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ORIGINAL RESEARCH

Assessment of the Diagnosis-To-Needle Times for Patients Admitted to the Emergency Department with Acute ST-Segment Elevation Myocardial Infarction

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ABSTRACT

Background: Coronary artery disease is one of the most common causes of death in the world. The outcome of patients with ST-elevation myocardial infarction is influenced by many factors, and the time elapsed from symptom onset to diagnosis and reperfusion have a critical role in this regard. **Aim:** The aim of this study was to investigate the differences in the diagnosis-to-needle times of patients with STEMI presenting to the hospital during and outside of working hours, and the effect of this relationship on in-hospital clinical events. **Methods:** This retrospective study analyzed the data of 50 patients admitted for emergency primary percutaneous coronary intervention. We assessed pain onset-to-diagnosis times and diagnosis-to-needle times, and evaluated their relationship with troponin values at admission and after 48 h. **Results:** The mean age of the patients was 55.64 ± 13.72 years. In total, 60% of the patients presented outside of working hours. Mean patient delay time from the onset of chest pain to seeking medical help was 2.64 ± 2.47 h. Mean troponin values were 4.39 ± 5.26 ng/ml at admission and 36.50 ± 12.95 ng/ml after 48 h. Mean post-angiography ejection fraction values were 47.36 ± 6.53%. We found a statistically significant difference in the pain onset-to-diagnosis and diagnosis-to-needle times of patients who presented to the hospital during and outside of working hours. We found a positive correlation between diagnosis-to-needle times and the troponin values of patients, and a statistically significant difference between pain onset-to-diagnosis times of patients who presented during and outside of working hours ($p < 0.05$). Although the relationship between the diagnosis-to-needle time and troponin elevation after 48 h was strong (97%), the relationship between pain onset-to-diagnosis time and troponin elevation after 48 h was weak (8%), suggesting that the duration of surgical intervention is much more important than the time until the first medical contact. **Conclusions:** In this study, there was a statistically significant difference in the pain onset-to-diagnosis and diagnosis-to-needle times of patients who presented to the hospital during and outside of working hours.

Keywords: ST-segment elevation myocardial infarction, reperfusion, strategy, diagnosis-to-needle time

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INTRODUCTION

Coronary artery disease (CAD) is one of the most common causes of death in the world. Generally, CAD is defined clinically as acute coronary syndrome (ACS). ACS is characterized by symptoms and clinical manifestations of acute myocardial ischemia, and occurs as a result of disruption of the integrity of the atherosclerotic plaque in the coronary artery.[1] The clot formed on the atherosclerotic plaque impairs the coronary blood flow to varying degrees. However, varying degrees of coronary spasm may accompany clot formation.[2] These changes in the atherosclerotic plaque of the coronary artery may lead to ST-elevation acute myocardial infarction (STEMI), non-ST-elevation acute myocardial infarction (NSTEMI), or unstable angina pectoris.[3] ACS is a general abbreviation for all clinical symptoms associated with acute myocardial ischemia, including unstable angina pectoris, Q-wave myocardial infarction (with ST elevation), and non-Q-wave myocardial infarction (non-ST elevation).

Age, sex, diabetes mellitus, laboratory findings, smoking, and hypertension are important prognostic determinants in patients with ACS. Age over 70 years negatively affects prognosis, and CAD and concomitant disease are more common in the elderly. As far as sex-related differences are concerned, the prognosis of acute myocardial infarction is worse in women.[4] Well-known risk factors for ACS include age, sex, ethnicity, smoking, diabetes mellitus, hypertension, alcohol consumption, obesity, family history, physical inactivity, and dietary habits. Some of these factors, such as smoking, diabetes mellitus, diet, and physical inactivity, are modifiable.[5] Although their presence may lead to ACS, the persistence of these risk factors in the subsequent clinical follow-up adversely affects the prognosis.[6]

Although there are many similarities in the clinical presentation of different types of ACS, there are also some key differences, for example in the time from the onset of chest pain to the time of presentation.[7] Despite the similarities and differences regarding the effect of age and sex, as well as the morbidity and mortality of patients with STEMI and NSTEMI, the number of relevant studies is very limited.[8]

