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Relationship of Frontal QRS-T Angle with Syntax Score in Non-St Elevated myocardial Infarction Patients In H. Adam Malik General Hospital Medan

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Abstract:-

Background: Acute Coronary Syndrome (ACS), which is part of Coronary Artery Disease (CAD), is a major cardiovascular problem because it causes high hospitalization rates and high mortality rates. From the previous study, 80% of NSTEMI patients had multivessel disease. So, the complexity of the lesions on NSTEMI is higher than that of STEMI. The SYNTAX score (SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery) is a scoring system that was developed comprehensively to describe the complexity of coronary arteries from angiographic results.

Methods: This study is a descriptive analytic study with a cross-sectional design conducted at the Department of Cardiology and Vascular Medicine at H. Adam Malik Hospital Medan by taking data on patients with Non-ST Evelation Myocardial Infarction (NSTEMI) and undergoing coronary angiographyfrom January 2019 to June 2020 and 50 samples were included in this study.From the ECG examination, the value of the FQRS-T angle will be measured. Then from the results of coronary angiography, the SYNTAX score for each patient will be calculated. Furthermore, statistical analysis was carried out to see whether there was a correlation between FQRST and SYNTAX scores in NSTEMI patients and how strong the correlation was.

Results: The mean SYNTAX score for male subjects was 23.97 ± 10.97, while the mean SYNTAX score for female subjects was 23.00 ± 8.14. The mean SYNTAX score in subjects with hypertension was 25.87 ± 10.07 while in subjects without hypertension it was 15.30 ± 6.58. From the analysis results obtained significant results between the FQRTS angle with the SYNTAX score (p = 0.02) with a positive correlation direction and the strength of the correlation is moderate (r = 0.43).

Conclusion: There is a relationship between the value of the FQRST angle and the SYNTAX score in NSTEMI patients undergoing coronary angiography and in NSTEMI patients undergoing angiography, the wider the FQRST angle, the higher the SYNTAX score with positive correlation and moderate correlation strength.

Keywords:- *Frontal QRS-T Angle, SYNTAX Score, NSTEMI.*

I. INTRODUCTION

Acute Coronary Syndrome (ACS) which is part of Coronary Artery Disease (CAD) is a major cardiovascular problem because it causes high hospitalization rates and high mortality rates.[1,2] ACS is a life-threatening condition and can occur suddenly in patients with atherosclerotic coronary artery disease. This syndrome consists of a conditions ranging from Unstable Angina Pectoris (UAP) to Acute Myocardial Infarction (AMI), which is irreversible necrosis of heart muscle.[3,4] The occurrence of ACS is caused by an acute disturbance of coronary blood flow, both partial and total, to the myocardium. ACS consists of Unstable Angina Pectoris (UAP), Non-ST Elevation Myocardial Infarction (NSTEMI), and ST Elevation Myocardial Infarction (STEMI).[5]

NSTEMI, which is a part of ACS, varies across countries. The Euro Heart Survey, a study based in 25 countries, showed an NSTEMI incidence of 58% with a mortality during hospitalization of 2.8%.[6] Meanwhile, based on the CRUSADE (Can Rapid Risk Stratification of Unstable Angina Patients Suppress ADverse Outcomes with Early Implementation of the ACC/AHA Guidelines) registry, the mortality rate during treatment at NSTEMI is 4.2%.[7] An even higher mortality rate is shown by the Global Registry of Acute Coronary Events (GRACE) study, which is 5% during treatment and increases after 6 months of treatment, reaching 6.2%-7.3%.[7,8]Terkelsen et al (2005) showed that the 1-year mortality rate in NSTEMI patients was 30.5% with an advanced age presentation and many comorbidities, such as diabetes mellitus.[9]

From the previous study, 80% of NSTEMI patients had multivessel disease. So the complexity of the lesions on NSTEMI is higher than that of STEMI. The SYNTAX score (SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery) is a scoring system that was developed comprehensively to describe the complexity of coronary arteries from angiographic results. The SYNTAX score was created taking into account the number of lesions and their functional consequences, location, and complexity. A higher SYNTAX score indicates a more complex disease and a poorer prognosis. This score helps make a decision whether to perform Coronary Artery Bypass Surgery (CABG) or Percutaneous Coronary Intervention (PCI). In patients with low (<23) and intermediate (23-32) SYNTAX scores, the clinical outcome was almost the same between PCI and CABG. However, in patients with a SYNTAX score of more than 32, the clinical outcome was better with CABG at 12 months. The SYNTAX score has also been shown to be a predictor of mid-term outcome after PCI in patients with occlusion of all 3 coronary arteries and can be used to help select a revascularization strategy in patients with occlusion of all 3 coronary arteries.[10,11]

