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Mitral Annular Plane Systolic Excursion (MAPSE) as a Predictor of Major Adverse Cardiac Events in Patients with ST Elevation Myocardial Infarction

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Abstract : Background : Mitral Annular Plane Systolic Excursion (MAPSE) is a simple and easily obtained parameter. MAPSE may contribute to the evaluation of left ventricular function. In critical care settings where acoustic windows are often suboptimal, MAPSE seems to be an attractive parameter. A decreased MAPSE is known to be associated with conditions affecting left ventricular function such as myocardial infarction. The prognostic value of MAPSE in patients with ST elevation myocardial infarction (STEMI) has not been studied too much. This study aims to prove whether MAPSE can be used as a predictor of adverse cardiac events (MACE) in patients with STEMI during hospitalized in Haji Adam Malik Hospital Medan. **Methods** : This is a prospective cohort study of 98 patients with STEMI who undergo treatment at Haji Adam Malik Hospital Medan since July 2017 until December 2017. All patients will be examined transthoracic echocardiography to assess MAPSE in 24 hours after patients admitted at this hospital. Patients will be followed during hospitalization to assess MACE. Then conducted analysis to see association between MAPSE and MACE. **Results** : In the ROC curve analysis, the cut-off value of MAPSE in the prediction of MACE was 7.65 mm (AUC 0.904, 95% CI 0.836-0.972, p<0.001). The STEMI group with dengan MAPSE ≤ 7.65 mm had a higher incidence of MACE than the group with MAPSE > 7.65 mm of 35 people (83.3%) versus 7 people (16.7%). MAPSE ≤ 7.65 mm is considered to predict the incidence of MACE with a sensitivity of 83.3%, a specificity of 92.2%, a negative predictive value (NPV) of 88.1% and a positive predictive value (PPV) of 89.7%. Multivariate analysis showed that MAPSE ≤ 7.65 mm was an independent factor that could predict the occurrence of MACE during the hospitalization period (OR 1.886, 95% CI 1.21-2.94, p=0.002). **Conclusion** : MAPSE ≤ 7.65 mm was an independent factor that could predict the occurrence of MACE during the hospitalization in STEMI patients with OR 1.886.
Keyword : MAPSE, MACE, STEMI.

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Introduction

Cardiovascular diseases are the main causes of death in the world. An estimated 17.7 million people died from cardiovascular diseases in 2015, representing 31% of all global deaths. Of these deaths, an estimated 7.4 million were due to coronary heart disease and 6.7 million were due to stroke. Over three quarters of cardiovascular disease deaths take place in low and middle income countries.[1] Meanwhile, the data from the Republic of Indonesia Health System Review found that cardiovascular disease was one of the main causes of death in Indonesia.[2]

Acute myocardial infarction (AMI) may cause loss of myocardial tissue and change the ventricular geometry. This condition will cause ventricular systolic and diastolic dysfunction. The abnormality of myocardial contraction which found after patient had ST-elevation myocardial infarction (STEMI) will cause regional myocardial abnormality on the infarct area and decrease the left ventricle systolic function, related to the necrotic size. The abnormality of myocardial contractility and left ventricular systolic dysfunction are strong predictors after patients have myocardial infarction.[3] Regional myocardial dysfunction will make left ventricular remodeling process on the next step that not only make fibrosis on necrotic area, but also make myocardial elongation on the other area, then make heart chambers dilatation and decrease the left ventricular function.[4]

The prognosis after myocardial infarction is associated with the degree of left ventricular dysfunction. The longitudinal left ventricle shortening is important to determine the cardiac function. Mitral annular plane systolic excursion (MAPSE) can be measure to evaluate the cardiac function.[5]

MAPSE is a simple and easily obtained parameter. MAPSE may contribute to the evaluation of left ventricular function. In critical care settings where acoustic windows are often suboptimal, MAPSE seems to be an attractive parameter. A decreased MAPSE is known to be associated with conditions affecting left ventricular function such as myocardial infarction. MAPSE can be measure in emergency unit and in intensive care unit to assess the left ventricular function in patients with cardiovascular disease.[5,6]

Methods

This is a prospective cohort study to prove whether MAPSE can be used as a predictor of adverse cardiac events (MACE) in patients with STEMI. All patients were given standard treatment of STEMI in cardiology department at Haji Adam Malik Hospital. The inclusion criteria was all patients diagnosed with STEMI and have been done echocardiography in 24 hours after admission to hospital. The exclusion criteria was patients with anatomical abnormality of mitral valve or patients with prosthetic mitral valve.

