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Role of Systolic Blood Pressure to Left Ventricular End-Diastolic Pressure Ratio in Prediction of Major Adverse Cardiovascular Events in Patients with ST-segment Elevation Myocardial Infarction Treated by Primary Percutaneous Coronary Intervention

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ABSTRACT

Background: Among all cardiovascular illnesses, myocardial infraction is regarded as one of the major causes of morbidity and death. Though, mortality rates have been reduced all over the past few years, there is still a relative risk for occurrence of the different major adverse cardiac events (MACEs).

Objective: To evaluate the role of ratio of systolic blood pressure to left ventricular end-diastolic pressure at the time of primary percutaneous coronary intervention (PPCI) to predict MACEs both in-hospital and during 3-months follow up in patients with STEMI.

Patients and Methods: This was a multicenter prospective study, conducted in Nasr City Health Insurance Hospital and Benha University Hospital in the period from March 2022 to March 2023. Included 100 patients who were presented by acute STEMI and managed by successful PPCI for a single vessel disease.

Results: In our results, there was no statistically significant difference between the 2 groups as regarding demographic data and risk factors. Patients with MACEs had higher incidence of door to balloon time > 90 minutes, higher incidence of Killip class II and III, and of anterior STEMI in comparison with those without MACEs. Also, patients with MACEs had lower SBP and DBP, higher HR, lower LVEF, higher LVESV, higher incidence of DD grade II and lower both mean septal and lateral e' wave velocities, higher mean E wave velocity, both septal and lateral e/e' ratios. Patients with MACEs also had higher TIMI and GRACE RS, LVEDP, higher incidence of LAD as a culprit vessel. While, they had lower invasive SBP, DBP and SBP/LVEDP ratio. Regarding ROC curve analysis, SBP/LVEDP ratio cutoff value of ≤ 4.7 was shown to have the best diagnostic accuracy. TIMI risk score cut-off value > 3 was shown to have the second diagnostic accuracy in prediction of MACEs. AUC of SBP/LVEDP ratio was higher than that of TIMI RS, so SBP/LVEDP ratio was more accurate in predicting MACEs in STEMI patients who underwent primary PCI to a single vessel disease.

Conclusion: SBP/LVEDP ratio is an easily rapidly determined ratio at the time of PPCI that can provide important prognostic information regarding risk stratification of STEMI patients.

Keywords: SBP, LVEDP, MACEs, STEMI, PPCI.

INTRODUCTION

Among all cardiovascular illnesses, myocardial infraction is regarded as one of the major causes of morbidity and death. Major adverse cardiovascular events (MACE) remain the main cause of mortality and morbidity in ST-elevation myocardial infarction (STEMI) patients, despite the fact that the mortality rate associated with STEMI has decreased over the past ten years [1]. MACE is referred to as a composite of clinical events, and endpoints that represent the efficacy and safety of various treatment modalities are often included [3]. Although the incidence of MACE after STEMI is mostly unexpected, the rate of occurrence might be reduced by using effective risk stratification techniques and strategies to direct various management techniques [2].

In order to make informed choices and get more benefit from employing efficient treatment modalities and hospital length of stay, accurate risk stratification has grown to be a primary emphasis in the first evaluation of patients with STEMI [4]. Age, gender, co-morbidities, electrocardiographic criteria, multi-vessel coronary artery disease (CAD), post-procedural flow grade, decreased left ventricular ejection fraction (LVEF), and greater Killip classification are some clinical variables that are associated with MACE in STEMI patients [5].

This led to the creation of a large number of different risk scores, with two major scores becoming the most popular as a result of numerous clinical studies and trials that accurately demonstrated their efficacy. These two scores are the Global Registry of Acute Coronary Events (GRACE) ACS risk score and the thrombolysis in myocardial infarction (TIMI) risk score for STEMI, both of which incorporate clinical data available at the time of admission to identify patients at highest risk for MACE [6].

Despite not being intended for use during primary percutaneous coronary intervention (PPCI), both of these risk ratings include certain non-invasive hemodynamic data (such as HR, SBP, and Killip class) [7]. The results of STEMI patients are more accurately predicted by hemodynamic parameters such as left ventricular end-diastolic pressure (LVEDP), pulse

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pressure (PP), and SBP/LVEDP ratio recorded at the time of PPCI than by these risk ratings, according to previous research [1].

This work aimed to evaluate the role of ratio of systolic blood pressure to left ventricular end-diastolic pressure at the time of PPCI to predict MACEs both In-Hospital and during 3-months follow up in patients with STEMI.

PATIENTS AND METHODS

Study Design:

This is a multi-center prospective study that was conducted in Benha University Hospital and Nasr City Health Insurance Hospital in the period from March 2022 to March 2023. This study included 100 consecutive patients presented with STEMI, undergoing successful PPCI for a single vessel disease with no significant lesions in other vessels. Then patients were divided into two groups according to the presence of MACEs: Group (I) included patients without MACEs occurrence (62 patients, 62%) and group (II) that composed of patients with MACEs occurrence (38 patients, 38%).

Inclusion Criteria: STEMI patients undergoing PPCI for a single vessel disease without significant lesions in other vessels, and stay compliant to medical treatment post PCI. Acute STEMI is characterised by an increase in cardiac troponin levels with at least one result over the upper 99th percentile reference limit and at least two contiguous leads exhibiting elevated ST-segment activity [8].

Exclusion Criteria: Patients presented with coronary anatomy showing significant lesions in more than one vessel, failure to achieve reliable LVEDP readings (Frequent premature ventricular contractions (PVCs) or malignant arrhythmia), patients presented with Killip class IV, mechanical complications of acute myocardial infarction at the time of presentation, patients with known ischemic cardiomyopathy, reperfusion in the culprit vessel with results of less than TIMI III flow, elderly patients (above age of 70 years), patients who were non-compliant to anti-ischemic medical treatment.