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Although there are still few, there are several studies linking the Frontal QRS-T (FQRST) angle with the SYNTAX score. Dogan et al (2018) studied 340 patients with a diagnosis of STEMI and found that the FQRST angle predicts CAD severity based on the SYNTAX score and is associated with atherosclerotic burden after PCI. Another study from Erdogan et al (2020) said that the FQRST angle can predict atherosclerotic load in NSTEMI patients. From these two studies, it is said that further research is still needed in this regard.[11,12]

II. METHODS

This study is a descriptive analytic study with a cross-sectional design carried out at the Department of Cardiology and Vascular Medicine at H. Adam Malik General Hospital Medan by taking data on patients with Non ST Elevation Myocardial Infarction (NSTEMI) and undergoing coronary angiography from January 2019 to June 2020. There were 100 patients who met the inclusion criteria and exclusion criteria. Then out of 100 patients, randomization was done. So that 50 samples were included in this study.

The inclusion criteria in this study were patients with a diagnosis ofNSTEMI who were treated atH. Adam Malik General Hospital Medan and underwent coronary angiography procedures during hospitalization and had never undergone PCI and CABG procedures before. While the exclusion criteria in this study were patients with incomplete medical record data, patients who had undergone previous PCI and CABG procedures, patients with a history of congestive heart failure, patients who had a history of severe heart valve disease, congenital heart disease, cardiomyopathy or heart disease. others, patients with acute or chronic inflammatory disease (eg rheumatoid arthritis), malignancy, anemia, chronic renal failure, hepatic impairment, sepsis, patients with chronic obstructive pulmonary disease (COPD), patients admitted with cardiogenic shock, patients with ECG Right Bundle Branch Block (RBBB), Left Bundle Branch Block (LBBB), and pace maker rhythms, and patients withunclear QRS and T axes from electrocardiography (ECG).

From the total number of samples, data were collected from the patient's medical records in the form of anamnesis, physical examination, echocardiography, electrocardiography, laboratory, and coronary angiography. From the ECG examination, the value of the FQRS-T angle will be measured asthe value of the difference between the frontal plane QRS and T axes for each patient. Then from the results of coronary angiography, the SYNTAX score for each patient will be calculated. Furthermore, statistical analysis was carried out to see whether there was a correlation between FQRST and SYNTAX scores in NSTEMI patients and how strong the correlation was.

Data processing and statistical data analysis using statistical computer tools. Numerical variables are represented by mean±SD for data with normal distribution and median (minimum-maximum) for non-normally distributed data. Categorical variables are represented by number or frequency (n) and percentage (%). Data normality test used Kolmogorov-Smirnoff for a total sample of more than 50 or used Saphiro-Wilk for a total sample of less than 50. To assess the hypothesis whether there is a relationship between the FQRST angle and the SYNTAX score wichobtained from coronary angiography, Pearson correlation test for normally distributed numerical data or Spearman correlation test for abnormally distributed data is used. It is said that the relationship between the two variables will be statistically significant if the p value is less than 0.05. After obtaining the relationship between the variables (FQRST angle and SYNTAX score), proceed with testing the strength of the relationship between the two variables which is expressed by the correlation coefficient (r).

III. RESULTS

This study involved 50 patients with Non STElevation Myocardial Infarction (NSTEMI) who met the study inclusion criteria and underwent randomization. Of the 50 research subjects, the majority were male around 39 people (78%) with an average age of 54.94 ± 8.95 years. The patient's median height was 165 cm (150-177 cm) with a median weight of 68 kg (50-155 kg) and the median body mass index was 25.33 (18.4-38.4) Kg/m2. The patient's median systolic blood pressure was 130 mmHg (100-200 mmHg) with a diastolic blood pressure of 80 mmHg (60-110 mmHg). From the characteristics of the risk factors, 40 (74%) people found hypertension, 26 (52%) diabetes mellitus, and 35 (70%) smoking.

Characteristics	Value
Gender	
Male (%)	39(78%)
Female (%)	11(22%)
Age (years)	54.94±8.95
Height (cm)	165(150-177)
Weight (Kg)	68(50-115)
BMI (Kg/m$^{2)}$	25.33(18.4-38.4)
SBP (mmHg)	130(100-200)
DBP (mmHg)	80(60-110)
Hypertension	
Yes	40(80%)
No	10(20%)
DM	
Yes	26 (52%)
No	24 (48%)

