Original Artticle

Nepalese Heart Journal 2025; Vol 22(1), 15-21

Prevalence of Coronary Artery Disease Among Patients Presenting with Chest Pain of Suspected Cardiac Origin at A Tertiary Care General Hospital in Gandaki Province of Nepal

Pragati Koirala[1], Chanchu Gopal Saha[1]

[1] Manipal College of Medical Sciences, Pokhara, Nepal

Corresponding Author:
Pragati Koirala
Manipal College of Medical Sciences, Pokhara, Nepal
Email address: pragati1koirala@gmail.com
ORCID ID: 0009-0001-6127-7789

Cite this article as: Koirala, P., & Saha, C. G. Prevalence Of Coronary Artery Disease Among Patients Presenting With Chest Pain Of Suspected Cardiac Origin At A Tertiary Care General Hospital In Gandaki Province Of Nepal . Nepalese Heart Journal, 22(1), 15-21.

Submission Date: June 14, 2024
Accepted Date: April 25, 2025

Submitted using Strobe checklist

Abstract

Background and Aim: The prevalence of coronary artery disease among patients presenting with chest pain of suspected cardiac origin in western part of Nepal is not known. We aimed to study the prevalence of coronary artery disease among patients presenting with chest pain of suspected cardiac origin in an emergency department of a general tertiary care hospital in Gandaki province of Nepal.

Methods: This was a prospective cross-sectional study conducted over a period of 5 months that included all patients aged 16 years and above presenting to the emergency department with acute chest pain of suspected or diagnosed cardiac origin. The primary outcome measure was to calculate the prevalence of coronary artery disease and secondary outcome measures included identification of common ECG changes in such patients and the relationship of such changes with the provisional diagnoses of the patients.

Results: One hundred fifty patients were enrolled in the study. The prevalence of coronary artery disease was 44% (66/150) among those patients with chest pain of cardiac origin. T wave inversion was the most prevalent ECG change (44%), followed by ST-T segment depression (28%), Left bundle branch block 11.33%, ST segment elevation 10.66%, left ventricular hypertrophy 10%. Pathological Q waves were present in 6.66% and poor R-wave progression was seen in 3% of the patients. ECG had high diagnostic accuracy to detect ischaemia.

Conclusion: The prevalence of coronary artery disease among patients with chest pain of suspected cardiac origin in the emergency department of tertiary care general hospital is around 44%. The common ECG changes are ST depression and T wave inversion. ECG detected most of the myocardial ischaemia in the emergency department.

Keywords: Chest pain; Electrocardiogram; Emergency department; Myocardial ischaemia

DOI: http://doi.org/10.3126/nhj.v22i1.78327

@Nepalese Heart Journal. Nepalese Heart Journal retains copyright and work is simultaneously licensed under Creative Commons Attribution License CC - BY 4.0 that allows others to share the work with an acknowledgement of the work's authorship and initial publication in this journal.

Introduction

Coronary artery disease (CAD) is a leading cause of morbidity and mortality worldwide, and its prevalence is increasing due to changing lifestyles and an aging population.[1] Studying the prevalence of CAD among patients presenting with chest pain of suspected cardiac origin is crucial for identifying high-risk patients and improving the quality of care in emergency departments of tertiary care general hospitals. These patients when discharged inadvertently from the emergency department have a short term mortality of 2%.[2] Previous studies have reported the prevalence of CAD in the general population and in cardiac center settings[2], but there is a lack of data on the prevalence of CAD among patients presenting with chest pain of suspected cardiac origin in an emergency department of a general tertiary care hospital in Nepal. This knowledge gap needs to be addressed to improve patient outcomes. We hypothesize that a significant proportion of patients presenting with chest pain of suspected cardiac origin in an emergency department of a general tertiary care hospital in Nepal will have CAD. The aim of this study is to determine the prevalence of CAD among patients presenting with chest pain of suspected cardiac origin in an emergency department of a general tertiary care hospital in Nepal.