Methods:

Full medical history taking (including age, gender, DM, HTN, smoking, dyslipidemia, positive family history of premature CAD and door to balloon time), clinical examination including vital data and Killip class assessment, 12 lead-surface ECG, laboratory investigations, trans-thoracic echocardiography, risk stratification using TIMI and GRACE RS, coronary angiography for revascularization and assessment of invasive pressures (SBP, DBP, LVEDP, SBP/LVEDP ratio).

Follow up: All patients were followed up for in-hospital and 3-months MACE occurrence (Figure 1).

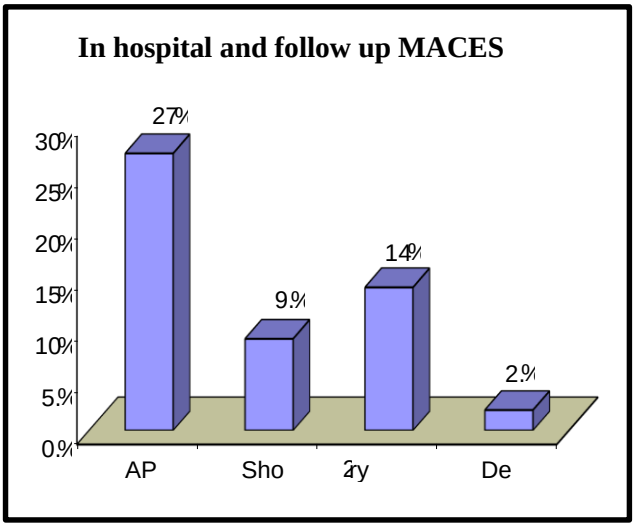

Figure (1): Types of in hospital and follow up MACES among the studied patients.

Ethical approval: The Ethics Committee of Faculty of Medicine, Benha University granted the study approval. All participants signed informed consents after a thorough explanation of the goals of the study. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis

Using SPSS V 22 for Windows®, the acquired data were coded, processed, and analysed. The Shapiro Walk test was used to determine whether the data distribution was normal. Frequencies and relative percentages were used to depict qualitative data. To assess differences between two or more sets of qualitative variables, the chi square test (X^2) was used. Mean ± SD was used to express quantitative data. To compare two independent groups of regularly distributed variables (parametric data), the independent samples t-test was employed. P values ≤ 0.05 were regarded as significant.

RESULTS

Patients in group II were statistically more likely than those in group I to have a door to balloon time of more than 90 minutes (21.1% vs. 3.2%, p-value = 0.004). Both mean systolic and diastolic blood pressures were statistically significant lower & mean heart rate was statistically higher in patients of group II with p-value < 0.05. No significant difference between both groups regarding pulse pressure (p-value= 0.137). Patients of group II had lower incidence of Killip class I and higher incidence of class II and III than those of group I (p-value at <0.001). Also, the percentage of patients with anterior STEMI was found higher in group II patients with p-value <0.001. No statistical significant difference regarding mean serum creatinine between the two groups (P-value= 0.695) (Table 1).

Table (1): Difference between studied groups regarding demographic data & clinical characteristics

		All cases	Group I	Group II	Test value	P-value	Sig.
		No. = 100	No. = 62	No. = 38			
Age	Mean ± SD Range	60.79 ± 6.45 38 – 70	60.16 ± 6.0 40 – 70	61.82 ± 7.1 38 – 70	-1.248•	0.215	NS
Gender	Males Females	81 (81.0%) 19 (19.0%)	51 (82.3%) 11 (17.7%)	30 (78.9%) 8 (21.1%)	0.168*	0.682	NS
DM	Yes	55 (55.0%)	36 (58.1%)	19 (50.0%)	0.619*	0.431	NS
HTN	Yes	78 (78.0%)	49 (79.0%)	29 (76.3%)	0.101*	0.750	NS
Smoker	Yes	56 (56.0%)	37 (59.7%)	19 (50.0%)	0.895*	0.344	NS
Dyslipidemia	Yes	48 (48.0%)	29 (46.8%)	19 (50.0%)	0.098*	0.754	NS
Familial hypercholesterolemia (FH)	Yes	31 (31.0%)	19 (30.6%)	12 (31.6%)	0.010*	0.922	NS
Time (door to balloon)	< 90 min > 90 min	90 (90.0%) 10(10%)	60 (96.8%) 2 (3.2%)	30 (78.9%) 8 (21.1%)	8.319*	**0.004**	**HS**
SBP	Mean ± SD Range	123.1 ± 14.89 90 – 160	127.26 ± 12.57 100 – 160	116.32 ± 16.01 90 – 150	3.803•	**0.000**	**HS**
DBP	Mean ± SD Range	77.4 ± 12.03 60 – 100	80.32 ± 11.01 60 – 100	72.63 ± 12.23 60 – 100	3.250•	**0.002**	**HS**
Pulse pressure	Mean ± SD Range	45.9 ± 8.89 30 – 70	46.94 ± 9.51 30 – 70	44.21 ± 7.58 30 – 60	1.498•	0.137	NS
HR	Mean ± SD Range	91.68 ± 12.96 65 – 130	86.94 ± 10.42 67 – 110	99.42 ± 13.09 65 – 130	-5.269•	**0.000**	**HS**
Killip	I II III	69 (69%) 29 (29%) 2 (2%)	58 (93.5%) 4 (6.5%) 0 (0.0%)	11 (28.9%) 25 (65.8%) 2 (5.3%)	46.118*	**0.000**	**HS**
Diagnosis	Anterior STEMI Non-Anterior STEMI	64 (64.0%) 36 (36.0%)	29 (46.8%) 33 (53.2%)	35(92.1%) 3 (7.9%)	21.013*	**0.000**	**HS**
Creatinine (mg/dl)	Mean ± SD Range	1.04 ± 0.25	1.03 ± 0.23	1.06 ± 0.26	-0.393•	0.695	NS

