The Outcome of Smoker Patients With ST-Elevation Myocardial Infarction (STEMI) Undergone Primary Percutaneous Coronary Intervention (P-PCI) Versus Thrombolytic Therapy

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Abstract

Background: Because of the high prevalence of cardiovascular diseases and their urgent treatment in a way that have minimal side effects and maximum benefits, this study aims to compare the mortality rate, re-hospitalization, and ejection fraction of smoker patients undergone P-PCI (primary percutaneous coronary intervention) with those who received thrombolytic therapy in autumn 2018.

Methods: This cross-sectional study was done in Ayatollah Taleghani and Labbafinejad hospitals of Tehran City, Iran. The study group consisted of 42 smoker patients referred to the hospitals with the diagnosis of ST-Elevation Myocardial Infarction (STEMI) and have undergone P-PCI or thrombolytic therapy from September 2018 to December 2018. Complications such as death and re-hospitalization were noted, and the ejection fraction of each patient was also recorded. Statistical analyses were performed using SPSS version 25. Statistical significance was considered at P< 0.05.

Results: The Independent Samples t-test showed no significant difference between two groups of PCI and thrombolytic therapy regarding ejection fraction (EF) at the time of admission. Also, there was no considerable EF difference after three months of follow-up between 2 groups in both smoker and ex-smoker ones (P>0.05). Mean (SD) values of EF in smoker patients who underwent PCI were 41.56 9.95 at the time of admission and 45.00 10.52 after three months of follow-up. The paired sample t-test showed no significant difference between both groups regarding EF at the time of admission and after three months. The mean (SD) values of EF in smoker patients who underwent thrombolytic therapy were 40.26 8.73 at the time of admission and 48.53 5.80 after three months of follow-up. The paired sample t-test showed no significant difference between EF at the time of admission and after three months in the ex-smoker group, but there was a considerable difference in the smoker group (P<0.05). Three months mortality rate was estimated at 23.1% in smokers with PCI and 7.1% in patients treated with thrombolytic therapy.

Conclusion: Thrombolytic therapy can increase the EF of smoking patients with STEMI for a long time, indicating a beneficial effect of thrombolytic therapy to prevent heart failure.

Background

Cardiovascular diseases are the most common cause of death in many countries, especially in Iran [1]. Coronary artery disease (CAD) is the leading cause of cardiac diseases in Iran. It usually happens in people aged the 70s, but nowadays, the prevalence of cardiac events has been raised up to 45% in middle-aged people (aged 40s and 50s) [2].

ST-Elevation Myocardial Infarction (STEMI) is a severe type of heart attack during which one of the heart's main arteries is occluded. The ST-segment elevation is an abnormality detected on the 12-lead ECG. This sudden disturbance in blood flow can be due to an obstructing thrombosis caused by erosion, fissuring, or dissection. Platelets gathering can form thrombus in the vessel and thus cause stenosis [3,
Sometimes it can block blood flow completely [5, 6]. The pain usually occurs when myocardial demand for oxygen gets higher, and blood flow is insufficient for this demand [7].

Several medications are used for the treatment of myocardial infarction (MI). To name some, there are beta-blockers, statin, aspirin, P2Y inhibitor, and nitroglycerin [8]. Antiplatelet medication choice can be affected by previous percutaneous coronary intervention (PCI) or fibrinolytic treatments. According to recent trials, ticagrelor and prasugrel are shown superior to clopidogrel and are preferred in patients with a history of PCI [9, 10] but clopidogrel should be prescribed in patients who are undergoing fibrinolytic therapy [11]. Sometimes the plaque ruptures and the diagnosis of STEMI is made by ECG changing and troponin rising, and symptoms cannot be controlled with medications. The golden time to perform PCI in PCI-capable hospitals is 90 minutes, or if not, the patient should be transferred to a PCI-capable hospital in 120 minutes [12]. Thrombolytic therapy should be started for the patient in the first 30 minutes of patient's presentation in the hospital if PCI is unavailable within 120 minutes of first medical contact [13]. The goal of thrombolytic therapy is to remove life threatening clots in blood vessels, facilitate blood flow, and protect the tissues and organs from being damaged. Thrombolysis can be performed by injecting clot-dissolving drugs using an intravenous (IV) line or using a long catheter to deliver the thrombolytic agent to the blockage site. The clot can also be removed or broken physically using a long catheter with an attached mechanical device to the catheter's tip [13]. Indication for thrombolytic therapy in emergencies is to dissolve clots in the main arteries of the heart, brain, and lungs [14]. PCI is a non-surgical procedure that involves a combination of angioplasty with stenting and is used to treat narrowing of the heart's coronary arteries. In this procedure, femoral or arterial arteries are used to access the bloodstream. Then X-ray imaging is used to determine the path of coronary arteries and the exact site of blockage. After that, a coronary angioplasty can be done to relieve the narrowing of coronary arteries using balloon catheters or keep them open using stents. CABG (coronary artery bypass grafting) involves replacing the stenotic arteries with grafted vessels from elsewhere in the body. PCI can be an alternative to CABG, but in some instances, CABG may be superior [15, 16].