Methods

Study design

This was a prospective cross-sectional study carried out at Manipal teaching hospital, Pokhara over a period of 12 months. The data collection was done over a period of 5 months after approval was obtained from the institutional review board of Manipal college of medical sciences. A written informed consent was taken from all the patients/guardians of patients participating in the study.

Sample size calculation

Sample size was calculated considering confidence level (CL) =95%, expected proportion of positive ECG for myocardial infarction (P) = 0.28 taken from the report by Challa et al[3] and total width of confidence interval (W)=0.15; calculation was done using the formula for sample size of observational studies suggested by Hulley et al and a final sample of 150 participants was taken.[4] We used a non-probability consecutive sampling technique for enrolling the patients.

Inclusion Criteria

All patients aged 16 years and above presenting to the emergency department of tertiary care hospital with acute chest pain of suspected or diagnosed cardiac origin were included in the study.

Exclusion Criteria

We excluded patients attending with chest pain who did not wish to participate in the study and the patients presenting with traumatic chest pain.

Demographic data

Personal and demographic information was obtained. The data regarding family history, personal medical history, risk factors of heart disease, provisional diagnosis was recorded.

Recording of electrocardiogram: A 12 lead electrocardiogram was recorded during the resting state. Data from the ECG was collected for heart rate, QRS axis and deviation, p-wave, atrial fibrillation or junctional rhythm was sought for if p-wave was absent, PR interval and heart blocks, QRS analysis on narrow, incomplete or complete bundle branch blocks, QT interval, analysis of Q waves, R waves and S waves, T wave abnormalities, ST segment analysis. Any remaining ECG abnormalities were classified and captured as others.

Variables, Definitions and diagnostic criteria

1. Chest pain of cardiac origin was defined as in the NICE guidance 2010[5]
2. Chest pain of non-cardiac origin was defined as mentioned by Kachintorn U[6]
3. ST elevation[7], ST-depression[8], and Myocardial infarction[9] were defined as stated in the cited papers.
4. The measurements of the different intervals were made as per American heart association guidelines.[10]
5. The ECG changes were classified into four categories as Challa et al.[3]

Category 1 consists of a "normal" electrocardiogram with upright T waves, isoelectric ST segments, and no Q waves. Category 1 ECGs include normal sinus rhythm, sinus tachycardia, sinus bradycardia, premature atrial contractions and premature ventricular contractions.

Category 2 consists of abnormal ECG with no clear evidence of ischemia. For example, heart block, Left Bundle Branch Block (LBBB), Right Bundle Branch Block (RBBB), atrial fibrillation, paced rhythm, supraventricular tachycardia, left axis deviation, and left ventricular hypertrophy.

Category 3 consists of an abnormal electrocardiogram with changes questionable for ischemia. These ECGs questionable for ischemia were defined as nonspecific ST segment and T wave changes, ST elevation/depression in single leads or ≤0.1 mV, and Q waves <25% the height of the subsequent R wave.

Category 4 consists of an abnormal electrocardiogram showing evidence of ischemia, (i.e., transient or permanent ST segment elevation) or depression ≥ 0.1 mV in two contiguous leads and q waves that are greater than 25% of the height of the subsequent R wave.Determination of Cardiac Biomarker

Troponin I was qualitatively evaluated in patients suspected to have acute coronary syndrome. The result was recorded as positive or negative.

The primary outcome measure was to calculate the prevalence of coronary artery disease in patients presenting to the emergency department with chest pain of suspected cardiac origin. The secondary outcome measures included identification of common ECG changes in such patients and the relationship of such changes with the provisional diagnoses of the patients.

Bias: Since this study had a possibility of measurement bias in terms of interobserver variability when different clinicians may interpret symptoms differently. Whenever possible, the patients were evaluated by at least two clinicians independently, one from the emergency department and another from the internal medicine/ cardiology department to reduce the chance of this bias.

Statistical Analysis

Descriptive statistics was presented in proportion percentage, mean and its standard deviation. Crosstabulation was done to identify the

relationship between ECG changes and provisional diagnosis and Troponin I.

