ISSN No:-2456-2165

The Association for Wave Peak Time and SYNTAX Scores to Assess Severity of Coronary Lesions on Non-St Segment Elevation Acute Myocardial Infarction Patients in Adam Malik Hospital Medan

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Abstract:-

Introduction: Acute Coronary Syndrome (ACS) is a major cardiovascular problem causes high hospitalization rates and high mortality rates. NSTEMI is a type ACS, due to the complexity of coronary lesion NSTEMIhas a high mortality rate, so we need to determine the risk stratification when the time is right for revascularization.Electrocardiography (ECG) can detect cardiac abnormalities such as ST-depression or T-inversion to diagnose NSTEMI and can also measure the peak time of the R wave from the ECG. The severity of myocardial infarction obtained from coronary angiography can be calculated using the SYNTAX(SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery)score. This study aims to determine whether there is a relationship between the peak time of the R wave and the SYNTAX score in NSTEMI patient

Method: This was a cross-sectional study of 71 patients with NSTEMI who performed angiography at RSUP HAM from July 2021 ato June 2022. R wave peak time and QRS duration were measured on the ECG. The SYNTAX score was calculated based on the angiography results.Statistical analysis was performed to assess the correlation between R peak time and SYNTAX score to measure severity of coronary artery lesion.

Result: A total of 71 of NSTEMI patients, which 46 (66.8%) had severe coronary artery lesion (SYNTAX score <23) and 23 (35.2%) had non-severe coronary artery lesion (SYNTAX score ≥23). There was a moderate positive correlation between R wave peak time and SYNTAX score (r=0.449; p<0.001). The R wave peak time can predict the severity of coronary artery diseasefrom results of ROC analysis, with AUC=0.729.

Conclusion:From ECG the R wave peak time is correlated with SYNTAX score, which can predict the severity of coronary lesions in NSTEMI patients.

Keywords:- *NSTEMI, R wave peak time, lesion of coronary artery ,SYNTAX score.*

I. INTRODUCTION

Cardiovascular disease is the number one cause of death globally, claiming an estimated 17.9 million lives each year. Heart disease is still one of the highest causes of death in Indonesia, so the whole community needs to take a role in preventing high rates of morbidity and mortality. Riskesdas data in 2018 shows the prevalence of cardiovascular disease in Indonesia is 15 out of 1000 people, or there are 4.2 million people who suffer from cardiovascular disease.

Acute Coronary Syndrome (ACS) is a major cardiovascular problem causes high hospitalization rates and high mortality rates. Most ACS is an acute manifestation of ruptured coronary atheromatous plaque.Non-ST-Elevation Myocardial Infarction (NSTEMI)is a type ACS, the diagnosis of NSTEMIand unstable angina pectoris (UAP) is made if there is a persistent complaint of acute angina pectoris without ST segment elevation. The ECG recordings at presentation may be ST segment depression, T wave inversion, flat T waves, pseudo-normalized T waves, or even no changes. Cardiac markers commonly used are Troponin I/T or CK-MB. If there is a significant increase of cardiac markers, the diagnosis will be NSTEMI.The mortality rate during hospitalization in NSTEMI patients is 4.2% according to the CRUSADE registry, ((PERKI,2018 ; Widimsky et al, 2007).

The peak time of the R wave is useful for detecting several cardiac abnormalities such as volume overload, hypertrophic cardiomyopathy, eccentric or diastolic left ventricular hypertrophy.The present study demonstrated that prolonged RWPT were associated with CAD severity in NSTEMI patients. The relationship between coronary heart disease and R wave parameters on the ECG is based on the ischemia-induced conduction delay in Purkinje fibers and ventricular myocytes resulting in a prolongation of the peak time of the R wave. (Ibrahim et al,2018)

The SYNTAX score is a scoring system that was developed comprehensively to describe the complexity of coronary arteries from angiographic results. (Sianos et *al* ., 2005)

ISSN No:-2456-2165

Considering the incidence of acute coronary syndromes, especially NSTEMI, and need to make appropriate decisions in determining the invasive strategy to be use,this study aimed to find out the relationship between R-wave peak time and severity of coronary artery lessionas the main mechanism of NSTEMI in Haji Adam Malik Hospital Medanand consider the ECG examination as an alternative and a very simple non-invasive examination that is performed routinely.

