Original Article

Fragmented QRS; as a new sign on ECG for pre-diagnosis of non-ST elevation myocardial infarction

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Abstract

Aim: The aim of this study is to evaluate the predictive value of fragmented QRS (fQRS) wave to detect non-ST elevation myocardial infarction (Non-STEMI).

Material and Methods: The study included patients who were diagnosed with Non-STEMI in emergency department and underwent percutaneous coronary intervention in the cardiology clinic. Coronary artery circulation is anatomically divided as the left anterior descending coronary artery (LAD) (V1-V5), the left Circumflex (LCx) (I, aVL and V5,V6) and the right coronary artery (RCA) (II, III and aVF).

Results: Our study included 191 patients. Significant fQRS was detected in 139 (%73) patients and ST/T was detected in 79 (%41) patients. The sensitivity, specificity, of fQRS in the inferior leads to predict RCA lesionwas 76%, 46%, respectively. The sensitivity, specificity, of ST/T in the inferior leads to "predict RCA lesion was 12%, 93%, respectively. The sensitivity, specificity of fQRS in the lateral leads to predict LCx lesion were 44% and 83%, respectively. The sensitivity, specificity of ST/T in the lateral leads to predict LCx lesion were 34%, 74%, respectively. The sensitivity, specificity of fQRS in the anterior leads to predict left LAD lesion were 34% and 82%, respectively. The sensitivity, specificity of ST/T in the anterior leads to predict LAD lesion were 38%, and 81%, respectively.

Conclusion: We have compared to fQRS and ST/T on ECG; fQRS has higher sensitivity than ST/T to predict culprit coronary artery lesion. Therefore, evaluation of fQRS in addition to ST/T on ECG may be more valuable in pre-diagnosis of Non-STEMI.

Keywords: Electrocardiogram; Fragmented QRS; Non-ST elevation myocardial infarction.

INTRODUCTION

Acute coronary syndrome (ACS) characterized by myocardial ischemia and necrosis associated with high mortality rate and poor prognosis. Diagnosis of ACS based on the patient's clinical manifestations and medical histories, the levels of cardiac enzymes, echocardiographic and electrocardiographic findings (1,2).

ACS is a clinical case which includes unstable angina pectoris (USAP), non-ST elevation myocardial infarction (Non-STEMI) and ST elevation myocardial infarction (STEMI). There are significant differences in the physiopathologies, prevalences, etiologies, ECG and biochemical characteristics, treatments and clinical outcomes of Non-STEMI and STEMI (1,3).

The first diagnostic test is ECG in the emergency department to detect ACS. In recent years, QRS fragmentation(fQRS) has been investigated in addition to pathological ECG findings (pathological Q, ST segment depression, R progression loss, T inversion) of Non-STEMI in the last studies and the studies have reported that fQRS may indicate coronary artery lesions (1,2,4).

Fragmented QRS complexes can be used as a marker of myocardial infarction and to predict cardiac events and cardiac death as a consequence of myocardial infarction. In addition, the appearance of the fQRS complex is more sensitive than ST-T changes and pathological Q waves in the diagnosis of Non-STEMI, and fQRS has also been associated with previous silent myocardial infarctions, which are commonly seen in females with atypical chest pain, patients with diabetes mellitus, and in older patients with dementia (5,6).

The early use of proper medications including anti-platelets and anticoagulants is critical for a favorable prognosis of Non-STEMI. However, it is difficult to differentiate patients with Non-STEMI from those with USAP if cardiac enzyme tests are not readily available. As the fQRS complex can be detected as early as several hours after AMI (6,7).

There are a few studies comparing fQRS with pathologic Q wave, ST segment depression and T inversion to predict culprit coronary artery lesion (cCAL) (2,7,8). However, no sufficient studies are available about comparing predictive values of fQRS and ST/T signs on predicting cCAL.

The aim of this study is to evaluate the predictive value of fragmented QRS (fQRS) wave to detect non-ST elevation myocardial infarction (Non-STEMI) and to compare the fQRS and ST-segment depression and/or T wave inversion (ST/T) signs on ECG in the patients who were diagnosed with Non-STEMI in the emergency and cardiology department.

MATERIALS AND METHODS

This study was performed retrospectively after receiving the approval of the hospital ethics committee. The study included patients over 18 years of age who were diagnosed with non-STEMI in emergency department of Antalya Education and Research Hospital between January 2013 and March 2017 and underwent percutaneous coronary intervention (PCI) in the cardiology clinic. Patients with a history of PCI and/or coronary artery bypass graft (CABG) due to CAD, pre-excitation syndrome and permanent external pacemaker, acute or chronic pulmonary thromboembolism and diagnosed with amyloidosis, hypertrophic cardiomyopathy and who did not have ECG record in the patient file or whose ECG could not be evaluated, were excluded from the study.

Standard data entry form was created for the study. The data was collected by recording the demographic data, ECG findings, Percutaneous Coronary Angiography and angioplasty report, echocardiography report, biomarkers in blood tests and final treatment decisions of the patients.