To evaluate the cardiac performance, usually, Ejection fraction (EF) and stroke volume (SV) are measured in emergency rooms or cardiac care unit (CCU). However, SV and EF do not always change in parallel and are affected differently by changes in cardiac load [17].

EF is defined as the percentage of the ejected blood to diastolic volume during ventricular contraction. Echocardiography is used to determine EF in the CCU, which usually is about 55% for LV [17]. In patients with acute STEMI who have undergone P-PCI and thrombolysis, the objective is to enhance the blood flow to ischemic sites as well as preserving the quality and quantity of the patient's life [18].

Previous studies have released controversial results. Some of them demonstrated no significant difference in mortality rate and re-hospitalization of patients who underwent PCI with those who received thrombolytic therapy [19–21]. However, some studies show that PCI is superior to thrombolytic therapy according to long-term outcomes [22].
To determine the prognosis in patients with STEMI, left ventricular ejection fraction (LVEF) is a reliable predictor of clinical outcomes; therefore, we aimed to compare the mortality rate, re-hospitalization, and ejection fraction of smoker patients who underwent PCI with those who received thrombolytic therapy in Ayatollah Taleghani and Labbafinejad hospitals of Shahid Beheshti University of Medical Sciences, Tehran City, Iran, in autumn 2018.

**Methods**

This cross-sectional study is done in Ayatollah Taleghani and Labbafinejad hospitals. The institutional Human Subjects Review Board approved the study protocol, and all patients signed an informed consent. The study group consisted of 42 smoker patients referred to the hospitals with the diagnosis of STEMI from September 2018 to December 2018.

During the present study, at first, 66 patients were admitted to hospitals with STEMI, from whom 54 patients were smokers and ex-smokers. Out of 54 smoker and ex-smoker patients admitted with STEMI, eight patients passed away in the next three months, and four patients refused to cooperate. Among the patients who passed away, six patients had undergone PCI, and two patients had undergone treatment with thrombolytic therapy. Eventually, 42 patients were included in the study (Fig. 1).

The enrolled patients had a history of smoking. If they had a particular past medical history, they should not have contraindications for thrombolytic therapy. They should also have had acute myocardial infarction symptoms, accompanied by an ECG with ST-segment elevation of more than 1 mm (0.1 mV) in two or more contiguous leads (STEMI). After providing an informed consent, the patients were assigned to undergo primary PCI or receive thrombolytic therapy according to their medical condition.

Baseline information such as demographic characteristics (age, sex), past medical history, family history, history of smoking, and its pack-year was recorded in a checklist.

After evaluating patients' ECG and other medical records, the type of MI and its characteristic features, such as EF at the time of admission were added to the checklist.

Follow-up information was obtained three months after the date of admission. All outpatients' reports were reviewed. For patients who had sustained clinical events during follow-up, hospital records were reviewed. Complications such as death and re-hospitalization were noted, and the EF of each patient was also recorded.

The statistical analyses were performed using SPSS version 25. Comparisons were made using the Independent Samples t-test and paired sample t-test. The Chi-square test was used to compare the categorical parameters. Statistical significance was considered at \( P < 0.05 \).