The mean LVEF by Simpson's method was statistically significantly lower in patients of group II (p-value < 0.001). However, regarding mean LVEDV, no statistically significant difference was found between the two groups (p-value= 0.709). Patients of group II had statistically significantly higher mean LVESV (p-value= 0.00). Patients of group II had statistically significantly lower incidence of DD grade I and higher incidence of DD grade II than those of group I (p-value <0.001).

Also, patients of group II had statistically significantly lower both mean septal e' wave and lateral e' wave velocities & higher mean E wave velocity, septal e/e' and lateral e/e' than those of group I (p-value <0.05) (Table 2).

Table (2): Difference between studied groups regarding echocardiographic parameters (Post-PCI/In-Hospital).

		All cases	Group I	Group II	Test value	P-value	Sig.
		No. = 100	No. = 62	No. = 38			
EF "Simpson" (%)	Mean ± SD Range	48.19 ±7.59 29-64	51.85 ± 6.11 41 – 64	42.21 ± 5.79 29 – 56	7.818•	**0.000**	**HS**
LVEDV (ml)	Mean ± SD Range	146.65 ± 32.16 67-274	147.6 ± 35.13 67 – 274	145.11 ± 27.02 70 – 199	0.374•	0.709	NS
LVESV (ml)	Mean ± SD Range	75.97 ± 20.8 30-160	71.34 ± 21.05 30 – 160	83.53 ± 18.22 39 – 133	-2.954•	**0.004**	**HS**
DD	I II III	45 (45.0%) 54 (54.0%) 1 (1.0%)	41 (66.1%) 20 (32.3%) 1 (1.6%)	4 (10.5%) 34 (89.5%) 0 (0.0%)	31.082*	**0.000**	**HS**
E velocity (m/s)	Mean ± SD Range	0.75 ± 0.15 0.5-1	0.68 ± 0.12 0.5 – 1	0.86 ± 0.14 0.6 – 1	-6.812•	**0.000**	**HS**
e' septal (m/s)	Mean ± SD Range	0.06 ± 0.02 0.03 -0.08	0.06 ± 0.01 0.04 - 0.08	0.04 ± 0.01 0.03 - 0.07	8.997•	**0.000**	**HS**
e' lateral (m/s)	Mean ± SD Range	0.07 ± 0.02 0.05 -0.1	0.08 ± 0.01 0.06 - 0.1	0.06 ± 0.01 0.05 - 0.1	2.660•	**0.009**	**HS**
Septal e/e'	Mean ± SD Range	15.08 ± 6.9 6.3 -33.3	11.28 ± 3.98 6.3 - 22.5	21.28 ± 6.14 8.6 - 33.3	-9.904•	**0.000**	**HS**
Lateral e/e'	Mean ± SD Range	10.9 ± 4.14 5 - 20	8.72 ± 2.67 5 - 16.7	14.47 ± 3.62 6 – 20	-9.117•	**0.000**	**HS**

Both GRACE and TIMI risk scores were statistically higher in patients of group II (p-value <0.001). There was statistically significant difference among the two groups regarding culprit vessel, as 29 patients (46.8%) of group I had LAD as a culprit vessel vs. 35 patients (92.1%) of group II (p-value <0.001). Mean LVEDP was significantly higher & both mean of invasive SBP and DBP were significantly lower in patients of group II with p-value <0.05. The mean SBP/LVEDP ratio was also found to be statistically significant lower in patients of group II than those of group I (p-value < 0.001) (Table 3).

Table (3): Difference between studied groups regarding risk stratification & 1ry PCI results

		All cases	Group I	Group II	Test value	P-value	Sig.
		No. =100	No. = 62	No. = 38			
Grace RS	Mean ± SD Range	120.66 ± 18.59 70 – 180	112.71 ± 11.47 86 – 147	133.63 ± 20.7 70 – 180	-6.505•	**0.000**	**HS**
TIMI RS	Mean ± SD Range	3.77 ± 2.41 1 – 11	2.44 ± 1.3 1 – 6	5.95 ± 2.22 2 – 11	-9.993•	**0.000**	**HS**
Culprit lesion	LAD LCX RCA	64 (64.0%) 9 (9.0%) 27 (27%)	29 (46.8%) 9 (14.5%) 24 (38.7%)	35 (92.1%) 0 (0.0%) 3 (7.9%)	21.367*	**0.000**	**HS**
LVEDP (mmHg)	Mean ± SD Range	20.76 ± 9.31 10 – 40	15.1 ± 4.7 10 – 30	30.0 ± 7.35 16 – 40	-12.374•	**0.000**	**HS**
Invasive SBP (mmHg)	Mean ± SD Range	124.1 ± 15.12 90 – 160	128.55 ± 12.52 100 – 160	116.84 ± 16.29 90 – 160	4.039•	**0.000**	**HS**
Invasive DBP (mmHg)	Mean ± SD Range	78 ± 12.47 60 -100	81.29 ± 10.94 60 – 100	72.63 ± 13.09 60 – 100	3.563•	**0.001**	**HS**
SBP/LVEDP	Mean ± SD Range	7.32 ± 3.36 2.5 – 15	9.25 ± 2.68 4.58 – 15	4.17 ± 1.39 2.5 - 7.5	10.798•	**0.000**	**HS**