II. METHODS

A. Study Population

The data of this study were taken from NSTEMI patients who were going to undergo angiography coronaryfrom July 2021 to June 2022 at Haji Adam Malik Hospital using consecutive sampling method.

B. Inclusion Criteria

- •Patients with clinical features and supporting examinations according to NSTEMI both from clinical, ECG and cardiac biomarkers
- • Patients who have undergone coronary angiography
- • Patients with no history of atrioventricular conduction obstruction
- • Patients with no history of valvular heart disease
- • Patients with no history of impaired left ventricular systolic function or cardiomyopathy
- • Patients with no history of congenital heart disease
- • Patients with no history of kidney disease according to the KDIGO 2021 classification

C. Exclusion Criteria

- • Patients with incomplete medical record data
- • Patients with an ECG that is difficult to assess
- • Patients who are not willing to participate in the study

D. ECG and Syntax Score

Upon admission to the emergency room (IGD), an ECG assessment was performed using the Bionet Cardiotouch 3000 tool at a rate of 25 mm/s and an amplitude scale of 10 mV/mm. R wave peak time of longest R wave on ECG and further verified by consultant cardiologist. Coronary angiographywas performed in the cathlab at H. Adam Malik Hospital in Medan.To evaluate the calculation of the SYNTAX score as a measure of coronary lesion severityusing the application at http://www.syntaxscore.com/calculator/start.htm.

E. Statistical analysis

Statistical data analysis using the SPSS application. For categorical variables, the bivariate analysis used the Chi-squaretest used for normally distributed data and Fisher's test for non-normal distribution data. While for numericalvariables, it used Student's -test for normally distributed data or the Mann-Whitney test for data not normallydistributed. Correlation test was performed to assess the level of strength of the relationship expressed by Pearson.Multivariate analysis will be carried out using logistic regression. The p value < 0.05 was said to be statisticallysignificant. Independent variables with significant relationship will be analyzed using ROC analysis to determinethe cut-off value, sensitivity, and specificity.

III. RESULTS

A. Research Characteristics

Patient with NSTEMI who undergo coronary angiography fromHaji Adam Malik Hospital Medanfrom July 2021 to June 2022, from medical records of NSTEMI patients during hospitalization from cardiac emergency room, cardiovascular intensive care (CVCU), and patients admitted to the ward. The study involved 71 NSTEMI patient, which met the inclusion and exclusion criteria of the included studies. Data were collected on patients clinical status at admission, laboratory findings, electrocardiography and coronary angiography.

B. Baseline Characteristics

A total 71 NSTEMI patient from Haji Adam Malik Hospital From July 2021 to June 2022, consisting of 58 men (81.7%) and 13 women (18.3%) with an average age of 56.39 ±8,815 years. According to the risk factors of study participants, a history of diabetes was the greatest risk factor in 58 (81.7%), followed by smoking in 53 (74.6%), and finally a history of hypertension in 34 (47.9%). From the hemodynamic parameters of the study participants, the median of systolic blood pressure was 130 (90-200) mmHg and for the median of diastolic blood pressure was 80 (60-75) mmHg. From angiographic results, the mean SYNTAX score of 60 (84.5%) patients with multiple coronary artery lesion and the remaining 11 (15.5%) patients with single coronary artery lesion was 24.57 ± 10.36.