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Smoking	
Yes	35(70%)
No	15(30%)
Hb (13-18 g/dL)	13.22(9.6-17.7)
Platelets (150000-450000/µL)	266000(157000-563000)
Leukocytes (4000-11000/µL)	11205(4670-20310)
Ureum (19-44 mg/dL)	32.5(11-90)
Creatinin (0.7-1.3 mg/dL)	0.99 (0.54-4.04)
Blood Glucose Level (< 200 mg/dL)	120(78-384)
Troponin I (< 0.002ng/mL)	1.7(0.12-26.2)
CK-MB (≤ 24 U/L)	47.5(11-123)
Total Cholesterol (< 200mg/dL)	201(118-296)
Triglyceride (< 150 mg/dL)	150(73-347)
HDL (> 40 mg/dL)	35(25-57)
LDL (< 130 mg/dL)	144.5(66-226)
LVEF (%)	45(25-65)
Coronary Angiography	
1VD	7(14%)
MVD	43(86%)
SYNTAX score	23.76±10.34
Low	21 (42%)
Moderate	23 (46%)
High	6 (12%)
FQRST angle (°)	72.5(6-179)
QTc (ms)	440(382-547)

Table 1: Characteristics of Research Subjects

From the laboratory examination, the median value of hemoglobin was 13.22 (9.6-17.7) g/dL, the median value of platelets was 266000/ L (157000-563000/ L), the median leukocyte value was 11205/ L (4670-20310/ L). . On examination of kidney function, the median value of urea was 32.5 (11-90) mg/dL, and the median value of creatinine was 0.99 (0.54-4.04) mg/dL. From the examination of blood sugar levels, the median value was 120 (78-384) mg/dL. On cardiac enzyme examination, the median value of troponin I was 1.7 (0.12-26.2) ng/mL, while the median value of CK-MB was 47.5 (11-123) U/L. On examination of the lipid profile, the median value of total cholesterol was 201 (118-296) mg/dL, the median value of triglycerides was 150 (73-347) mg/dL, the median value of HDL was 35 (25-57) mg/dL, and the mean value of HDL was 35 (25-57) mg/dL. the median LDL was 144.5 (66-226) mg/dL.

From the echocardiography examination, it was found that the median value of the left ventricular ejection fraction was 45 (25-65) %. In this study, from the results of coronary angiography, 7 (14%) patients had 1 Vessel Disease (VD), while 43 (86%) had Multi Vessel Disease (MVD). From the measurement of the SYNTAX score, it was found that the average score was 23.76±10.34. Patients with low SYNTAX scores were found as many as 21 people (42%), moderate as many as 23 people (46%), and high as 6 people (12%). From the ECG data, the median value of the QRS-T angle in the frontal plane (FQRST) is 72.5 (6-179) with the median value of QTc is 440 (382-547) ms.

In the bivariate analysis of categorical variables from the characteristics of the research subjects with the SYNTAX score, the mean SYNTAX score for male subjects was 23.97 ± 10.97 while the mean SYNTAX score for women was 23.00 ± 8.14. The mean SYNTAX score in subjects with hypertension was 25.87 ± 10.07 while in subjects without hypertension it was 15.30 ± 6.58. A significant difference was found between subjects with hypertension and those without hypertension ($p = 0.001$). The median SYNTAX score in DM subjects was 26.75 (8.0 – 54.5) while in subjects without DM it was 20.50 (7.0 – 30.0). A significant difference was also found between subjects with DM and those without DM ($p = 0.009$). The mean SYNTAX score in subjects who smoked was 25.90 ± 10.37 while that of subjects who did not smoke was 18.77 ± 8.65.A significant difference was found between smokers and non-smokers ($p = 0.017$).

The median SYNTAX score in subjects with coronary angiography was 1 VD 9.00 (7.0 – 15.0) while in subjects with multi vessel disease it was 25.5 (8.0 – 54.5). There was also a significant difference between coronary angiography with the results of 1 VD and multi vessel disease ($p < 0.001$). In the bivariate analysis of the numerical variables of the characteristics of the research subjects with the SYNTAX score, significant results were found. Complete data are presented in tables 2 and 3.

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Characteristics	SYNTAX score	*p Value*
Gender		
Male	23.97 ± 10.97	0.75[b]
Female	23.00 ± 8.14	
Hypertension		
Yes	25.87 ± 10.07	0.001[a]
No	15.30 ± 6.58	
DM		
Yes	26.75 (8.0 – 54.5)	0.009[b]
No	20.50 (7.0 – 30.0)	
Smoking		
Yes	25.90 ± 10.37	0.017[a]
No	18.77 ± 8.65	
Coronary Angiography		< 0.001
1VD	9.00 (7.0 – 15.0)	
MVD	25.5 (8.0 – 54.5)	

Table 2: Bivariate Analysis of Research Subject Characteristics with SYNTAX scores (Category)
[a] T Independent test [b] MannWhitney test