At the univariate logistic regression analysis; door to balloon time, both SBP and DBP, heart rate at presentation, Killip class, anterior STEMI, Echo parameters [as LVEF %, LVESV, E wave velocity, both septal and lateral e' wave velocities and both septal and lateral e/e' ratios], GRACE, TIMI risk scores and angiographic data [LAD as a culprit vessel, invasive both SBP and DBP, and SBP/LVEDP] were significantly associated with in-hospital and short-term follow up MACEs with p-value <0.05. Then, in the multivariate logistic regression analysis, SBP/LVEDP ratio and TIMI risk score were found to be the only independent predictors of MACEs in STEMI patients who underwent primary PCI for a single vessel disease [hazard ratio= 84.095, 95% CI: 9.402 – 752.203, p-value <0.001 and hazard ratio= 10.854, 95% CI: 2.410 – 48.890, p-value = 0.002; respectively]. (Table 4).

Table (4): Univariate and multivariate logistic regression analysis using Backward Wald method for the most important factors associated with occurrence of MACEs

	Univariate				**Multivariate (Backward-Wald)**			
	P-value	**OR**	**95% C.I. for OR**		**P-value**	**OR**	**95% C.I. for OR**	
			Lower	**Upper**			**Lower**	**Upper**
Door to balloon > 90 min	**0.011**	8.000	1.599	40.033	-	-	-	-
SBP < 110 mmHg	**0.000**	7.973	3.119	20.385	-	-	-	-
DBP < 70 mmHg	**0.001**	4.550	1.912	10.826	-	-	-	-
HR > 99 bpm	**0.000**	14.082	4.615	42.971	-	-	-	-
Killip class	**0.000**	33.172	9.680	113.682	-	-	-	-
Anterior STEMI	**0.000**	13.276	3.690	47.762	-	-	-	-
LAD culprit lesion	**0.000**	13.276	3.690	47.762	-	-	-	-
LVEDP > 20 mmHg	**0.000**	49.778	14.813	167.276	-	-	-	-
EF Simpson ≤ 45%	**0.000**	18.452	6.560	51.906	-	-	-	-
LVESV >72 ml	**0.000**	6.554	2.498	17.194	-	-	-	-
E velocity > 0.7 m/s	**0.000**	12.857	4.820	34.297	-	-	-	-
e septal ≤ 0.04 m/s	**0.000**	35.591	10.381	122.022	-	-	-	-
e lateral ≤ 0.07 m/s	**0.000**	24.500	6.719	89.337	-	-	-	-
Septal e/e' > 14	**0.000**	34.320	10.772	109.343	-	-	-	-
Lateral e/e' > 10	**0.000**	30.600	9.745	96.084	-	-	-	-
Grace > 129	**0.000**	24.857	7.422	83.253	-	-	-	-
TIMIRS > 3	**0.000**	32.038	9.621	106.693	**0.002**	10.854	2.410	48.890
Invasive SBP < 110	**0.000**	7.973	3.119	20.385	-	-	-	-
Invasive DBP < 70	**0.001**	4.550	1.912	10.826	-	-	-	-
SBP/LVEDP ≤ 4.7	**0.000**	196.556	23.764	1625.708	**0.000**	84.095	9.402	752.203

ROC curve was used to test the diagnostic value (overall accuracy) of SBP/LVEDP ratio and TIMI risk score in prediction of MACEs in STEMI patients who underwent primary PCI to a single vessel disease. SBP/LVEDP ratio cut-off value of ≤ 4.7 was shown to have the best diagnostic accuracy (sensitivity= 76.32%, specificity= 98.39% and area under curve (AUC) = 0.958). TIMI risk score cut-off value > 3 was shown to have the second diagnostic accuracy in prediction of MACEs (sensitivity= 89.47%, specificity= 79.03% and AUC= 0.918). AUC of SBP/LVEDP ratio was higher than that of TIMI RS, so SBP/LVEDP ratio was more accurate in predicting MACEs in STEMI patients underwent primary PCI to a single vessel disease. (Table 5, Figure 1)

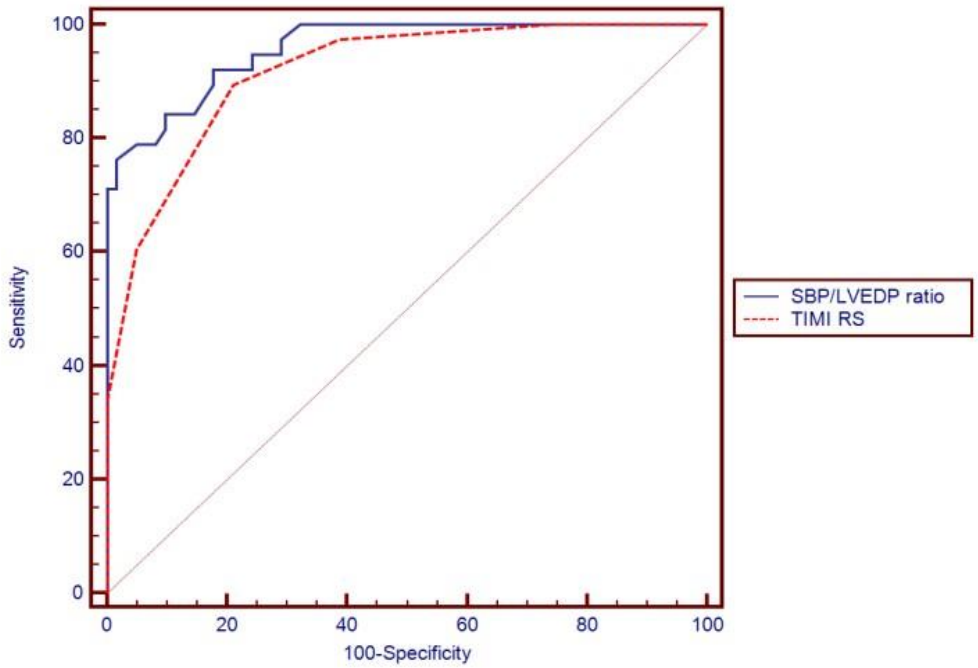

Figure (2): Receiver operating characteristic curve (ROC) for SBP/LVEDP ratio as a predictor for occurrence of MACEs.