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Characteristics	N=71
Sex	
Male	58 (81.7%)
Females	13 (18.3%)
Age (years)	56.39 ± 8.815
Risk Factor	
Hypertension	34 (47.9%)
Diabetes Mellitus	58 (81.7%)
Smokers	53 (74.6%)
Body Mass Index	25 (17.6-30.4)
Hemodynamic Parameters	
Systolic Blood Pressure (mmHg)	130 (90 - 200)
Diastolic Blood Pressure (mmHg)	80 (60 - 75)
Laboratorium Parameters	
Hemoglobin (g/dL)	13.8 (9.6 - 17.7)
Leukocyte (/µL)	10,000 (4,670 – 20,310)
Platelets (10^3/µL)	257.0 (157 – 563)
Ureum (mg/dL)	30 (11 – 90)
Creatinin (mg/dL)	1 (0.54 – 4.04)
Blood Glucose (mg/dL)	120 (69 – 517)
Troponin I (ng/mL)	1.76 (0.05 – 26.2)
CKMB (U/L)	50 (11 – 480)
Total Cholesterol (mg/dL)	184 ± 39.97
Triglycerides (mg/dL)	139 (73 – 347)
HDL (mg/dL)	35 (6 – 57)
LDL (mg/dL)	133.77 ± 39.31
GRACE Score	107.58 ± 24.10
Electrocardiography Parameter	
RWPT	37.31 ± 6.923
Angiography Parameters	
Single Vessel	11 (15.5%)
Multi Vessels	60 (84.5%)
SYNTAX Score	24.57± 10.36

Table 1: Baseline Characteristics

C. Bivariate Analysis of Subject Characteristics with Severity of Coronary Lesions

Bivariate analyses were performed using T-tests of independence, Mann-Whitney Tests, Chi-square Tests, and Fisher's Tests to determine whether there were significant relationships or differences among study participants characteristics based on the severity of coronary artery lesions. In 46 (64.8%) subjects, a SYNTAX score of 23 was classified as severe CAD, and in up to 25 (35.2%) subjects, a SYNTAX score of <23 was classified as non-severe CAD.

From bivariate analysis there were statistically significant ($p<0.05$) differences in the characteristics of multiple parameters such as diabetes history, smoking history, R wave peak time, troponin I, GRACE, number of coronary artery lesions and SYNTAX scores.

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Characteristics	Severe CAD n = 46 (64.8%)	Non-Severe CAD n = 25 (35.2%)	p value
Sex			
Male	39 (67.2%)	19 (32.8%)	0.522[2]
Females	7 (53.8%)	6 (46.2%)	
Age (years)	57.3 ± 9.489	54.72 ± 7.3	0.241[3]
Risk Factor			
Hypertension	24 (70.6%)	10 (29.4%)	0.165[1]
Diabetes Mellitus	42 (72.4%)	16 (27.6%)	**0.008[2]**
Smokers	39 (73.6%)	14 (26.4%)	**0.017[1]**
Body Mass Index	25 (17.6-30.4)	25 (21.6)	0.418[4]
Hemodynamic Parameters			
Systolic Blood Pressure (mmHg)	129.57 (90 – 190)	132 (100 – 200)	0.860[4]
Diastolic Blood Pressure (mmHg)	75.61 (60 – 75)	78.6 (60 – 100)	0.530[4]
Laboratorium Parameters			
Hemoglobin (g/dL)	13.3 (9.9 – 15.4)	13.8 (9.6 – 17.7)	0.805[4]
Leukocyte (/µL)	8960 (4.670 – 20,310)	11,360(5,740 – 16,340)	0.099[4]
Platelets (10^3/µL)	249 (157 – 432)	274 (185 – 563)	0.885[4]
Ureum (mg/dL)	33 (13 – 86)	26 (11 – 90)	0.412[4]
Creatinin (mg/dL)	0.9 (0.38 – 4.04)	0.89 (0.54 – 2.24)	0.914[4]
Blood Glucose (mg/dL)	124 (69 – 332)	115 (69 – 517)	0.276[4]
Troponin I (ng/mL)	3.3 (0.2 – 17.6)	1.45 (0.05 – 26.20)	**0.009[4]**
CKMB (U/L)	57.5 (11 – 480)	45 (14 – 134)	0.135[4]
Total Cholesterol (mg/dL)	183 ± 44.24	184 ± 31.46	0.704[3]
Triglycerides (mg/dL)	130 (73 – 305)	154 (92 – 347)	0.066[4]
HDL (mg/dL)	35 (6 – 54)	35 (25 – 57)	0.462[4]
LDL (mg/dL)	132 ± 41.86	135 ± 35.61	0.727[3]
GRACE Score	112.41 ± 23.464	98 ± 22.87	**0.015[3]**
Electrocardiography Parameter			
RWPT	39.15 ± 6.72	33.92 ± 6.05	**0.002[3]**
Angiography Parameters			
Single Vessel	1 (9.1%)	10 (90.9%)	**< 0.001[1]**
Multi Vessels	45 (75%)	15 (25.0%)	
SYNTAX Score	29.5 (23-54.5)	12 (7-22)	**<0.001[4]**