There are several factors that affect the care of patients with ACS in the emergency department. These include the triage of patients, ECG recording and evaluation time, initiation time of emergency service treatment protocols, consultation times, and the distance of the angiography laboratory from the emergency department. Chest pain, shortness of breath, palpitations, and similar symptoms, which may be among the main complaints of patients with ACS, are evaluated as category 1 within the framework of triage rules. Patients presenting with these and similar symptoms should be monitored in the emergency department triage area without waiting, and their 12-lead ECG should be performed. The time from the patient's admission to the evaluation of the 12-lead ECG is defined as the door-to-ECG time. In its 2006 guidelines, the American Heart Association recommended the door-to-ECG time to be less than 10 min.[9] Based on this recommendation, a 2009 study reported that door-to-ECG times were reduced from 14 min to 10 min.[10] After the ECG is evaluated by emergency medicine specialists, the coronary angiography team is activated by reaching the consultant cardiologist via the in-hospital telephone system. This time interval, defined as the activation time in our study, was shortened to an average of 7.5 min in a study published in 2009.[11] Another factor affecting the door-to-balloon time is arrival to the angiography laboratory. Important factors affecting this time are the meeting time of the angiography team, especially during non-working hours, whether or not the laboratory is being used for another case during working hours, and the distance between the emergency unit and the laboratory. According to the 2017 guidelines of the European Society of Cardiology on STEMI,[12] the diagnosis of STEMI should be made before the hospital door. In the selection of the reperfusion strategy, minute 0 of the diagnosis (ST elevation or equivalent on ECG) was accepted as the starting point of the reperfusion strategy. The term 'first medical contact' has been removed from the guideline, as it does not contribute to the diagnosis time. It is recommended to start the chronometer after the diagnosis of STEMI is established on the electrocardiogram. To accelerate the diagnosis, the ECG should be performed in properly equipped ambulances, and an experienced team that can provide fibrinolytic therapy should be available to accelerate the treatment. The term 'door-to-balloon time' was removed and replaced with the term 'needle transition from diagnosis'. Time for needle passage in the pPCI center should be less than 60 min to decrease mortality and morbidity.

In this study, we aimed to evaluate the clinical characteristics of patients with STEMI who presented to the emergency department, and to assess how STEMI treatment strategies can be carried out in accordance with the guidelines, to draw attention to these problems and to raise the awareness. We also aimed to investigate diagnosis-to-needle times and the relationship between the working hours of the emergency unit personnel and the duration of pPCI.

MATERIAL AND METHODS

We carried out a retrospective analytical study at the departments of cardiology and emergency medicine, between October and November 2023. The study included patients admitted to the emergency department and hospitalized in the cardiological intensive care unit with the diagnosis of ACS. Cases with ST-segment elevation were studied according to the classification of ACS. The diagnosis of ACS was made by evaluating the clinical presentation, ECG findings, and laboratory findings.

We analyzed the data of 50 patients who had been admitted to the catheter laboratory for emergency pPCI. We investigated whether there was a relationship between the working hours of the physician who established the clinical diagnosis by performing the first evaluation of the patient in the emergency department and the patient's diagnosis-to-needle time, and the effect of this relationship on in-hospital clinical events. The demographic characteristics of the patients and the results of in-hospital complications were obtained from the epicrisis information. Angiography images were obtained from the catheter laboratory records of the patients. The time of admission to the emergency department was accessed from the hospital registry system. The pain onset-to-diagnosis time was determined based on the time elapsed from the onset of symptoms to the admission of the patient to the emergency department, the duration of ECG evaluation, and the time elapsed from establishing the diagnosis of AMI to informing the personnel in the catheterization laboratory. The diagnosis-to-needle time was determined based on the arrival of the cardiology resident physician to the emergency room to evaluate the patient, the time of arrival of the patient to the laboratory after the preparation of the catheter laboratory and team, the time required for catheterization, and the time of diagnosis of TIMI 3 or best possible flow was.

STATISTICAL ANALYSIS

Statistical analysis was carried out using SPSS 25.0 (IBM Corp). The raw scores for all measures were converted to z-scores to examine the outliers. Then, the outliers at the scale level were evaluated and the normality assessment was performed. Categorical variables were expressed as numbers or percentages, and continuous variables were expressed as mean ± standard deviation. In the comparison of continuous variables, normal distribution was examined with the Kolmogorov–Smirnov test. The chi-squared or Fisher's exact test were used to compare categorical variables. Continuous data consisting of independent measurements and showing normal distribution

