Original Article

Chest Pain-to-Emergency Department Time Effect on EF After Primary PCI

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ABSTRACT

Background: For several years now, primary percutaneous coronary intervention (PPCI) has been considered an effective treatment for ST-elevation myocardial infarction (STEMI). Efforts have been made to reduce the time interval between the patient's admission to the hospital and PPCI. We evaluated the effect of the time interval between patients' admission to the emergency department and PPCI on left ventricular ejection fraction (LVEF) in patients with STEMI.

Methods: The target population comprised patients who were admitted to the Emergency Department of Shahid Mohammadi Hospital with acute STEMI and scheduled for PPCI between 2017 and 2018. Eventually, 174 patients, who met the inclusion criteria, were investigated using a questionnaire, and the data were analyzed by SPSS20.

Results: From the 174 patients diagnosed with acute STEMI, 72% were male and 28% were female. The mean age of the patients was 57.2 years (SD= ±13). A statistically significant linear relationship existed between symptom-to-balloon time and LVEF ($P \leq 0.05$), but no statistically significant linear relationship existed between the door-to-balloon time (DBT) and LVEF ($P \leq 0.05$).

Conclusions: Reducing symptom-to-balloon time in PPCI for patients with acute STEMI could preserve LVEF and improve prognosis. ***(Iranian Heart Journal 2022; 23(2): 68-74)***

KEYWORDS: Chest pain, Primary PCI, Ejection fraction, Emergency Department

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During the past decade, primary percutaneous coronary intervention (PPCI) has emerged as an effective therapeutic strategy in patients with acute ST-segment-elevation myocardial infarction (STEMI).[1] Despite advanced diagnostic and therapeutic strategies regarding cardiovascular diseases, MI accounts for 16 million deaths in the world, accounting for 29% of all causes of mortality. In 2014, in

Europe, MI was responsible for 20% of all deaths.[2] Reports from the Iranian Ministry of Health and Medical Education showed that the rate of mortality due to cardiovascular diseases, especially acute MI, has risen dramatically within the past decade, accounting for about 46% of all cases of mortality in Iran.[3] Acute MI occurs through ST-segment-elevation due to a full obstruction in a coronary artery by thrombosis. Reduced treatment duration would decrease patient mortality by 50%; nonetheless, if treatment is delayed, the side effects increase significantly. The strategy aimed at lessening MI mortality is to shorten the time between patient symptoms and decision-making to call emergency services.[4] Early reperfusion as a standard treatment for patients with STEMI can prevent myocardial necrosis and reduce the myocardial infarct size, thereby preventing heart failure and improving patients' survival.[5,6] PPCI is a safe and effective treatment strategy that could be performed in centers with cardiac catheterization capability.[7] By comparison with thrombolytic therapy, the advantages of PPCI are a low frequency of stroke and reinfarction, short hospital lengths of stay, and increased life expectancy.[1]

The symptom-to-the emergency department time (STED) has a key role in the rate of survival following PPCI. According to studies concerning STED, a period shorter than 60 minutes is associated with less mortality than a period longer than 90 minutes.[8]

Considering the time-survival dependency in patients with STEMI who undergo PPCI, the American College of Cardiology/American Heart Association (ACC/AHA) guidelines recommend that the door-to-balloon time (DBT) be kept below 90 minutes as a gold-standard DBT for PPCI.[9] Some studies have demonstrated that a DBT below 60 minutes in patients with acute STEMI has even a better outcome both in short and long-term follow-ups.[10]

There are no standard reperfusion strategies, fibrinolysis, and primary angioplasty. If the required facilities are provided for primary angioplasty, almost no indications exist for thrombolytic therapy.[5,11] Nevertheless, thrombolytic therapy is contraindicated in many underlying diseases that may increase bleeding risk.[5,12] Several studies have demonstrated the priority of primary angioplasty treatment over thrombolytic therapy in reducing side effects, reinfarction, and mortality.[5,11] The probability of reaching the third flow grade of thrombolysis in myocardial infarction (TIMI) in primary angioplasty is significantly higher than that in thrombolysis.[13] Although it appears that primary angioplasty costs are significantly higher than those of thrombolytic therapy, considering the number of patients who need an intervention after thrombolytic therapy, longer hospital lengths of stay and higher incidence rates of heart failure make PPCI the treatment of choice in patients with acute STEMI.[6] Whenever the ischemic time is longer, the infarct size will be larger.[5,6,11]

We conducted the present study to provide further information on the effect of the time interval between patients' admission to the ED and PPCI on LVEF in Iranian patients with STEMI.