Table 2: Bivariate Analysis of Subject Characteristics with Severity of Coronary Lesions

[1]Chi-Square [2]Fisher Exact [3]T-independent [4]Mann Whitney

The results of the measuring ECG R-wave peak time and the value of the SYNTAX score obtained from the angiography results is numerical data and for the occurrence of bias during the measurement, 2 measurements were carried out by 2 experienced observers, namely a cardiologist or interventional cardiologist. In addition, the interobserver reliability was assessed using the Bland-Altman test, and the two observers measurements difference did not exceed 5, so the results obtained, including the time to the peak of the R wave and the SYNTAX score, were fairly reliable.

ISSN No:-2456-2165

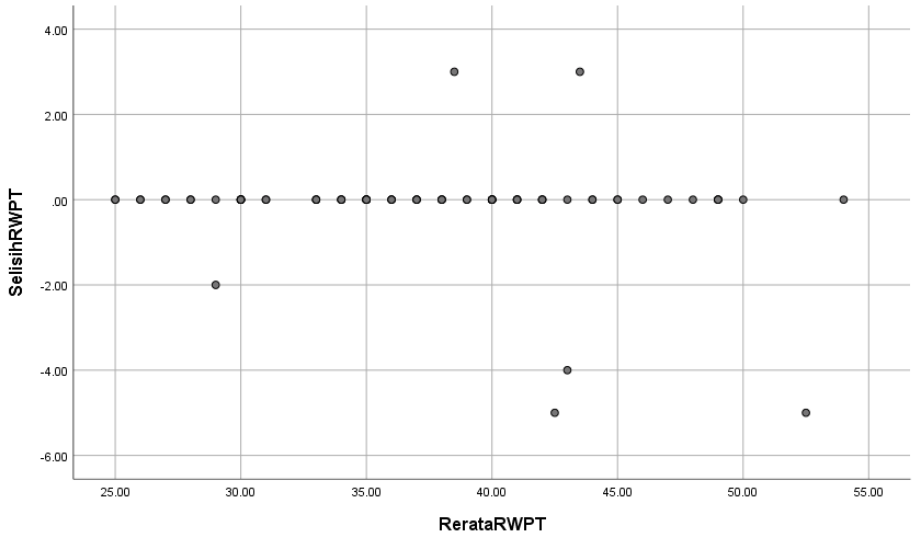

Fig. 1: Bland-Altman Graph of R wave peak time on Interobserver Reliability Test

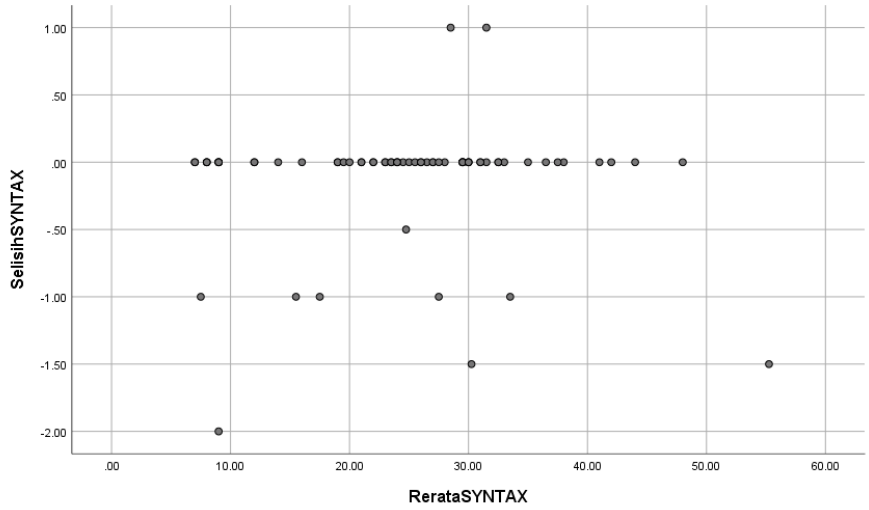

Fig. 2: Bland-Altman Graph of SYNTAX Score on Interobserver Reliability Test

D. Correlation Analysis of R Wave Peak Time with Coronary Lesions Severity

In this study, to determine the correlation of the peak time of the R wave and coronary lesion severity from SYNTAX score, pearson correlation analysis was performed with the data normally distributed. From the correlation results, significant results were found, with a positive correlation between the peak time of the R wave and the SYNTAX score (r=0.401; p-value 0.001) with moderate strength.

Variable	Correlation Analysis	SYNTAX Score
RWPT	p value	<0.001
	r	0.401