Table 5: Validity of TIMI RS and SBP/LVEDP ratio in prediction of short term MACEs

	Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
TIMI RS	>3	0.918	89.47	79.03	72.3	92.5
SBP/LVEDP ratio	≤ 4.7	0.958	76.32	98.39	96.7	87.1

There was statistically significant positive correlation found between SBP/LVEDP ratio and SBP, DBP, EF "Simpson", e' septal and e' lateral and also significant negative correlation between SBP/LVEDP ratio and HR, serum creatinine, LVESV, E velocity, septal e/e', lateral e/e', GRACE RS, TIMI RS and LVEDP (Table 6).

Table (6): Quantitative correlation of SBP/LVEDP ratio to the different variables

	SBP/LVEDP	
	R	p-value
Age	-0.196	0.051
SBP	**0.476****	**0.000**
DBP	**0.460****	**0.000**
PP	0.137	0.174
HR	**-0.575****	**0.000**
Creat.	**-0.198***	**0.048**
EF "Simpson"	**0.769****	**0.000**
LVEDV	-0.058	0.564
LVESV	**-0.453****	**0.000**
E velocity	**-0.753****	**0.000**
e' septal	**0.883****	**0.000**
e' lateral	**0.821****	**0.000**
Septal e/e'	**-0.911****	**0.000**
Lateral e/e'	**-0.876****	**0.000**
Grace RS	**-0.660****	**0.000**
TIMI RS	**-0.749****	**0.000**
LVEDP	**-0.971****	**0.000**

There was no statistically significant relation found between SBP/LVEDP ratio and gender, DM, HTN, smoking, dyslipidemia and positive FH of premature CAD in the studied patients. While there was statistically significant decrease in SBP/LVEDP ratio in patients with door to balloon time > 90 min with p value < 0.001. Also, significant decrease in the SBP/LVEDP ratio with the increase of Killip class and DD grade with p-value < 0.001. SBP/LVEDP ratio was decreased in patients with anterior STEMI than those with non-anterior STEMI with p-value <0.001. The ratio also decreased in patients with LAD culprit lesion with p value < 0.001. Also, the ratio decreased in patients with APO, shock, secondary arrhythmia and death with p-value < 0.001, < 0.001, 0.004 and 0.049; respectively (Table 7).

Table (7): Qualitative correlation of SBP/LVEDP ratio to the different variables

		SBP/LVEDP		**Test value**	**P-value**	**Sig.**
		Mean ± SD	**Range**			
Gender	Males Females	7.21 ± 3.24 7.76 ± 3.9	2.5 - 14 2.9 - 15	0.639•	0.525	NS
DM	Yes	7.81 ± 3.52	2.75 - 15	1.631•	0.106	NS
HTN	Yes	7.38 ± 3.53	2.5 - 15	0.360•	0.720	NS
Smoker	Yes	7.16 ± 3.16	2.75 - 14	0.528•	0.598	NS
Dyslipidemia	Yes	7.13 ± 3.47	2.5 - 14	0.542•	0.588	NS
positive FH of IHD	Yes	6.8 ± 3.0	2.5 – 14	1.039•	0.301	NS
Time (door to balloon)	< 90 min > 90 min	7.73 ± 3.28 3.66 ± 1.07	2.5 - 15 2.75 – 6	3.883•	**0.000**	HS
Killip	I II III	8.83 ± 2.88 4.02 ± 1.19 2.85 ± 0.07	3.57 - 15 2.5 - 7.86 2.8 - 2.9	41.385*	**0.000**	HS
Diagnosis	Anterior STEMI Non-Anterior STEMI	5.83 ± 2.66 9.97 ± 2.8	2.5 - 13 3.75 - 15	7.329•	**0.000**	HS
DD	I II III	9.81 ± 2.79 5.27 ± 2.24 6.0 ± 0.0	2.9 - 15 2.5 - 10.8 6 - 6	40.258*	**0.000**	HS
Culprit lesion	LAD LCX RCA	5.83 ± 2.66 9.48 ± 2.1 10.13 ± 3.02	2.5 - 13 6.7 - 13 3.75 - 15	26.881*	**0.000**	HS
Follow Up MACES	Yes	4.17 ± 1.39	2.5 - 7.5	7.329•	**0.000**	HS
APO	Yes	3.56 ± 0.72	2.5 - 5.8	9.306•	**0.000**	HS
Shock	Yes	3.47 ± 1.2	2.5 - 6.5	3.851•	**0.000**	HS
2ry Arrythmia	Yes	4.97 ± 1.69	2.8 - 7.5	2.923•	**0.004**	HS
Death	Yes	2.7 ± 0.28	2.5 - 2.9	12.057•	**0.049**	HS

DISCUSSION

Although the incidence of MACE after STEMI is mostly unexpected, the rate of occurrence might be reduced by using the proper risk stratification techniques and strategies to direct various management techniques [2]. Some non-invasive hemodynamic data that was not intended to be utilised during PPCI is included into risk ratings like the TIMI risk score and GRACE [7]. According to some earlier research, hemodynamic parameters such as LVEDP and pulse pressure (PP) recorded during PPCI are more accurate predictors of outcomes for STEMI patients than these risk ratings [1].

