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ADULT CARDIOLOGY

Association of Systolic BP to LVED Pressure Ratio with In-Hospital Mortality in STEMI Patients Undergoing PPCI

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ABSTRACT

Objective: To determine the association of Systolic Blood Pressure to Left Ventricular End-Diastolic Pressure ratio with in-hospital mortality in ST-Elevation Myocardial Infarction patients undergoing Primary Percutaneous Coronary Intervention.

Study Design: Analytical, cross-sectional study.

Place and Duration of Study: Armed Forces Institute of Cardiology, National Institute of Heart Diseases, Rawalpindi Pakistan, from Apr-Jun 2023.

Methodology: One hundred and ninety-eight patients who underwent Primary Percutaneous Coronary Intervention for ST-Elevation Myocardial Infarction patients presenting within 12-hours were included using non-probability consecutive sampling technique. Patients were divided into two groups (Group-I= SBP/LVEDP ratio ≤4; Group-II= SBP/LVEDP ratio >4). SBP and LVEDP were measured during Primary Percutaneous Coronary Intervention. Demographic and clinical data, including risk factors and laboratory findings, were collected and SBP/LVEDP ratio was calculated. Study variables were compared among groups by applying independent t-test and Chi-square test. *p*-value<0.05 was kept as significant.

Results: Among the study sample of 198, 126(63.6%) were males and females were 72(36.3%), mean age was 61.31±9.16 years. 21(10.6%) patients had SBP/LVEDP ratio≤4 (Group-I), while 177(89.3%) patients had SBP/LVEDP ratio>4 (Group-II). Group-I showed a higher prevalence of heart failure 5(23.8%), lower ejection fraction (35.48±7.56%), longer duration of in-hospital stay (8.76±2.48 days) (p<0.05), and higher TIMI scores (9.28±1.10) compared to Group-II. In-hospital mortality was also higher in Group-I (33.3%), compared to Group-II (6.2%) (p<0.05).

Conclusion: The SBP/LVEDP ratio≤4 has significantly predicted increased risk of adverse outcomes and in-hospital mortality in STEMI patients who underwent Primary Percutaneous Coronary Intervention. This ratio may serve as a marker of compromised cardiac function and disease severity.

Keywords: In-hospital mortality, Left Ventricular End-Diastolic Pressure, Primary Percutaneous Coronary Intervention, Systolic Blood Pressure

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INTRODUCTION

Coronary artery disease (CAD) is responsible for causing 17.1 million deaths worldwide each year and is the major cause of worldwide deaths.[1] In low income and middle income countries, CAD is responsible for the majority of deaths (39%) among individuals below the age of 70 years.[2] A major compli-cation of CAD is Myocardial Infarction (MI), which is particularly prevalent among the Asian population.[3,4]

The majority of the population in Pakistan, around 67.5%, resides in rural areas and faces a higher burden of heart disease.[5,6] According to the Framingham study, the main risk factors for developing CAD include obesity, hypertension, smoking, diabetes mellitus, and hypercholesterolemia. These factors are prevalent in Pakistan, where more than 30% of the population over the age of 45 years is afflicted by MI.[7]

Invasive hemodynamic measurements during Primary Percutaneous Coronary Intervention (PPCI) offer the potential advantage of providing a more accurate assessment of pre-load and after-load on left ventricle compared to non-invasive assessments. Several parameters, such as; low Systolic Blood Pressure (SBP), low pulse pressure, and elevated Left Ventricular End Diastolic Pressure (LVEDP) have been independently linked to higher rate of mortality.[8] Study conducted by Planer *et al* involving 2797 PPCI patients as part of the Harmonizing Outcomes with Revascularization followed by Stents in Acute Myocardial Infarction (AMI) trial, determined that LVEDP was an independent determinant of adverse consequences. Patients having LVEDP>18 mmHg exhibited higher hazard ratios for death, at both 30-days and 2-

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years follow-up, compared to patients who had LVEDP <18mmHg.[9] El-Menyar discovered correlation of pulse pressure with SBP, and mean arterial pressure. In a study involving over n=2500 patients with ST-elevation myocardial infarction (STEMI), a pulse pressure <30 mmHg was significantly associated with increased mortality.[10]