Characteristics	Value	*p Value*
Age (years)	54.94±8.95	0.11[c]
Height (cm)	165(150-177)	0.07[d]
Weight (kg)	68(50-115)	0.47[d]
BMI (kg/m^2)	25.33(18.4-38.4)	0.96[d]
SBP (mmHg)	130(100-200)	0.67[d]
DBP (mmHg)	80(60-110)	0.41[d]
Hb (13-18 g/dL)	13.22(9.6-17.7)	0.25[d]
Platelets (150000-450000/µL)	266000(157000-563000)	0.54[d]
Leukocytes (4000-11000/µL)	11205(4670-20310)	0.81[d]
Ureum (19-44 mg/dL)	32.5(11-90)	0.28[d]
Creatinin (0.7-1.3 mg/dL)	0.99 (0.54-4.04)	0.68[d]
KGD (< 200mg/dL)	120(78-384)	0.67[d]
Troponin I (< 0.002 ng/mL)	1.7(0.12-26.2)	0.23[d]
CK-MB (≤ 24 U/L)	47.5(11-123)	0.26[d]
Total Cholesterol (< 200 mg/dL)	201(118-296)	0.96[d]
Triglyceride (< 150 mg/dL)	150(73-347)	0.28[d]
HDL (> 40 mg/dL)	35(25-57)	0.74[d]
LDL (< 130 mg/dL)	144.5(66-226)	0.47[d]
LVEF (%)	45(25-65)	0.05[d]
FQRST angle (°)	72.5(6-179)	**0.02[d]**
QTc (ms)	440(382-547)	0.1[d]

Table 3: Bivariate Analysis of Research Subject Characteristics with SYNTAX scores (Numeric)

[c]Pearson Correlationtest [d]Spearman Correlation test

Based on the conformity test with Bland-Altman, the limit of agreement value does not exceed the specified value. The limit of agreement for SYNTAX score in this study is 2.

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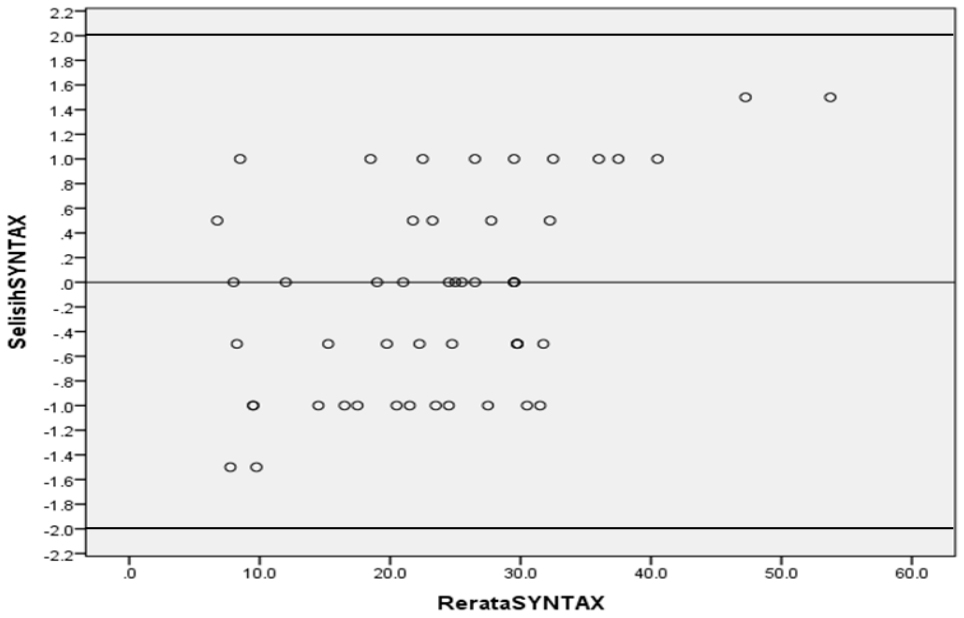

Fig. 1: Graph of the suitability of the SYNTAX interobserver score assessment

Based on the conformity test with Bland-Altman, the limit of agreement value does not exceed the specified value. The limit of agreement for FQRST value in this study is 5.

