ORIGINAL ARTICLE

# Pulse pressure and inferior wall ST-segment elevation myocardial infarction: investigating mortality, hospital major cardiovascular events, and long-term prognosis

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**Abstract.** Inferior Wall ST-Segment Elevation Myocardial Infarction (INF STEMI) is a severe condition with high mortality. Rapid treatment with Primary Percutaneous Coronary Intervention (PPCI) is preferred. Pulse Pressure (PP) is a known risk factor for both cardiovascular disease and may be a valuable predictor of outcomes in these patients. The study aims to evaluate the relationship between PP and long-term prognosis, mortality, and major cardiovascular events after inferior STEMI in cases who underwent PPCI. This cross-sectional study included subjects with a confirmed diagnosis of inferior STEMI who underwent PPCI. Patient data were gathered from hospital records and analyzed for the relationship between PP and MACE during hospitalization and one-year follow-up. Statistical analysis was performed using SPSS. This cross-sectional study of 320 cases found that DM, DBP, and Cr patients had a higher incidence of MACEs (P-value <0.05). Subjects with higher LVEF and SBP had fewer MACEs (P-value <0.05). Cases with a PP of ≤50 had a higher mortality and heart failure incidence during hospitalization than those with a PP >50 (P-value <0.05). However, the two groups had no significant difference in one-year MACE rates. The study found that increasing DBP, Cr, and DM and decreasing LVEF and SBP impacted MACE incidence. PP ≤50 had more heart failure incidence and mortality during hospitalization in patients with inferior STEMI.

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## Introduction

Inferior Wall ST-Segment Elevation Myocardial Infarction (INF STEMI) is estimated to account for 40-50% of all STEMIs and is associated with a mortality rate of 2-9% (1). Inf STEMI is often caused by acute occlusion of the Left Circumflex Artery (LCX) and Right Coronary Artery (RCA), among the most common culprits of this condition (2). The significant STEMI patients who get rapid reperfusion by the Primary Percutaneous Coronary Intervention (PPCI) in an accessible catheterization laboratory facility benefit more from comparing fibrinolytic treatment (3). The maximum time between first medical contact and balloon inflation is 90 min suggested by The American College of Cardiology/American Heart Association for PPCI (4).

Pulsatile Blood Pressure (BP) elements are more effective in capturing cardiac risk components than steady components in assessing cardiovascular risk (5-7). Pulse Pressure (PP) for Cardiovascular Disease (CVD) is determined as a vigorous risk factor, such as cardiovascular mortality, stroke, and MI. Furthermore, a high level of PP increases multiple adverse cardiovascular events risk (8,9).

In the assessment of CVD prognosis, PP has emerged as a more reliable predictor compared to Mean Arterial Pressure (MAP), Diastolic Blood Pressure (DBP), and Systolic Blood Pressure (SBP), despite being calculated by misapplication of SBP and DBP readings (10-12). In addition, low and high PP levels were associated with an elevated death risk in cases with acute coronary syndrome (12). Hence, we aimed to assess the correlation between PP and mortality rate, long-term prognosis, and hospital Major Cardiovascular Events (MACEs) following inferior STEMI in cases who underwent PPCI.

## Materials and methods

This Cross-sectional study was conducted between March 2020 and March 2022 in Tabriz Madani Hospital, Iran. All patients with the confirmed diagnosis of inferior STEMI who had less than 24 h have started since the

onset of symptoms and underwent PPCI were included in the study. Tabriz University of Medical Sciences Medical Ethics Committee approved the study protocol (Registration Code: IR.TBZMED.REC.1401.897), and informed consent was obtained from all participants. The patients' data were collected from hospital medical records. Inclusion criteria included age between 18-80 years, inferior STEMI patients, cases who underwent PPCI, and less than 24 h have started since the onset of symptoms. Exclusion criteria included cases with inanition of symptoms over 12 h, valvular heart disease, heart failure, chronic lung disease, Glomerular Filtration Rate (GFR) <30, chronic liver disease, cerebrovascular disease, cases with hemodynamic instability or cases took inotropic medication or needed intra-aortic balloon pump.

All information was obtained in the form of a prepared checklist. These included demographic variables such as sex, age, DBP, SBP, Heart Rate (HR), Left Ventricular Ejection Fraction (LVEF), Door-to-Balloon Time (DBT), MACE during hospitalization, and comorbidities, like Hyperlipidemia (HLP), Hypertension (HTN), and Diabetes Mellitus (DM). Angiographic and laboratory findings were gartered too. Then SBP, DBP, PP, and recorded in the Cath lab are gathered from hospital medical records. Cases were divided into five groups according to the PP level, PP >60, PP: 51-60, PP: 41-50, PP: 31-40, and PP <30. The patients were followed up for one year regarding MACE. In-hospital MACE and one-year MACE was a parameter composite such as mortality, heart failure, ischemia, stroke and further new MI. At first, the patients were divided into two groups, MACE and non-MACE, and their basic parameters were measured together. Next, the cases were divided into PP above 50 and below 50 groups, and their MACE was compared.

