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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Evaluation of Coronary Angiography Results of Patients Diagnosed with STEMI in the Emergency Department

Acil Serviste STEMI Tanısı Alan Hastaların Koroner Anjiyografi Sonuçlarının Değerlendirilmesi

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ABSTRACT

Aim: In this study, we evaluated patients with STEMI findings on the ECG obtained in the emergency department with coronary angiography results. We aimed to investigate the accuracy and reliability of the findings in the ECG by looking at the presence of coronary artery occlusion in the myocardial areas matching the leads where ST segment elevation was detected in the ECG.

Materials and Method: The study was planned as a retrospective, observational study. STEMI was defined as elevation from the J point in 2 or more adjacent leads with a cutoff equal to or greater than 0.2 mV in V1, V2, or V3 and greater than or equal to 0.1 mV in other leads according to the specified criteria. The presence of 50% or more stenosis in at least one coronary artery or the presence of a visible thrombus-containing coronary lesion responsible for STEMI is considered to be the presence of coronary artery disease.

Results: A total of 221 patients who met the study criteria were included in the study. The mean age of our patients was 63.1±14 years and 70.13% were male. The most common comorbid disease was HT (50.68%). Coronary angiography revealed no coronary artery obstruction in 9% patients. When the ECG lead groups with ST elevation are analysed, it is seen that the difference between the groups is due to the patients with anterolateral STEMI on ECG. While the risk of vascular occlusion was estimated at a high rate (93.6%) in other ECG findings, this rate was lower in patients with anterolateral STEMI (77.1%) and differed from the other groups.

Conclusion: The causes and clinical implications of false positive STEMI are complex and multifactorial. Strategies to reduce false positive activations should include standardized ECG interpretation, real-time physician supervision, algorithmic support, and education. These efforts are crucial to optimizing STEMI diagnosis, improving patient care, and maximizing healthcare resource use.

Keywords: Coroner angiography, emergency, false positive, STEMI

ÖZ

Amaç: Bu çalışmada Acil serviste elde edilen EKG de STEMI bulguları olan hastaları koroner anjiyografi sonuçları ile değerlendirdik. EKG de ST segment yüksekliğinin tespit edildiği derivasyonlara uyan myokard alanlarında gerçekte koroner arter oklüzyonu mevcudiyetine bakarak EKG deki bulguların doğruluğunu ve güvenilirliğini araştırmayı amaçladık.

Gereç ve Yöntem: Çalışma retrospektif, gözlemsel bir çalışma olarak planlandı. STEMI, belirtilen kriterlere göre V1, V2 veya V3'te 0,2 mV'ye eşit veya daha büyük ve diğer derivasyonlarda 0,1 mV'ye eşit veya daha büyük bir kesim ile 2 veya daha fazla bitişik derivasyonda J noktasından yükselmesi olarak tanımlandı. En az bir koroner arterde %50 veya daha fazla darlık olması veya STEMI'den sorumlu görünür trombüs içeren koroner lezyonun varlığı koroner arter hastalığı varlığı olarak kabul edilir.

Bulgular: Çalışma kriterlerini karşılayan toplam 221 hasta çalışmaya dahil edildi. Hastalarımızın yaş ortalaması 63,1±14 yıldı ve %70,13'ü erkekti. En sık eşlik eden hastalık HT idi (%50,68). Koroner anjiyografide hastaların %9'unda koroner arter tıkanıklığı saptanmadı. ST yükselmesi olan EKG derivasyon grupları incelendiğinde, gruplar arasındaki farkın EKG'de anterolateral STEMI olan hastalardan kaynaklandığı görülmektedir. Diğer EKG bulgularında damar tıkanıklığı riski yüksek oranda (%93,6) tahmin edilirken, anterolateral STEMI'li hastalarda bu oran daha düşük olup (%77,1) diğer gruplardan farklılık göstermektedir.

Sonuç: Bu çalışma, STEMI vakalarında negatif koroner anjiyografiyi ele alan literatüre katkıda bulunmaktadır. Bu olgunun nedenleri ve klinik sonuçları karmaşık ve çok faktörlüdür. Yanlış pozitif aktivasyonları azaltmaya yönelik stratejiler, standartlaştırılmış EKG yorumunu, gerçek zamanlı doktor gözetimini, algoritmik desteği ve eğitimi içermelidir. Bu çabalar STEMI teşhisini optimize etmek, hasta bakımını iyileştirmek ve sağlık hizmetleri kaynak kullanımını en üst düzeye çıkarmak için çok önemlidir.