The patient's data were filled in sheets containing clinical data, laboratory data, standard echocardiography result with MAPSE value from transthoracic echocardiography which has been done by cardiology residents in cardiac emergency or in cardiovascular care unit on the first 24 hours after patient hospitalized. Echocardiography examinations were performed using a Medison Accuvix V10 at lateral decubitus position.

MAPSE was measured on 4-chamber and 2-chamber pieces by placing the M-mode cursor through 4 regions (septal, lateral, anterior, and inferior) of the mitral valve annulus and measuring the distance between the lowest point at the beginning of systolic (the beginning of the QRS complex) to the highest point at the end of systolic (end of wave T).[5] After obtaining all four values of MAPSE from all regions, an average MAPSE score was taken that reflects the global longitudinal function in the left ventricle.[5,7]

The categorical variable is presented with the number or frequency (n) and percentage (%). The numerical variables are assigned with mean (mean) and standard deviation values for normally distributed data. Normality test in numerical variables of all subjects using one sample Kolmogorov Smirnov with n>50. Cut off point of numerical data was obtained from ROC. Comparison between dependent variable and independent variable was assessed by Pearson Chi Square.[8]

For samples that was found significant in the bivariate analysis test, the next step is a multivariate test with logistic regression. Statistical data analysis using statistical software, p <0.05 is considered to be statistically significant.

Results

The total number of study subjects was 98 people, consisting of 56 people (57.1%) without MACE and 45 people (42.8%) with MACE. From 42 people with MACE, 26 people (61.9%) were man and 16 people (37.1%) were woman. The mean age of the MACE group was 58 years versus 53 years in the other group, there was a statistically significant difference between these groups (p=0.05). The mean MAPSE was statistically significant different, 7.2±1.7 mm in MACE group and 10.3±2.0 mm in group without MACE, with p<0.001).

By using ROC curve, we could find the area under the curve (AUC) from MAPSE value, which showed the ability of MAPSE as a predictor of MACE in STEMI patients during hospitalized. In this study we found the AUC was 0.904 with p value < 0.001. This shows us that MAP value is clinically significant as a predictor of KKVM in patient with STEMI during hospitalize. The cut off point is ≤ 7.65 mm that can predict MACE with 83,3,% sensitivity and 92,9 % specificity.

In 98 people as the subject study, we found 39 people have mean MAPSE ≤ 7.65 mm and 59 pepole had mean MAPSE > 7.65 mm. The STEMI group with dengan MAPSE ≤ 7.65 mm had a higher incidence of MACE than the group with MAPSE > 7.65 mm of 35 people (83.3%) versus 7 people (16.7%). The STEMI group with MAPSE > 7.65 mm had lower MACE than group with MAPSE ≤ 7.65 mm. There were 52 people (92.9%) in MAPSE > 7.65 mm group and 4 people (7.1%) people in MAPSE ≤ 7.65 mm group did not have MACE.

Mean MAPSE ≤ 7.65 mm is considered to predict the incidence of MACE with a sensitivity of 83.3%, a specificity of 92.9%, negative predictive value 88.1% and positive predictive value 89.7%.

Then we did bivariate analysis to the other factors that determined MACE durinf hospitalized. After that we did multivariate analysis to find the dominant dependent variable to predict MACE. The multivariate analysis in this study showed that there were three independent factors that could predict MACE during hospitalized, consist of Killip Class [OR 88.04 (8.85-896.05), p<0.001], Hemoglobin [OR 1.47 (1.02-2.12), p=0.039] and MAPSE [OR 1.886 (1.21-2.94), p=0.002].