TABLE 1. Sociodemographic and clinical characteristics

	%
Smoking	
Yes	60
No	40
Diabetes mellitus	
Yes	20
No	80
Hypertension	
Yes	20
No	80
History of coronary artery disease	
Yes	20
No	80
Type of myocardial infarction	
Anterior	48
Inferior	48
Lateral	4
Localization of the culprit lesion	
CX, mid region	6
LAD, mid region	24
LAD, osteal region	2
LAD, proximal	6
LAD, proximal region	14
LAD-SAFEN proximal region	2
RCA, pre-crux	2
RCA, distal region	4
RCA, mid region	20
RCA, proximal	6
RCA, proximal region	10
RCA, proximal and crux region	2
RCA, proximal and distal region	2
Contrast nephropathy	
Not developed	96
Developed	4
Patient's time of arrival	
Out of working hours	60
During working hours	40

TABLE 2. Evaluation of diagnosis-to-needle time

	Mean ± SD
Onset of pain-to-diagnosis time (h)	2.64 ± 2.47
Post-angiography ejection fraction (%)	47.36 ± 6.53
Baseline troponin (ng/ml)	4.39 ± 5.26
Control troponin after 48 h (ng/ml)	36.50 ± 12.95
Troponin increase (ng/ml)	32.10 ± 13.09

TABLE 3. Relationship between the localization of the culprit lesion and post-angiography ejection fraction

Localization of the culprit lesion	*n*	Post-angiography ejection fraction (%)	p value
LAD mid region[a]	12	44.50 ± 7.65	0.017*
LAD proximal region[b]	7	43.29 ± 8.30	0.035& (difference between [a] and [c])
RCA mid region[c]	10	52.20 ± 3.99	0.034& (difference between [b] and [c])

* One-way analysis of variance
& Post-hoc Tukey test

were analyzed using the independent t-test. Pearson's correlation test was used to analyze the direction and intensity of the relationship between two variables, and a p value below 0.05 was considered statistically significant.

RESULTS

The study included 50 patients aged between 30 and 84 years, of which 40 (80%) were male and 10 (20%) were female. In total, 20% of the patients (*n* = 10) had a first-degree relative with a history of CAD at an early age (<55 years in male patients and <65 years in female patients). We found acute inferior myocardial infarction in 24 patients (48%), hypertension in 10 patients (20%), and diabetes mellitus in 10 patients (20%). The majority of patients (*n* = 30, 60%) were smokers. The mean age of the patients was 55.64 ± 13.72 years, and 60% had presented to the hospital out of working hours. Contrast-induced nephropathy syndrome was observed in only two patients (4%) (Table 1).

TABLE 4. The relationship between diagnosis-to-needle times according to working hours

	During working hours (*n* = 20)		Outside of working hours (*n* = 30)		p value
	Frequency	%	Frequency	%	
Male	13	65	25	83.3	0.210*
Female	7	35	5	16.6	
Age	58.89 ± 12		53.62 ± 14		0.205**
Smoking					
Yes	11	55	19	63.3	0.594*
No	9	45	11	36.7	
Onset of pain-to-diagnosis time (h)	1.87 ± 0.99		3.12 ± 2.97		0.043**
Diagnosis-to-needle time (min)	29.89 ± 6.12		37.31 ± 6.43		0.000**
Baseline troponin (ng/ml)	5.04 ± 5.98		3.98 ± 4.84		0.974**
Control troponin after 48 h (ng/ml)	28.77 ± 12.76		41.29 ± 10.71		0.001**
Troponin increase	23.73 ± 11.93		37.30 ± 11.04		0.000**
Post-angiography ejection fraction (%)	50.39 ± 4.57		45.48 ± 6.91		0.011**
Diabetes mellitus					
Yes	3	15	7	23.3	0.334*
No	17	85	23	76.7	
Hypertension					
Yes	5	25	5	16.6	0.210*
No	15	75	25	83.4	

