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ASSESSMENT OF INFERIOR ST SEGMENT DEVIATION FROM ECG TO DETERMINE THE SITE OF LEFT ANTERIOR DESCENDING CORONARY ARTERY OCCLUSION IN ANTERIOR ST SEGMENT ELEVATION MYOCARDIAL INFARCTION

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Abstract

Background: The anterior ST segment elevation myocardial infarction (STEMI) is the most commonly found of STEMI, which involves the left anterior descending (LAD) coronary artery. The occlusion on the proximal part of LAD is known to have worse prognosis than distal occlusion, because it relates with extended of infarction area. Therefore knowing early the site of occlusion through admission ECG before coronary angiography procedure, can provide us the important information, especially for further treatment.

Methods: This study involved 66 patients of anterior STEMI with the onset of symptoms ≤ 24 hours whom admission at emergency department of Pusat Jantung Terpadu RSUP Haji Adam Malik Medan. Then, deviation of the inferior ST segment on admission ECG be assessed based on ECG criteria A as a group I (depression of ST segment on lead III + aVF ≥ 2.5 mm) and ECG criteria B as a group II (elevation/isoelectric on lead III, aVF), and then the site of LAD coronary artery occlusion determined by coronary angiography procedure who performed during hospitalization. Statistical analysis was conducted using the Chi square correlation test and the under the Curve (AUC) curve of the receiver operating curve (ROC).

Results: From 66 subjects result 32 patients in group I (48.4%) and 34 patients in group II (51.5%). There is a significant relation between ECG criteria and the site of LAD coronary artery occlusion in the anterior STEMI patient ($p < 0.05$). The group I that predict coronary angiography showed sensitivity and specificity of 74,3% and 80,6% respectively with positive predictive values and negative predictive values of 81% and 73,5%. While group II that predict coronary angiography showed sensitivity and specificity 80,6% and 74,3% respectively with positive predictive and negative predictive values of 73,5% and 81% respectively. The ECG criteria can be used as a strong predictor to predict the site of LAD coronary artery occlusion in the anterior STEMI patient, with an under the curve area of 0775 ((95% CI 0,658-0.892., $p < 0.05$).

Conclusion: ECG criteria in anterior STEMI patient based on ST‑segment deviations in inferior lead allowed to predict the site of occlusion with good accuracy.

Introduction

Cardiovascular disease remains a major burden globally with high morbidity and mortality where 17,5 million deaths are caused by cardiovascular disease every year.[1] In 2014, coronary artery disease was the most common cause of death after stroke in Indonesia at 12.9%.[2] Acute manifestation of coronary artery disease is acute coronary syndrome, a life threatening condition, consist of Unstable Angina Pectoris (UAP), Non ST-segment Elevation Myocardial Infarction (NSTEMI), ST-Segment Elevation Myocardial Infarction (STEMI).[3]STEMI is a part of severe acute myocardial infarction.[4]

The electrocardiogram (ECG) remains a crucial tool in the identification and management of STEMI. Admission ECG in STEMI patient perform not only to assess decisions regarding the perfusion therapy, but to identification early of the infarct‑related artery which can help predict the area of myocardium at risk. This information is important, especially in anterior STEMI because its occur frequent and have a worse prognosis than others.[5,6]

Anterior STEMI involves left anterior descending (LAD) coronary artery, who have significant contribution (50%) to left ventricular myocardial blood flow.[7]The site of occlusion in the left anterior descending (LAD) coronary artery is related to the extent of the myocardial necrosis and prognosis. An early prediction of proximal LAD occlusion is important not only from an academic standpoint but also from a clinical point of view[8].

Based on Fiol et al study, there are five criteria to determine site of occlusion in LAD coronary artery, but just two criteria can be used as a standard to differentiate site of occlusion because had high positive predictive value, and they were criteria A (decreased ST segment III+aVF ≥ 2.5mm) to predict proximal LAD occlusion and criteria B (elevated/isoelectric III, aVF) to predict distal LAD occlusion[9]. This study is accordant to Kamal et al and Chakraborty et al study, which is use deviation of the inferior ST segment to differentiate proximal or distal occlusion of LAD coronary artery[8,10]

Because it is well known that site of occlusion in the left anterior descending (LAD) coronary artery is related to the extent of the myocardial necrosis and prognosis. The early detection from admission ECG, can help us to do the best further management and can decrease the morbidity and mortality. We aimed to investigated the relationship between ECG criteria and site of LAD coronary artery occlusion in patients anterior STEMI who underwent coronary angiography.

