.4%. (Table-V).

DISCUSSION

Blockages in the LAD artery can cause different extents of anterior myocardial infarction, such as apical-anterior, mid-anterior and septal branch infarctions, determined by site of the obstruction.(7,11) Proximal blockages in the LAD artery are associated with adverse outcomes, including increased mortality rates and recurrent MI, while distal blockages typically carry more favorable prognoses.(8) Ischemia resulting from LAD occlusion often manifests as ST-elevation in precordial leads.[12,13] Location of occlusion can be predicted by a range of ECG criteria, guided by the direction of the injury vector.[8,14,15]

Table-II: Value of ECG in Detecting Blockage Before Origin of S1 and D1 in Left Anterior Descending Artery (n=101)

ECG pattern	Angiogram Finding (Present/Total)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Complete RBBB	8/13	28.5	93.1	61.5	77.2	75.2
ST-elevation ≥2.5 mm in Vl	5/10	17.8	93.1	50.0	74.7	72.2
ST-depression ≥l mm in II, III, aVF	4/8	14.2	94.5	50.0	74.1	72.2
ST-elevation aVR	21/45	75.0	67.1	46.6	87.5	69.3
ST-depressionV5	2/4	7.1	97.2	50.0	73.2	72.2
Q in aVL	2/10	7.1	89.0	20.0	71.4	66.3
ST-elevation in aVL, Vl	13/25	46.4	83.5	52.0	80.2	73.2

LAD=Left Anterior Descending Artery; PPV=Positive Predictive Value; NPV=Negative Predictive Value; RBBB=Right Bundle Branch Block; S1=1st Septal Branch; D1=1st Diagonal Branch

Table-III: Value of ECG in Detecting Occlusion Before Origin of S1 and after Origin of D1 in Left Anterior Descending Artery (n=101)

ECG pattern	Angiogram Finding (Present/Total)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Complete RBBB	3/13	42.8	89.3	23.0	95.4	86.1
ST-Elevation aVR	2/8	28.5	93.6	25.0	94.6	89.1
ST-Depression V5	0/4	0.0	95.7	0.0	92.7	89.1
ST-Depression aVL	2/8	28.5	93.6	25.0	94.6	89.1

LAD=Left Anterior Descending Artery; PPV=Positive Predictive Value; NPV=Negative Predictive Value; RBBB=Right Bundle Branch Block; S1=1st Septal Branch; D1=1st Diagonal Branch

Before origin of S1 and after origin of D1: Among ECG patterns to detect blockage before origin of S1 but after origin of D1, complete RBBB was highly sensitive (42.86%). While ST depression inV5 had highest specificity (95.7%) ST-depression in aVL as well as ST elevation in aVR, both has (93.6%) specificity. For complete RBBB specificity was 89.36%. Accuracy of all

In our investigation, we utilized diverse ECG criteria to identify the responsible artery in individuals having anterior wall myocardial infarction. Seven criteria were employed to localize the vessel before S1

Table-IV: Value of ECG in Detecting Blockage After Origin of S1and Before Origin of D1 in Left Anterior Descending Artery (n=101)

ECG pattern	Angiogram Finding (Present/Total)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Q Wave in V4-V6	3/20	37.5	81.7	15.0	93.8	78.2
Q Wave in aVL	1/11	12.5	89.2	9.1	92.2	83.1
ST-Elevation aVL	6/51	75.0	51.6	11.7	96.0	53.4
ST-Depression III >II	4/25	50.0	77.4	16.0	94.7	75.2

LAD=Left Anterior Descending Artery; PPV=Positive Predictive Value; NPV=Negative Predictive Value; RBBB=Right Bundle Branch Block; S1=1st Septal Branch; D1=1st Diagonal Branch

Table-V: Value of ECG in Detecting Blockage After Origin of both S1 and D1 in Left Anterior Descending Artery (n=101)

ECG pattern	Angiogram Finding (Present/Total)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Q Wave in V4-V6	12/20	20.6	81.4	60.0	43.2	46.5
ST-Elevation in II, III, aVF	7/8	12.0	97.6	87.5	45.1	48.5
ST-Elevation in V3-V6	51/87	87.9	16.2	58.6	50.0	57.4
ST-Depression aVL	4/8	6.9	90.7	50.0	41.9	42.5

LAD=Left Anterior Descending Artery; PPV=Positive Predictive Value; NPV=Negative Predictive Value; RBBB=Right Bundle Branch Block; S1=1st Septal Branch; D1=1st Diagonal Branch

and D1.[16] Notably, ST depression ≥1mm in II, III, aVF showed the highest sensitivity (75.0%), while ST depression in V5 demonstrated the highest specificity (97.2%).[16] These findings are consistent with previous studies,[16,17] where ST-depression ≥1 mm II, III, aVF had 78% and ST-depression in V5 had 100% specificity, Additionally, the specificity exceeding 90% for complete RBBB observed in present research supports the findings documented by past studies,[6,16,17] where complete RBBB and ST-elevation aVR had 90.6% and 97% specificities, respectively Another study showed complete RBBB, ST-elevation in lead aVR, ST depression in lead V5, and ST elevation in V1 ≥2.5 mm serve as reliable indicators of proximal to S1 occlusion in LAD.[18] Among ECG patterns to detect blockage before S1 and distal to D1, complete RBBB had highest sensitivity (42.86%). While ST depression V5 had highest specificity (95.7%) while ST elevation in aVR and ST depression in aVL showed a specificity of 93.6%. For complete RBBB specificity was 89.36% as shown in prior studies.where specificity of RBBB was(82%) ST-elevation in aVR and ST-depression in V5 also indicated a notable sensitivity of 90%.[16,18]

In identifying occlusion within distal part of S1 and proximal section of D1, ST elevation in aVL showed the highest sensitivity (75.0%), while ST depression in III > II demonstrated a sensitivity of 50.0%. Additionally, Q wave in V4-V6 and Q wave in aVL displayed specificities of 81.7% and 89.2%, respectively, in identifying blockage distal to S1 and proximal to D1.[8,16,19] Nevertheless, the prevalence of this type of occlusion was exceptionally less in our research, thereby contributing for the restricted validation of the ECG criteria.

Our research focusing on identifying blockage after S1 and D1, we found that only ST elevation in V3-V6 exhibited a notable sensitivity of 87.93%, meanwhile ST elevation in II, III, aVF exhibited the highest specificity reaching (97.67%), and ST depression in aVL had a specificity of 90.7%, consistent with findings from previous studies where ST-elevation in V3–V6 demonstrated a substantial sensitivity of 78.6%. and ST elevation in II, III, aVF showed 94% specificity.[8,16,20]

Overall, our study results align closely with prior research, indicating that this ECG algorithm can be used to pinpoint the site of occlusion in the LAD.

CONCLUSION

The current study emphasizes the importance of electrocardiography (ECG) not only in guiding the timely administration of reperfusion therapy but also in offering insights into the site and severity of acute myocardial injury in individuals with ST-elevation myocardial infarction (STEMI) before undergoing angiography. While coronary angiogram rests the established way for identifying the vessel involved in myocardial infarction. ECG findings can serve as valuable indicators of the potentially affected culprit artery prior to angiography, particularly in settings where immediate access to angiographic facilities may be limited. In cases of anterior wall myocardial infarction (AWMI), ECG proves to be especially reliable in identifying occlusions proximal to S1 and D1. Moreover, ECG patterns associated with blockage in early part of vessel often indicate larger myocardial infarctions, indicating the potential advantage of timely and thorough revascularization strategies such as angioplasty.

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Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

ZI & AN: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

NA & IA & ZM: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

NA & FU & AG: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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