Prevalence of coronary artery disease among patients presenting with chest pain was calculated using the following formula:

Prevalence=(all chronic stable angina and acute coronary syndrome cases / total number of patients presenting with chest pain of suspected cardiac origin) x 100 (%)population.

The data was entered in Microsoft Excel Program And was analyzed using SPSS (Statistical Package for Social Sciences) for Windows version 16.0. A p value of <0.05 was considered statistically significant whenever indicated.

Results

During the data collection period of five months, a total of 8349 patients visited the emergency department of Manipal teaching hospital. Among them, 987 patients presented with a complaint of chest pain (cardiac and non-cardiac origin). Out of those 987 patients, only 150 consecutive patients with the principal complaint of chest pain that met the definition of suspected cardiac origin were recruited for this prospective study. The demographic characteristics are shown in table 1.

Table 1: Demographic characteristics

Variable	Mean	Standard Deviation	Minimum - Maximum
Age (in years)	59.2	15.08	28-93
Age group	Number (%)		
40 or less	18 (12.0)		
41-60 years	62 (41.33)		
61-75 years	48 (32.0)		
> 75 years	22 (14.67)		
Gender	Male n (%)	Female n (%)	Other n (%)
	94 (62.66%)	56 (37.33%)	0 (0)
Type of chest pain	n (%)		
Typical	100 (66.6)		
Atypical	50 (33.4)		
History of heart disease	n (%)		
Present	79 (52.66)		
Absent	71 (47.34)		

Presence of risk factors for coronary artery disease is shown in the following Figure 2.

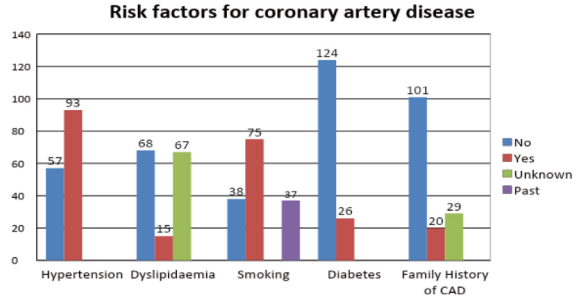

Figure 1: *Risk factors for coronary artery disease:*

Electrocardiographic characteristics

Heart rate

The mean heart rate at presentation was 82.96 ± 16.15 beats per minute and ranged from 48 to 155 beats per minute, with 3 (2%) patients having heart rate more than 120 beats per minute.

P wave

Normal P-wave was present in 145 patients. Remaining 5 (3.3%) patients presented with atrial fibrillation.

PR interval

A PR interval could be calculated in only 144 patients as five (3.3%) patients had atrial fibrillation and one (0.66%) patient presented with complete heart block and among remaining 144 patients, 4 (2.7%) had a PR interval longer than 120ms. All four patients had first degree heart block.

QRS complex

The QRS complex was narrow in 130 (86.66%) patients. There were 3 (2%) patients with incomplete left bundle branch block (QRS complex width more than 80 ms but less than 120 ms) and 17 (11.33%) presented with LBBB (QRS complex width more than or equal to 120ms). There were no cases of RBBB.

QT interval

We defined a prolonged QT interval as present if QTc> 440 ms in men or > 460 ms in women. A short QTc interval on an ECG was defined as QTc of ≤ 300 ms that does not significantly change with heart rate. There were 4 (2.7%) patients with prolonged QTc among all 150 patients. There were no patients with a short QT interval.

Q wave

Q waves were present in 10 (6.66%) of the patients who presented with chest pain. Q waves were most common in inferior and anterior leads.

T wave abnormalities

T wave inversion was present in 66 (44%) of the patients. Thirteen (8.66%) patients had T wave inversion of all the leads. T inversion was present in 18 (12%) patients in II, III, aVF leads. Similarly, T wave inversion was present in leads II, III, aVF, V1-V4 in one (0.66%) patient, in leads II, III, aVF, V2-V6 in also one (0.66%) patient, in II III aVL V1-V6 in another one (0.66%) patient.