Table 1. Baseline Characteristic of Subject Study

Parameter	KKVM (+) (n=42)	KKVM (-) (n=56)	P value
Sex (%)			0.153
Male	26(61.9)	43(76.8)	
Female	16(37.1)	13(23.2)	
Age (year±SD)	58±10	53±10	0.050
Length of stay (%)			0.013
≥ 7 hari	18(42.9)	11(19.6)	
< 7 hari	24(57.1)	45(80.4)	
Risk Factors (%)			
DM	21(50)	19(33.9)	0.109
Hypertension	26(61.9)	36(64.3)	0.089
Dyslipidemia	36(85.7)	43(76.8)	0.269
Smoking	28(66.7)	43(76.8)	0.267
Family History	1(2.4)	0(0)	0.181
Lokasi IMAEST (%)			0.129
Anteroseptal	13(30.2)	19(34.5)	
Anterolateral	4(9.3)	8(14.5)	
Anteroextensive	12(27.9)	6(10.9)	
Inferior	11(25.6)	21(38.2)	
Others	3(7)	1(1.8)	

Killip Class (%)			<0.001
I	11(26.2)	56(100)	
II	20(47.6)	0(0)	
III	5(11.9)	0(0)	
IV	6(14.3)	0(0)	
TIMI Score (%)			<0.001
<3/14	3(7.1)	21(37.5)	
3-4/14	10(23.8)	27(48.2)	
>4/14	29(69)	8(14.3)	
GRACE Score (%)			<0.001
< 141	10(23.8)	36(64.3)	
142-171	19(45.2)	16(28.6)	
>172	13(31)	4(7.1)	
GRACE Score (n±SD)	167±39	137±20	<0.001
Haemoglobin (mg/dL±SD)	12.8±2.6	13.9±1.8	0.017
Ureum (mg/dL±SD)	39±27	29±20	0.040
Creatinine (mg/dL±SD)	1.17±0.8	1.03±0.5	0.258
Ejection Fraction (%)			0.001
<40%	27(64.3)	6(10.7)	
≥40%	15(35.7)	50(89.3)	
Ejection Fraction (%±SD)	38.0±8.6	51.5±10.2	<0.001
MAPSE (mm±SD)	7.2±1.7	10.3±2.0	<0.001
LV EDD (mm±SD)	51.3±5.9	46.6±7.2	0.010
LV ESD (mm±SD)	41.4±7.2	33.3±6.5	0.010

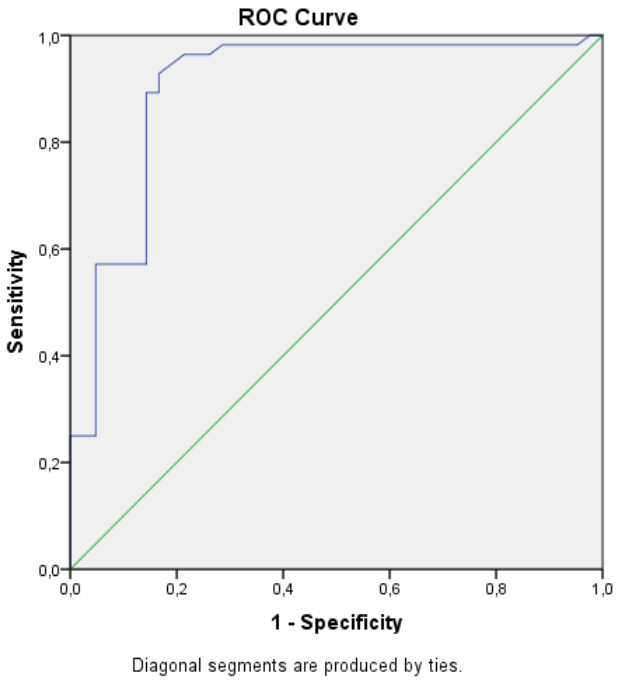

Figure 1. ROC curve mean MAPSE to predict MACE

Table 2. Results from ROC analysis

Cut-off Point	**Sens**	**Spes**	**AUC**	**P value**	**95% CI**
7.65 mm	83.3%	92.9%	0.904	<0.001	0.836-0.972

Table 3. Diagnostic test to the Cut-off Point of MAPSE

Cut-off MAPSE	**MACE**		**Total**	**P value**	**Sens**	**Spes**	**NPV**	**PPV**
	Yes	**No**						
≤ 7.65 mm	35 (83.3)	4 (7.1)	39 (39.8)	<0.001	83.3 %	92.9 %	88.1 %	89.7 %
> 7.65 mm	7 (16.7)	52 (92.9)	59 (60.2)					
Total	42 (100)	56 (100)	98 (100)					

