Electrocardiographic Changes and Coronary Findings in Patients with Acute non-ST-Elevation Myocardial Infarction: A Cross-Sectional Study

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Abstract

Background: Despite significant improvements in diagnosis and treatment, non-ST-Elevation Myocardial Infarction (NSTEMI) is still one of the health problems in developed and developing countries.

Objectives: The present study was performed to assess the electrocardiographic changes and coronary findings in patients with NSTEMI.

Methods: The study enrolled 158 patients with NSTEMI diagnosis at the discharge time. Demographic characteristics and electrocardiographic changes were collected using a checklist from the medical records of the patients. The angiography data were used to calculate a syntax score for each patient. Finally, patients were divided into three groups based on this score: high risk >32, intermediate risk 22-32, and low risk < 22. Involved vessels, including the left anterior descending artery, Right Coronary Artery (RCA), Left Circumflex Artery (LCX), and the left main stem, were also determined.

Results: The mean age of the patients was 60.68 ± 12.15 years. The LAD, LCX, and RCA were the most common involved vessels, in sequence. About 27.73, 67.15, and 5.12% of the patients were assigned to low, moderate, and high-risk groups, respectively. Statistically significant differences were observed in the frequencies of ECG changes (P = 0.003) and types of involved vessels (P < 0.001) between low, moderate, and high-risk patients. In addition, there were statistically significant differences in the mean syntax scores between different types of involved vessels (P < 0.001).

Conclusions: The findings of the present study showed a significant relationship between the types of vessel involvement and syntax score. Also, there was a high prevalence of ST changes in precordial leads that may improve the sensitivity of diagnosis. We did not find any significant relationship between the frequencies of ECG changes based on the types of involved vessels.

Keywords: Electrocardiography, Myocardial Infarction, Diagnosis

1. Background

Cardiovascular diseases are the most common causes of mortality worldwide. They account for about 138,000 deaths annually in Iran, about half of which are heart attacks (1). According to the Iran Ministry of Health, cardiovascular disease mortality increased in the past decade, accounting for about 46% of all deaths in Iran (2). There are two major types of ischemic heart diseases, including stable angina and Acute Coronary Syndrome (ACS). The ACS is divided into unstable angina, acute ST-elevation myocardial infarction (STEMI), and acute non-ST-elevation myocardial infarction (NSTEMI). There are two main groups of risk factors for cardiovascular diseases: Modifiable (e.g., obesity, smoking, diabetes, hypertension, hyperlipidemia, and oral contraceptive use) and unmodifiable (sex, family his-

tory, and race) (3). For instance, diabetes can increase the risk of cardiovascular diseases (4). Obesity increases the levels of glucose, triglyceride (5), low-density lipoprotein (LDL), and heart rate, which can lead to metabolic and cardiovascular diseases.

The SYNTAX (Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery) score is a grading system to evaluate the complexity and prognosis of patients undergoing percutaneous coronary intervention (6). It is a tool to select revascularization strategies and is obtained based on 11 angiography variables that consider the location and properties of lesions. The study of ST changes in ECG can be used to improve the sensitivity of diagnosis.

Only in the United States, about one million patients

are hospitalized because of acute myocardial infarction (7). Acute Myocardial Infarction (AMI), also known as heart attack, is caused by narrowing or occlusion of a coronary artery as a result of a sudden and sustained lack of blood flow to the heart tissue (1). As known, AMI is one of the most important medical emergencies imposing a high financial burden on health care systems and patients' families. The prognosis of AMI is not good, and despite the increasing survival rate in the last decade, the median survival rate has not changed (about three years after diagnosis) (8). Thus, AMI is the most common cause of disability and mortality (9), although the mortality is declining due to the reduced incidence of the disease and progressions in diagnosis and treatment. Although the short-term mortality of STEMI patients receiving fibrinolytic treatment has been reported to be 6.5 to 7.5% in randomized studies, clinical and descriptive studies have shown that it is about 15 to 20% (10).

Although MI used to occur more often in the elderly, the incidence currently is more prevalent among young people (8, 11). The mortality is about 30%, and almost half of the deaths occur in the first hour when the patient has not yet been admitted to the hospital. Cardiovascular mortality is increasing, and by 2030, it will remain among the three main causes of the global burden of disease (12).

