

Evaluation of the Causes of Door-to-Balloon Time Delays in Patients with ST-Elevation Myocardial Infarction at Tehran Heart Center

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Abstract

Background: Coronary artery disease (CAD) is the leading cause of cardiovascular death globally, and the most severe form of CAD, ST-elevation myocardial infarction (STEMI), needs immediate treatment. This study aimed to report patient characteristics and the causes of door-to-balloon time (D2BT) delays in STEMI patients admitted to Tehran Heart Center with a D2BT exceeding 90 minutes.

Methods: This cross-sectional study was conducted at Tehran Heart Center, Iran, from March 20th, 2020, through March 20th, 2022. Variables consisted of age, sex, diabetes mellitus, hypertension, dyslipidemia, smoking, opium, family history of CAD, in-hospital mortality, primary percutaneous coronary intervention results, culprit vessels, causes of delays, the ejection fraction, triglycerides, and low and high-density lipoprotein levels.

Results: The study population was composed of 363 patients (272 males [74.9]) at a mean (SD) age of 60±11.47 years. The leading causes of D2BT delays were the catheterization lab used in 95 patients (26.2) and misdiagnosis in 90 (24.8). Other causes were ST-elevation less than 2 mm in electrocardiograms in 50 patients (13.8) and referral from other hospitals in 40 (11.0).

Conclusion: The catheterization lab in use and misdiagnosis were the leading causes of D2BT delays. We recommend that high-volume centers allocate an additional catheterization lab with an on-call cardiologist. Improved resident training and supervision in hospitals with many residents are also necessary.

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Introduction

Coronary artery disease (CAD) is one of the leading causes of death globally. ST-elevation myocardial infarction (STEMI) occurs when one or more coronary arteries are blocked, obstructing blood flow to the heart muscle.^{1, 2} Several factors are usually involved in the abrupt disruption of blood flow, including plaque rupture, erosion, fissuring, or dissection of the coronary arteries. A combination of these factors can result in an occluding thrombus in the artery and myocardial injury or necrosis. In 2019, worldwide, 9.14 million deaths and 182 million disability-adjusted life years due to CAD and STEMI were recorded. Compared with the past decades, these numbers have risen significantly.³ In tandem with the global trend, CAD ranked as the number one cause of mortality in Iran in 2019, with a 29.9% increase compared with 2009.⁴

Primary percutaneous coronary intervention (PCI) is the principal treatment in patients with STEMI. Based on the American Heart Association's guidelines, a door-to-balloon time (D2BT) of below 90 minutes is preferred. Previous studies have shown that D2BT delays increase the risk of in-hospital mortality in the first 30 days and 1 year after the procedure.⁵ The efforts of health systems over the past decades have lessened the delay percentage in STEMI patients. Nonetheless, whereas Israel and Singapore are the only Asian countries with shorter D2BT, other Asian countries have failed to solve this problem.⁶

The current study aimed to describe patient characteristics and causes of D2BT delays among STEMI patients admitted to Tehran Heart Center with a D2BT exceeding 90 minutes.

Methods

The present cross-sectional study was conducted at Tehran Heart Center, Iran, from March 20th, 2020, through March 20th, 2022. The study included all STEMI patients admitted through the 24/7 service of Tehran Heart Center with a D2BT exceeding 90 minutes. The patients' data were initially retrieved from the Tehran Heart Center PCI Databank and completed based on the patients' files. The studied variables were age, sex, diabetes mellitus, hypertension, dyslipidemia, smoking, opium, family history of CAD, in-hospital mortality, primary PCI results, culprit vessels, causes of delays, the ejection fraction, triglycerides, and low and high-density lipoprotein levels.

D2BT is defined as the time of patient entry into the emergency department to inflate the balloon in the culprit vessel. D2BT delays were considered a period exceeding 90 minutes. Primary PCI results were categorized as successful, acceptable (30.0%–50.0% residual stenosis), unacceptable (>50.0% residual stenosis), and failed to pass, guide wires, balloons or stents. Delays were considered to

have several causes, including ST-elevation less than 2 mm on the electrocardiogram (ECG), rescue PCI, unsuccessful PCI, referral from another hospital, misdiagnosis, patients' refusal to consent for PCI, and the catheterization lab in use.

Frequencies were calculated for quantitative variables, while means and standard deviations (SDs) were calculated for qualitative variables. The data analyses were conducted using SPSS 25.

The study protocol was approved by the Research Ethics Committee of Tehran University of Medical Sciences and the Research Committee of the Cardiology Department. Based on the protocol of our center, informed consent was obtained from the patients at the time of admission for the use of their clinical data for research purposes.

Results

The study population was composed of 363 patients, including 272 males (74.9%), at a mean age of 60 ± 11.47 years. The mean ejection fraction was 40.3 ± 8.29 . Ninety-two patients (25.3%) had a family history of CAD, 214 (59.3%) had hyperlipidemia, 181 (50.1%) had hypertension, and 178 (49.3%) had diabetes mellitus. Additionally, 115 patients (31.7%) were current smokers, and 35 (9.6%) were former smokers. Meanwhile, 45 patients (8.3%) were current opium users, and 26 (8.3%) were former users. PCI was successful in 281 patients (82.6%) and acceptable in 41 (12.1%). In 143 patients (42.1%), the left anterior descending artery was the most prominent culprit vessel, followed by the right coronary artery in 84 (24.7%) and the left circumflex artery in 38 (11.2%). The leading causes of D2BT delays were the catheterization lab in use in 95 patients (26.2%) and misdiagnosis in 90 (24.8%). Other causes were ST-elevation less than 2 mm on the initial ECG in 50 patients (13.8%) and referral from other hospitals in 40 (11.0%). In-hospital mortality occurred in 12 patients (3.9%).