METHODS

The study design was observational and cross-sectional. After the study protocol was approved by the Ethics Committee of Shahid Mohammadi Hospital and written informed consent was obtained from 206 patients, the study commenced. All patients diagnosed with acute STEMI admitted to the ED of Shahid Mohammadi Hospital were included. Data were collected in a 1-year period (September 2015 through September 2016) by questionnaire. Finally, 206 patients diagnosed with acute STEMI were enrolled

in the study. The exclusion criterion was death within 24 hours. LVEF was recorded at admission time and 24 hours after PPCI. The data were entered into SPSS, version 20, for statistical analysis. The results were reported as the mean, the standard deviation (SD), percentages, and the χ^2 test.

RESULTS

The studied patients were admitted to the ED in 4 ways: direct referral, inpatient, ambulance transfer, and transfer from a hospital non-equipped for PPCI. From 174 patients, the data related to 140 patients were available. The majority of the patients (59.4%) self-transferred to the ED. The study population was divided into 5 categories in terms of artery obstruction type treated through angioplasty. Among the 174 patients, the most frequent type of obstruction was that of the middle (n=84, 48.2%), proximal (n=64, 36.7%), and distal (n=8, 4.5%).

The data regarding the time interval between the onset of chest pain and balloon angioplasty and the percentage of LVEF after primary angioplasty are summarized in Table 2. For the exploration of the correlation between the symptom-to-balloon time (SBT) and LVEF, a linear χ^2 test was run. The frequencies and percentages are indicated in the following tables.

Table 1: Distribution of the patients diagnosed with acute MI

Variables		f.	%
Type of Transfer to the Emergency Department	Self-transfer	107	59.4
	Ambulance transfer	18	10
	Transfer from a hospital non-equipped for angioplasty	12	6.7
	Inpatient	3	1.7
Type of MI	Anterior	90	50
	Inferior	70	39
	Lateral	4	2.2
	Lateral and anterior	4	2.2
	Posterior	3	1.7
	Inferior and posterior	2	1.1
	Inferior and anterior	1	.6
Infarct-Related Artery	LAD RCA LCX Others	86 67 18 3	8/4% 2/3% 3/1% 7/1%

MI, Myocardial infarction; LAD, Left anterior descending; RCA, Right coronary artery; LCX, Left circumflex

Table 2: Distribution of LVEF and SBT by time category

			First LVEF					
			20-29	30-34	35-39	40-44	45-50	>50%
SBT	≤60 min	f.	0	0	1	1	0	3
		%	.0	.0	20.0	20.0	.0	60.0
	61-180 min	f.	0	3	3	10	18	21
		%	.0	5.5	5.5	18.2	32.7	38.2
	181-360 min	f.	3	5	3	5	16	16
		%	6.3	10.4	6.3	10.4	33.3	33.3
	> 360 min	f.	4	5	5	11	16	16
		%	7.0	8.8	8.8	19.3	28.1	28.1

LVEF, Left ventricular ejection fraction; SBT, Symptom-to-balloon time

Table 3: Frequencies and percentages of the relationships between DBT and LVEF

			First LVEF					
			20-29	30-34	35-39	40-44	45-50	>50
DBT	≤30 min	f.	1	0	2	4	2	6
		%	6.7	.0	13.3	26.7	13.3	40.0
	31-60 min	f.	4	4	3	13	24	24
		%	5.6	5.6	4.	18.1	33.3	33.3
	61-120 min	f.	0	6	6	3	15	15
		%	.0	13.3	13.3	6.7	33.3	33.3
	> 120 min	f.	3	4	2	7	7	11
		%	8.8	11.8	5.9	20.6	20.6	32.4

LVEF, Left ventricular ejection fraction; DBT, Door-to-balloon time

As indicated above, a χ^2 test result of 4.53 at a *P* value of 0.033 was statistically significant. Thus, there was a linear correlation between SBT and LVEF.

Table 3 shows the information regarding the time interval between self-transfer to the ED and the balloon catheterization procedure in different groups. The LVEF percentages after angioplasty can be observed.

DISCUSSION

The most significant physiological risk for patients with acute STEMI is delay, which means that the time interval between the onset of symptoms and access to treatment facilities is long. This delay accounts for 55% to 80% of deaths from MI within the first few hours after symptom onset, which can be curtailed by timely treatment.[14] The results of our study also showed a linear correlation between SBT and LVEF, which was statistically significant ($P<0.05$). It can be concluded that the time interval between the onset of chest pain and balloon angioplasty can affect LVEF. However, the time interval between self-transfer to the ED and balloon catheterization (DBT) did not show any statistically significant effect on LVEF ($P<0.05$). Thus, there was no significant linear correlation between DBT and LVEF. In interpreting these results, it can be said that delay in hospital emergencies may defer the commencement of anti-ischemic treatment, resulting in progressive damage to cardiac tissue. Conversely, if the patient arrives at the appropriate time at the ED and is treated with an anti-ischemic strategy, heart injury and diminished LVEF do not occur with a delay in DBT.[15]

Similar to the present findings, Rahuman et al[16] in 2016 in Sri Lanka reported a mean DBT of 147 minutes in patients undergoing PPCI. Patients' EF was also estimated upon admission, before discharge, and at follow-up for 6 weeks and 6 months by a cardiologist. The mean EF showed a rapid increase after the procedure from 46% to 50%. Six weeks after hospital discharge, it remained stable in the follow-up. Then, in the next 5 months, it rose to some extent and reached 51%. In this research, there was no statistically significant correlation between DBT and PPCI outcomes. Only 32.7% of the patients who underwent PPCI had a DBT equal to or less than 120 minutes.