The NSTEMI is defined by an elevation of cardiac biomarkers in the absence of ST elevation. Despite significant improvements in diagnosis and treatment, NSTEMI is still one of the health problems in developed and developing countries (10, 13). The NSTEMI patients are usually older and sicker, with higher risks of adverse events such as cardiogenic shock when compared to STEMI patients (14). Furthermore, these patients have left ventricular dysfunction, renal failure, complex and extensive anatomic coronary disease, older age, and greater risk of developing or presenting with cardiogenic shock (15); thus, there remains a considerable variation in the treatment management of NSTEMI patients (14). Therefore, NSTEMI patients are a high-risk population. Up to half of the NSTEMI patients do not exhibit chest pain, compared to about one-fourth of STEMI patients. The lack of chest pain increases the diagnostic time of patients (15). One study showed that, Among patients with NSTEMI, only 53% of patients had definite ECG ischemic abnormalities. However, it could be due to the fact that only patients with single- vessel CAD were evaluated in this study, while a large percentage of patients with NSTEMI have multivessel CAD. This low percentage could also be explained by the relatively low troponin level that used for inclusion in the stud (16). Early detection and appropriate management of myocardial infarction are imperative to improving patient outcomes (17).

2. Objectives

Due to the poor prognosis of NSTEMI, the presence of typical comorbidities and associated causes, the old age of most patients, and the complexity of treatment decisions, on the one hand, and the lack of studies in this field and the criticality of coronary artery problems, on the other hand, we decided to measure and evaluate electrocardiographic changes and coronary artery findings in patients with NSTEMI to prevent re-hospitalization and reMI of these patients. The data from this study would lead to accelerated diagnosis and treatment and increased prognosis in the patients.

3. Methods

The study sample was selected from MI patients admitted to Heshmat hospital during the first six months of 2018. The sample size was 158 patients. To comply with the ethical considerations of research, written informed consent was obtained from all participants. All ECGs obtained during the index hospitalization, as well as previous ECGs (when available for comparison), were interpreted by a single experienced electrocardiography interpreter (WSA) who was blinded to patient history, angiographic findings, and previous ECG interpretation. Data were obtained from the medical records of the patients. The ECG criteria for non-ST elevation acute myocardial infarction was defined by the presence of ischemic chest pain lasting more than five minutes and positive troponin-I level (defined in our clinical laboratory as > 0.01 ng/mL) without any evidence of ST-segment elevation on 12-lead electrocardiogram (16, 18).

In this study, the inclusion criteria were having a diagnosis of non-ST elevation acute myocardial infarction and age of 18 years or above in both genders. Also, the exclusion criteria were patients with ST-elevation ACS, patients with paced electrical rhythm ACS, patients who were intubated or died, and those whose medical records were incomplete/illegible. Besides, we obtained demographic and medical characteristics, including age, sex, smoking, history of hypertension, diabetes, family history of coronary diseases, and lipid profile (cholesterol, TG, LDL-C, and HDL-C). The lipid profile was measured at the time of referral to the hospital. Quantitative coronary angiography was performed using the Judkins technique by two experienced interventional cardiologists unaware of the clinical and laboratory results of the patients. Significant CAD was defined as >50% stenosis in at least one coronary artery. Each coronary lesion producing a ≥ 50% luminal obstruction in vessels ≥ 1.5 mm was separately scored and added to provide the vessel syntax score. Also, the angiography data were

used to calculate a syntax score for each patient. According to the syntax score, the patients were assigned into three groups: high-risk group (syntax score > 32), intermediate-risk group (syntax score of 22 to 32), and low-risk group (syntax score < 22). Involved vessels, including the left anterior descending artery, Right Coronary Artery (RCA), Left Circumflex Artery (LCX), and the left main stem, were also determined (6, 18, 19). This study was approved by the Ethics Committee of Guilan University of Medical Sciences (no.IR.GUMS.REC.1397.388). All necessary permissions were obtained from the relevant authorities before beginning the study.