**Results**
In this study, 42 smoker patients completed all stages of this study, of which 41 were male (97.62%), and 1 was female (2.38%). The most common risk factors were hypertension (45.24%), diabetes (42.86%), and family history of ischemic heart disease (21.42%), which are shown separately or in combination with other factors in Table 1.
Table 1
Demographic and clinical characteristics of the patients

|                  | Absolute frequency | Percentage  |
|------------------|--------------------|-------------|
| **Sex**          |                    |             |
| Male             | 41                 | 97.62       |
| Female           | 1                  | 2.38        |
| **Age**          |                    |             |
| ≤ 50             | 12                 | 28.57       |
| > 50             | 30                 | 71.43       |
| Mean: 54.90±8.93|                    |             |
| **Risk factors** |                    |             |
| Hypertension     | 9                  | 21.43       |
| Dyslipidemia     | 6                  | 14.29       |
| Diabetes         | 8                  | 19.05       |
| Family history of ischemic heart disease | 5 | 11.90 |
| Past MI history  | 2                  | 4.76        |
| Hypertension + Diabetes | 6 | 14.29 |
| Hypertension + Diabetes + Family history of ischemic heart disease | 3 | 7.14 |
| Hypertension + Diabetes + Family history of ischemic heart disease + Past MI history | 1 | 2.38 |
| None             | 2                  | 4.76        |
| **Total**        | 42                 | 100.00      |
| **Location of Culprit lesion** |        |             |
| LAD              | 9                  | 21.43       |
| RCA              | 7                  | 16.67       |
| LAD + RCA        | 17                 | 40.47       |
| LAD + RCA + LCX  | 9                  | 21.43       |
| **Total**        | 42                 | 100         |
| **Vascular involvement** |    |             |
| One Vessel       | 16                 | 38.10       |
| Two Vessels      | 17                 | 40.47       |
| Three Vessels    | 9                  | 21.43       |
| **Total**        | 42                 | 100         |
According to the angiographic records of patients, simultaneous involvement of left anterior descending (LAD) and right coronary artery (RCA) vessels with a frequency of 17 cases (40.47%) were the most commonly involved vessels. After that, LAD artery involvement and simultaneous involvement of LAD, RCA, and left circumflex artery (LCX) were the most frequently involved vessels with a frequency of 9 cases (21.43%). The number of patients with RCA involvement was 7 (16.67%).

Since admission time after the onset of MI symptoms is crucial for making treatment decisions, the duration is taken to get the patient into hospital after the symptoms are summarized in Table 2. As this Table shows, most patients were admitted after one hour, and only 7.14% of them were admitted in the golden time of 30 minutes.

From the whole study sample, 24 patients were admitted to a hospital not capable of performing PCI. Out of them, 8 cases (33.33%) received thrombolytic therapy in less than 30 minutes, and 16 patients (66.67%) get the treatment after 30 minutes of arrival. Also, 18 patients were admitted to a hospital capable of PCI, the time of door-to-balloon for 5 of them (27.78%) was less than 90 minutes, and for 13 of them (72.22%) was more than 90 minutes (Table 2).

| Table 2 | Recorded time frames for the onset of MI symptoms to patient response and door-to-balloon and door-to-needle |
|----------|----------------------------------------------------------------------------------------------------------|
| **Onset of MI to patient response** | **Absolute frequency** | **Percentage** |
| < 30 minutes | 3 | 7.14 |
| 30 to 60 minutes | 12 | 28.57 |
| > 60 minutes | 27 | 64.29 |
| Total | 42 | 100 |
| **Door to Balloon** | **PCI** | **≤ 90 minutes** | **> 90 minutes** | **Total** | **100** |
| ≤ 90 minutes | 5 | 27.78 |
| > 90 minutes | 13 | 72.22 |
| Total | 18 | 100 |
| **Door to Needle** | **Thrombolytic Therapy** | **≤ 30 minutes** | **> 30 minutes** | **Total** | **100** |
| ≤ 30 minutes | 8 | 33.33 |
| > 30 minutes | 16 | 66.67 |
| Total | 24 | 100 |
To match the baseline characteristics, we used the Independent Samples t-test that showed no significant difference of EF at the time of admission between two PCI and thrombolytic therapy groups. Also, there was no considerable EF difference between the two groups after three months of follow-up in both smoker and ex-smoker ones (Table 3).

Table 3
The Independent Samples t-test to compare EF in two treatment groups

| Treatment                        | Mean (SD) | t     | P-Value |
|----------------------------------|-----------|-------|---------|
| Smokers                          |           |       |         |
| EF1 PCI                          | 41.56 (9.95) | 0.411 | 0.683   |
| Thrombolytic Therapy             | 40.26 (8.73) |       |         |
| EF2 PCI                          | 45.00 (10.52) | -1.154 | 0.262   |
| Thrombolytic Therapy             | 48.53 (5.80) |       |         |
| EF2-EF1 PCI                      | 3.00 (5.91) | -1.804 | 0.081   |
| Thrombolytic Therapy             | 7.94 (9.02) |       |         |
| Ex-smokers                       |           |       |         |
| EF1 PCI                          | 45.00 (7.07) | 0.598 | 0.576   |
| Thrombolytic Therapy             | 41.00 (8.21) |       |         |
| EF2 PCI                          | 52.50 (3.53) | 0.692 | 0.520   |
| Thrombolytic Therapy             | 49.00 (6.51) |       |         |
| EF2-EF1 PCI                      | 7.50 (5.91) | -0.139 | 0.891   |
| Thrombolytic Therapy             | 8.00 (9.02) |       |         |