Isolated T inversion was present in lead III in three (2%) patients. In the precordial leads, T inversion was present in leads V1-V3 in 1 (0.66%) patient, in leads V1-V4 in 11 (7.33%) patients, in leads V1-V6 in 1 (0.66%), in leads V3-V6 in 4 (2.66%), and in leads V4-V6 in 12 (8%) patients. Remaining 84 (56%) patients had no T wave abnormalities.

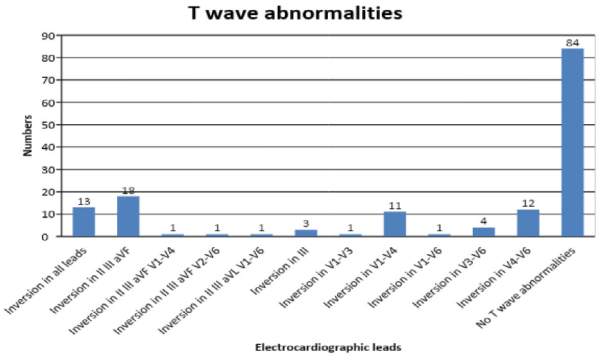

Figure 2: *Types of T-wave abnormalities*

ST Segment analysis

The ST segment was normal in 92 (61.33%) patients. ST segment elevation was seen in 16 (10.66%) patients. ST segment depression was seen in 42 (28%) patients. The following figure 8 shows results of ST segment analysis.

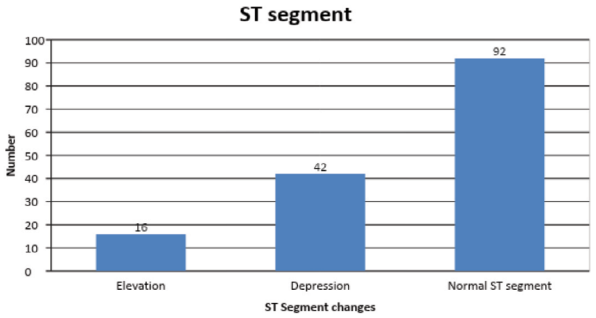

Figure 3: *Distribution of ST-segment changes*

ST segment elevation

Among 16 patients with ST segment elevation (Figure 9), 10 patients had ST elevation in leads V1-V4, 4 patients had ST elevation in leads II, III, aVF, and one patient each had ST elevation in leads V1-V6 and V4-V6.

ST segment depression

ST segment depression was more common in inferior leads (II, III, aVF, 15 patients {10%}), (V1-V4 10 patients {6.66%}) and all leads (6 patients 4%).

Other ECG abnormalities

There were other ECG abnormalities present in the patients (Figure 11). Patients had left ventricular hypertrophy, poor R wave progression, and 3 patients presented with supraventricular tachycardia as a cause of chest discomfort.

Provisional Diagnosis at the emergency department

Of 150 patients, 80 (53.33%) patients had no definite evidence of ischaemia based on clinical findings, ECG, and biomarkers. Three (2%) patients were diagnosed with chronic stable angina. Unstable angina was diagnosed in 39 (26%) patients and myocardial infarction in the emergency department was diagnosed in 24 (16%) patients. Among remaining patients 3 (2%) patients had paroxysmal supraventricular tachycardia and 1 (0.66%) patient had complete heart block as the cause of chest pain.

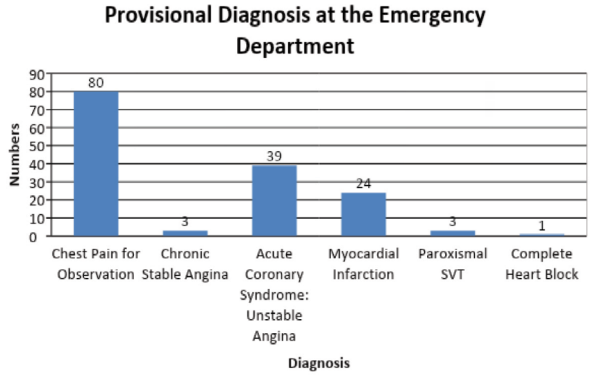

Figure 4: *Provisional diagnosis of patients presenting with chest pain of suspected cardiac origin*

To calculate the prevalence of coronary artery disease (CAD) among patients presenting with chest pain, all new and old cases of angina and myocardial infarction was taken in the numerator, that included acute coronary syndromes (unstable angina and myocardial infarction) and chronic stable angina) and total number of patients with chest pain of suspected cardiac origin was taken as denominator.