3.1. Statistical Analysis

Data analysis was performed using SPSS version 16 software. Data were presented as frequency, percentage, and mean ± SD. The normality of quantitative variables was assessed using the Kolmogorov-Smirnov test. Variables that did not have a normal distribution were presented as median and Interquartile Range (IQR). The one-way ANOVA test was used to compare the mean syntax scores based on involved vessels and electrocardiographic changes. The relationship between qualitative variables was assessed using the chi-square test, Fisher exact test, or Kruskal-Wallis test, where applicable. A p-value of less than 0.05 was considered statistically significant.

4. Results

The demographic characteristics of the studied patients are shown in Table 1. As shown, 116 patients (73.41%) were men. The mean age of the patients was 60.68 ± 12.15 years (range: 33 to 88 years) and they were in the age groups of 51 to 60 (49%), 61 to 70 (24.7%), 71 to 80 (18.4%), 41 to 50 (17.1%), < 40 (4.4%), and > 80 years (4.4%). Of patients, 53 (33.5%) and 92 (58.2%) had diabetes and hypertension, respectively. Besides, 43 (27.2%) were smokers, and 85 (53.8%) had a family history of AMI.

Table 2 indicates the lipid profile and involved vessels in the studied patients. The mean levels of cholesterol, TG, LDL, and HDL were 164.59 ± 45.88 mg/dl, 159.56 ± 95.38 mg/dl, 98.41 ± 37.90 mg/dl, and 37.67 ± 9.24 mg/dl, respectively. LAD, LCX, and RCA were the most common involved vessels, in sequence. Ten (7.24%) and 41 (29.71) patients had concomitant involvement of two (LAD and RCA) and three (LDA, RCA, LCX) vessels, respectively. The concomitant involvement of LDA, RCA, LCX, and LM was seen only in six (4.34%) patients.

Table 3 shows the frequencies of ECG changes in patients with different severities of vessel involvement. The ST change in leads I and AvL had the lowest frequencies (4.5%).

Table 1. Demographic Characteristics of the Studied Subjects

Variable	No. (%)
Sex	
Male	116 (73.4)
Female	42 (26.6)
Age (years)	
<40	7 (4.4)
41-50	27 (17.1)
51-60	49 (31)
61-70	39 (24.7)
71-80	29 (18.4)
>80	7 (4.4)
Diabetes	53 (33.5)
Hypertension	92 (58.2)
Smoking	43 (27.2)
Family history	85 (53.8)

Table 2. Lipid Profile and Involved Vessels in the Studied Patients

Variable	Values[a]	Min	Max
Cholesterol (mg/dl)	164.59 ± 45.88	61	326
TG (mg/dl)	159.56 ± 95.38	50	628
LDL	98.41 ± 37.90	34	229
HDL	37.67 ± 9.24	22	86
Involved vessels			
LCX	18 (13.04)		
LAD	45 (32.60)		
RCA	18 (13.04)		
2VD (LDA, RCA)	10 (7.24)		
3VD (LDA, RCA, LCX)	41 (29.71)		
3VD and LM	6 (4.34)		

Abbreviation: LAD, left anterior descending artery; RCA, right coronary artery; LCX, left circumflex artery; LM, left main stem.
[a]Values are presented as mean ± SD or No. (%).

Also, 39.1% of changes were seen in the T segment in the form of T invert. The majority of the patients (n = 92; 67.15%) were assigned into the moderate-risk group (syntax score 22 to 32). Thirty-eight (27.73%) and seven (5.12%) patients were in the low (syntax score < 22) and high (syntax score > 32) risk groups, respectively. The prevalence of ST change in leads V1 to V6 was about 50% (n = 4). In other words, half of the patients with ST change in precordial (V1-V6) leads had severe involvement (high-risk group). The ST change in leads V1 to V6 had the highest mean syntax score (29.87 ± 7.41). About 80% (n = 4) of the patients with ST

Table 3. Frequencies of ECG Changes in Patients with Different Severities of vessel Involvement (Syntax Score)