Anahtar Kelimeler: Acil durum, koroner anjiyografi, yanlış pozitif, STEMI

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INTRODUCTION

ST-elevation myocardial infarction (STEMI) is a medical emergency characterized by acute myocardial ischemia due to complete occlusion of a coronary artery. Rapid diagnosis and immediate reperfusion therapy are pivotal in minimizing myocardial damage and improving patient outcomes (1). The cornerstone of STEMI management is the timely activation of the cardiac catheterization laboratory for coronary angiography and potential percutaneous coronary intervention (PCI).

While the urgency of this process is well-recognized, there is an inherent challenge in STEMI diagnosis – the occurrence of negative coronary angiography. Negative coronary angiography refers to the absence of significant coronary artery occlusion in patients with clinical and electrocardiographic features suggestive of STEMI (2). In such cases, the activation of the catheterization laboratory may have been triggered by a false-positive assessment of the patient's condition. This phenomenon raises several critical issues in the management of STEMI patients.

Negative coronary angiography represents a clinical dilemma with multifaceted implications. On one hand, the imperative to activate the catheterization laboratory promptly is driven by the life-saving potential of timely reperfusion. On the other hand, false-positive activations can lead to unnecessary invasive procedures, healthcare resource allocation, increased costs, and potential patient discomfort and risks. These issues necessitate a comprehensive examination of the causes and consequences of negative coronary angiography in STEMI cases.

The significance of addressing negative coronary angiography in STEMI lies in its clinical and economic impact. First, false-positive activations can consume valuable resources, including personnel, equipment, and facilities, which may be better utilized for patients with genuine STEMI (3). Second, patients subjected to unnecessary invasive procedures may experience physical and psychological discomfort, as well as potential complications. Third, delays in treating true STEMI cases due to false-positive activations can lead to adverse outcomes for patients who require urgent reperfusion therapy (2).

This manuscript aims to provide a comprehensive overview of the causes and clinical impact of negative coronary angiography in patients with suspected STEMI. By synthesizing insights from previous studies and clinical experiences, we seek to elucidate the challenges and potential strategies for reducing the incidence of false-positive catheterization laboratory activations. This endeavor aligns with the overarching goal of optimizing STEMI diagnosis and treatment, ultimately enhancing patient care and healthcare resource utilization.

MATERIAL AND METHOD

The study was planned as a retrospective, observational study. The study was started after the approval of the ethics committee (Nov 24,2022-0492). Between 1 January 2020 and 1 January 2023, patients admitted to the 3rd step emergency department of our university-affiliated hospital with STEMI detected on ECG were included in the study.

Inclusion Criteria

STEMI was defined as J-point elevation in 2 or more adjacent leads with a cut-off equal to or greater than 0.2 mV in V1, V2 or V3 and equal to or greater than 0.1 mV in other leads according to the criteria specified in the European Society of Cardiology (ESC) AMI guideline.

Patients whose ECG is evaluated as STEMI according to these criteria are consulted to a cardiologist, and patients are taken to coronary angiography after the evaluation of the cardiologist.

The presence of 50% or more stenosis in at least one coronary artery or the presence of a coronary lesion containing a visible thrombus responsible for STEMI is considered as the presence of coronary artery disease. If there was more than one potentially responsible coronary artery, the responsible artery was listed as more than one potentially culprit artery. If there was no angiographic evidence of a coronary lesion responsible for acute coronary syndrome, it was listed as absent.

Exclusion criteria

Patients under 18 years of age, pregnant patients, patients who died before coronary angiography could be performed, and patients with other diagnoses that could cause ST elevation on ECG in addition to the diagnosis of myocardial infarction in the emergency department were excluded from the study. In addition, patients with incomplete data, whose medical history was unknown or could not be learnt were also excluded. Total number of excluded patients are 129.

Primary outcomes

Demographic data (age, gender, pulse and ECG characteristics at presentation, blood pressure, cardiovascular risk factors (history of DM, HT and smoking, history of previous CAG and myocardial infarction, history of previous cerebrovascular disease and history of previous bypass, if any) and vital values of all patients were recorded on the study form. 30-day mortality rates were recorded.

Statistical method

The evaluation of the obtained data was performed in IBM SPSS Statics Version 20 package programme. Descriptive statistics, frequency and percentage distribution, mean, standard deviation, minimum and maximum values for continuous variables were calculated. The conformity of continuous variables to normal distribution was analysed by Kolmogorov-Smirnova and Shapiro-Wilk ($p<0.05$)

tests, and then it was decided to use parametric or non-parametric tests. While Chi-Square Tests statistics were used for the comparison of categorical variables between groups, Mann Whitney U test was used for the comparisons between two groups and Independent Sampe t Test was used for the comparisons between two groups due to the fact that continuous data consisted of values not suitable for normal distribution.