The predictive power of Killip class, which combines LV-filling pressures and SBP, indicates its significance in determining outcomes.[11] However, it remains uncertain whether the assessment of hemodynamic variables would enhance predictive accuracy invasively or not. Hence, our study aimed to assess the prognostic value of the SBP/LVEDP ratio measured invasively, in predicting outcomes of patients with STEMI undergoing PPCI. Despite previous studies highlighting the importance of various parameters such as low pulse pressure, elevated LVEDP and low SBP, in predicting adverse outcomes in STEMI patients, still a research gap exists in the literature regarding the prognostic value of the SBP/LVEDP ratio measured invasively. Thereby, the present study was conducted to evaluate the association of SBP/LVEDP ratio with in-hospital mortality, providing valuable insights into the potential of this ratio as a marker for compromised cardiac function and disease severity.

METHODOLOGY

This Analytical Cross-sectional study was conducted at Armed Forces Institute of Cardiology/ National Institute of Heart Diseases, Rawalpindi, Pakistan, after the ethical approval from Institutional Ethical Review Board (IERB Ltr# 9/2/R&D/ 2023/256). Study duration was Apr-Jun 2023 and non-probability consecutive sampling technique was used.

WHO calculator was used for sample size calculation. Sample size of n=198 was calculated by using 15.18% prevalence of STEMI, 95% confidence level and 5% margin of error.[12]

Inclusion Criteria: All adult patients who underwent PPCI after STEMI and presented within 12 hours and aged >18 years of either gender were included for study purpose.

Exclusion Criteria: Patients who presented with shock, Acute Coronary Syndrome (ACS), renal failure, valvular heart diseases, non-ischemic cardiomyopathy and failure to obtain LVEDP for any reason, were excluded.

STEMI was characterized as the presence of ST-elevation at the J point, with a magnitude of at least 1.5mm (0.15mV) in women and 2 mm(0.2mV) in men, in at least 2 contiguous leads (V2-V3), or 1mm(0.1mV) in other contiguous limb leads and chest leads.[13]

Hemodynamic parameters such as SBP, LVEDP, mean aortic pressure, and aortic diastolic blood pressure was measured. The TIMI and GRACE scores, which provide risk assessments, were calculated. Killip class was assessed based upon the physical examination findings conducted prior to PPCI. Patients' data including creatinine and troponin-I levels upon admission were obtained via consecutive sampling technique and were noted from medical records of patients.

Patients' pre-existing medical history of conditions such as hyperlipidemia, diabetes mellitus, and hyper-tension were noted. Cerebrovascular disease, heart failure and, chronic kidney disease, were identified through patient's past medical records and history. The post-PPCI ejection fraction value was obtained through echocardiography performed within 24-hours after the procedure. Patients were divided into two groups based upon SBP/LVEDP ratio (Group-I =SBP/LVEDP Ratio ≤4; Group-II=SBP/ LVEDP Ratio >4).[14] Continuous variables were analyzed using the Shapiro Wilk test to evaluate data normality. Various factors, including SBP, LVEDP, TIMI score, SBP/LVEDP ratio, Killip Score, GRACE Score, shock index, modified shock index, pulse pressure, and mortality rate, were compared among study groups by applying chi-square and t-test where appropriate and p-value<0.05 was taken as statistically significant.

RESULTS

The present study included one hundred and ninety-eight patients, partitioned into two groups based on the SBP/LVEDP ratio. Group-I (SBP/LVEDP ≤4) consisted of 21(10.6%) patients, while Group-II(SBP/LVEDP>4) included 177(89.4%) patients. Regarding the demographic characteristics, gender distribution showed no significant difference between the groups (p>0.05). Mean age of the study participants was 61.31±9.16 years, with significant difference between the two groups (p=0.04). There was no significant difference between the groups regarding hyperlipidemia, diabetes (p>0.05) while hypertension and smoking history were significantly associated with SBP/LVEDP ratio (p<0.01). Percentage of patients with history of CVD were significantly higher

[15(71.4%) out of 21] in group-I (p=0.01) as compared to group-II [58(32.8%) out of 177]. In terms of medical history, there was no signi-ficant difference in study groups in the prevalence of Chronic Kidney Disease (CKD) (p>0.05). However, significant difference was noted in patients' heart failure status (p<0.01), with Group-I having a higher prevalence compared to Group-II (23.8% vs. 7.9%, p=0.005) (Table-I).