ECG Changes	Vessel Involvement			P Value[a]	Syntax Score		P Value[b]
	Low (< 22), No. (%)	Moderate (22-32), No. (%)	High (> 32), No. (%)		n	Mean ± SD	
ST change in V1-V2-V3 leads	6 (35.3)	10 (58.8)	1 (59)		17	24.52 ± 3.98	
ST change in V1 to V6 leads	2 (25)	2 (25)	4 (50)		8	29.87 ± 7.41	
ST change in V4 and V6 leads	1 (20)	4 (80)	0 (0)		5	26.23 ± 4.14	
ST change in I and Avl leads	4 (66.7)	2 (33.3)	0 (0)	0.003	6	21.83 ± 5.67	0.029
ST change in II, III, and Avf leads	4 (28.6)	10 (71.4)	0 (0)		14	24.51 ± 5.28	
T change (T-invert)	10 (17.2)	46 (79.3)	2 (3.4)		58	25.77 ± 4.23	
Without any change in ECG	11 (42.3)	15 (57.7)	0 (0)		26	23.42 ± 4.85	
Total	38 (27.73)	92 (67.15)	7 (5.12)				

[a] Fisher's exact test.
[b] One-way ANOVA.

change in V4 to V6 leads had moderate involvement, and 66.7% (n = 4) of the patients with ST change in lateral (I and Avl) leads had low involvement. A statistically significant difference was observed in the frequency of ECG changes among low, moderate, and high-risk patients (P = 0.003). Similarly, the means of syntax scores were significantly different between the groups (P = 0.029).

Table 4 shows the frequencies of the types of involved vessels in patients with different severities of vessel involvement. Among 38 low-risk patients, the RCA and 3VD,3VD &LM vessels had the highest and lowest involvements, respectively. In the moderate-risk group, the most and least involved vessels were 3VD and 3VD/LM, respectively. Only seven patients (5.12%) were assigned into the severe-risk group for whom 3VD/LM was the most involved vessel. No severe involvement was observed in patients with LCX, LAD, and RCA vessel involvement. The frequencies of the types of involved vessels were significantly different between low, moderate, and high-risk patients (P < 0.001). In addition, there was a statistically significant difference in the mean syntax scores between different types of involved vessels (P < 0.001).

5. Discussion

In the present study, 158 patients with NSTEMI were studied. Of them, 73.4% (116 patients) were male and 26.6% (42 patients) were female. The mean age of the patients was 60.68 ± 12.15 years. The highest frequency of NSTEMI was observed in patients aged 51 to 60 years (31%).

The results indicated that 33.5% and 58.2% of the studied patients had diabetes and hypertension, respectively. About 27.2% were smokers, and 53.8% had a family history of AMI. In the Shahmirzaee et al. study, 63.5% of the patients had no history of hypertension. However, 58.8% showed hypertension during hospitalization. Shahmirzaee et al. also found that 21% of the patients had diabetes. Keikha et al. (20) found that in patients with diagnostic ECG patterns, 40% had a history of ACS, 30% were smokers, and 6.26, 3.23, and 3.23% had a history of hypertension, diabetes, and MI, respectively.

In the present study, the mean levels of cholesterol, TG, LDL, and HDL were 164.59 ± 45.88 mg/dl, 159.56 ± 95.38 mg/dl, 98.41 ± 37.90 mg/dl, and 37.67 ± 9.24 mg/dl, respectively. In the Shahmirzaee et al. study, none of the studied patients had a history of hyperlipidemia (20) Sannani et al. reported that 64.9% of the patients had dyslipidemia (20). The angiography findings showed that 3VD/LM and LAD were the least and most involved vessels in the studied patients, respectively (4.3 vs. 32.6%). In addition, T segment (in the form of T invert).had the lowest and highest frequencies, respectively (4.5 vs. 39.1%). The classification of patients based on the syntax score showed that 67.2% had moderate involvement, and only 5.1% had severe involvement (syntax score >32). The frequencies of the types of involved vessels were significantly different between low, moderate, and high-risk patients (P < 0.001). In addition, there was a statistically significant difference in the mean syntax scores between different types of involved vessels (P < 0.001). Sannani et al. reported that the most involved vessels were the LAD vessel in anterior STEMI patients and LCX and/or RCA in inferior STEMI patients, whereas the most involved vessel was LAD in NSTEMI patients (16). We also found a statistically significant difference in the frequency of ECG changes between low, moderate, and high-risk patients (P = 0.003). Similarly, the mean syntax scores were significantly different between the groups (P = 0.029). There was a statistically significant difference in the fre-