Mean (SD) values of EF in smoker patients who underwent PCI were 41.56 + 9.95 at the time of admission and 45.00 + 10.52 after three months of follow-up. The paired sample t-test showed no significant difference between both groups regarding EF at the time of admission and after three months. Mean (SD) values of EF in smoker patients who underwent thrombolytic therapy were 40.26 + 8.73 at the time of admission and 48.53 + 5.80 after three months of follow-up (Fig. 2,3). The paired sample t-test showed no significant difference between EF at the time of admission and after three months in the ex-smoker group, but there was a significant difference in the smoker group (Table 4).
Table 4
Paired sample t-test to compare EF at the time of admission and after three months in two treatment groups

| Treatment             | EF   | Mean | SD  | t     | P-Value |
|-----------------------|------|------|-----|-------|---------|
| **Smokers** PCI       | EF1  | 41.56| 9.95| -1.964| 0.070   |
|                       | EF2  | 45.00| 10.52|       |         |
| Thrombolytic Therapy  | EF1  | 40.26| 8.73| -3.628| 0.002   |
|                       | EF2  | 48.53| 5.80|       |         |
| **Ex-smokers PCI**    | EF1  | 45.00| 7.07| -3.00 | 0.205   |
|                       | EF2  | 52.50| 3.53|       |         |
| Thrombolytic Therapy  | EF1  | 41.00| 8.21| -4.00 | 0.016   |
|                       | EF2  | 49.00| 6.52|       |         |

To measure MACE (Major Adverse Cardiac Events), we evaluated patients’ mortality and re-hospitalization during three months of follow-up. Three months mortality of patients who underwent PCI was 23.10%, and was 7.10% in those who received thrombolytic therapy. The Chi-square test showed no significant difference between the two groups. About 11.50% of smoker patients who underwent PCI were admitted to the hospital during three months of follow-up. None of those who received thrombolytic therapy had an experience of re-hospitalization in this period. Anyway, the Chi-square test showed no significant difference between the two groups (Table 5).

Table 5
Mortality rate and re-hospitalization of patients during three months

|                                | Frequency | Percentage | Chi-square | P-Value |
|--------------------------------|-----------|------------|------------|---------|
| **Mortality during 3 months of follow up** | PCI       | 6          | 23.10      | 0.100   |
| Thrombolytic Therapy           | 2         | 7.10       |            |         |
| **Re-hospitalization during 3 months of follow up** | PCI       | 3          | 11.50      | 0.064   |
| Thrombolytic Therapy           | 0         | 0.00       |            |         |

Discussion
According to the World Health Organization (WHO) report, ischemic heart disease (IHD) is responsible for 7.3 million people's deaths in the world with approximately 58 DALY (Disability Adjusted Life Years) global disease burden [23]. In 2010, The American Heart Association announced that 15.4 million people in America were afflicted with IHD [24]. Angina pectoris occurs when myocardial blood perfusion is inadequate and has two types: stable and unstable [25, 26]. Stable angina is caused by severe exercise or emotional stress and has no symptom at rest; it usually responses to drugs. But in some instances with excessive stenosis or patients who are not responding to medication, revascularization is the best treatment [25]. The goal of revascularization is to relieve the symptoms and quality of life in patients and long-term survival. Percutaneous Coronary Intervention (PCI) is a type of revascularization that has been used for more than 20 years [27]. Based on studies, stent use in patients with acute coronary syndrome reduces morbidity and mortality of myocardial infarction, almost 5% more than medication only [28, 29].

In general, stent application removes balloon angioplasty limitations, reduces complications, and improves cardiovascular outcomes. Despite the clinical benefit of the stent, there are some unwanted outcomes like plaque rupture and emboli formation [30, 31].

Since PCI is an expensive treatment, it needs lots of caution and expertise and not all hospitals can do it; in this study, we aimed to describe the mortality rate, re-hospitalization, and ejection fraction of smoker patients with STEMI who underwent PCI versus thrombolytic therapy.