RESULTS

A total of 221 patients who met the study criteria were included in the study. The mean age of our patients was 63.1±14 years and 70.13% were male. The most common ECG finding was inferior STEMI (38%). Lateral STEMI was the least common (7%). The most common comorbid disease was HT (50.68%). There was a history of MI in 29.41% and by-pass operation in 9.05% of our patients. Coronary angiography revealed no coronary artery obstruction in 9% patients (**Table 1**).

There was a significant difference between the rates of coronary artery obstruction in the coronary artery corresponding to the ECG leads after coronary angiography.

When the ECG lead groups with ST elevation are analysed, it is seen that the difference between the groups is due to the patients with anterolateral STEMI on ECG. While the risk of vascular occlusion was estimated at a high rate (93.6%) in other ECG findings, this rate was lower in patients with anterolateral STEMI (77.1%) and differed from the other groups (**Table 2**).

DISCUSSION

Acute myocardial infarction is a medical emergency that occurs when one of the coronary arteries supplying blood to the heart muscle is suddenly and completely blocked. This blockage is typically caused by a rupture of atherosclerotic plaque, leading to the formation of a blood clot (thrombus) that blocks blood flow to part of the heart muscle. Myocardial ischemia leads to ST segment elevation on the ECG. In STEMI cases, rapid intervention is critical because the longer the heart muscle is deprived of oxygen, the more damage occurs and the worse the prognosis. However, not all patients with ST elevation on ECG have coronary artery obstruction. Regueiro et al., in a study evaluating patients with ST elevation on ECG, reported that coronary angiography identified the culprit artery in 85.4% of 5007 patients, while the remaining 14.6% had no identifiable causal lesion (4). The discharge diagnosis of the same patients was STEMI in 88.4% and a condition unrelated to cardiac disease in 11.6%, and these patients were discharged with a diagnosis other than acute coronary syndrome (4). Similarly, Proulx et al., reported that a definitive diagnosis of STEMI was made in 91% of patients in a study of 428 patients (5). Our results are similar to those of these studies. According to our results, in 9% of the patients whose ECG was evaluated as STEMI, the culprit coronary artery was not present in coronary angiography. This finding prompts a thorough discussion on the causes, clinical implications, and potential strategies to address this issue.

Table 1. General characteristics of the patients

Variable	All patients (N=221) Mean±SD (Minimum-Maximum)
Age	
All patients	63,1±14(31-104)
Female	70,4±15(34-104)
Male	60,0±13(31-93)
Pulse	77,5±22,7(0-145)
Systolic blood pressure	125±32,7(0-220)
Diastolic blood pressure	73,5±17,3(0-118)
	Count (%)
Gender	
Female	66(29,9)
Male	155(70,1)
ECG findings	
Anterior STEMI	56 (25,33)
Anterolateral STEMI	35 (15,84)
Inferior STEMI	84 (38,00)
Inferoposterior STEMI	31 (14,00)
Lateral STEMI	15 (6,7)
HT	
No	109 (49,32)
There is	112 (50,68)
DM	
No	160 (72,4)
There is	61 (27,6)
Hyperlipidemia	
No	166 (75,11)
There is	55 (24,89)
Smoker	
No	112 (50,68)
There is	109(49,32)
CVD story	
No	208 (94,98)
There is	11 (5,02)
Past MI	
No	156 (70,59)
There is	65 (29,41)
Past CAG	
No	152 (68,78)
There is	69 (31,22)
Past by-pass	
No	200 (90,50)
There is	20 (9,05)
30-day mortality	
No (Right)	216 (97,74)
There is (Dead)	5 (2,26)
Troponin	
Positive	40 (18,10)
Negative	181 (81,90)
Coronary artery obstruction	
There is	201 (91)
No	20 (9)

STEMI: ST eleve myocardial infarction, ECG: Electrocardiography, HT: Hypertension, DM: Diabetes Mellitus, CVD: cerebrovascular disease, CAG: Coronary angiography, MI: Myocardial infarction

Table 2. The presence of obstruction in the coronary arteries supplying the myocardial region corresponding to the leads with ST segment elevation on ECG.

Coronart arter obstruction Yes/No* first ECG crısstabulation						
	ECG					Total
	Anerior STEMI	Anterolaeral STEMI	Inferior STEMI	Inferoposterior STEMI	Lateral STEMI	
Cascular occlusion present/absent						
No						
Number	4[a,b]	8[b]	4[a]	2[a,b]	2[a,b]	20
%	7,1	22,9	4,8	6,5	13,3	9,0
There is						
Number	52[a,b]	27[b]	80[a]	29[a,b]	13[a,b]	201
%	92,9	77,1	95,2	93,5	86,7	91,0
Total						
Number	56	35	84	31	15	221
%	100	100	100	100	100	100
General %	25,3	15,8	38	14	6,8	100

Each subscript letter denotes a subset of the first ECG categories wwhose column proportions do not differ significantly from each other at the .05 level