Table 4. Frequencies of the Types of Involved Vessels in Patients with Different Severities of Vessel Involvement (Syntax Score)

ECG Changes	Vessel Involvement			P Value[a]	Syntax Score		P Value[b]
	Low (<22), No. (%)	Moderate (22-32), No. (%)	High (>32), No. (%)		n	Mean ± SD	
LCX	9 (50)	9 (50)	0 (0)		18	22.05 ± 3.03	
LAD	17 (38.63)	27 (61.37)	0 (0)		44	22.97 ± 3.71	
RCA	11 (61.11)	7 (38.89)	0 (0)		18	21.22 ± 4.1	
2VD (LDA, RCA)	1 (10)	8 (80)	1 (10)	< 0.0001	10	26.4 ± 6.38	< 0.0001
3VD (LDA, RCA, LCX)	0 (0)	39 (95.13)	2 (4.87)		41	29.29 ± 1.91	
3VD & LM	0 (0)	2 (33.33)	4 (66.67)		6	32.33 ± 1.86	
Total	38 (27.73)	92 (67.15)	7 (5.12)				

[a] Fisher's exact test.
[b] One-way ANOVA.

quency of ECG changes between low, moderate, and high-risk patients (P = 0.003). Similarly, the mean syntax scores were significantly different between the groups (P = 0.029). Poh et al. showed that in patients with acute chest pain and ST depression in the 12-lead ECG, concomitant posterior ST elevation may be a reliable indicator of ST-elevation posterior MI, which is likely because of the occlusion of the circumflex artery (21). Patients with acute left circumflex occlusion are typically characterized primarily on the standard 12-lead ECG by ST depression. The posterior left ventricular wall is one of the parts that is hidden in ECG, and thus many cases of posterior infarction are not diagnosed. Therefore, these patients are not good candidates to receive thrombolytic therapy. This may affect the short- and long-term prognosis in these patients (22). Khaw et al., in a study of 33 patients with chest pain but without any symptoms in favor of AMI in 12-lead ECG, observed that 45.5% had evidence of MI in posterior leads, and 67% had reciprocal patterns in anterior leads (23). Matetzky et al. studied 87 acute inferior MI patients with thrombolytic therapy and found that 46 patients had ST elevation in leads V7, V8, and V9 (24). Zalenski et al. showed that the addition of posterior and right ventricular leads is useful in the diagnosis of patients with acute MI (25). The ST elevation in leads II, III, and Avf were the most common ECG changes (95%) in the right coronary angioplasty, and during circumflex angioplasty, the frequency of ST elevation in posterior leads V7, V8, and V9 was about 68% (26).

As mentioned, many heart diseases cannot be diagnosed with ECG. Typically, 50% of patients with UA and NSTEMI do not have any ECG changes at the time of cardiac emergencies. Therefore, the correct choice of any diagnostic tool for any heart disease is an important responsibility of the physician.

The SYNTAX Score is a method of ranking the severity of coronary arteries and a tool for determining the progno-sis of patients who are candidates for renovascular surgery, especially Percutaneous Coronary Intervention (PCI). The scores are given based on 11 angiographic variables by considering the location and characteristics of the lesion. This scoring system is an effective tool for classifying patients with complex coronary arteries for treatment with PCI and pharmacotherapy or GABG. Therefore, the sensitivity of diagnosis can be affected by examining the prevalence of ST changes in electrocardiography. Making correct and rapid decisions in the emergency room is important to save the lives of these patients. In patients undergoing coronary angiography, the SYNTAX scoring criterion is of acceptable value. Therefore, in a prospective cohort study, it is proposed to use it as a method to determine the diagnostic-therapeutic strategy.

5.1. Limitation

One of the limitations of this study is the illegibility and shortcomings in the files and laboratory documents of patients, as well as the lack of cooperation of some patients to perform laboratory tests. Incomplete files were excluded from the study.