In our study, the normal levels of high sensitive troponin T(hs-TnT) were determined as 0 - 14 ng/L.

ECG Analysis
ECG analysis was performed by the emergency physician and cardiologist blinded to the patients' coronary angiography reports. The presence of rhythm, velocity, right and left bundle branch block, T wave inversion, ST segment depression and pathological Q wave was evaluated in ECG analysis.

Depression value more than 0.05mV at the ST segment was determined as ST segment depression. Inversion value more than 1.00mV at the T wave was determined as the T wave inversion. The fQRS complex was defined by Das et al.(7) as the existence of an additional R wave (R'), notching of the S wave or R wave in two related leads corresponding to a major coronary artery on 12-leads ECG, with a QRS complex of less than 120 ms.The fQRS

pattern could occur in patients with or without Q waves. However, patients with a typical bundle-branch block pattern (QRS ≥ 120 ms) or incomplete bundle-branch block pattern were excluded. Furthermore, patients with a pathological Q wave in the ECG and a history of prior myocardial infarction were also excluded.

Coronary artery circulations were evaluated as the left anterior descending coronary artery (LAD) (V1-V5), the left Circumflex (LCx) (I,aVL and V5,V6) and the right coronary artery (RCA) (II, III and aVF). When fQRS and ST/T findings were detected at least two related leads on 12-leads ECG, was accepted as pathological findings (8).

Two comparisons were performed in the statistical analysis. In the study the first comparison was determined the predictive value of fQRS. For that, patients included who presented with fQRS on 12-leads ECG were in the 1st group and patients included without fQRS on 12-leads ECG were in the 2nd group. In the study the second comparison was determined the predictive value of ST/T. In the second comparison, patients included who presented with ST/T on 12-leads ECG were in the 1st group and patients included without ST/T on 12-leads ECG were in the 2nd group.

Percutaneous Coronary Angiography Results
The Percutaneous Coronary Angiography (PCA) reports of the patients were obtained from the files in the hospital's archive. The presence of stenosis more than 50% in the coronary artery was considered as pathological findings for ACS.

Statistical Method
The statistical analyzes were performed using the SPSS version 21.0 software. Categorical measurements were summarized as number and percentage; continuous measurements were summarized as mean and standard deviation. Chi-square test or Fisher test statistic was used to compare categorical variables. The distributions were checked in the comparison of continuous measurements between the groups, Student T test was used for normally distributed parameters and Mann Whitney U test was used for non-normally distributed parameters. Receiver Operating Characteristic (ROC) analysis was performed to determine the sensitivity and specificity of fQRS and pathological ECG in showing the lesion. The statistical significance level was considered as 0.05 in all tests.

RESULTS

In this present study, 218 patients were retrospectively studied. A total of 27 patients were excluded; 23 patients who were with a history of coronary artery disease and 4 patients who were detected to have right and left bundle blocks. In the study 191 patients were included; 35% of the patients were females (66) and 65% (125) were males. The mean age of the patients was 62±13. There were 3 (2%) patients with atrial fibrillation and 188 (98%) patients with normal sinus rhythm. 184 (96%) patients had right dominant coronary artery circulation and 7 (4%) patients had left dominant coronary artery circulation.

In the study no coronary artery lesions were detected in 39(20%) patients who underwent PCA. Coronary artery lesions were identified in 152 (80%) patients; 83 (43%) patients were identified to have RCA lesion, 65 (34%) patients were identified to have LCx lesion, 106 (55%) patients were identified to have LAD lesion, and 9 (5%) patients were identified to have LMCA (left main coronary artery) lesion. Significant difference was identified between hs-TnT values of patients with coronary artery lesion (CAL) and patients with no CAL.(p<0.001) (Table 1,2; Figure 1).

Table 1. Comparison of coronary artery lesion presence with high sensitive troponin T levels

Lesion	N	Mean ±SD (ng/L)	Min-max (ng/L)
Presence of CAL	152	258±447	3-3035
No-CAL	39	19±39	3-181
CAL : Coronary artery lesion			

Table 2. Results of coronary angiography reports of patients

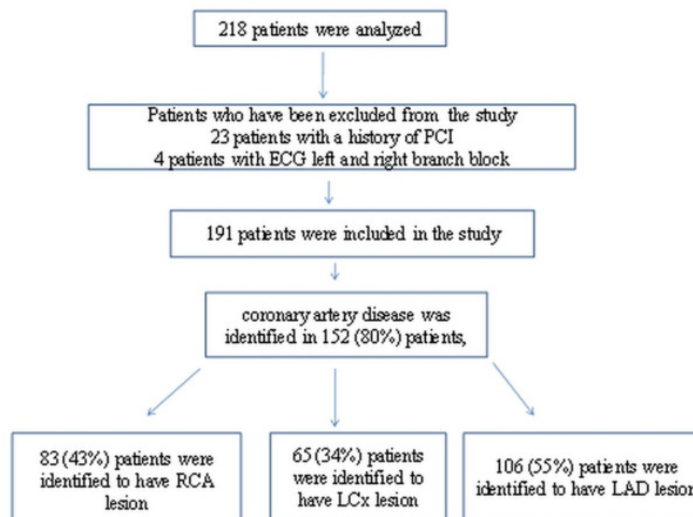| Lesion	Count	%
No-lesion	39	20
RCA only	9	5
LCx only	18	10
LAD only	40	21
RCA+LCx	10	5
RCA+LAD	29	15
LCx+LAD	11	5
RCA+LCx+LAD	26	14
RCA+LMCA	9	5
Total	191	100
RCA: Right coronary artery, LCx: Left circumflex coronary artery, LAD: Left anterior descending coronary artery, LMCA: Left main coronary artery		