Previous studies have suggested female gender, history of infarction or left bundle branch block, treatment in a hospital without the possibility of PCI by clinical definition, and absence of identified major complications as reasons for the identification of false positive STEMI (4,5). In an article on ECG interpretation errors and their causes, Peace et al., wrote that ECG artifacts can be caused by variable proficiency in ECG reading, intra/inter-rater reliability, lack of standardized ECG training, varying ECG machine and filter settings, cognitive biases (such as automation bias, which is the tendency to agree with computer-assisted assessment), sequence of information received, fatigue or decision fatigue, as well as noisy ECGs or ECG artifacts such as electrode wire misplacement (6). Shoaih et al., also reported Pericarditis, coronary artery disease other than STEMI, atypical chest pain, and stress induced cardiomyopathy were the common diagnoses in false positive activations (7).

In this study, we investigated whether there was obstruction in the coronary artery supplying the myocardial area corresponding to the leads in which ST elevation was detected. We considered patients with obstruction in another coronary artery or diagnosed with other than coronary artery disease as false positive ST elevation. Our study reveals a significant difference in the rates of coronary artery obstruction among different ECG lead groups after coronary angiography. Notably, patients with anterolateral STEMI had a lower rate of coronary artery obstruction compared to other ECG findings (%77.1). Anterolateral myocardial infarctions are usually caused by occlusion of the left anterior descending coronary artery or occlusion of the LAD in combination with other arteries. The ECG can show arrhythmias such as right and left bundle branch blocks, hemiblocks and type II second-degree atrioventricular conduction blocks, which sometimes complicate the diagnosis of anterolateral MI and can identify high-risk patients. Because it occurs simultaneously in different regions of ischemia, there is sometimes cancellation of the ischemic vector and reduction of ST segment deviation in some segments. Usually, the "anteroseptal" STEMI pattern (ST elevation limited to V1-V3) is associated with occlusion of a short LAD coronary artery and is believed to represent a smaller infarct compared with the "wide anterior" STEMI pattern (ST elevation extends to V4-V6). However, proximal occlusion of a long LAD can often lead to a limited "anteroseptal" STEMI pattern (8). The ischemic vector generated from the basal anterior segments and the more inferior and apical segments cancel each other out and the ECG presentation is indistinguishable from a limited small infarct due to a short LAD occlusion (8).Occlusion of the LAD before the first diagonal branch, if the LAD is short, causes ST elevation in I and aVL and reciprocal ST depression in the inferior leads. However, in cases with proximal occlusion of a long LAD, ischemic vectors of the inferior segments and lateral segments tend to attenuate ST deviation in limb leads (9).On the other hand, small apical infarction due to distal occlusion of the LAD usually manifests as ST elevation in both inferior and precordial leads (9). Leads V2-v3 visualize the septum. Elevations up to 2 -2.5 mm are considered normal due to the high electrical activity in the septum. This may have led to a false positive ST elevation diagnosis in patients with chest pain by less experienced physicians.

Several factors may contribute to these findings, reflecting the complexity of STEMI diagnosis. ECG interpretation can be subject to variability among healthcare providers, as demonstrated in previous studies (6,10). Variations in interpreting subtle ST-segment changes or the presence of confounding factors, such as left bundle branch block or early repolarization, may lead to false-positive activations (11,12).

In our cohort, the most common ECG finding was inferior STEMI (38%), whereas lateral STEMI was the least common (7%). This distribution mirrors the diverse ECG presentations of STEMI, emphasizing the importance of rapid and accurate diagnosis across a wide spectrum of clinical scenarios.

The demographic characteristics of our study population reflect the typical profile of patients presenting with suspected STEMI. The mean age of 63.1 years is consistent with the prevalence of coronary artery disease in the elderly population, and the predominance of males (70.13%) aligns with existing epidemiological data (4). The high prevalence of hypertension (HT) as the most common comorbid disease (50.68%) in our patients underscores the association between cardiovascular risk factors and coronary artery disease (CAD). It is well-established that risk factors like HT contribute to the development of atherosclerotic lesions that can eventually lead to STEMI (13).

CONCLUSION

In this study contributes to the growing body of literature addressing negative coronary angiography in suspected STEMI cases. The causes and clinical implications of this phenomenon are complex and multifactorial. Strategies to mitigate false-positive activations should involve standardized ECG interpretation, real-time physician oversight, algorithmic support, and education. These efforts are crucial to optimize STEMI diagnosis, improve patient care, and maximize healthcare resource utilization..

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Izmir Katip Çelebi University Clinical Research Ethics Committee (Decision number 0492, Dated 24/11/2022).

Informed Consent: Informed consent form did not obtained from the participants due to the nature of the study.

Referee Evaluation Process: Externally peer-reviewed.

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