* Fisher's exact test
** Independent samples *t*-test

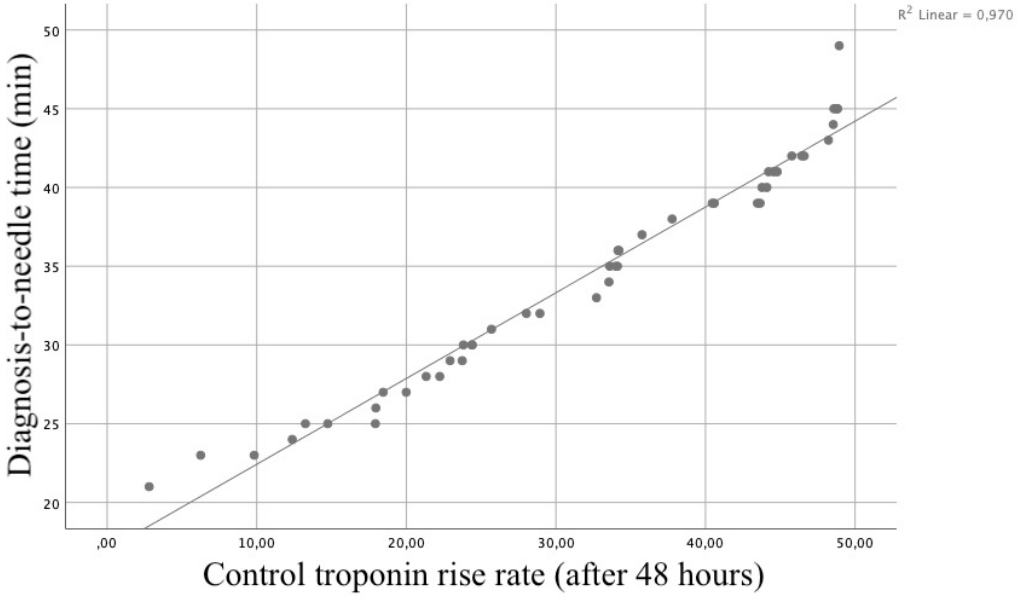

FIGURE 1. Relationship between diagnosis-to-needle time and troponin values after 48 h

The average length of patient delay from the onset of chest pain to seeking medical help was 2.64 ± 2.47 h. Mean troponin value was 4.39 ± 5.26 ng/ml on admission 36.50 ± 12.95 ng/ml after 48 h. Mean ejection fraction after angiography was 47.36 ± 6.53% (Table 2).

We found no statistically significant relationship between the age and sex of the patients and ejection fraction measurements. The localization of culprit lesions (the mid region of the left anterior descending artery (LAD), the proximal region of the LAD, and the mid region of the right coronary artery (RCA)) and post-angiography ejection fraction values were significantly different. The region with the highest post-angiography ejection fraction values was the mid region of the RCA (Table 3).

We found a statistically significant difference between the post-angiography ejection fraction values of patients

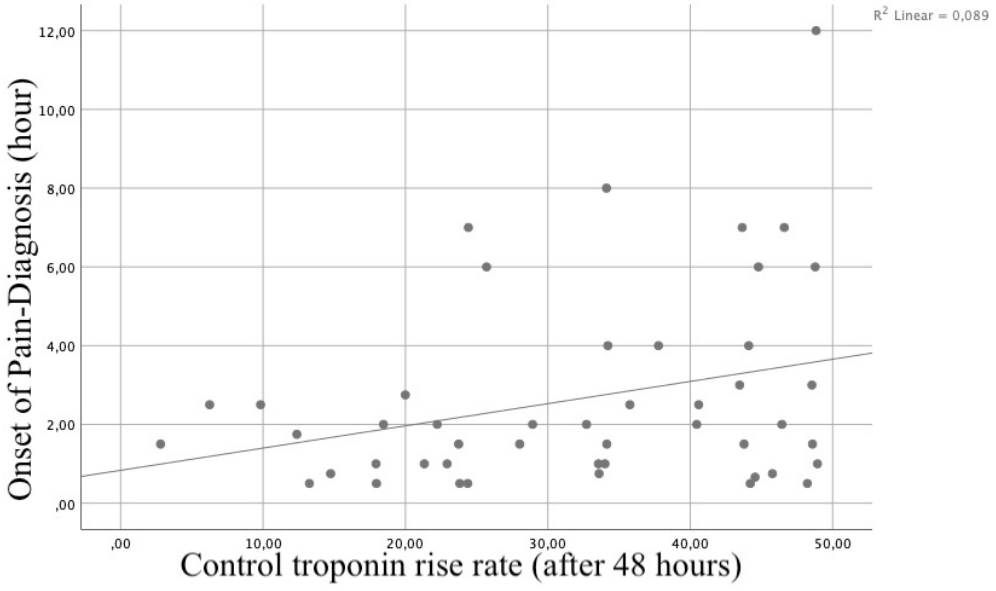

FIGURE 2. Relationship between pain onset-to-diagnosis time and troponin values after 48 h

who presented during and outside of working hours ($p < 0.05$). We also found a positive correlation between the diagnosis-to-needle time, pain onset-to-diagnosis time, and the troponin values of patients presenting to the hospital during and outside of working hours (Table 4).