Prevalence of CAD= (66/150)*100% = 44% patients with chest pain of suspected cardiac origin.

Among 150 patients, myocardial infarction (MI) as confirmed by elevated troponin was diagnosed in 24 patients in the emergency department. However, the troponin test was not conducted in 20 (13.33%) patients.

Altogether 79 (52.66%) patients were admitted. Fourteen (9.33%) patients were kept under observation and 48 (32%) of patients were discharged from the emergency department. However, there were 7 (4.66%) patients who left against medical advice (LAMA) and 2 (1.33%) patients were discharged on the patients' request.

An association was sought between the provisional diagnosis and ECG changes. Only one patient with myocardial infarction had normal ECG. However, there were 9 patients who had typical chest pain and diagnosed as unstable angina had normal ECG. Similarly, definite evidence of ischaemia were seen only in patients with myocardial infarction and unstable angina. The association between all the diagnoses and electrographic changes is shown in the following table.

Table 2: Association between all the diagnoses and electrographic changes

Category According to Challa et al	Myocardial infarction (n=24)	Unstable Angina (n=39)	Chest pain for observation (n=80)	Chronic stable angina (n=3)	Complete heart block (n=1)	Paroxysmal SVT (n=3)
I Normal ECG with no evidence of ischaemia (n=56)	1	9	44	0	0	2
II (abnormal ECG but with no clear evidence of ischaemia) (n=44)	3	10	28	2	0	1
III (abnormal ECG with changes questionable for ischaemia) (n=29)	1	19	7	1	1	0
IV (abnormal ECG with evidence of ischaemia) (n=20)	19	1	0	0	0	0

Relation between tropinin I and ECG changes was also studied. Troponin I was negative only in 1 patient with category IV ECG

changes (definite evidence of ischaemia) and was positive in 1 patient with category I ECG (normal ECG). The complete relationship between the ECG changes and Troponin I is shown in the following table.

Table 3: Relationship between the ECG changes and Troponin I

Category According to Challa et al	Troponin I positive (n=24)	Troponin I Negative (n=106)	Troponin I not performed (n=20)
I (n=56)	1	43	12
II (n=44)	3	34	7
III (n=29)	1	27	1
IV (n=20)	19	1	0

Discussion

This study was conducted to evaluate the prevalence of coronary artery disease and the spectrum of ECG changes in patients with chest pain of suspected cardiac origin presented to the Emergency Department of Manipal Teaching Hospital, a tertiary care center in Western Nepal.

In the clinical assessment of patients presenting in ER with chest pain, interpretation of the ECG is an essential adjunct to the history and examination. Reaching a rapid and accurate clinical diagnosis is of great importance to improve prognosis in patients with myocardial infarction. Patients presenting to the ED with chest pain are triaged to early reperfusion therapies based on their initial ECG. Manipal teaching hospital is currently the only hospital in the western region of Nepal that has a cath lab with coronary intervention facility. The initial presenting ECG is the primary modalities of investigation in conjunction with clinical symptoms that help emergency physicians decide on immediate reperfusion therapy even before biomarker evidence of infarction and results of biochemical analysis are available. This study not only tries to present the electrocardiographic profile of patients presenting to ER with chest pain, but also describes several other clinical aspects including risk factors of coronary artery disease in the Western region of Nepal.

