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Terminal QRS Distortion on Admission ECG as a Predictor for Major Cardiovascular Adverse Events During Hospitalization in Patient with ST Segment Elevation Myocardial Infarction in Haji Adam Malik General Hospital

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ABSTRACT

Background: Mortality in patient with acute myocardial infarction has decreased due to evolution in management system in patient with acute coronary syndrome, but mortality rate during hospitalization remains high, especially STEMI. Electrocardiography (ECG) has a role for diagnosing and predict prognosis in acute myocardial infarction. Terminal QRS distortion defined as J point elevation more than 50% of R wave in lead with qR configuration and/or loss of S wave with RS configuration. Changes of terminal QRS segment believed to be caused by electrical conduction elongation in Purkinje fiber or myocardial ischemic zone that represent severe ischemia. The purpose of this study is to assess the role of terminal QRS distortion as one of the parameter to predict major adverse cardiovascular events during hospitalization in ST elevation myocardial infarction in RSUP H. Adam Malik

Methods: This is a ambispective observational study consist of STEMI patients who were hospitalized from Mei 2019 to September 2019. All subjects diagnosed with STEMI and already fulfilled the inclusion and exclusion criterias. The terminal QRS distortion on the ECGs was assessed when the patient came to emergency departement. Then during hospitalization, the patients will undergo intervention and then observed during hospitalization for MACE occurrence.

Results: Of the 78 STEMI patients, 44 people had terminal QRS distortion and 34 did not have terminal QRS distortion. In group with terminal QRS distortion, 27 people experiences MACE. From the correlation analysis, there is positive correlation between terminal QRS distortion with MACE with correlation coefficient 0.317 (p value < 0.001). Multivariate analysis for most significant variable for MACE occurrence shows that terminal QRS distortion can predict MACE (OR 3.66 [1.317-10.166], 95% CI, p = 0.013)

Conclusion: Terminal QRS distortion found in ECG at admission in STEMI patient correlate with major adverse cardiovascular event during hospitalization.

INTISARI

Latar Belakang: Mortalitas pada pasien dengan infark miokard akut telah menurun dikarenakan perkembangan dari sistem tatalaksana pasien-pasien dengan sindroma koroner akut, akan tetapi tingkat mortalitas selama rawatan masih termasuk tinggi, terutama pada pasien dengan IMA-EST. Elektrokardiografi (EKG) berperan untuk mendiagnosa dan menentukan prognosis pada infark miokard akut. Distorsi terminal QRS didefinisikan sebagai dijumpainya elevasi J point lebih dari 50% dari tinggi gelombang R pada sadapan dengan konfigurasi qR dan/atau hilangnya gelombang S pada sadapan dengan konfigurasi Rs. Perubahan pada bagian terminal dari QR*S*

diyakini disebabkan oleh pemanjangan konduksi listrik pada serat Purkinje atau zona iskemia pada miokard yang menggambarkan iskemia berat. Tujuan dari penelitian ini adalah untuk menilai peranan distorsi terminal QRS sebagai salah satu parameter yang dapat digunakan untuk prediksi kejadian kardiovaskular mayor selama rawatan pada pasien infark miokard akut elevasi segmen ST di RSUP H. Adam Malik.

Metode: Penelitian ini merupakan penelitian observasional ambispektif terhadap pasien IMAEST yang menjalani perawatan di RSUP HAM sejak Mei 2019 sampai September 2019. Semua subyek penelitian yang didiagnosa dengan IMAEST dan memenuhi kriteria inklusi dan eksklusi diikutsertakan dalam penelitian dan dinilai distorsi terminal QRS pada EKG saat pasien pertama kali datang ke rumah sakit. Selama perawatan pasien akan menjalani intervensi dan dilakukan pemantauan selama rawatan untuk menilai KKvM.

Hasil: Dari 78 pasien IMAEST, sebanyak 44 orang mempunyai distorsi terminal QRS dan 34 orang tidak mempunyai distorsi terminal QRS. Dari kelompok dengan distorsi terminal QRS, 27 orang mengalami KKvM. Berdasarkan pada analisa korelasi, dijumpai korelasi positif antara distorsi terminal QRS dengan KKVM dengan koefisien korelasi 0.317 ($p < 0.001$). Analisa multivariat untuk variabel yang paling bermakna terhadap KKvM, didapati distorsi terminal QRS dapat memprediksi KKvM (OR 3.66 [1.317-10.166], 95% CI, $p = 0.013$)

Kesimpulan: Distorsi terminal QRS pada EKG saat admisi pada pasien IMAEST berhubungan dengan kejadian kardiovaskular mayor selama rawatan.