This study performed all statistical analyses using IBM SPSS Statistics software version 24 (IBM Corp., Armonk, USA). The normal distribution assumption for continuous variables was assessed using the Kolmogorov-Smirnov test. Descriptive statistics were calculated, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Differences between groups were evaluated using the chi-square test for categorical variables and the independent t-test for continuous variables. Statistical significance was determined as a P-value of less than 0.05. These methods were employed to investigate the relationship between the variables and the outcomes of interest in the study.

## Results

This cross-sectional study of 320 cases includes 52 females and 268 males. 48.8 percent of cases were current smokers. 65 and 255 patients were in the MACE and non-MACE groups, respectively. 26.6, 55.3, and 15 percent of patients had DM, HTN, and HLP, respectively. In comparing the non-MACE and MACE, DM, DBP, and Cr, are statistically significantly more than in the MACE group. At the same time, LVEF and SBP are statistically significantly more in the non-MACE group. Demographic, laboratory, and angiographic features are shown in Table I.

Two hundred forty-two patients had PP >50, and 78 patients had PP ≤50. Mortality and Heart Failure (HF) in the hospital MACE had a statistically significant difference based on PP; however, there was no one-year MACE HF, and there was no statistically significant HF one-year MACE. HF and mortality in the hospital are significantly more in cases with PP ≤50 than those with PP >50. In-hospital and one-year MACE rates are illustrated in Tables II and III.

## Discussion

Our study showed that DBP, Cr, and DM impact the incidence of MACE, although PP does not affect the incidence of MACE. In addition, PP ≤50 is effective in the incidence of mortality and HF during hospitalization.

PP varies from static pressure elements, including systolic and mean arterial pressures, in numerous ways. The sole mean arterial pressure determines the total arteriolar system peripheral resistance and cardiac output. In contrast, PP is also impacted by large arteries' elastic recoil, ventricular ejection pattern, and reflected wave timing. The ratio of collagen to elastin changing with elastic lamellae fragmentation and aging in central arteries leads to vessel compliance loss. Arterial stiffness can lead to an increase in systolic blood pressure due to a reduction in the dispensability of large arteries during increased pulse wave velocity and systolic ejection. This is because the earlier reflected wave timing and loss of elastic recoil in late systole compound to a reduction in DBP, typically maintained by reflected waves during diastole. These mechanisms may play a role in the pathophysiology of HTN and other CVD associated with arterial stiffness. Understanding the complex interplay between arterial stiffness and BP regulation may aid in developing more effective diagnostic and therapeutic strategies for these conditions (13,14).

The prognostic PP value has been demonstrated in many research (15-17). One research that studied 2152 cases aged more than 65 years found that a higher PP level was an independent predictor of heart failure and coronary heart disease among older adults (17). Wang *et al* (12). illustrated PP level as cardiac mortality and 1-year all-cause prognostic factor in subjects with ACS. Also, they showed that ACS prognosis and PP have a J-shaped correlation, particularly in Anterior MI cases.

A higher level of PP is correlated with more common CVD risk factors and increased age. In contrast, cases with lower levels of PP have poorer in-hospital results and clinical characteristics. In ACS patients, lower PP is a consequence of prognostic factors. In spite, PP did not enhance the GRACE risk score discriminatory performance in comparison to SBP (18).

The Cardiovascular Health study found that among patients over 65, only elevated SBP was significantly correlated with total mortality. Similarly, the Multiple Risk Factor Intervention Trial revealed that in male cases aged 35-55, higher levels of DBP were observed. However, SBP had a stronger association with cardiovascular disease-related mortality than PP. These findings highlight the importance of carefully assessing and managing BP in different age and gender groups to prevent cardiovascular morbidity and mortality (19,20). Park *et al* (21). showed that in cases with STEMI undergoing PCI, patients with normal presenting SBP had remarkably more mortality in hospital and less LVEF compared to subjects with high SBP. Although another research illustrated that in cases with acute

Table I. Demographic, laboratory, and angiographic characteristics of study cases.

| Parameter | MACE (n=65) | Non-MACE (n=255) | P-value |
|---|---|---|---|
| Age | 60.48±11.28 | 59.22±11.05 | 0.41 |
| Male | 50 (76.9) | 218 (85.5) | 0.13 |
| HR | 80.95±16.69 | 80.05±15.32 | 0.67 |
| SBP | 120.86±34.21 | 130.19±24.76 | 0.01 |
| DBP | 87.25±23.82 | 79.69±14.34 | 0.001 |
| Hb | 14.04±2.23 | 14.7±2.06 | 0.04 |
| Cr | 1.48±1.29 | 1.08±0.29 | <0.001 |
| DBT | 1.81±1.50 | 1.63±1.25 | 0.58 |
| LVEF | 40.38±6.74 | 42.31±5.96 | 0.02 |
| Smoking | 29 (44.6) | 127 (49.8) | 0.48 |
| DM | 26 (40.0) | 59 (23.1) | 0.008 |
| HTN | 32 (49.2) | 145 (56.9) | 0.32 |
| HLP | 10 (15.4) | 38 (14.9) | 0.52 |
| VD | | | 0.26 |
| 1 VD | 18 (27.7) | 71 (27.8) | |
| 2 VDs | 10 (29.2) | 99 (38.8) | |
| 3 VDs | 28 (43.1) | 85 (33.3) | |
| PP | | | 0.08 |
| <30 | 3 (4.6) | 1 (0.4) | |
| 31-40 | 2 (3.1) | 17 (6.7) | |
| 41-50 | 16 (24.6) | 39 (15.3) | |
| 51-60 | 14 (21.5) | 56 (22.0) | |
| >60 | 30 (46.2) | 142 (55.7) | |

HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; Cr, creatinine; DBT, door-to-balloon time; LVEF, left ventricular ejection fraction; DM, diabetes mellitus; HTN, hypertension; HLP, hyperlipidemia; VD, vessels disease; PP, pulse pressure.

Table II. In-hospital MACE rate based on the pulse pressure (PP).

| Parameter | PP >50 (n=242) | PP ≤50 (n=78) | P-value |
|---|---|---|---|
| HF | 4 (1.7) | 6 (7.7) | 0.01 |
| MI | 2 (0.8) | 0 (0.0) | 0.57 |
| Stroke | 0 (0.0) | 1 (1.3) | 0.244 |
| Ischemia | 1 (0.4) | 0 (0.0) | 0.75 |
| Mortality | 4 (1.7) | 5 (6.4) | 0.04 |

PP, pulse pressure; HF, heart failure; MI, myocardial infarction.

Table III. One-year MACE rate based on the pulse pressure (PP).

| Parameter | PP >50 (n=242) | PP ≤50 (n=78) | P-value |
|---|---|---|---|
| HF | 0 (0.0) | 0 (0.0) | - |
| MI | 1 (0.4) | 1 (1.3) | 0.42 |
| Stroke | 3 (1.2) | 0 (0.0) | 0.43 |
| Ischemia | 27 (11.2) | 7 (9) | 0.38 |
| Mortality | 7 (2.9) | 5 (6.4) | 0.17 |

PP, pulse pressure; HF, heart failure; MI, myocardial infarction.

MI, not a 'normal' SBP range (121 to 140mm Hg) was correlated with the best 1-year result; however, the highest values were (22).

A recent study has found a U-shaped relationship between mortality rate and PP in octogenarians with acute coronary syndrome ACS. The study also shows that PP levels equal to or less than 50 mmHg have a significant independent prognostic value for long-term all-cause mortality in octogenarians with ACS, including those with HTN. These findings suggest that PP could be a good prognostic factor for healthcare professionals treating elderly patients with ACS (23).

Another investigation showed that PP and SBP were significantly correlated with 30-day mortality cases with STEMI (24). In contrast, our study did not show any association between PP and mortality in the MACE group. They also found that the PP level may be the most essential measure in mortality prediction. Also, they revealed that STEMI cases with SBP lower than 110 mm Hg are associated with a significant mortality rate in 30 days. As our study showed, the incidence of MACE was higher in the group with less SBP, and the results of their study were in line with ours. In addition, another study showed the correlation between coronary artery disease severities based on gender, age, number of vessels involved, family history, blood pressure, and diabetes (25).

One potential limitation of our original research article is that the majority of our study participants were male. Additionally, the number of patients with PP≤50 was smaller than the number of patients with PP>50, which may have impacted our findings. As our study was cross-sectional, it is essential to acknowledge that selection bias is also a potential limitation. While these limitations should be considered when interpreting our results, our study provides valuable insights into the relationship between MACE and PP. Future studies with more extensive and diverse samples would be helpful in further exploring these relationships. Also, they revealed that STEMI cases with SBP lower than 110 mm Hg are associated with a significant mortality rate in 30 days. As our study showed, the incidence of MACE was higher in the group with less SBP, and the results of their study were in line with ours.

## Conclusions

Our study showed that more DBP and Cr, and DM have a statistically significant effect on the incidence of MACE, while LVEF and SBP are less effective on the incidence of MACE. PP≤50 compared to PP>50 during hospitalization in Inf. STEMI patients had a higher incidence of HF and mortality, which is statistically significant.

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**Ethics approval and consent to participate**

This study was performed according to the principles outlined by the World Medical Association's Declaration of Helsinki on experimentation involving human subjects, as revised in 2000, and has been approved by the ethics committee of the Tabriz University of Medical Sciences.

**Availability of data and materials**

All data generated or analyzed during this study are included in this published article.

**Authors' contributions**

AK, conception and design of the report; EHJ, drafting the article or revising it critically for important intellectual content and data analysis; AA, data collection and revising the article. All the authors have read and approved the final version of the manuscript and agreed to be held accountable for all aspects of the work.

**Conflict of interest**

The authors declare no potential conflict of interest.

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