Results of this study showed that three months mortality rate of patients who underwent PCI was 23.1%, and those who received thrombolytic therapy was 7.1%, but the difference was not statistically significant. So many previous studies presented the same result; some are mentioned here. Arso et al. studied 136 patients in 2016 and evaluated MACE in patients who underwent PCI and received thrombolytic therapy. Results of that study showed no significant difference between the two groups in MACE [19]. In another study done by Danchin et al. in 2019, no significant difference were demonstrated about five years mortality after PCI versus thrombolytic therapy [20]. Armstrong et al. studied 1892 patients in 2013 and evaluated mortality and re-hospitalization in patients who underwent PCI and received thrombolytic therapy. The study showed no significant difference between the two groups regarding mortality rate and re-hospitalization [21].

On the other hand, few studies show different results from the ones achieved in this study. For example, in 2004, Mehta et al. showed that in patients with STEMI, the mortality rate is lower in patients who underwent PCI than those who underwent thrombolytic therapy [22]. Maybe this controversy comes out of different sample populations, as in the Mehta study, the study group were more than 70 years old, but in the current study, the mean (SD) age was 54.90 + 8.93 years. Thus, age can be an effective parameter in choosing the best treatment in STEMI.

The most common risk factors were hypertension (45.24%), diabetes (42.86%), and family history of ischemic heart disease (21.42%). As shown in the previous studies, diabetes, hypertension, dyslipidemia, and family history of ischemic heart disease are the most critical risk factors for occurring STEMI [32, 33].
Results of the present study in smoker patients described that mean (SD) EF values of patients who underwent PCI were 41.56 + 9.95 at the time of admission and 45.00 10.52 after three months, and statistical analyses showed no significant difference between the two numbers. Mean (SD) EF values of patients who received thrombolytic therapy were 40.26 + 8.73 at the time of admission and 48.53 + 5.80 after three months, and statistical analyses showed a significant difference between the two numbers. Also, in ex-smoker patients, mean (SD) EF values of patients who underwent PCI were 45.00 + 7.07 at the time of admission and 52.50 + 3.53 after three months, and statistical analyses showed no significant difference between the two numbers. By the way, mean (SD) EF values of patients who received thrombolytic therapy were 41.00 + 8.21 at the time of admission and 49.00 + 6.52 after three months, and statistical analyses showed a significant difference between the two numbers. Itho et al. conducted a study in 2010 to compare EF changes in both treatments. In that study, mean EF values of patients who received thrombolytic therapy were 55.4% at the time of admission and 61.6% after six months; mean EF of patients who underwent PCI was 54.3% at the time of admission and 55% after six months of follow up. The Itho study results are in line with this study, and both of them demonstrate that EF raised significantly during a long time after thrombolytic therapy [34].

Conclusion

History of hypertension and diabetes are the most critical risk factors for occurring STEMI in smoker patients. This study showed that only 7.1% of patients with MI are admitted to the hospital within the golden time of 30 minutes. It can be concluded that there should be more educational programs about MI symptoms and what to the when it happens in Iran.

Thrombolytic therapy can improve patients’ EF after STEMI for a long time and prevent further ischemic heart disease complications. Mortality rate and re-hospitalization between two groups of PCI and thrombolytic therapy had no significant difference.

Declarations

Ethics approval and consent to participate

The study protocol was in accordance with the Helsinki Declaration and confirmed by the Ethics Committee of Shahid Beheshti University of Medical Sciences (Approval Code: IR.SBMU.MSPREC.1398.092). The participants were informed about the research objectives and the written informed consent was obtained from the subjects before starting the survey.

Consent for publication

Not applicable

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors' contributions**

MAK: Writing-original draft, Methodology, Data curation, Investigation, Resources, Writing-editing and Review. MAP: Conceptualization, Data curation, Supervision. MJF: Data curation, Project Administration, Writing-editing and Review. AS: Software, Data analysis, Writing-editing, and Review. HH: Data collection. All authors read and approved the final manuscript.

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**Figures**

![Flow diagram](image)

**Figure 1**

Participant recruitment flow diagram (STEMI, ST-Elevation Myocardial Infarction; PCI, Percutaneous Coronary Intervention)
Figure 2

Ejection fraction at the time of admission and three months later in smoker patients
Figure 3

Ejection fraction at the time of admission and three months later in ex-smoker patients