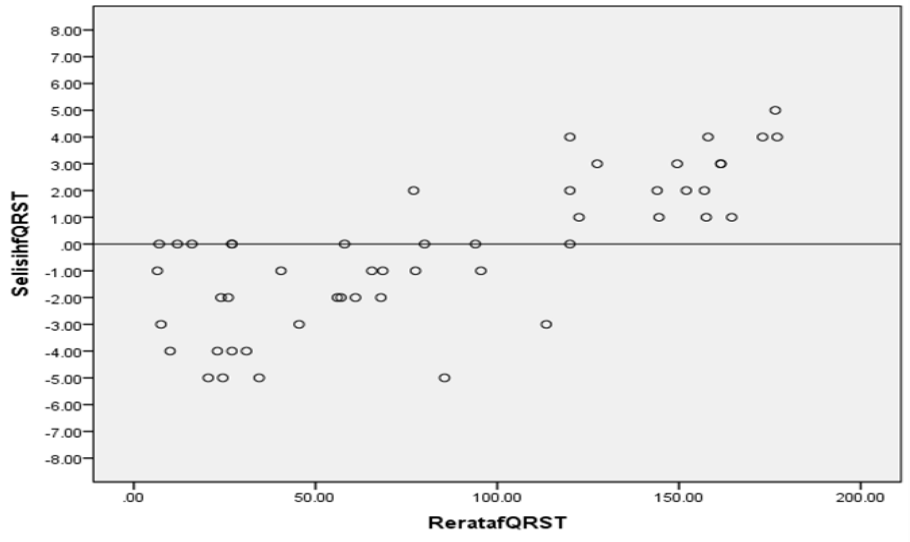

Fig. 2: Graph of the suitability of the interobserver FQRST assessment

To assess the relationship between the FQRST angle and the SYNTAX score, Spearman correlation analysis was performed because the data distribution was not normally distributed. From the analysis results obtained significant results between the FQRTS angle with the SYNTAX score (p = 0.02) with a positive correlation direction and the strength of the correlation is moderate (r = 0.43).

	SYNTAX score
fQRST score	r = 0,43 p = 0,02 n = 50

Table 4: Results of Spearman Correlation Analysis

The correlation test was then followed by a linear regression test to determine the equation of the relationship between the QRST frontal angle and the SYNTAX score. From statistical analysis obtained equation

SYNTAX score = 0.078 * frontal angle QRST + 17.326

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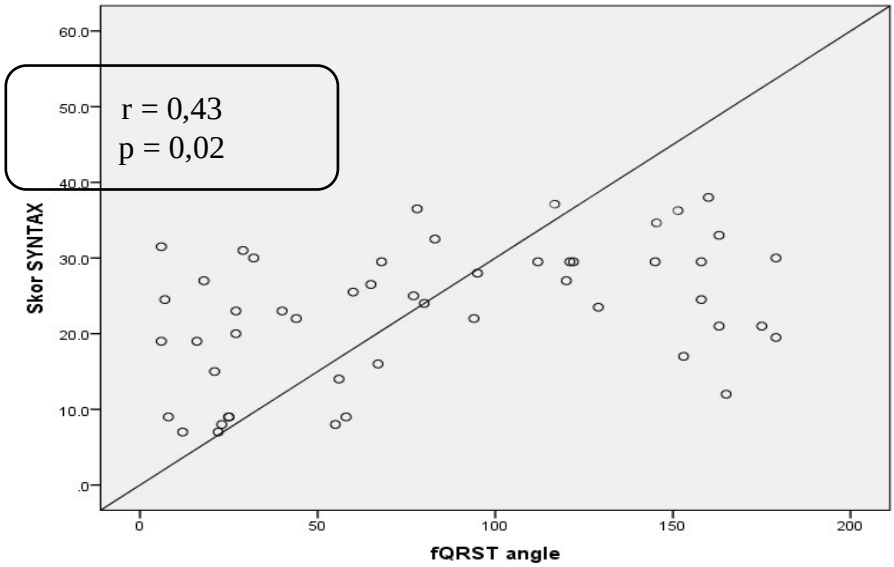

Fig. 3: FQRST linear regression graph with SYNTAX score

IV. DISCUSSION

The FrontalQRS-T angle (FQRST) is an easily measured electrocardiographic parameter, defined as the angle between the QRS frontal electrical axis and the T wave, both of which are routinely measured using standard electrocardiographic diagnostic software. This angle is an approximation of the QRS-T spatial angle, which is the angle of the spatial axis of ventricular depolarization and repolarization. A larger angle represents a greater discordance between depolarization and repolarization. This represents the abnormality and heterogeneity of ventricular repolarization. Abnormalities in ventricular repolarization result from damage or the presence of inhomogeneous areas of the myocardium, which indicates a more serious disease.[13]

In ischemic conditions, inhomogeneous areas of the myocardium lead to an imbalance of electrical activation and ventricular restoration. So that the axis of the QRS wave and the axis of the T-wave are no longer aligned and therefore the QRS-T angle will widen. Normally, the direction of the depolarization axes of the myocardium and the repolarization axes havea closer orientation. Thus, the FQRST angle tends to be narrow (<45º).[14]

Treatment with CABG is preferred over PCI in the treatment of three-vessel disease and SYNTAX score ≥ 23. In patients with lower SYNTAX scores, PCI is preferred because it is considered the most proportional alternative.[15]The application of the SYNTAX score is very important because it can describe the complexity of coronary artery lesions in NSTEMI patients who have more complex lesions. Patients with relatively higher SYNTAX scores had poorer cardiovascular clinical outcomes.[16,17] In addition, the higher the SYNTAX score, the worse the cardiovascular clinical outcome and the more complex the CAD case.[18]