Table-I: Baseline and Clinical Characteristics of Study Participants(n=198)

Characteristics		Group-I (Total=21) Frequency(%)	Group-II (Total=177) Frequency(%)	*p*-value
Gender	Male	16(76.2)	110(62.1)	0.20
	Female	5(23.8)	67(37.9)	
Age(years) (Mean±SD)		64.33±8.01	60.95±9.31	0.04
Hypertension		19(90.4)	103(58.1)	0.006
Hyperlipidemia		12(57.1)	92(52.0)	0.65
Diabetes		16(76.1)	96(54.2)	0.05
Smoking history		13(61.9)	55(31.1)	0.005
CVD		15(71.4)	58(32.8)	0.01
CKD		9(42.9)	62(35.0)	0.47
Heart Failure		5(23.8)	14(7.9)	0.005
Killip Class	I	-	35(19.7)	0.0002
	II	-	32(18.1)	
	III	2(9.5)	71(40.1)	
	IV	19(90.5)	38(21.5)	

EF=Ejection Fraction; TIMI=Thrombolysis In Myocardial Infarction; LVEDP=Left Ventricular End Diastolic Pressure; SBP=Systolic Blood Pressure

Laboratory findings showed no statistically signi-ficant difference in troponin-I levels between the two groups (p>0.05). However, significant difference was observed in the creatinine level and ejection fraction (EF), with Group-I having high creatinine level (1.48±0.33 mg/dl vs 1.02±0.35 mg/dl; p<0.001) and a lower EF compared to Group-II (35.5% vs. 47.9%, p<0.001) as demonstrated in Table-II.

Table-II: Laboratory Findings of Study Participants (n=198)

Variables	Group-I (Total=21) (Mean±SD)	Group-II (Total=177) (Mean±SD)	*p*-value
Creatinine (mg/dL)	1.48±0.33	1.02±0.35	<0.001
Troponin-I (ng/mL)	1.30±1.09	3.1±11.06	0.453
EF (%)	35.48±7.56	47.98±14.06	<0.001
Modified Shock index	1.37±0.29	2.35±6.16	0.03
LVEDP (mmHg)	35.52±4.90	18.9±8.05	<0.001
SBP (mmHg)	125.57±9.84	133.73±14.55	0.002

EF=Ejection Fraction; TIMI=Thrombolysis In Myocardial Infarction; LVEDP=Left Ventricular End Diastolic Pressure; SBP=Systolic Blood Pressure

The length of hospital stay was significantly higher in Group-I compared to Group-II (8.76±2.48 days vs. 5.05±2.39 days, p<0.001). TIMI scoring was also higher in Group-I compared to Group-II (9.28±1.10 vs. 6.50±24.01, p>0.05), indicating a higher severity of disease in Group-I. Moreover, the SBP/ LVEDP ratio was significantly lower in Group-I compared to Group-II (3.57±0.35 vs. 12.31±21.15, p<0.001), indicating a higher risk of adverse outcomes in Group-I. Mortality was comparatively higher in Group-I [7(33.3%)vs 11(6.2%)] with significant findings (p<0.05). However, overall mortality rate was 18(9.0%). (Table III)

Table- III Association of SBP/LVEDP Ratio with In-Hospital Outcomes (n=198)

	Group-I (Total=21) (Mean±SD)	Group-II (Total=177) (Mean±SD)	*p*-value
Length of Stay (Days)	8.76±2.48	5.05±2.39	<0.001
TIMI scoring	9.28±1.10	6.50±24.01	0.54
GRACE Score	194.76±48.95	84.49±60.04	<0.001
SBP/LVEDP ratio	3.57±0.35	12.31±21.15	<0.001
Mortality [Frequency(%)]	7(33.3)	11(6.2)	0.02