Introduction

Heart disease is a global problem that was found in various developing and developed countries. According to WHO in 2015, ischemic heart disease was placed as number one cause of death worldwide.[1] In Indonesia, highest cause of death after stroke is caused by coronary artery disease, with around 12.9% of total population, based on survey data from 2014.[2] Acute coronary syndrome data from developing countries is still scarce, including Indonesia. According to Jakarta Acute Corornary Syndrome registry that began in 2014, around 30% of patient with ACS were patient with ST segment elevation myocardial infarction. From all patient with STEMI, 54% received primary reperfusion by percutaneous coronary intervention or thrombolytics where mortality rates during hospitalization was higher in patient without reperfusion.[3]

Mortality in patient with ACS has decreased due to advances in management system of ACS patients, but mortality rate during hospitalization remains high, especially in STEMI. There are several factor that affect mortality which is age, heart rate, diabetes, decreased kidney function, left ventricular dysfunction (from heart failure until cardiogenic shock), history of cardiac arrest and ventricular arrythmia.[4,5,6]

Risk stratification in STEMI generally done by using several risk score according to clinical presentation and prove of left ventricular dysfunction. Electrocardiography (ECG) has a role for diagnosing and prognosis in acute myocardial infarction. Assessment of QRS morphology in STEMI patient ECG can be done to predict in hospital mortality. Specific QRS morphology that known as terminal QRS distortion during admission independently correlate with increased mortality during hospitalization.[7,8]

Terminal QRS distortion defined as J point elevation more than 50% of R wave height in lead with qR configuration and/or loss of S wave in lead with Rs configuration. Changes in terminal segment of QRS complex is believed to be caused by longer electrical conduction in purkinje fiber or ischemic zone in the myocardium that represent severe ischemia. Birnbaum hypothesize that no terminal QRS distortion in STEMI patient is a sign of myocardial protection due to persistent perfusion (by collateral circulation or incomplete arterial occlusion) or because of ischemic preconditioning or medication.[9,10]

Rommel et al. uses cardiac magneting resonance (CMR) to assess myocardial damage after STEMI. In their study, it is concluded that grade III ischemia marked by terminal QRS distortion also correlate with infark size, myocardial salvage, microvascular obstruction and MACE in STEMI patients.[11]

Knowing the correlation of terminal QRS distortion with MACE, we try to analyze the role of terminal QRS distortion as a parameter for MACE prediction in STEMI patient in H. Adam Malik General Hospital, Medan, Indonesia.

Methods

Study Design

This is an observational ambispective study conducted at H. Adam Malik General Hospital in Medan, Indonesia, with

permission from the Research Ethics Committee of Faculty of Medicine, University of Sumatera Utara.

The study subjects were patients that diagnosed as STEMI that admitted to the emergency department (ED) from May 2019 until September 2019. The inclusion criteria were patients with a diagnosis of STEMI. Patient with ECG feature that disturb interpretation of ST segment such as bundle branch block or pacemaker rhythm, patient with history of CABG or PCI, and patient with fibrinolytics were excluded from this study. Terminal QRS distortion was assessed in the ED then the patient observed during hospitalization.. In this study, 78 peoples have met the inclusion and exclusion criteria.

Study Procedure

Baseline clinical and demographic characteristics including age, sex, previous history of illness such as diabetes mellitus, hypertension, heart failure, stroke, vascular disease and hyperlipidemia, smoking history, family history of CHD and vital sign. The initial important data evaluated were terminal QRS distortion from admission ECG in the emergency room of H. Adam Malik General Hospital. The patient also undergoes blood test and chest x-ray. Patient then observed for MACE during hospitalization, left ventricular ejection fraction and intervention such as PCI, primary PCI, CABG or conservative management were also recorded

Statistical Analysis

All statistical analyses were carried out using the SPSS statistical software. Categoric variables are presented by number or frequency (n) and percentage (%). Numeric variables are presented with mean values with standard deviations for normally distributed data. The normality test of numeric variables in all study subjects was using the Kolmogorov-Smirnov test (n>50). Bivariate analysis was done by using Mann Whitney test for numerical variable and Fisher Test for categorical variable. Correlation between terminal QRS distortion with MACE analyzed by using Pearson Correlation

Multivariat analysis was done by using logistic regression to find the best variable for MACE prediction in STEMI patient, p value < 0.05 considered statistically significant.

Results

Baseline Characteristics

Total subject of this study is 78 patient which consist of 67 male (85.9%) and 11 female (14.1%). Based on risk factors, smoking history is the most frequent risk factor that patient have which are 61 patients (78.2%) followed by dyslipidemia, hypertension, and diabetes (table 1).

Based on STEMI location, we found 56 (71.8%) anterior STEMI and 22 (28.2%) non anterior STEMI. From the ECG, 44 (56.4%) patient has terminal QRS distortion and 34 (43.6%) patient did not. During hospitalisation, 37 patients (47%) experience MACE with acute heart failure were the most frequent MACE which is 19 case (24.4%) followed by inhospital death (13 case, 16.7%), cardiogenic shock (10 case, 12.8%), ventricular arrythmia (8 case, 10.3%) and heart block (3 case, 3.8%).