Table 3: Correlation Analysis of R Wave Peak Time with Coronary Lesions Severity

E. ROC Analysis of R Wave Peak Time with Coronary Lesion Severity

To assess the accuracy of R-wave peak time in predicting coronary lesion severityROC analysis was performed. The severity of coronary lesions was divided into severe CAD (SYNTAX score 23) and non-severe CAD (SYNTAX score < 23). The area under the curve (AUC) of the R wave peak time yielded a result of 72.9%. AUC value.

ISSN No:-2456-2165

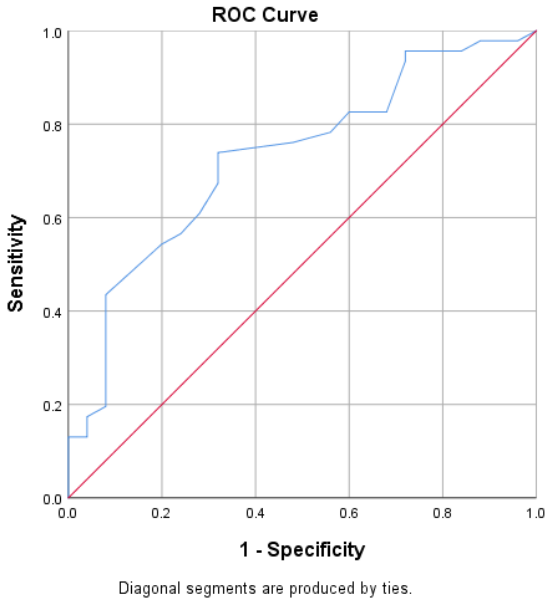

Fig. 3: ROC Analysis of R Wave Peak Time with Coronary Lesion Severity

The cut off point of the peak time of the R wave is 35.5 ms with a sensitivity of 73.9% and a specificity of 68%.

Parameter	AUC	p value	Cut off	Sensitivity	Specificity
RWPT	72.9%	0.002	35.5	73.9%	68 %

Table 4: Cut off ROC Analysis of R Wave Peak Time with Coronary Lesions Severity

IV. DISCUSSION

The study from Ibrahim et al (2018), showed that there was a relationship between the prolongation of the peak time of the R wave and the severity of coronary lesions in IMA-NEST patients based on the patient's SYNTAX score. The study hypothesized that ischemia-induced conduction delays in Purkinje fibers and ventricular myocytes would be more pronounced in patients with high SYNTAX scores associated with greater ischemic myocardium, and could therefore result in greater elongation of QRDS and RWPT. In fact, the results showed that QRSD and RWPT were significantly longer in patients with high SYNTAX scores, and that RWPT was an independent predictor of high SYNTAX scores.