Menees et al[17] in 2013 conducted a study in 1400 hospitals and excluded time periods exceeding 3 hours. Overall, 96 738 patients who underwent PCI for STEMI were recruited in that study. Despite a reduced DBT, overall, there was no statistically significant change in the adjusted in-hospital mortality rate. These findings showed that additional methods were required to decrease the in-hospital mortality rate in this category of patients. According to the authors, one of

the reasons for this ineffectiveness in shortening DBT was the intrinsic challenges in the accurate timing of the onset of coronary occlusion (ie, when infarction begins vs the pre-infarct anginal phase).

Berger et al[8] in 1999 evaluated 565 patients in 9 countries. These patients were randomly selected from among those undergoing PPCI. The mean time interval was 76 minutes. The mean LVEF was 60% among patients treated within 1 hour of ED arrival, 50% among patients treated within 61 to 75 minutes of ED arrival, 51% among patients treated within 76 to 90 minutes of ED arrival, and 50% among patients treated within more than 91 minutes of ED arrival. Patients with no angioplasty had a mean LVEF of 50%. Berger and colleagues found no statistically significant difference between these groups.

In contrast to our results, Tudor Dadu et al[11] in 2016 in the United States found that out of 122 patients with STEMI admitted to a hospital within less than 4 hours of chest pain onset, those with a mean DBT of less than 60 minutes had a better prognosis in the first 48 hours than those with a mean DBT of equal to or more than 60 minutes (69% vs 47%; P=0.03). The authors also reported that LVEF was better in short and long-term follow-ups in patients with a shorter DBT. Thus, a reduced DBT can lower subsequent costs of healthcare (no need for defibrillators and hospitalization) and reduce the related mortality and disability rates.

Minutello et al[18] in 2010 assessed 179 American patients diagnosed with acute MI and ST-segment elevation and emergently transferred to the catheterization laboratory. All these patients underwent PPCI within 3 hours of symptom onset. The mean DBT was 87 minutes (65–113 min), and the mean LVEF was 42±10%. Overall, Minutello and colleagues concluded that a longer DBT was associated with a higher average mortality rate and a lower LVEF value.

Rezaei et al[19] in 2005 carried out a cross-sectional study in Iran on 120 patients with a definitive diagnosis of MI within 9 months. The time interval between the onset of symptoms and admission to the ED was 259±273 minutes. The most prevalent cause of delay in admission was unawareness of symptoms and their relative significance. Consequently, a time interval of 4.5 hours between the onset of symptoms to the hospitalization of patients with acute MI was not satisfactory. Rezaei and colleagues concluded that there was a need for educational programs to raise public awareness of the primary symptoms of MI and their significance.

Farshidi et al[20] in 2013 reported similar findings in their study. Moreover, an investigation by Poursheikhian et al[21] in 2005 in Iran on 100 patients with acute MI showed that the time interval between the onset of chest pain and call for help was 91 minutes. Additionally, the transfer time to a medical center of primary care (or a heart center) was 55 minutes, and the time interval between patients' transfer from a primary care center to a cardiac center was 84 minutes. The overall time between the onset of chest pain and admission to a heart center was 230 minutes (≈4 h). The patients in that study were delayed in all 3 stages. Still, the longest delay was in seeking help after the onset of chest pain. Thus, the authors concluded that raising patients' awareness of the early symptoms of acute MI, especially among women, could expedite decision-making as regards seeking help.

CONCLUSIONS

Raising patients' awareness concerning the symptoms of acute MI can facilitate their decision-making as to seeking help following the onset of chest pain. Thus, the time delay and its complications can be avoided. The mean DBT in Iran is significantly different from the standard

global time (90 min). Some studies have concluded that a shorter DBT among patients with STEMI is associated with a better LVEF in the short and long terms. Nevertheless, the present findings and those of the related literature lead us to conclude that the correlation between DBT and a better LVEF is not statistically significant, although reducing this interval can increase therapeutic effects and help improve LVEF after PPCI.

Limitations

One of the limitations of the present study is its small sample size compared with other similar studies. In addition, we could have bolstered our results had we taken into consideration socioeconomic factors, underlying diseases, and surgical procedures in the target population.

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