5.2. Conclusions

The findings of the present study showed a significant relationship between the types of vessel involvement and the syntax score. Patients with stenosis in three coronaries had a syntax score >32. In addition, the ST changes in V1 to V6 leads was >32 in 50% of the studied patients. This high prevalence of ST changes in precordial leads may improve the sensitivity of diagnosis. We did not find a significant relationship between the frequencies of ECG changes based on the types of involved vessels. However, 3VD and LM showed the highest changes in V1-V6 leads and T-invert.

Acknowledgments

Footnotes

References

1. Ebrahimi K, Khadem Vatan K, Salarilak S, Gharaaghaji R. Epidemiological features of risk factors occurrence and outcomes of myocardial infraction in patients admitted to hospitals in west azerbaijan province during the years 2011 and 2012. *Studies in Medical Sciences*. 2015;**26**(8):724–34.

2. Kramer JM, Newby LK, Chang WC, Simes RJ, Van de Werf F, Granger CB, et al. International variation in the use of evidence-based medicines for acute coronary syndromes. *Eur Heart J*. 2003;**24**(23):2133–41. doi: 10.1016/j.ehj.2003.09.018. [PubMed: 14643274].

3. Radisauskas R, Bernotiene G, Rastenyte D. Trends in out-of-hospital mortality from ischemic heart disease in Kaunas middle-aged population during 1983-1998. *Medicina (Kaunas, Lithuania)*. 2004;**40**(1):75–80.

4. Jafari H, Shafipour V, Mokhtarpour R, Rhanama N, Esmaeili R, Nasiri E. Study of some risk factors and accelerating factors of heart attack and the delay reasons in referring to theMazandaran Cardiac Center in 2009. *J Mazandaran Uni Med Sci*. 2009;**19**(73):68–74.

5. Otgontuya D, Oum S, Buckley BS, Bonita R. Assessment of total cardiovascular risk using WHO/ISH risk prediction charts in three low and middle income countries in Asia. *BMC Public Health*. 2013;**13**:539. doi: 10.1186/1471-2458-13-539. [PubMed: 23734670]. [PubMed Central: PMC3679976].

6. Zeng Y, Yang S, Wang X, Fan J, Nie S, Wei Y. Prognostic impact of residual SYNTAX score in patients with obstructive sleep apnea and acute coronary syndrome: a prospective cohort study. *Respir Res*. 2019;**20**(1):43. doi: 10.1186/s12931-019-1008-z. [PubMed: 30819182]. [PubMed Central: PMC6393988].

7. Mazloomy S, Mirzaei A, Afkhami Ardakani M, Baghiani Moghadam M, Fallahzadeh H. The role of health beliefs in preventive behaviors of individuals at high-risk of type2 diabetes mellitus. *SSU_Journals*. 2010;**18**(1):24–31.

8. Zubaid M, Rashed WA, Husain M, Mohammad BA, Ridha M, Basharuthulla M, et al. A registry of acute myocardial infarction in Kuwait: Patient characteristics and practice patterns. *Can J Cardiol*. 2004;**20**(8):783.

9. Berenson GS, Srinivasan SR, Bao W, Newman W3, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. *N Engl J Med*. 1998;**338**(23):1650–6. doi: 10.1056/NEJM199806043382302. [PubMed: 9614255].

10. Canto JG, Rogers WJ, Chandra NC, French WJ, Barron HV, Frederick PD, et al. The association of sex and payer status on management and subsequent survival in acute myocardial infarction. *Arch Intern Med*. 2002;**162**(5):587–93. doi: 10.1001/archinte.162.5.587. [PubMed: 11871928].

11. Jiang H, Ge J. Epidemiology and clinical management of cardiomyopathies and heart failure in China. *Heart*. 2009;**95**(21):1727–31. doi: 10.1136/hrt.2008.150177. [PubMed: 19318343].

12. Nicholas M, Townsend N, Scarborough P, Rayner M. Corrigendum to: cardiovascular disease in Europe 2014: epidemiological update. *Eur Heart J*. 2015;**36**(13):794. doi: 10.1093/eurheartj/ehu489. [PubMed: 25514929].

13. American Heart Association. *Heart disease and stroke statistics-2004 update*. 2002.

14. Dondo TB, Hall M, Timmis AD, Gilthorpe MS, Alabas OA, Batin PD, et al. Excess mortality and guideline-indicated care following non-ST-elevation myocardial infarction. *Eur Heart J Acute Cardiovasc Care*. 2017;**6**(5):412–20. doi: 10.1177/2048872616647705. [PubMed: 27142174].