The correlation between diagnosis-to-needle time, post-angiography ejection fraction values, pain onset-to-diagnosis time, and troponin values after 48 h was also statistically significant ($p < 0.05$).

DISCUSSION

Despite advances in the treatment of ACS, it still remains an important cause of mortality and morbidity in developed countries and is an increasingly serious problem.[13]

Several studies have compared STEMI presentation times and loss times, and diabetes mellitus, hypertension, and ischemic heart disease were found more frequently in patients with STEMI.[14–16]

The patients included in this study presented similar sociodemographic characteristics and risk factors to the cases described in the literature. We found statistically significant differences in the pain onset-to-diagnosis and diagnosis-to-needle times of patients who presented to the hospital during and outside of working hours. In addition, we observed differences in the time elapsed between the diagnosis and the surgical intervention, the most important reason for this being the non-availability of a specialist physician in the emergency department outside of working hours, and the long time needed to reach them. Although the average delay in our study was higher than in many developed European countries, it was similar to some developed European countries.[17,18]

STEMI was diagnosed according to World Health Organization (WHO) criteria in the emergency department. Based on the 2004 AMI guideline of the American Society of Cardiology (AHA), patients presenting within the first 3 h of pain onset were considered as early admissions, and patients presenting after 3 h were considered as late admissions.[19] We found no significant differences when comparing the duration of admission and the presence of risk factors such as hypertension ($p = 0.58$) or CAD ($p = 0.28$). Mean ejection fraction values were 64.7 ± 5.9% in the study of Sugeng *et al.*[20] and 66.6 ± 6.5% in the study of Vugar *et al.*,[21] compared to 47.36 ± 6.53% in our study.

The mean time between pain onset and diagnosis was 1.87 ± 0.99 h for patients who presented to the hospital during working hours and 3.12 ± 2.97 h for patients who presented to the hospital outside of working hours ($p < 0.05$). We also found a statistically significant difference between the diagnosis-to-needle time of patients presenting to the hospital during and outside of working hours ($p < 0.05$).

Troponin values at admission were similar in patients presenting during and outside of working hours but were significantly higher in those presenting outside of working hours ($p < 0.05$). This may be explained by the longer diagnosis-to-needle times of these patients. We found a positive correlation between the diagnosis-to-needle times and troponin values of patients, and a statistically significant difference ($p < 0.05$) between the onset of pain-to-diagnosis times of patients who presented to the hospital during and outside working hours (Figure 1 and 2).

Lower pain onset-to-diagnosis times were associated with lower increases in troponin levels at 48 h. However, this effect was not as dominant as the diagnosis-to-needle time. Although we found a strong relationship (97%) between the diagnosis-to-needle time and troponin elevation after 48 h, the relationship between pain onset-to-diagnosis time and troponin elevation after 48 h was weak (8%). This suggests that the duration of surgical intervention is much more important than the time until the first medical contact.

Post-angiography ejection values of the patients who presented to the hospital during working hours were higher than those of patients who presented outside of working hours ($p < 0.05$).

In addition, no difference was observed in the variables of age, sex, smoking, diabetes mellitus, and hypertension between patients who presented to the hospital during and outside of working hours.

CONCLUSIONS

In this study, there was a statistically significant difference in the pain onset-to-diagnosis and diagnosis-to-needle times of patients who presented to the hospital during and outside of working hours.

CONFLICT OF INTEREST

We declare that we have no conflicts of interest.

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This study received no funding.

AUTHOR CONTRIBUTIONS

All authors contributed equally.

ETHICAL APPROVAL

The study was approved by the ethics committee of the Faculty of Medicine of Karamanoğlu Mehmetbey University (approval no. 08-2023/03 from 13.09.2023).