Our study included 100 STEMI patients and divided into two groups according to the presence of MACEs: Group (I): Patients without MACEs occurrence (62 patients, 62%) and group (II): Patients with MACEs occurrence (38 patients, 38%). This match with **Tsai *et al.*** [9] who investigated the impact of major adverse cardiac events in CAD patients and discovered a 36.7% frequency of MACE. This is also consistent with **Sato *et al.*** [10] who investigated how the CADILLAC and GRACE risk ratings affected short- and long-term clinical outcomes in patients with acute myocardial infarction and found that 262 patients (32.4%) suffered from MACEs. However, our study is in contrast with **Zhang *et al.*** [11] who studied if central arterial pressure predicts in-hospital MACEs after acute STEMI and revealed that MACEs occurred in 22.6% of patients. Also, **Kumar *et al.*** [12] who studied the burden of short-term MACEs and its determinants after emergency PCI where MACEs were observed in 210 (19.1%) patients. This can be explained by larger sample size in these studies (512 and 1150 patients respectively vs. 100 patients in our study).

In our study, door to balloon time, both SBP and DBP, heart rate at presentation, Killip class, anterior STEMI, Echo parameters [as LVEF %, LVESV, E wave velocity, both septal and lateral e' wave velocities and both septal and lateral e/e' ratios], GRACE, TIMI risk scores and angiographic data [LAD as a culprit vessel, invasive both SBP and DBP, and SBP/LVEDP] were significantly associated with in-hospital and short-term follow up MACEs with p-value <0.05. Our results are consistent with **Nasution *et al.*** [13] who showed statistically significant difference between MACE and no MACE groups as they detected longer median time-to-treatment, higher Killip class (II-V) & LVESV and lower LV EF% in MACE group with p-value < 0.05. Also, **Del Buono *et al.*** [14] who investigated the clinical determinants and prognostic function of high Killip class in patients with their first episode of anterior STEMI and found that it was an independent predictor of in-hospital death [hazard ratio 7.790, 95% CI (1.024--59.276)], P = 0.047 and of MACEs at follow-up [hazard ratio 4.155 (1.558--11.082), P = 0.004]. **Bordejevic *et al.*** [15] revealed that lower SBP <105 mmHg and higher admission HR > 80 bpm were associated with higher incidence of in-hospital mortality with p-values < 0.0001 and 0.02 respectively. **Yan *et al.*** [16] evaluated prevalence and associated factors of mortality after PCI for adult patients with STEMI and found that across three studies (N = 7, 292), anterior infarction was a risk factor (OR = 1.66, 95% CI: 1.46–1.90, P < 0.001) of mortality for STEMI patients after PCI. Consistent with our result, **Gong *et al.*** [17] showed statistically significant difference between MACE and no MACE groups as regards mean LVEF (46.1 ± 6.9% vs. 52.3 ± 9.0% with p value= 0.009) and mean LVESV, which was higher in MACE group (76.1±15.6 ml vs. 61.9±18.2 ml with p-value= 0.002). Also, **Park *et al.*** [18] evaluated the long-term prognostic significance of E/e' in STEMI patients and found that those with an aberrant E/e' ratio (>15) had a considerably larger percentage of MACEs than those with a normal E/e' ratio (34.8% vs. 12.7%, p 0.001). Patients in that study were subdivided according to E/e' ratio into two groups (E/e' > 15 and E/e' < 15) and showed statistically significant higher mean E wave velocity (87.37 ± 25.88 cm/s vs. 62.65 ± 16.57 cm/s, with p value < 0.001) and lower mean septal e' wave velocity (4.21 ± 0.17 cm/s vs. 6.43 ± 0.12 cm/s, with p-value < 0.001) in patients with E/e' > 15.

Regarding risk scores, **Sato *et al.*** [10] showed that higher GRACE risk scores were shown to be strongly related with an increased risk of in-hospital mortality and MACE; as in-hospital MACE occurred in 193 patients (75.7%) of high GRACE score group vs. 53 patients (19.1%) and 16 patients (5.8%) of intermediate and low GRACE RS groups respectively with p-value < 0.001. Again, **Shah *et al.*** [19] found that higher TIMI score had increased the mortality rates with in-hospital death occurred in 4 patients (1.1%) with TIMI RS= 5 and increased in patients with TIMI RS= 10 and 11 to 5 patients (1.5%) for each, with p value < 0.001.

Regarding angiographic data, **Zhang *et al.*** [11] showed that low central systolic blood pressure group had the highest incidence of in-hospital complications. Similar to our result, **Tesak *et al.*** [20] showed statistically significant higher LVEDP in non-survivors group (median= 30 mmHg, range 22-39 mmHg) when compared to survivors group (24 mmHg, range 12-38 mmHg) with p-value= 0.001 & with LVEDP was independent predictor for 30-day mortality [AUC 0.715, 95% CI (0.626; 0.803), p-value <0.001, cut-off value ≥20.5 mmHg]. Also, **Khan *et al.*** [21] in examination of the TIMI II randomised controlled trial examining the prognostic significance of LVEDP in re-perfused STEMI, as well as its natural history. That study subdivided patients into 4 quartiles according to their LVEDP (quartile 1: median LVEDP= 10 mmHg vs 16 mmHg in quartile 2, 20 mmHg in quartile 3 and 27 mmHg in quartile 4) and found significant increase of all-cause mortality [15 patients (5%), 17 patients (5%), 15 patients (6%) and 39 patients (14%); respectively] and heart failure [41 patients (12%) vs. 51 patients (15%), 54 patients (21%) and 86 patients (32%); respectively] with p-value < 0.001. LVEDP was found

to be independent predictor of death and heart failure [OR=1.7, 95% CI (1.2–2.4), p-value= 0.002, cut-off value > 18 mmHg].