Bivariate analysis was done to assess the correlation or significant difference between baseline characteristic of this study toward MACE and we found that several characteristic had statistical significance (p value <0.05) which is terminal QRS distortion, onset, Killip, leukocyte level, and creatinin level. Baseline characteristic according to MACE can be seen in table 2.

Table 1.

Baseline Characteristic	
Characteristics	
Sex	
Male	67 (85.9%)
Female	11 (14.1%)
Age	55 (34-82)
Risk Factor	
Hypertension	40 (51.3%)
Diabetes Melitus	36 (46.2%)
Dyslipidemia	51 (65.4%)
Smoking History	61 (78.2%)
Clincal Parameter	
Heart Rate (bpm)	85 (60–120)
Systolic BP (mmHg)	120 (70-180)
Diastolic BP (mmHg)	75(50–100)
Onset (hours)	27 (1-96)
Killip	
I	54 (69.2%)
II	20 (25.6%)
III	1 (1.3%)
IV	3 (3.8%)
ECG	
ST Elevation	
Anterior	56 (71.8%)
Non Anterior	22 (28.2%)
Terminal QRS Distortion	
Yes	44 (56.4%)
No	34 (43.6%)
Laboratory Result	
Haemoglobin	13.9 (11.2-17.7)
Leucocyte	12,000(6,010-25,560)
Ureum	30.6 (11-62)
Creatinin	0.97 (0.38-2.2)
Ejection Fraction	43.5 (25-67)
Coronary Angiography	
1VD	31 (39.7%)
MVD	47 (60.3%)
Intervention	
PCI	39 (50%)
Primary PCI	22 (28.2%)
CABG	1 (1.3%)
Conservative	16 (20.5%)
MACE	37 (47.4%)
Acute Heart Failure	19 (24.4%)
In Hospital Mortality	13 (16.7%)
Heart Block	3 (3.8%)
Ventricular Arrythmia	8 (10.3%)
Cardiogenic Shock	10 (12.8%)

Table 2.
Baseline Characteristics According to MACE

Characteristics	MACE		p
	Yes (n=37)	No (n=41)	
Sex			
Male	31 (83.8%)	35 (87.8%)	0.616
Female	6 (16.2%)	5 (12.2%)	
Age	57 (38-77)	53 (36-74)	0.059
Risk Factor			
Hypertension	14 (58.3%)	17 (60.7%)	0.663
Diabetes Melitus	15 (62.5%)	9 (32.1%)	0.679
Dyslipidemia	13 (54.2%)	14 (50%)	0.381
Smoking History	21 (87.5%)	20 (71.4%)	0.565
Clincal Parameter			
Heart Rate (bpm)	83 (60-115)	83 (64-96)	0.1
Systolic BP (mmHg)	121 (70-160)	124 (100-180)	0.476
Diastolic BP (mmHg)	75 (50-100)	77 (60-100)	0.463
Onset (hours)	18.5 (2-72)	36 (1-96)	0.019
Killip			<0.01
I	19 (51.4%)	35(85.4%)	
II	14 (37.8%)	6 (14.6%)	
III	1 (2.7%)	-	
IV	3 (8.1%)	-	
EKG			
ST Elevation			0.225
Anterior	29 (78.4%)	27 (65.9%)	
Non Anterior	8 (21.6%)	14 (34.1%)	
Terminal QRS Distortion			<0.01
Yes	27 (73%)	17 (41.5%)	
No	10 (27%)	24 (58.5%)	
Laboratory Result			
Haemoglobin	13.3 (11.2-17.7)	14.1 (11.2-16.6)	0.34
Leucocyte	13,700 (6,010-28,580)	11,160 (6,200-13,470)	<0.01
Ureum	32 (15-62)		0.406
Creatinin	29 (11-60) 1.1(0.7-1.84)	0.8 (0.3-2.2)	<0.01
Ejection Fraction	42.7 (25-67)	44.2 (27-61)	0.123
Coronary Angiography			<0.01
1VD	9 (24.3%)	22 (53.7%)	
MVD	28 (75.7%)	19 (46.3%)	
Intervention			0.732
PCI	18 (48.6%)	21 (51.2%)	
Primary PCI	12 (32.4%)	10 (24.4%)	
CABG	1 (2.7%)	-	
Conservative	6 (16.2%)	10 (24.4%)	

Correlation between Terminal QRS Distortion with Major Adverse Cardiac Events (MACE)

By using Pearson correlation analysis, we found moderately positive correlation between terminal QRS distortion (r =0.317, p <0.001). Among 44 (56.4%) STEMI patient with terminal QRS distortion, there are 27 MACE occurrences if compared to 34 (43.6%) STEMI patient without terminal QRS distortion.