REFERENCES

1. Foo RS, De Bono DP. Concepts in acute coronary syndrome. Singapore Med J. 2000;41(12):606–610.
2. Acharya P, Adhikari RR, Bhattarai J, Shrestha NR, Sharma SK, Karki P. Delayed presentation of acute coronary syndrome: a challenge in its early management. JNMA J Nepal Med Assoc. 2009;48(173):1–4. doi: 10.31729/jnma.173
3. Rogers FJ. The clinical spectrum of acute coronary syndromes. J Am Osteopath Assoc. 2000;100(11):1–7.
4. Rosengren A, Wallentin L, K Git A, Behar S, Battler A. Sex, age, and clinical presentation of acute coronary syndromes. Eur Heart J. 2004;25(8):663–670. doi: 10.1016/j.ehj.2004.02.023
5. Diop D, Aghababian RV. Definition, classification, and pathophysiology of acute coronary ischemic syndromes. Emerg Med Clin North Am. 2001;19(2):259–267. doi: 10.1016/S0733-8627(05)70182-6
6. Kamineni R, Alpert JS. Acute coronary syndromes: initial evaluation and risk stratification. Prog Cardiovase Dis. 2004;46(5):379–392. doi: 10.1016/j.pcad.2003.12.002
7. Mount R, Waqar S, Jutley RS, Parkar PK. Management of acute coronary syndrome. Br J Hosp Med (Lond). 2008;69(6):324–329. doi: 10.12968/hmed.2008.69.6.29620
8. Selno Y. Risk factors of cardiovascular disease and those managements, especially for acute coronary syndrome. J Nippon Med Sch. 2000;67(3):202–205. doi: 10.1272/jnms.67.202
9. Krumholz HM. A campaign to improve the timeliness of primary percutaneous coronary intervention door-to-balloon: an alliance for quality. J Am Coll Cardiol Cardiovasc Inter. 2008;1:97–104. doi: 10.1016/j.jcin.2007.10.006
10. Parikh SV, Treichler DB. Systems-Based Improvement in Door-to-Balloon Times at a Large Urban Teaching Hospital. Circ Cardiovasc Qual Outcomes. 2009;2:116–122. doi: 10.1161/CIRCOUTCOMES.108.820134
11. Levis JT, Mercer MP, Thanassi M, Lin J. Factors Contributing to Door-to-Balloon Times of ≤90 Minutes in 97% of Patients with ST-Elevation Myocardial Infarction: Our One-Year Experience with a Heart Alert Protocol. The Permanente Journal. 2010;14(3):31–38. doi: 10.7812/TPP/10.977
12. Ibanez B, James S, Agewall S, et al; ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39(2):119–177. doi: 10.1093/eurheartj/ehx393
13. Selno Y. Risk factors of cardiovascular disease and those managements, especially for acute coronary syndrome. J Nippon Med Sch. 2000;67(3):202–205. doi: 10.1272/jnms.67.202
14. Luepker RV, Raczynski JM, Osganian S, et al. The Rapid Early Action for Coronary Treatment (REACT) Trial. JAMA. 2000;284(1):60–67. doi: 10.1001/jama.284.1.60
15. Burány B, Rudas L. Interhospital transport of acute coronary syndrome patients from Bács-Kiskun county. Orv Hetil. 2005;146(35):1819–1825.
16. Berglin Blohm M, Hartford M, Karlsson T, Herlitz J. Factors associated with pre-hospital and in-hospital delay time in acute myocardial infarction: a 6-year experience. J Intern Med. 1998;243(3):243–250. doi: 10.1046/j.1365-2796.1998.00296.x
17. Sim DS, Kim JH, Jeong MH. Differences in Clinical Outcomes Between Patients with ST-Elevation Versus Non-ST-Elevation Acute Myocardial Infarction in Korea. Korean Circ J. 2009;39(8):297–303. doi: 10.4070/kcj.2009.39.8.297
18. Rott D. STEMI and NSTEMI are two distinct pathophysiological entities: Letters to the Editor. European Heart Journal. 2007;28:2685–2692. doi: 10.1093/eurheartj/ehm368
19. Antman EM, Hand M, Armstrong PW, et al. 2007 focused update of the ACC/AHA 2004 Guidelines for the Management of Patients With ST- Elevation Myocardial Infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Group to Review New Evidence and Update the ACC/AHA 2004 Guidelines for the Management of Patients with ST-Elevation Myocardial Infarction). J Am Coll Cardiol. 2008;51:210. doi: 10.1016/j.jacc.2007.10.001
20. Sugeng L, Mor-Avi V, Weinert L, et al. Quantitative assessment of left ventricular size and function: side-by-side comparison of real-time three-dimensional echocardiography and computed tomography with magnetic resonance reference. Circulation. 2006;114(4):654–661. doi: 10.1161/CIRCULATIONAHA.106.626143
21. Vulgar H. Sol ventrikül fonksiyonunun çok kesitli bilgisayarlı tomografi ile değerlendirilmesi ve bulguların 3 boyutlu ekokardiyografi ile karşılaştırılması. Radyoloji tezi. GATA Tıp Fakültesi. 2011:36–39.