Based on the characteristics of the research subjects, the mean age of the research subjects was 55 years. This is different from the average age of the previous study conducted by Burak (2019) which is 64 years and research by Cagdas et al (2017) with a mean age of 65 years. For cardiovascular risk factors, a history of diabetes mellitus was the most risk factor, namely 58 (81.7%), followed by smoking 53 people (74.6%) and the last was a history of hypertension 34 people (47.9%). This is in line with the previous study conducted by Zebua (2022) where as many as cardiovascular risk factors in patients with NSTEMI as many as 78.3% were patients with diabetes mellitus and 71.7% were smokers and 51.7% were hypertensive patients.

Gender in the study was dominated by male sex with a proportion of 81.7%) when compared to female sex. The research of Ville et al (2015) also shows that men are 2.4 times more likely to suffer from NSTEMI than women (Ville et al, 2015). This shows that men have a higher risk factor for NSTEMI than women.Demographically, the data obtained from the results of the study showed that there was no statistically significant difference between gender, age, history of hypertension, history of diabetes and body mass index on the severity of coronary lesions with p value > 0.05. Significant differences were found only in the history of diabetes with a P value = 0.008 and smoking with a p value = 0.017. Research by Zebua (2022) explained the same thing, where there was a significant difference in the history of diabetes mellitus in NSTEMI patients with p value = 0.021.

In this study, there was a significant difference between the peak time of the R wave and the severity of coronary lesions. The peak time of the R wave was statistically different between the SYNTAX score group < 23 and the SYNTAX score 23 group with p value = 0.002. Based on research conducted by Ibrahim et al (2018) with a p value = 0.001.

The researchers conducted a correlation test and obtained a correlation coefficient with a value of r = 0.401. This correlation value is a positive correlation meaning that the higher the peak time value of wave R, the higher the SYNTAX value, with a correlation with moderate strength (0.4 r < 0.6). Previous research by Ibrahim et al (2018) found a correlation value of r = 0.413 for the peak time of the R wave. Where the correlation value at the peak time of the R wave still showed a significant relationship.

To assess the ability of the R wave peak time value in predicting the severity of coronary lesions, the study performed an ROC analysis. The resultswasthe area under the curve for the peak time of the R wave is 72.9%. The AUC value for the peak time of the R wave is moderate. A previous study conducted by Ibrahim et al (2018) obtained an AUC value of 65.8% for the peak time of the R wave by predicting the severity of coronary lesions. Previous research by Cagdas et al (2017) conducted a study to assess the peak time of the R wave in predicting the incidence of no-reflow in acute coronary disease outbreaks undergoing primary PCI. and obtained AUC results of 92.4% for preprocedural R wave peak times and 90.4 % for post-procedural R waves peak time. Fromthat study, pre-preprocedural R wavepeak time was an independent predictor of the incidence of no reflow.

The result of this study indicate that the AUC results obtained indicate that the R wave peak time is quite good in predicting the severity of coronary lesions, although the ability of the peak time of the R wave has not reached a strong levelconnection. From this study shows the relationship between the peak time of the R wave with the severity of coronary lesions with a moderate strength of correlation. Therefore, the peak time of this R wave can be considered in daily practice in helping us predict the severity of coronary lesions because electrocardiography is a diagnostic modality that is easy to perform and almost all hospitals have it and is inexpensive.

V. CONCLUSION

- The average peak time of the R wave in NSTEMI patients in this study was 37.31±6.923ms
- In this study the mean score of SYNTAX of NSTEMI patients was 24.57± 10.36
- There is a relationship between the peak time of the R wave and the severity of coronary lesions based on the SYNTAX score, for the R wave peak time ($p = 0.002$) with a positive correlation and the strength of the correlation is moderate ($0.4 r < 0.6$) .
- R wave peak time canpredicts the severity of coronary artery lesions based on the moderate SYNTAX score (AUC = 72.9%).

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