This study is a descriptive analytic study with a cross-sectional design that looks at the correlation between FQRST and SYNTAX scores in NSTEMI patients. In this study, there were significant results between the FQRST angle and the SYNTAX score (p = 0.02) with a positive correlation direction and moderate correlation strength (r = 0.43) in NSTEMI patients. The relationship between FQRST and CAD severity based on the number of vessels or localization of the involved lesion has been studied previously. Erdogan et al in 2020 conducted a study on this subject. They stated that in NSTEMI patients, apart from age and infarcted arteries, the baseline FQRST value was also an independent predictor of coronary atherosclerotic burden as assessed by the high-intermediate SYNTAX score (≥23). The study also obtained significant results (p<0.001) with a positive direction of correlation and moderate correlation strength (r = 0.49) between FQRST and SYNTAX scores in NSTEMI patients. The cut-off value of FQRST for detecting a SYNTAX score 23 is 73.5°. Erdogan et.al found that the mean value of FQRST in NSTEMI patients (100.5°±55.3°) was found to be higher than that of STEMI patients (81°) in other studies, indicating the presence of a more serious and complex disease in patients with NSTEMI.[11,12]

The high atherosclerotic burden on NSTEMI manifested in the SYNTAX score causes ischemia. This gives rise to heterogeneity of depolarization and repolarization which is described by widening of the FQRST angle. Erdogan et al stated that the widening of the baseline FQRST value in NSTEMI patients was related to the extent of myocardial scar tissue regardless of the localization of myocardial infarction. Thus, early recognition of the severity of CHD can assist in planning revascularization methods. In this regard, the use of FQRST can help stratify patients prior to coronary angiography.[11]

In the study of Palaniswamy et.al, it was found that the prevalence of CAD with 2 or 3 vessel obstruction was significantly higher in patients with a QRS-T planar angle >90° than in patients with a QRS-T planar angle ≤90°. The QRS-T planar angle is defined as the angle between the vector maximum of the QRS wave and the T wave in the frontal plane. The planar QRS-T angle was found to be a risk factor for obstructive CAD in 2-3 vessels with an odds

ratio of 7.2 (p<0.0001) so from these data it was found that the QRS-T angle can be used in patients with a high suspicion of obstructive CAD.[19]Walder and Spodick reported that global T wave inversion (spatial T vector) can differentiate patients with obstructive CAD from CAD without obstruction.[21]

In Colluoglu et al.'s study, patients with a baseline QRS-T angle of 95.6° were found to have significantly more three vessel disease than patients with a baseline FQRST angle of <95.6° among STEMI patients. Patients with baseline FQRST 95.6° were also more frequently found to have proximal vessel disease. In addition, Colluoglu et.al detected that a decrease in the value of the FQRST angle after thrombolytic therapy was associated with successful reperfusion.[22]

Contrary to the results of this study, Raposeiras-Roubin et al. reported that there was no association between FQRST and multivessel CAD in a study involving myocardial infarction patients with reduced LVEF values (<40%).[14] However, in the study of Lown et.al, it was found that a wide FQRST angle (> 90) is a good marker that can describe long-term mortality in patients with left ventricular systolic dysfunction after acute myocardial infarction. The use ofFQRST appears to be an interesting tool for predicting mortality among a broad spectrum of Acute Myocardial Infarction (AMI) patients.[23] In addition, baseline and post-procedure FQRST values can predict in-hospital mortality in patients with acute AMI. Dogan et.al demonstrated that FQRST is an independent predictor of coronary atherosclerotic burden in STEMI patients.[12]

In the study of Gotsman et al., it was found that the FQRST angle can be a strong predictor for assessing clinical outcomes, including all-cause mortality and cardiac-related care. This predictive value was found in both patients with reduced and preserved left ventricular function.[13] Two previous studies found that the FQRST angle can be a predictor of the incidence of arrhythmias in patients with advanced HF and systolic dysfunction.[24] The research of Gotsman et.al also revealed that the FQRST value can still be applied to the general population with heart failure with significant predictive value.[13]

From the data on the characteristics of the research subjects, there were significant differences between subjects with hypertension and those without hypertension. The hypertensive population had a higher SYNTAX score (25.87 ± 10.07) than the non-hypertensive (15.30 ± 6.58) (p = 0.001). From another study conducted by El Kersh et al, it was also found that there was a significant difference between the hypertensive population and the non-hypertensive population. Where the hypertensive population had a higher SYNTAX score with a mean of 20 ± 7.2 while the non-hypertensive population had a SYNTAX score with a median value of 10 (10-15) (p = 0.003).[25]