15. Vetrovec GW. NSTEMI: Not just a 'small heart attack'. *Cardiovasc Revasc Med*. 2019;**20**(8):634–5. doi: 10.1016/j.carrev.2019.07.005. [PubMed: 31420073].

16. Sanaani A, Yandrapalli S, Jolly G, Paudel R, Cooper HA, Aronow WS. Correlation between electrocardiographic changes and coronary findings in patients with acute myocardial infarction and single-vessel disease. *Ann Transl Med*. 2017;**5**(17):347. doi: 10.21037/atm.2017.06.33. [PubMed: 28936441]. [PubMed Central: PMC5599289].

17. Harrington DH, Stueben F, Lenahan CM. ST-elevation myocardial infarction and non-ST-elevation myocardial infarction: Medical and surgical interventions. *Crit Care Nurs Clin North Am*. 2019;**31**(1):49–64. doi: 10.1016/j.cnc.2018.10.002. [PubMed: 30736935].

18. Kurtul S, Sarli B, Baktir AO, Demirbas M, Saglam H, Doğan Y, et al. Neutrophil to lymphocyte ratio predicts SYNTAX score in patients with non-ST segment elevation myocardial infarction. *Int heart J*. 2014:14–175.

19. Zipes DP, Libby P, Bonow RO, Mann DL, Tomaselli GF. *Braunwald's heart disease e-book: A textbook of cardiovascular medicine*. Elsevier Health Sciences; 2018.

20. Shahmirzaee R, Sadrnia S, Solhi H, Ghasemi A. The evaluation of electrocardiogram in patients with unstable angina and non-ST elevation myocardial infarction. *Arak Medical University Journal*. 2010;**13**(2).

21. Poh KK, Chia BL, Tan HC, Yeo TC, Lim YT. Absence of ST elevation in ECG leads V7, V8, V9 in ischaemia of non-occlusive aetiologies. *Int J Cardiol*. 2004;**97**(3):389–92. doi: 10.1016/j.ijcard.2003.10.022. [PubMed: 15561323].

22. Ripa RS, Holmvang L, Maynard C, Sejersten M, Clemmensen P, Grande P, et al. Consideration of the total ST-segment deviation on the initial electrocardiogram for predicting final acute posterior myocardial infarct size in patients with maximum ST-segment deviation as depression in leads V1 through V3. A FRISC II substudy. *J Electrocardiol*. 2005;**38**(3):180–6. doi: 10.1016/j.jelectrocard.2005.03.011. [PubMed: 16003697].

23. Khaw K, Moreyra AE, Tannenbaum AK, Hosler MN, Brewer TJ, Agarwal JB. Improved detection of posterior myocardial wall ischemia with the 15-lead electrocardiogram. *Am Heart J*. 1999;**138**(5):934–40. doi: 10.1016/s0002-8703(99)70020-7.

24. Matetzky S, Freimark D, Chouraqui P, Rabinowitz B, Rath S, Kaplinsky E, et al. Significance of ST Segment Elevations in Posterior Chest Leads (V7 to V9) in Patients With Acute Inferior Myocardial Infarction: Application for Thrombolytic Therapy. *J Am Coll Cardiol*. 1998;**31**(3):506–11. doi: 10.1016/s0735-1097(97)00538-x.

25. Zalenski RJ, Rydman RJ, Sloan EP, Hahn KH, Cooke D, Fagan J, et al. Value of posterior and right ventricular leads in comparison to the standard 12-lead electrocardiogram in evaluation of st-segment elevation in suspected acute myocardial infarction. *The American Journal of Cardiology*. 1997;**79**(12):1579–85. doi: 10.1016/s0002-9149(97)00202-6.

26. Kulkarni AU, Brown R, Ayoubi M, Banka VS. Clinical use of posterior electrocardiographic leads: A prospective electrocardiographic analysis during coronary occlusion. *American Heart Journal*. 1996;**131**(4):736–41. doi: 10.1016/s0002-8703(96)90280-x.