ECG changes and chest pain

Among our 150 patients, only one patient with myocardial infarction had normal ECG. However, there were 9 patients who had typical chest pain and diagnosed as unstable angina had normal ECG. Similarly, category IV ECG changes (definite evidence of ischaemia) were seen only in patients with myocardial infarction and unstable angina. In 2000, Bassan et al[4,5] evaluated all consecutive patients presenting to an emergency department for a period of two years and 1003 patients with the principal complaint of chest pain were analyzed. The admittance electrocardiogram (available in 971 patients) showed ST elevation in 106 (11%), ST depression or inversion of T wave in 159 (16%), left bundle-branch block in 38 (4%) and absence of these changes (normal or nonspecific ECG) in 668 (69%). Of 1003 patients studied, 165 (16%) had the final diagnosis of acute myocardial infarction, 225 (22%) of unstable angina, 324 (32%) of the absence of acute coronary syndrome and 289 (29%) had an indefinite diagnosis. They concluded that electrocardiogram has a crucial part in the interpretation of the clinical history and will determine the greater efficiency of the medical approach and the lower cost of emergency treatment.

Similarly, in 2007, Challa and colleagues[3] studied the initial presenting electrocardiogram as determinant for hospital admission in patients presenting to the emergency department with chest pain. They retrospectively reviewed initial ECG records of 250 patients for abnormalities and compared with the final diagnosis. Seventy-five patients (30%) had Category 1 (normal) ECGs. Fifty-five patients (22%) had Category 2 ECGs (abnormal without evidence of ischemia). Forty-eight patients (19.2%) had Category 3 ECGs (abnormal questionable for ischemia). Seventy-two patients (28.8%) had Category 4 ECGs (abnormal with evidence of ischemia).

ST segment changes

In our study population, the ST segment was normal in 92 (61.33%) patients. ST segment elevation was seen in 16 (10.66%) patients. ST segment depression was seen in 42 (28%) patients. Among 16 patients with ST segment elevation, 10 patients had ST elevation in leads V1-V4, 4 patients had ST elevation in leads II, III, aVF, and one patient each had ST elevation in leads V1-V6 and V4-V6. ST segment depression was more common in inferior leads (II, III, aVF). Although many conditions affect the ST segment, its elevation or depression are considered hallmarks of myocardial ischaemia. However, there are several causes of ST-segment elevation besides acute myocardial infarction. The most common causes of ST-segment elevation are left ventricular hypertrophy, left bundle-branch block, early repolarization, and ventricular aneurysm. Some of these conditions can be misdiagnosed as acute infarction, resulting in unwarranted thrombolytic therapy or emergency angiography.[10]

T-wave changes

The T-wave changes were one of the most common changes present in the patients with chest pain of cardiac origin. T wave inversion was present in 66 (44%) of the patients. Remaining 84 (56%) patients had no T wave abnormalities. The earliest electrocardiographic finding resulting from AMI is the hyperacute T wave which may appear minutes after the interruption of blood flow; the R wave also increases in amplitude at this stage. The hyperacute T wave is noted as early as 30 minutes after the onset of coronary occlusion and transmural infarction. It tends to be a short lived structure which evolves rapidly on to ST segment elevation. Our patients probably presented a little late and no patients had hyperactive T waves. Later, after a myocardial infarction T wave inversion occurs. T wave inversion may be a cause of myocardial ischaemia and may be a non-specific abnormality associated with other myocardial disease conditions like hypertension, aortic stenosis or myocarditis etc.[8] The high prevalence of hypertension in our study population might be the reason for T wave inversion.

Left Bundle Branch Block

There were 17 (11.33%) patients who presented to our emergency department with LBBB. The challenge of appropriately recognizing MI in patients with LBBB, who represent about 7% of patients with MI in a sample from the National Registry of MI 2 (NRMI 2), may be increased by the frequency with which they present with atypical symptoms. Left bundle-branch block patients with MI are older (76 vs. 68 years) and more likely to be women (50% vs. 41%) than patients with MI and without LBBB, and they have a higher prevalence of diabetes (36% vs. 26%)—all characteristics associated with an atypical presentation of MI. A recent study from NRMI 2

demonstrated that nearly half of LBBB patients with MI presented to medical attention without chest pain (compared with 30% of MI patients without LBBB) but did not address potential differences in treatment or survival in this subgroup.[11]

Atrial fibrillation and chest pain

A total of 5 (3.3%) patients presented with atrial fibrillation. Atrial fibrillation is one of the most commonly encountered clinical arrhythmia, often complicates chest pain and acute myocardial infarction with an incidence between 6 and 21%.[12] Predictors of the arrhythmia in the setting of AMI include advanced age, heart failure symptoms, and depressed left ventricular function.