Concordant with our result **Venkatesh *et al.*** [22] investigated whether the ratio of SBP to LVEDP could be used to predict survival in patients who had acute myocardial infarction and discovered that lower SBP/LVEDP ratios were linked to increased rates of MACE and overall mortality in both NSTEMI and STEMI groups. **Tesak *et al.*** [20] also showed statistically significant lower SBP/LVEDP ratio in non-survivors group (median= 3.9 mmHg, range 2.5-6.2 mmHg) when compared to survivors group (5.6 mmHg, range 3.6-11 mmHg) with p-value< 0.001. Again **Sola *et al.*** [23] who studied if ratio of SBP/LVEDP at the time of primary PCI predicts in-hospital mortality in patients with STEMI and showed that patients with SBP/LVEDP < 4 had increased risk of in-hospital death (32% vs. 5.3%, P < 0.0001) compared to patients with SBP/LVEDP > 4.

ROC curve analysis in our study showed that SBP/LVEDP ratio cut-off value of ≤ 4.7 was shown to have the best diagnostic accuracy & TIMI risk score cut-off value > 3 was shown to have the second diagnostic accuracy in prediction of MACEs. AUC of SBP/LVEDP ratio was higher than that of TIMI RS, so SBP/LVEDP ratio was more accurate in predicting MACEs in STEMI patients underwent primary PCI to a single vessel disease. When compared to previous studies, there was slight variation in SBP/LVEDP ratio cut-off value between our result and the previous studies mentioned where **Venkatesh *et al.*** [22] showed that SBP/LVEDP < 5 was associated with higher mortality and **Tesak *et al.*** [20] showed that SBP/LVEDP is an independent predictor for 30-day mortality [AUC 0.843, 95% CI (0.758; 0.928), p-value <0.001, cut-off value ≤4.4 mmHg], while **Sola *et al.*** [23] suggested a cutoff point of 4. These variations can be explained by lower risk study group in **Venkatesh *et al.*** [22] as they included NSTEMI patients also with STEMI patients, and both **Tesak *et al.*** [20] and **Sola *et al.*** [23] assessed only mortality rather than all MACEs parameters like in our study. Again, **Tesak *et al.*** [20] found that SBP/LVEDP and TIMI score had similar AUC at predicting 30-day mortality, whereas in **Sola *et al.*** [23] study, TIMI had more predictive ability with AUC= 0.85. These variations mainly are due to including all MACEs parameters in our study, not only mortality, as previous studies and longer follow up period [3 months vs. 30 days in **Sola *et al.*** [23]].

SBP and mortality have been linked in a number of studies. It is unclear whether SBP is the best hemodynamic parameter to identify patients at the time of PPCI who are at the highest risk of left ventricular failure and the occurrence of MACEs due to factors other than cardiac output, such as increased sympathetic tone and activation of compensatory mechanisms that increase heart rate, augmented LV contractility, fluid retention, and vasoconstriction [1].

A low SBP/LVEDP ratio is indicative of a bad prognosis for a number of causes. One is substitute indicators for impaired left ventricular function (decreased SBP and increased LVEDP). Second, the diastolic pressure gradient between the aorta and left ventricular pressures is what drives myocardial perfusion. Reduced myocardial perfusion pressure, which might decrease myocardial function, is the result of low aortic diastolic pressures (which are a product of low SBP) and increased LVEDP [23]. According to our findings, invasive hemodynamic measures might possibly enhance and simplify the risk ratings used in patients having PPCI for STEMI. Due to two factors, the SBP/LVEDP ratio significantly improves current existing rating systems. First, it's easy to determine the SBP/LVEDP ratio. Currently utilised risk scores include five or more factors, some of which might not be accessible at the time of PPCI (such as lab data), and frequently entail sophisticated scoring systems that call for the use of online calculators. Examples of these risk scores are TIMI-STEMI and GRACE. Additionally, during PPCI, when judgements for mechanical circulatory support are frequently made, the SBP/LVEDP ratio demonstrated strong discriminating and is simpler to compute. In addition, the SBP/LVEDP ratio makes use of directly acquired intra-arterial and intra-ventricular hemodynamic parameters collected during PPCI, which offer a valuable prognostic data [1].

CONCLUSION

SBP/LVEDP ratio is a readily obtained ratio during PPCI that can give crucial prognostic information about STEMI risk stratification. Our study demonstrated that patients with lower SBP/LVEDP had more in-hospital and short-term outcome. With a high predictive ability for occurrence of MACEs at a cutoff point of ≤ 4.7 during hospital stay and short-term follow up. Its predictive value outperforms conventional risk score (TIMI risk score and GRACE score).