Methods

This study is an cross sectional study who performed at Haji Adam Malik General Hospital Medan with permission from Research Ethics Committee of Faculty of Medicine, Universitas Sumatera Utara-RSHAM. Subjects were recruited from January to December 2019. The study involved 66 patients. The inclusion criteria were patients who were clinically confirmed as anterior STEMI within ≤ 24 hours from the onset of symptoms, never had history of myocardial infarction before and undergoing coronary angiography procedure during hospitalization and found lesion in LAD coronary artery as a culprit lesion. While exclusion criteria were patients with previous coronary bypass or angioplasty, implanted pacemaker, previous bundle branch block in ECG, known case of congenital heart disease, known as primary heart valve disease, and poor description/coronary angiography video.

Study Procedure

Subjects clinical, demographic characteristics and ECG who admitted in the ER with anterior STEMI onset ≤ 24 hours as working diagnose were recorded. ECG was taken from all subjects upon admission. Patients divided into two groups: I, II according to ECG criteria. Group I was patient with ECG criteria A (decreased ST segment III+aVF ≥ 2.5mm) to predict proximal LAD occlusion and Group II was patient with ECG criteria B (elevated/isoelectric III, aVF) to predict distal LAD occlusion. The patients were performed coronary angiography during hospitalization to assess site of LAD coronary artery occlusion. Angiography finding were evaluated by an experienced angiographer (Cardiologist) blinded to the results of the ECG findings. Proximal LAD was defined as the part of LAD artery proximal to and or including the origin of first diagonal branch (D-1). Distal LAD was defined as the part of distal LAD artery to D-1 or after the origin first diagonal branch.

Statistical Analysis

Categorical variables are presented by number or frequency (n) and percentage (%). Numerical variables are represented by mean and standard deviation for normally distributed data, if data not normally distributed, the data shown by median. For bivariate analysis, Chi Square test was conducted between ECG criteria and site of LAD coronary artery occlusion. Standard methods were used to calculate sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV); 95% confidence intervals (95% CIs) were calculated.

Results

A total of 66 patients with anterior STEMI were included in this study. Most of the subjects were men (89.4%) with average age was 50 years old and above. For the risk factors, smoker was dominant risk factor than others, about 69%. For Killip classification, the most found in Killip class I (78.8%). Overall there were no significant

difference between variables in two groups, but some variables found significant difference, such as deviation in inferior lead, ejection fraction (EF), onset time and CK-MB level. For the onset of STEMI, the median each group were 8.25 (0-24) hours and 23 (2-24) hours. From the echocardiography data, we found that average EF in group I was 44±6,8%, showed that EF in group I was lower than group II. For the CK-MB level between two groups, the highest CK-MB level came from group I, with the level was 255±239,4.

Table 1. Baseline Characteristics based on ECG Criteria

Variables	ECG Criteria		P value
	A (n= 32) (48.5%)	**B (n= 34) (51.5%)**	
Age (years)	53,4± 11,7	50,6±7,8	0,255*
Gender			
Male	28 (87,5%)	31 (91%)	0,705*
Female	4 (12,5%)	3 (9%)	
Risk factors			
Diabetes Mellitus	5 (15,6%)	11 (32,3%)	0,194#
Smoker	20 (62,5%)	26 (76,4%)	0,334#
Hypertension	20 (62,5%)	12 (35,3%)	0,050#
Dyslipidemia	6 (18,7%)	7 (20,5%)	>0,999#
Killip Classification			
I	25 (78,1%)	27 (79,4%)	
II	6 (18,8%)	6 (17,6%)	
III	0 (0%)	0 (0%)	0,992#
IV	1 (3,1%)	1 (3%)	
Onset (hours)	8.25 (0,5-24)	23 (2-24)	0,001##
Elevated ST segment (mm)	3 (2-4,5)	3 (2-4,5)	0.106##
Deviation of lead III (mm)	1,5 (0-2)	0 (0-2)	0,000##
Deviation of lead aVF (mm)	1,25 (0-2,5)	0 (0-2)	0,000##
Deviation of inferior ST segment			
Depression	26 (81.2%)	9 (26,5%)	-
Elevation/Isoelectric	6 (18,8%)	25 (73,5%)	
Infarct location			
Anteroseptal	17 (53%)	21 (61,7%)	
Anterolateral	7 (21,8%)	8 (23,5%)	0,571#
Exstensive anterior	8 (25%)	5 (14,7%)	
Ejection fraction	44±6,8	48±5,6	0,020*
Troponin I (ng/mL)	8 (0-35)	11,5 (0,10-32)	0,433##
CK-MB (U/L)	255±239.4	144±118,6	0,017*
Site of Occlusion			
Proximal	26 (81.2%)	9 (26,5%)	-
Distal	6 (18.8%)	25 (73,5%)	
Vessel Disease			
CAD1VD	28 (87,5%)	27 (79,4%)	
CAD2VD	3 (9,3%)	2 (5,8%)	0,243#
CAD3VD	1 (3,1%)	5 (14,7%)	