PR interval and heart block

A PR interval could be calculated in only 144 patients as five (3.3%) patients had atrial fibrillation and one (0.66%) patient presented with complete heart block and among remaining 144 patients, 4 (2.7%) had a PR interval longer than 120ms. All four patients had first degree heart block. First degree block was seen in around 10% of all myocardial infarction patients; one-third of these-many with a P-R interval of 0.24 seconds or more-progressed to a higher level of block. Some myocardial infarction patients (around 5%) demonstrate second-degree block. Mobitz Type I block (Wenckebach) occurs much more frequently than type II. Complete heart block occurs in around 5% of myocardial infarction patients.[13]

QT interval

In our study population, 4 (2.66%) patients had prolonged QTc among all 150 patients. There were no patients with a short QT interval. The exact incidence of prolonged QT and QTc during chest pain of cardiac origin is unknown. However, lengthening of the Q-T interval is common 12 to 24 hours after the onset of an acute myocardial infarction and that prolongation of up to 20 percent over the initial values may occur in cases not complicated by severe ventricular arrhythmias.[14] Since we evaluated the QTc at the time of presentation with chest pain, our study population showed an increase in QTc interval in only 4 (2.66%) of patients.

ECG changes and reperfusion therapy

Sixteen (10.66%) of our patients had ECG indication for reperfusion therapy. However, due to the cross-sectional nature of our study, we did not follow the patients till actual reperfusion therapy was administered.

One of the aims of our study was to find any association between the provisional diagnosis and ECG changes. We used clinical, electrocardiographic and biomarkers to make the provisional diagnosis. Only one patient with myocardial infarction had normal ECG. However, there were 9 patients who had typical chest pain and diagnosed as unstable angina had normal ECG. Similarly, category IV ECG changes (definite evidence of ischaemia) were seen only in patients with myocardial infarction and unstable angina.

Similarly, to study the relation between troponin I and ECG changes was also one of the aims of our study. Troponin I was negative only in 1 patient with category IV ECG changes (definite evidence of ischaemia) and was positive in 1 patient with category I ECG (normal ECG). The results show that initial presenting ECG has a very high chance of detecting myocardial ischaemia.

Limitations: This study was the first of its kind to determine the ECG changes, and it identified T-wave abnormalities as major changes in patients presenting to the emergency department with chest pain of suspected cardiac origin. However, a detailed further subanalysis of such changes were not planned during the development of the research protocol and is a major limitation of this study.

Conclusions

In our study, we observed a noteworthy prevalence of coronary artery disease, calculated at 44% patients presenting with suspected cardiac origin chest pain. T wave inversion emerged as the most prevalent electrocardiographic change, evident in 44% of cases. Additionally, ST segment elevation in 10.66%, and ST segment depression in 28% of patients. Further findings included left ventricular hypertrophy (10%), Q waves (6.66%), and LBBB (11.33%). Acute coronary syndrome was primarily identified in patients with ECG evidence of ischemia, as only one patient with a normal ECG presented with this condition. The combined assessment of electrocardiographic changes, clinical history, and cardiac biomarkers exhibited substantial efficacy in detecting and ruling out coronary artery disease and acute coronary syndrome within the emergency department setting in a regional tertiary level hospital of western Nepal.