DISCUSSION

The existing study focused to evaluate the association of SBP/LVEDP ratio with clinical outcomes in PPCI patients. The findings revealed that patients with SBP/LVEDP ratio ≤4 had distinct characteristics and worse clinical outcomes in comparison to those who had SBP/LVEDP ratio >4. According to current study's findings, mortality was significantly higher in Group-I having SBP/LVEDP≤4 compared to Group-II having SBP/LVEDP>4 (33.3% versus 6.2%). It was comparable to a study done by Sola *et al*, where they found that in patients who had SBP/LVEDP ratio of <4 had significantly more risk of in-hospital death (32% vs. 5.3%, p<0.001), higher heart failure rates and poor clinical outcomes compared to >4 SBP/LVEDP ratio patients. One of the key findings of our study was the higher prevalence of heart failure 5(23.8%) and higher in-hospital mortality 7(33.3%) in patients with ≤4 SBP/LVEDP ratio. This suggested that a lower SBP/LVEDP ratio may be indicative of compromised cardiac function and increased congestion. The higher Killip class observed in this group further supported the notion of a more severe cardiac status. These findings aligned with previous research, indicated that hemodynamic instability and impaired left ventricular function are associated significantly with adverse clinical outcomes in AMI patients.[14]

Another notable finding was the lower ejection fraction in patients with SBP/LVEDP ratio ≤4. A reduced ejection fraction is a well-known predictor of poor prognosis of heart disease as it reflects impaired

cardiac contractility.[15] The lower ejection fraction noted in Group-I underscored the potential role of the SBP/LVEDP ratio as a marker of cardiac dysfunction and its association with worse outcomes. These findings were compatible with the findings of a study done by Changqing Liu *et al*., where they found that LVEDP was independently associated with lower EF scores (EF ≤40%) (OR =4.08; 95% CI: 1.68–9.91).[16]

The length of hospital stay (8.76±2.48 days) and in-hospital mortality (33.3%) were significantly higher in patients with an SBP/LVEDP ratio ≤4. Prolonged hospitalization may be attributed to the increased severity of the disease, as evidenced by higher Killip class and TIMI scoring in this group. These findings highlighted the impact of the SBP/LVEDP ratio on disease severity and the need for management that is more intensive and monitoring in patients with a lower ratio. Another study reported a significant difference in length of hospital and ICU stay in patients with lesser LVEDP and LVEF scores (3.1±2.3 days versus 2.1±0.8 days) in Group-I and Group-II respectively (p<0.001).[17]

LVEDP scores less than median have poor patient outcomes in clinical settings according to a study done by Cubbedu *et al*.[18] In our study the SBP/LVEDP ratio demonstrated potential prognostic value in predicting in-hospital mortality. Patients with an SBP/LVEDP ratio ≤4 had a significantly higher risk of in-hospital death compared to those with an SBP/LVEDP ratio >4. Rate of heart failure was also significantly higher in Group-I (23.8% vs 7.9%).

A study conducted by Millo *et al.*, documented that comparisons with other clinical indices, the SBP/LVEDP ratio performed similarly to the shock index (SI) and modified shock index (MSI) in predicting mortality.[19] However, it outperformed LVEDP, pulse pressure, and some established risk scores such as the TIMI score and GRACE score. These findings suggested that the SBP/LVEDP ratio could be a valuable adjunct to existing risk assessment tools, providing additional insight into hemodynamic status and prognosis as also reported by Venkatesh *et al*., and Ebaid *et al*., where they found the ratio of SBP/LVEDP to be a novel clinical predictor after myocardial infarction.[20,21]

LIMITATIONS OF STUDY

Small sample size and potential missing data are the major limitations. However, it still offers valuable insights. Future studies should aim for larger sample sizes, longitudinal study designs and comprehensive data collection.

CONCLUSION

In conclusion, the present study depicted that a lower SBP/LVEDP ratio (≤4) was associated with worse clinical outcomes in patients undergoing PPCI. The ratio was found to be a potential determinant of in-hospital mortality, as well as a marker of heart failure, reduced ejection fraction, and increased disease severity. Incorporating the SBP/LVEDP ratio into risk stratification algorithms may enhance the assessment of patients with AMI and guide appropriate management strategies.

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Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript:

ZA & SKS: Study design, critical review, drafting the manuscript, approval of the final version to be published

ZAK & AN: Concept, data acquisition, drafting the manuscript, critical review

NAS, IA & AHS: Data acquisition, data analysis, data interpretation, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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