Table 4. Bivariate Analysis of MAPSE to Predict MACE in STEMI Patients during Hospitalized

Parameter	**P value**	**OR**	**Lower**	**Upper**
Length of stay (>7 hari)	0.015	3.02	1.24	7.51
Killip Class (>II)	<0.001	100.56	12.27	24.02
GRACE Score (>172)	<0.001	3.59	1.90	6.80
TIMI Score (>4)	<0.001	6.06	2.89	12.65
Hemoglobin	0.018	1.28	1.04	1.57
Ureum	0.055	1.02	1.00	1.04
MAPSE	<0.001	2.41	1.70	3.41
Ejection Fraction (<40 %)	<0.001	14.92	5.21	43.47
LV EDD	0.002	1.11	1.04	1.19
LV ESD	<0.001	1.19	1.10	1.28
Age	0.05	1.04	0.99	1.08

Table 5. Multivarite Logistic Regression Analysis of MAPSE to Predict MACE in STEMI Patients during Hospitalized

Parameter	**P value**	**OR**	**Lower**	**Upper**
Killip Class	<0.001	88.05	8.65	896.05
Hemoglobin	0.039	1.47	1.02	2.12
MAPSE	0.002	1.886	1.21	2.94

Discussion

This was an observational study from patients with STEMI that treated from July to December 2017. In this study data were taken from medical records of cardiac surgery patients from January to December 2017. There were 98 patients who have met the inclusion and exclusion criteria.

The baseline characteristic showed the total subjects study were 98 people that consist of 42 people (42.8%) with MACE and 56 people (57.1%) without MACE. The mean MAPSE in MACE group were lower than in the other group, 7.2±1.7 mm versus 10.3±2.0 mm, this is statistically different with p<0.001. The mean MAPSE of total subjects study were 9.00±2.47 mm.

In STEMI condition, the cardiomyocytes are death caused by prolong ischemia due to imbalance oxygen supply and oxygen demand.[9] This condition will make cardiac dysfunction. The prognosis after STEMI is related to degree of left ventricular dysfunction.[10] MAPSE is a simple, easily obtained parameter and may contribute to the evaluation of left ventricular function, and then we suggest that MAPSE also has prognostic value in patients with STEMI. The previous study found that MAPSE < 8 mm associated with decrease left

ventricular ejection fraction (< 50%),[11] MAPSE ≥ 10 mm associated with good ejection fraction (≥ 55%),[12] MAPSE < 7 mm could detect ejection fraction < 30% in patients with dilated cardiomyopathy and severe heart failure,[13] and MAPSE 8-10 mm was intermediate value (grey zone) with there were no statement about this value. Study from Efendi Z (2017) in Adam Malik General Hospital Medan found that mean MAPSE < 11.375 mm associated with left ventricular systolic function abnormality (≤ 49%) with a sensitivity of 100%, a specificity of 97.8%, negative predictive value 100% and positive predictive value 97.2%.

The cut-off point MAPSE that significant to predict MACE was obtained from ROC curve. Mean MAPSE ≤ 7.65 mm was the optimal value to predict MACE with a sensitivity of 83.3% and a specificity of 92.9%. Subject study in people with MAPSE ≤ 7.65 mm had higher MACE than people with MAPSE > 7.65 mm, that was 35 people (83,3%) versus 7 people (16,7%). This is suitable with previous study which found that in patients with MAPSE < 8 mm after acute myocardial infarction had mortality and hospitality rate 443.8%.[16] The study of Nammas W dkk. found that MAPSE < 10 mm could predict MACE during hospitalized in patient IMA with a sensitivity of 72.7% and a specificity of 91.5%.

After we did multivariate analysis we found there were three independent factors that could predict MACE during hospitalized, consist of Killip Class [OR 88.04 (8.85-896.05), p<0.001], Hemoglobin [OR 1.47 (1.02-2.12), p=0.039] and MAPSE [OR 1.886 (1.21-2.94), p=0.002].

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