Conflict of Interests: None

Funding: Self-funded

References

1. Okrainec K, Banerjee DK, Eisenberg MJ. Coronary artery disease in the developing world. American heart journal. 2004 Jul 1;148(1):7-15. https://doi.org/10.1016/j.ahj.2003.11.027
2. Ackroyd-Stolarz S, Guernsey JR, Mackinnon NJ, Kovacs G. The association between a prolonged stay in the emergency department and adverse events in older patients admitted to hospital: a retrospective cohort study. BMJ quality & safety. 2011 Jul 1;20(7):564-9. https://doi.org/10.1136/bmjqs.2009.034926
3. Challa PK, Smith KM, Conti CR. Initial presenting electrocardiogram as determinant for hospital admission in patients presenting to the emergency department with chest pain: a pilot investigation. Clinical Cardiology 2007;30(11):558-561. https://doi.org/10.1002/clc.20141
4. Hulley SB, Cummings SR, Browner WS, Grady D, Newman TB. Designing clinical research: an epidemiologic approach. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2013. Appendix 6E, page 81.
5. Skinner JS, Smeeth L, Kendall JM, Adams PC, Timmis A. NICE guidance. Chest pain of recent onset: assessment and diagnosis of recent onset chest pain or discomfort of suspected cardiac origin. Heart. 2010 Jun 1;96(12):974-8. https://doi.org/10.1136/hrt.2009.190066
6. Kachintorn U. How do we define non-cardiac chest pain?. Journal of gastroenterology and hepatology. 2005 Dec;20:S2-5. https://doi.org/10.1111/j.1440-1746.2005.04164.x
7. Kleber AG. ST-segment elevation in the electrocardiogram: a sign of myocardial ischemia. Cardiovascular research. 2000 Jan 1;45(1):111-8. https://doi.org/10.1016/s0008-6363(99)00301-6
8. Boon D, van Goudoever J, Piek JJ, van Montfrans GA. ST segment depression criteria and the prevalence of silent cardiac ischemia in hypertensives. Hypertension. 2003 Mar 1;41(3):476-81. https://doi.org/10.1161/01.hyp.0000054980.69529.14

9. Mendis S, Thygesen K, Kuulasmaa K, Giampaoli S, Mähönen M, Ngu Blackett K, et al. World Health Organization definition of myocardial infarction: 2008–09 revision. International journal of epidemiology. 2011 Feb 1;40(1):139-46. https://doi.org/10.1093/ije/dyq165

10. Kligfield P, Gettes LS, Bailey JJ, Childers R, Deal BJ, Hancock EW, Van Herpen G, Kors JA, Macfarlane P, Mirvis DM, Pahlm O. Recommendations for the standardization and interpretation of the electrocardiogram: part I: the electrocardiogram and its technology: a scientific statement. Circulation. 2007 Mar 13;115(10):1306-24. https://doi.org/10.1016/j.hrthm.2007.01.027

11. Shlipak MG, Go AS, Frederick PD, Malmgren J, Barron HV, Canto JG. National Registry of Myocardial Infarction 2 Investigators. Treatment and outcomes of left bundle-branch block patients with myocardial infarction who present without chest pain. Journal of the American College of Cardiology. 2000 Sep;36(3):706-12. https://doi.org/10.1016/s0735-1097(00)00789-0

12. Schmitt J, Duray G, Gersh BJ, Hohnloser SH. Atrial fibrillation in acute myocardial infarction: a systematic review of the incidence, clinical features and prognostic implications. European heart journal. 2009 May 1;30(9):1038-45. https://doi.org/10.1093/eurheartj/ehn579

13. Rathore SS, Gersh BJ, Berger PB, Weinfurt KP, Oetgen WJ, Schulman KA, Solomon AJ. Acute myocardial infarction complicated by heart block in the elderly: prevalence and outcomes. American heart journal. 2001 Jan 1;141(1):47-54. https://doi.org/10.1067/mhj.2001.111259

14. Hasanien AA, Drew BJ, Howie-Esquivel J. Prevalence and prognostic significance of long QT interval in patients with acute coronary syndrome: review of the literature. Journal of cardiovascular Nursing. 2014 May 1;29(3):271-9. https://doi.org/10.1097/jcn.0b013e31829bcf1a