Figure 1 shows that 363 patients (15.2%) had D2BT delays. A remarkable number of patients with STEMI were admitted to our hospital in 2021 compared with 2020. Furthermore, the number of patients with D2BT delays exceeding 90 minutes was higher during this period, with the most significant number of D2BT delays recorded in December 2021.

Discussion

In the current study, we found that among all patients admitted to our center with STEMI, 363 patients (15.2%) had delays in D2BT, with the catheterization lab in use and misdiagnosis constituting the leading delay causes. Our center is a referral hospital with a high volume of admitted patients, but only a single catheterization lab is available on

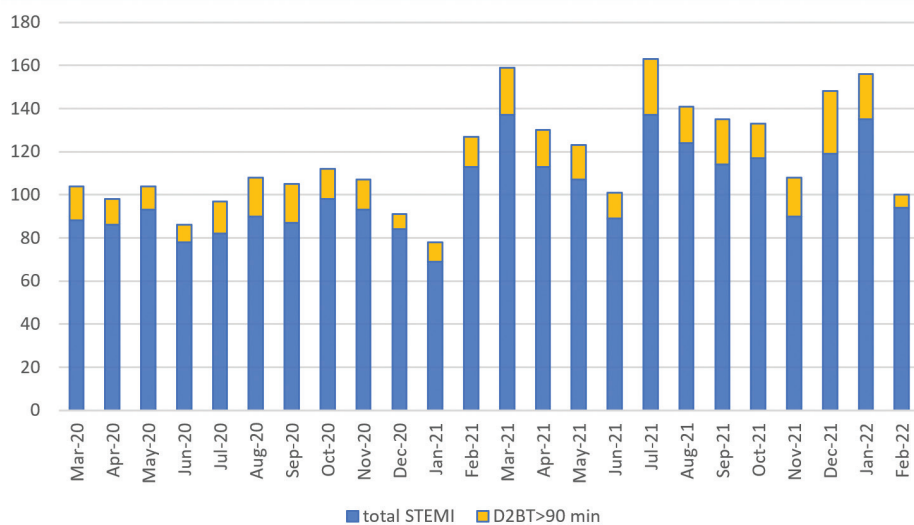


Figure 1. The bar chart presents the number of patients with total STEMI and door-to-balloon time (D2BT) delays exceeding 90 minutes. D2BT, Door-to-balloon time; STEMI, ST-elevation myocardial infarction

night shifts. For STEMI patients requiring primary PCI, our results identified the catheterization lab in use as the most significant contributor to D2BT delays. Park et al⁷ considered patient transfer to high-volume PCI centers as an independent predictor for a D2BT exceeding 120 minutes. Consequently, we needed to establish a second catheterization lab to prevent D2BT delays in STEMI patients.

We determined misdiagnosis as another principal cause of D2BT delays. Considering our center’s educational function, cardiology residents play a significant role in diagnosing and treating patients. Indeed, our findings indicated the need for the enhanced training of residents concerning unusual ECG patterns.

The importance of time in the treatment of STEMI patients should be considered. Based on the guidelines, D2BT must be less than 90 minutes. Studies have illustrated that the delay in primary PCI could lead to increased in-hospital mortality.⁸⁻¹² In terms of reducing D2BT, myocardial salvage could be improved by reducing reperfusion times after STEMI. In contrast, only 12 patients (3.3%) with in-hospital mortality were reported in our delayed D2BT group. Other investigations have revealed that a shorter D2BT did not decrease in-hospital mortality.¹³ The symptom onset-to-reperfusion time is significant and could explain high in-hospital mortality in patients with a shorter D2BT.^{14,15}

The emergency medical service (EMS) transports our patients 24/7. Trained EMS technicians record ECGs in the first contact with patients at home. Upon the confirmation of MI by a cardiologist, the patient is transferred to a nearby PCI center. After arriving at the hospital without being admitted to the emergency department, patients are admitted to the catheterization lab, thus shortening prehospital and hospital delays. Several studies have demonstrated the significance of EMS transfers in preventing delays.¹⁶⁻¹⁸

Other related evidence indicates that D2BT delays are

more prevalent among women than men.¹⁹⁻²⁰ However, one-fourth of our patients with D2BT delays were women. Consistent with our finding, a study from Portugal concluded that women did not experience more delays than men.¹⁶

We also found that 40 patients (11.0%) with D2BT delays were referred from other hospitals. Likewise, a Korean study indicated that interhospital transfers were associated with delays in D2BT.^{7,18} Our recommendation is to transfer STEMI patients referred from other hospitals to the catheterization laboratory rapidly without repeating diagnostic procedures in the emergency department. Furthermore, several studies have reported that obtaining patient consent delays D2BT, particularly in Asian countries such as China and India.⁶ Only 9 patients (2.5%) delayed primary PCI due to consent. A recent study has suggested that consent requirement be removed based on this reasoning.²¹

Lastly, subtle STEMI (ie, ST-elevation <2 mm) was another cause of delay. Long li et al⁶ showed that abnormal ECGs for the first time were a predictor of a shorter D2BT. Another investigation determined that D2BT was longer in patients with inconclusive ECGs.²² These results show that physicians should be trained in ECG reading to prevent delays in diagnosis.

The current study had some limitations, the most notable of which is that we did not calculate the symptom onset-to-reperfusion time for the included patients. Additionally, we considered D2BT delays only based on the time from hospital admission and did not evaluate the pre-admission delay. We recommend a multicenter study with a sizable population to identify the predictors for D2BT delays.

Conclusion

The catheterization lab in use was the primary cause of D2BT delays in our study. We suggest that high-volume



hospitals allocate extra catheterization labs at night with on-call interventional cardiologists to prevent D2BT delays.

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