*T-test **Fisher #Chi-Square ## Mann-Whitney

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From the table 2 we can see that, patients with anterior STEMI demonstrate that in group I 26 of 32 (81.3%) patients met the ECG criteria of proximal LAD, whereas in group II 25 of 34 (73.5%) patients met the ECG criteria of distal LAD. So there was a statistically significant relation found in the analysis of the relation between the ECG criteria and the site of LAD coronary artery occlusion by angiographic findings.

Table 2. Comparison Test Between ECG Criteria and Site Occlusion of LAD Coronary Artery

		Site of LAD Occlusion				P value*
		Proximal LAD		Distal LAD		
		n	%	n	%	
ECG Criteria						
	A	26	81,3	6	18,8	<0,0001
	B	9	26,5	25	73,5	
	Total	35	53,0	31	47,0	

* Chi-Square

From the table 3 we can see that, In group I, ECG criteria that predict the angiographic findings showed a sensitivity and specificity of 74% and 83%, respectively, with 42.6% PPV and 73% NPV. However, in group II, the sensitivity and specificity of the ECG criteria were 80% and 74%, respectively, with 40.9% PPV and 81% NPV. In predict the site of LAD artery occlusion, the ECG criteria had strong prediction.

Table 3. Diagnostic Value of ECG Criteria in Determine Site Occlusion of LAD Coronary Artery

		AUC	Sensitivity	Specificity	PPV	NPV
ECG Criteria	A	0.775	74,3%	80,6%	81,2%	73,5%
	B	0.775	80,6%	74,3%	73,5%	81,2%

PPV:Positive Predictive Value NPV:Negative Predictive Value

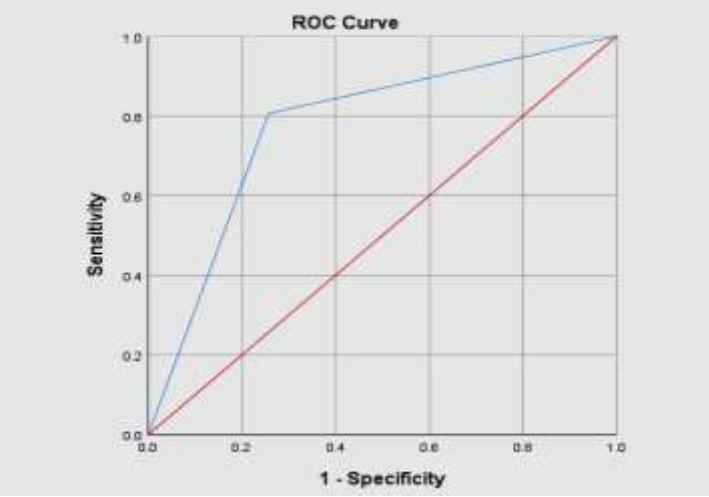

Figure 1. ROC Curve of ECG Criteria to Predict Site Occlusion LAD

Discussion

Anterior STEMI is the most commonly found of STEMI, that involves LAD coronary artery, which have significant contribution blood flow to left ventricular myocardial, about 50%. Site occlusion of LAD coronary artery related to extended size of myocardial infarction and worse prognosis. The early detection from admission ECG, can help us to do the best further management and can decrease the morbidity and mortality.[8]
This research is a cross sectional to find out relationship ECG criteria with site occlusion of LAD coronary artery in patient with anterior STEMI. This research was conducted at RSUP Adam Malik Medan from January to December 2019 and involved 66 subjects that met inclusion and exclusion criteria. The ECG was recorded at admission in ER, and then coronary angiography procedure performed during patients hospitalization.