In the characteristics of the research subjects, there were also significant differences between subjects with DM and subjects without DM. Subjects with DM were found to have a higher SYNTAX score with a median value of 26.75 (8.0-54.5) compared to subjects without DM with a median value of 20.50 (7.0-30.0) (p = 0.009). In another study conducted by ElKersh et al, there was also a significant difference between subjects with DM and subjects without DM. DM subjects had a higher SYNTAX score with a mean of 24.4 ± 5.5 than those without DM with a median value of 12 (10-18) (p < 0.001). In this study it was said that DM was associated with the complexity of CAD and was an independent risk factor of CAD.[25]

From the characteristics of the research subjects, it was also found that there were significant differences between subjects who smoked and those who did not. Subjects who smoked had a higher SYNTAX score than those who did not. The mean score of SYNTAX was 25.90 ± 10.37 in subjects who smoked while in subjects who did not smoke, the mean score of SYNTAX was 18.77 ± 8.65 (P = 0.01). In another study conducted by El Kersh, there were also significant differences between subjects who smoked and those who did not. Subjects who smoked had a mean score of SYNTAX 20.1 ± 7.3 higher than non-smokers with a median value of 15 (10-21.5) (p = 0.006). In this study, smoking was found to be an independent risk factor for the complexity of CAD.[25]

V. CONCLUSION

From this study, it can be concluded that the QRS-T examination in the frontal plane is a non-invasive, inexpensive, and very easy examination as a tool for predicting the severity of CA21D, especially in NSTEMI patients. There is a relationship between the value of the FQRST angle and the SYNTAX score in NSTEMI patients undergoing coronary angiography (p = 0.02) and in NSTEMI patients undergoing angiography, the wider the FQRST angle, the higher the SYNTAX score with a positive correlation and moderate correlation strength (r = 0,43).

REFERENCES

[1.] Irmalita, Juzar DA, Andrianto, Setianto BY, Tobing DPL, Firman D, et al.Pedomantatalaksanasindromakoronerakut.3rd ed. Jakarta: Centra Communication;2015.
[2.] Juzar DA, Danny SS, Irmalita, Tobing DPL, Firdaus I, Widyantoro B. Pedomantatalaksanasindromakoronerakut. 4th ed. Jakarta: PERKI;2018.
[3.] Rhee JW,SabatineMS, Lilly LS. Acute coronary syndrome In: Pathophysiology of Heart Disease: A Collaborative Project of Medical Students and Faculty. 5th edition. Baltimore: Lippincott of Williams and Wilkin; 2015.
[4.] Wilder J, Sabatine MS, LilyLS. Acute Coronary Syndromes. In: Pathophysiology of Heart Disease. 6th edition. ed. Wolters Kluwer, Philadelphia; 2016. pp 162-91.
[5.] Kim MC, Kini, AS,Fuster,V. Definitions and Pathogenesis of Acute Coronary Syndromes. In Hurst's the Heart Manual of Cariology. 13th ed. New York: Mc Graw Hill; 2013.
[6.] Hasdai, D, Behar S, Wallentin, L, Danchin N, Gitt AK, Boersma E,*et al*. A prospective survey of the

characteristics, treatments and outcomes of patients with acute coronary syndromes in Europe and the Mediterranean basin – The Euro Heart Survey of Acute Coronary Syndromes (Euro Heart Survey ACS). Eur Heart J. 2002;23(15): 1190-1201. Available from :doi: 10.1053/euhj.2002.3193.

[7.] Widimsky, P. 2007. ACS Registries. Available from : https://www.escardio.org/Journals/E-Journal-of-Cardiology Practice/Volume5/ACS-Registries-Title-ACS-Registries

[8.] Fox KAA, Goodman SG, Klein W, Brieger D, Steg PG, Dobbpus O. Management of acute coronary syndromes. Variations in practice and outcomes; finding from the global registry of acute coronary events (GRACE). EurHeart J. Aug 2002;23(15):1177-89. Available from :doi: 10.1053/euhj.2001.3081.

[9.] Terkelsen CJ, Lassen JL, Noorgaard BJ, Gerdes JC, Jensen T,Hansen LBH. Mortality rates in patients with ST-elevations vs. non- ST elevation acute yocardialinfarction : Observations from an unselected cohort. EurHeartJ. Januari 2005; 26(1):18-26. Available from :doi: 10.1093/eurheartj/ehi002.

[10.] Sianos G, Morel MA, Kappetein AP, Morice MC, Colombo A, Dawkins K, *et al.* The Syntax score : an angiography tool grading the complexity of coronary artery disease. EuroIntervention. Augustus 2005; 1(2) : 219-227.

[11.] Erdogan G, Yontar OC, Yenercag M, Gul S, Arslan U. Frontal QRS-T angle predicts syntax score in patients with non-ST elevation myocardial infarction. . J Electocardiol. July-August 2020 ; 61: 86-91.

[12.] Dogan A, Kahraman . Frontal QRS-T angle predicts coronary atherosclerotic burden in patients with ST segment elevation myocardial infarction. J Electocardiol. Jan-Feb 2020; 58:155-159. Available from :doi: 10.1016/j.jelectrocard.2019.11.042.