Analysis of Variables that Correlates with MACE in STEMI patients

From univariate analysis, there are several parameters that correlates with MACE, all 5 significant variable then analyzed by using multivariate analysis. The variable are terminal QRS distortion, onset, Killip, leukocyte level, and creatinin level with odds ratio of terminal QRS distortion are 2.08 (1.46-9.91, 95% CI)

Multivariate analysis was done by using logistic regression to find most significant variable that affect MACE in STEMI patient and we fouond that terminal QRS distortion and Killip class are the most significant variable (Table 3).

Table 3.
Logistic Regression Analysis of Parameter that Correlates with MACE

Parameter	OR (95% CI)	P value
Terminal QRS Distortion	3.66 (1.317-10.166)	0.013
Killip	5.323 (1.72-16.464)	0.004

Discussion

Baseline characteristic between two groups shows significant differences from STEMI onset, Killip class, leukocyte and creatinin level. MACE in STEMI patient can occur in 4.2% until 51% without considering methods of management and MACE can still happened until 10 years after index hospitalization, this in turn caused MACE to be unpredictable accurately.[12]

Hou et al, states that there are several parameter that can be used to assess prognosis of STEMI patient that has been reperfused by PCI which is anterior infarction, cardiogenic shock, CKMB and creatinin level, Killip class, and GRACE score.[13]

From baseline characteristic, we found 78 subject which 44 (56.4%) has terminal QRS distortion and 34 (43.6%) without. Among those subject, 37 (47.4%) experienced MACE and 41 (52.5%) did not. Correlation between terminal QRS distortion at admission ECG with MACE during hospitalization has statistical significance with p value < 0.001. Terminal QRS distortion has moderately positive correlation with Pearson r value 0.317. multivariate analysis with logistic regression found that terminal QRS distortion and Killip are two most significant parameter to predict MACE during hospitalization where terminal QRS distortion has odds ratio 3.66 (1.317-10.166, 95% CI, p 0.013).

Several other studies shows that patient with grade III ischemia, shown from admission ECG, correlate with poor prognosis during hospitalization, poor response from fibrinolytic therapy, higher mortality even after primary PCI and higher infarct size. Grade III ischemia also related with higher SYNTAX score, higher no reflow phenomenon, and severely reduced left ventricular function.[14,15]

Sejersten et al states that higher 30 day mortality of STEMI patient with terminal QRS distortion on admission ECG if comapred to without terminal QRS distortion (9.7% vs 4.8%, p value < 0.001) and even in STEMI population that had done early reperfusion by primary PCI, only patient with onset < 3 hour has benefit of reduced mortality. Logistic regression shows that grade III ischemia independently correlated with mortality (odds ratio 1.9 (1.06-3.44) ; 95% CI, p = 0.03).[16]

Rommel et al uses cardiac magneting resonance (CMR) to assess myocardial damage after STEMI. In their study, it is concluded that grade III ischemia marked by terminal QRS distortion also correlate with infark size, myocardial salvage, microvascular obstruction and MACE in STEMI patients. Grade III ischemia also independently correlate with MACE around 45 incidence (7.9%).11 Yilmaz et al states that short term mortality is higher in STEMI patient with grade III ischemia (17.2% vs 4.8%; p <0.001), even during 36 months follow up, grade III ischemia still related to higher STEMI mortality (35.4% vs 19.5%; p = 0.01).[17]

Result of this study is consistent with other studies, which shows that terminal QRS distortion from admission ECG correlated with higher MACE in STEMI patients. In this study, we found no significant correaltion between type of intervention with MACE in STEMI patients with terminal QRS distortion. Garcia et al shows that in hospital mortality from their study was around 7.16%, which by implementing reperfusion network, overall inhospital mortality was reduced but after further analysis, reperfusion therapy is not the main factor for reduced mortality but possibly also benefit from guideline directed medical therapy.6 Niccoli et al also found that along the advances in STEMI management, mortality rates reduced during last 4 decade with 1 year mortality rate around 7% until 8%. But, rates of inhospital mortality did not changes significantly and rates of morbidity caused by LV remodelling and heart failure still significant and keep increasing. This is possibly due to presence of microvascular obstruction with varying degree.[18]

Study Limitation

Sample size in this study is relatively smaller than other study and only collected from one hospital so this study has bias potential and subject observation only done during hospitalization so we need longer and continual observation for STEMI patient. This study also includes non spesific STEMI population which may caused weaker correlation from statistic analysis

Conclusion

This study concludes that terminal QRS distortion from admission ECG in STEMI patient has moderately positive correlation with MACE during hospitalization

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Disclosures and Ethics

This study received ethical permission from Health Research Ethical Committee Of North Sumatera c/o Medical school, Universitas Sumatera Utara and Research and Development Division of Adam Malik General Hospital

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