From 66 subjects, we found that the average was above 50 years old, and there were59 male (89.4%) and 7 female (10.6%) patients. Our data was similar with previous studies by Kamal et al 2019, in which the average age was 51-60 years old, with the presentation of male was more dominant than female, 86% and 14%. Khan et al also found the similar data, percentage of male gender was higher than female, 63% and 34%, with the average age was 51-60 years old. This condition defined that myocardial infarction frequently occurs in the middle age and the gender dominated by male.[10,11]

In Our study showed that smokers was seen among majority of subjects, about 69% and then followed by hypertension 48%, and diabetes mellitus 24%. Similar data also found, from the study of Kamal et al2019, subjects with smoker was most common, about 68%, and the others, such as hypertension 48% and diabetes mellitus 38%.[10]

The average value of EF in our study was 46% and the Killip class was most common in Killip class I about 78.8%. Previous study from Tagileri et al, also found similar data, with the median value of EF was 50% (40-58%) with the same Killip classification most common with Killip class 1, about 63%.[12] And there was significant difference of EF value between two groups, which in EF from group I was higher than group II. This condition similar with study data from Sasaki et al 2007, EF value in group subjects with depression ST segment inferior had lower EF than group subjects elevated ST segment inferior, which in 48±6,10and 53±6.[13] This condition defined that site occlusion of LAD related with extended size of myocardial infarction who can impact of EF value, because more proximal the site of occlusion, so the area of infarction will be occurred also more expansive.[8]

In our study was found that significance difference in the median of onset between these two groups, which in 8.25 (0-24) hours and 23 (2-24) hours. But in study of Camara et al found the average onset was 3.95 hours, while in Fiol et al study 2007, found that the average of onset was 147±108 min. From the data we can see that there were so difference value of the onset, this condition occurs because in previous study, the onset was 6 < hours, this condition appropriate with the median of troponin in group II was higher than group I, even not significant difference statistically.[9,14] But as the theory, this condition consistent with the troponin level, which start to raise at 3-4 hours after the symptoms, and reach the peak level at 18-36 hours after. This condition was inversely from CK-MB level, we found the significance difference from its, which CK-MB in group I was higher than group II, 255 ± 239,4 U/Lvs144±118,6 U/L. This condition may occurs because the CK-MB levels start to raise at 3-8 first hours.[15]From Fiol et al, also found that the CK-MB levels in group high risk (proximal LAD occlusion) was higher than group low risk (distal LAD occlusion), which in 479±371 and 321±265 (p = 0.027).[9]

The main goal of this study was to assess the relation between ECG criteria and the site of LAD coronary occlusion, based on Chi Square test, we found significant relation between this two, with p value < 0.0001.

From this study also found, in group I, ECG criteria that predict the angiographic findings showed a sensitivity and specificity of 74,3% and 80,6%, respectively, with 81,2% PPV and 73,5% NPV. However, in group II, the sensitivity and specificity of the ECG criteria were 80,6% and 74,3%, respectively, with 73,5% PPV and 81,2% NPV. In predict the site of LAD artery occlusion, the ECG criteria had strong prediction (AUC 0.775) for each

criteria. From previous study of Fiol et al 2007, this study was performed in 100 subjects anterior STEMI patients to predict site of LAD coronary artery occlusion, found that group I that predict the angiographic findings showed a sensitivity and specificity of 77% and 84%, respectively PPV and NPV, 92% and 61% while for in group II found that sensitivity and specificity, 62% and 69%, respectively PPV and NPV, which in 45% and 82%. From Kamal et al 2016, found that in group I found sensitivity and specificity, which in 55.6% and 100%, respectively PPV and NPV was 100% and 80%, while in group II, sensitivity and specificity was 84.4% and 100%, respectively PPV and NPV was 100% and 78.3%.[9,10]

There is some limitation of this study such as single center with limited study subjects, so needed the next study with bigger sample to decrease bias. In this study did not performed serial ECG, so we can not determine the clear onset about reciprocal of ECG back to isoelectric line.

Conclusion

ECG criteria in anterior STEMI patient based on ST‑segment deviations in inferior lead allowed to predict the site of occlusion with good accuracy

Conflict of Interest

The authors declare that there is no conflict of interest.

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