REFERENCES

1. **Goins A, Rayson R, Caughey M *et al.* (2018):** Correlation of infarct size with invasive hemodynamics in patients with ST-elevation myocardial infarction. Catheter Cardiovasc Interv., 92 (5): 333-340.
2. **Poudel I, Tejpal C, Rashid H *et al.* (2019):** Major Adverse Cardiovascular Events : An Inevitable Outcome of ST-elevation myocardial infarction ? A Literature Review Method. Cureus, 11 (7): 1-5.
3. **Gaba P, Gersh B, Muller J *et al.* (2023):** Evolving concepts of the vulnerable atherosclerotic plaque and the vulnerable patient: implications for patient care and future research. Nature Reviews Cardiology, 20 (3): 181–196.
4. **Vogel B, Claessen B, Arnold S *et al.* (2019):** ST-segment elevation myocardial infarction. Nature Reviews Disease Primers, 5 (1): 39-43.
5. **Varghese T (2019):** Predictors of acute left ventricular failure and mortality in patients with acute ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention. Lietuvos sveikatos

Mokslų Universitetas, Pp: 47. https://gs.elaba.lt/object/elaba: 36892814/

6. **Çınar T, Şaylık F, Akbulut T *et al.* (2023):** Evaluation of intermountain risk score for short-and long-term mortality in ST elevation myocardial infarction patients. Angiology, 74 (4): 357–364.
7. **Kite T (2022):** Evolving Strategies for the Management of Patients with Acute Coronary Syndrome during the COVID-19 Era. University of Leicester, Pp: 73. https://figshare.com/articles/thesis/Evolving_Strategies_for_the_Management_of_Patients_with_Acute_Coronary_Syndrome_during_the_COVID-19_Era/21695381
8. **Ibanez B, James S, Agewall S *et al.* (2018):** 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with STsegment elevation of the European Society of Cardiology (ESC). European Heart Journal, 39 (2): 119 – 177.
9. **Tsai I, Wang C, Lu Y *et al.* (2017):** The burden of major adverse cardiac events in patients with coronary artery disease. BMC Cardiovasc Disord., 17 (1): 1. doi: 10.1186/s12872-016-0436-7.
10. **Sato T, Saito Y, Matsumoto T *et al.* (2021):** Impact of CADILLAC and GRACE risk scores on short- and long-term clinical outcomes in patients with acute myocardial infarction. Journal of Cardiology, 78 (3): 201–205.
11. **Zhang L, Wang Z, Lu X *et al.* (2023):** Central arterial pressure predicts in-hospital major adverse cardiovascular events after acute ST-segment elevation myocardial infarction: a retrospective cohort study. Annals of Translational Medicine, 11 (5): 214–214.
12. **Kumar R, Shah J, Solangi B *et al.* (2022):** The Burden of Short-term Major Adverse Cardiac Events and its Determinants after Emergency Percutaneous Coronary Revascularization: A Prospective Follow-up Study. Journal of the Saudi Heart Association, 34 (2): 72–81.
13. **Nasution S, Perkasa H, Ginanjar E *et al.* (2022):** In-Hospital Major Adverse Cardiac Events Factor Predictors on ST-Elevation Myocardial Infarction after Primary Percutaneous Coronary Intervention at dr. Cipto Mangunkusumo General Hospital. EJournal Kedokteran Indonesia, 10 (2): 107–13.
14. **Del Buono M, Montone R, Rinaldi R *et al.* (2021):** Clinical predictors and prognostic role of high Killip class in patients with a first episode of anterior ST-segment elevation acute myocardial infarction. Journal of Cardiovascular Medicine, 22 (7): 530–538.
15. **Bordejevic D, Caruntu F, Mornos C *et al.* (2017):** Prognostic impact of blood pressure and heart rate at admission on in-hospital mortality after primary percutaneous intervention for acute myocardial infarction with ST-segment elevation in Western Romania. Therapeutics and Clinical Risk Management, 13: 1061–1068.
16. **Yan F, Zhang Y, Pan Y *et al.* (2023):** Prevalence and associated factors of mortality after percutaneous coronary intervention for adult patients with ST-elevation myocardial infarction: A systematic review and meta-analysis. Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences, 28: 17-21.
17. **Gong Y, Lu Y, Wang Z *et al.* (2020):** Cardiac Strains for Prediction of Adverse Events and Ventricular Remodeling. Europe PMC. https://doi.org/10.21203/rs.3.rs-41701/v1
18. **Park J, Song Y, Kim S *et al.* (2022):** The long-term prognostic value of E/e'in patients with ST segment elevation myocardial infarction. Indian Heart Journal, 74 (5): 369-374.
19. **Shah S, Shah A, Qasim A *et al.* (2022):** Association between TIMI Risk Score and in-Hospital Mortality in Acute STEMI Patients Undergoing Primary PCI. Pakistan Journal of Medical and Health Sciences, 16 (11): 158–160.
20. **Tesak M, Kala P, Jarkovsky J *et al.* (2016):** The value of novel invasive hemodynamic parameters added to the TIMI risk score for short-term prognosis assessment in patients with ST segment elevation myocardial infarction. International Journal of Cardiology, 214: 235–240.
21. **Khan A, Al-Omary M, Collins N *et al.* (2021):** Natural history and prognostic implications of left ventricular end-diastolic pressure in reperfused ST-segment elevation myocardial infarction: an analysis of the thrombolysis in myocardial infarction (TIMI) II randomized controlled trial. BMC Cardiovascular Disorders, 21 (1): 243. doi: 10.1186/s12872-021-02046-x.
22. **Venkatesh K, Yeung M, Stouffer G (2015):** The ratio of systolic blood pressure to left ventricular end diastolic pressure predicts survival in patients presenting with acute myocardial infarction. Journal of the American College of Cardiology, 65 (10): 198-95.
23. **Sola M, Venkatesh K, Caughey M *et al.* (2017):** Ratio of systolic blood pressure to left ventricular end-diastolic pressure at the time of primary percutaneous coronary intervention predicts in-hospital mortality in patients with ST-elevation myocardial infarction. Catheterization and Cardiovascular Interventions, 90 (3): 389-395.