[13.] Gotsman I, Keren A, Hellman Y, Banker J, Lotan C, Zwas DR. Usefulness of Electrocardiographic Frontal QRS-T Angle to Predict Increased Morbidity and Mortality in Patients With Chronic Heart Failure. Am J Cardiol.May 2013: 111(10): 1452-9. Available from: doi: 10.1016/j.amjcard.2013.01.294.

[14.] Roubin SR, Lamela AV, Cruz NB, Lopes AL, Busto MC, Garda RF. Usefulness of the QRS-T Angle to Improve Long-Term Risk Stratification of Patients with Acute Myocardial Infarction and Depressed Left Ventricular Ejection Fraction. American Journal of Cardiology. Apr 2014; 113(8); 1312–19. Available from: http://dx.doi.org/10.1016/j.amjcard.2014.01.406.

[15.] Mohr FW, Morice MC, Kappetein AP, Feldman TE, Stahle E, Colombo A, *et al.* Coronary Artery Bypass Graft Surgery versus Percutaneous Coronary Intervention in Patients with Three-Vessel Disease and Left Main Coronary Disease: 5-Year Follow-up of the Randomised, Clinical SYNTAX Trial. The Lancet. Feb 2013: 381(9867); 629-38. Available from :doi: 10.1016/S0140-6736(13)60141-5.

[16.] Farooq V, Serruys PW, Bourantas C, Vranckx P, Diletti R, Garcia HM. Incidence and Multivariable Correlates of Long-Term Mortality in Patients Treated with Surgical or Percutaneous Revascularization in the Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (SYNTAX) Trial. European Heart Journal. Dec 2012: 33(24); 3105–13. Available from :doi: 10.1093/eurheartj/ehs367.

[17.] Garg S, Serruys PW, Silber S, Wykrzykowska J, Geuns RJV, Richardt G, *et al.* The Prognostic Utility of the SYNTAX Score on 1-Year Outcomes after Revascularization with Zotarolimus- and Everolimus-Eluting Stents: A Substudy of the Resolute All Comers Trial. JACC: Cardiovascular Interventions. Apr 2011: 4(4); 432-441. Availabrefrom :doi: 10.1016/j.jcin.2011.01.008

[18.] Bundhun PK, Sookharee Y, Bholee A, Huang F. Application of the SYNTAX Score in Interventional Cardiology: A Systematic Review and Meta-Analysis. Medicine (Baltimore). Juli 2017: 96(28); e7410.

[19.] Palaniswamy C, Singh T, Aronow WS, Ahn C, Kalapatapu K, Weiss MB, Pucillo AL, Monsen CE. A Planar QRS-T Angle >90° Is Associated with Multivessel Coronary Artery Disease in Patients Undergoing Coronary Angiography. Medical Science Monitor. December 2009:15(12); 31-34.

[20.] Walder, LA, and DH Spodick. 1999. "Global T Wave Inversion." American Journal of Geriatric Cardiology: 1999; 8(4): 183.

[21.] Colluoglu T, Tanriverdi Z, Unal B, Ozcan EE, Dursun H, Kaya D. The Role of Baseline and Post-Procedural Frontal Plane QRS-T Angles for Cardiac Risk Assessment in Patients with Acute STEMI. Annals of NoninvasiveElectrocardiology. March 2018; 23(5): 1-10.

[22.] Lown MT, Munyombwe T, Harrison W, West RM, Hall CA, Morrell C. Association of frontal QRS- T angle—age risk score on admission electrocardiogram with mortality in patients admitted with an acute coronary syndrome. American Journal of Cardiology.2012 ; 109(3) : 307-312. Available from : . http://dx.doi.org/10.1016/j.amjcard.2011.09.014.

[23.] Pavri BB, Hillis MB, Subacius H, Brumberg GE, Schaechter A, Levine JH, Kadish A. Prognostic Value and Temporal Behavior of the Planar QRS-T Angle in Patients WithNonischemic Cardiomyopathy. Circulation. Juni 2008 ;117: 3181-3186.

[24.] Borleffs CJW, Scherptong RWC, Man SC, Welsenes GHV, Bax JJ, Erven LV, Swenne CA. 2009. "Predicting ventricular arrhythmias in patients with ischemic heart disease: clinical application of the ECG-Derived QRS-T Angle. Circulation: Arrhythmia and Electrophysiology. 2009; 2(5): 548–54.

[25.] El Kersh AM, Reda AA, l Hadad MG, El-Sharnouby KH. Correlation between SYNTAX score and pattern of risk factors in patients referred for coronary angiography in Cardiology Department, Menoufia University. World Journal of Cardiovascilar Disease. Aug 2018; 8: 431-439.