Figure 1. Flow chart of study patients

In the study, significant fQRS sign was determined in 139 (73%) patients with Non-STEMI and ST T sign was determined in 79 (41%) patients with Non-STEMI.

RCA lesion was detected in 83 (43%) patients in the study. Significant fQRS was detected in 121 (63%) patients in the inferior leads. The sensitivity, specificity of fQRS in the inferior leads to predictRCA lesion was 76%, 46%, respectively. ST/T was detected in 18 (22%) patients in the inferior leads. The sensitivity, specificity, of ST/T in the inferior leads to predict RCA lesion was 12%, 93%, respectively. (Figure 2,3) (Table 3).
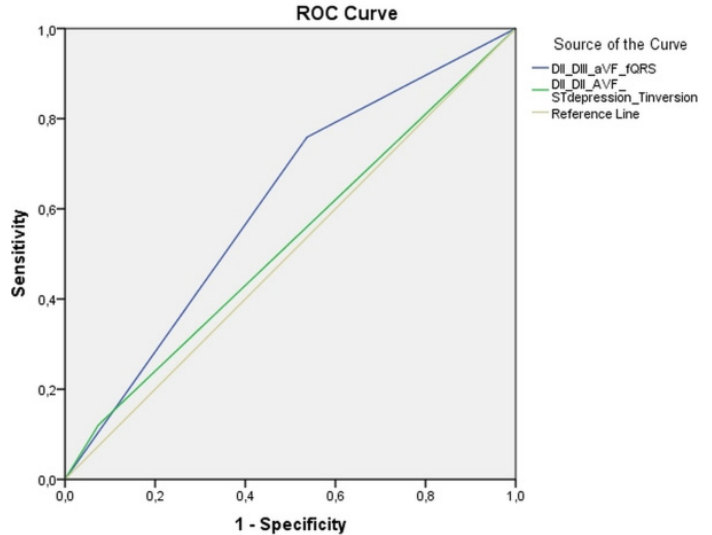

Figure 2. Comparison of ST segment depression/T wave inversion and Fragmented QRS findings to predict the RCA lesion
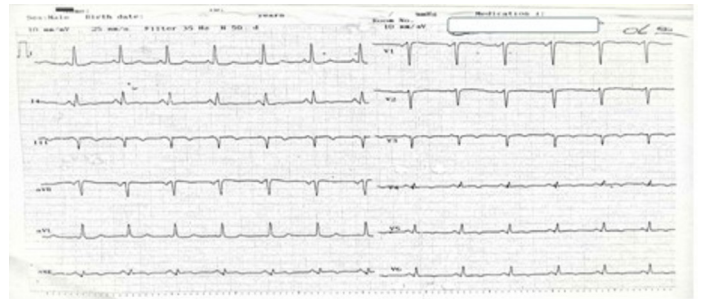

Figure 3. Sixty years old male patient with diabetes mellitus admitted to emergency department with atypical chest pain. fQRS and ST/T findings were detected in the inferior leads and V4,V5,V6 leads on ECG. The Percutaneous Coronary Angiography (PCA) report of the patient was revealed the presence of stenosis more than %50 in RCA and LAD artery

In the study, LCx lesion was detected in 65 (34%) patients. Significant fQRS was detected in 22 (34%)patients in the lateralleads (DI,aVL,V5,V6). The sensitivity, specificity of fQRSin the lateral leads to predict LCx lesion were 34%, 83%, respectively. ST/T was detected in 28(43%) patients in the lateral leads. The sensitivity, specificity of ST/Tin the lateral leads to predict LCx lesion were 34%, 74%, respectively (Table 3).

In the study, LAD lesion was detected in 106 (55%) patients. Significant fQRS was detected in 52 (49%) patients in the anterior leads (V1-V5). The sensitivity, specificity of fQRSin the anterior leads to predict LAD lesion were 34%, 82%, respectively. ST/T was detected in56 (29%) patients in the anterior leads. The sensitivity, specificity of ST/T in the anterior leads to predict LAD lesion were 38%, 81%, respectively (Table3).

The sensitivity of significant fQRS was highest in patients with RCA lesions. The highest significant fQRS specificities were detected in patients with LCx lesions. The highest ST/T sensitivities were detected in LAD lesions. The highest ST/T specificities were detected in RCA lesions (Table 3).

There were both fQRS and ST/T findings in only 15 (23%) patients of 65 patients with LCx lesions, only 6 (7%) patients of 83 patients with RCA lesions and only 12 (11%) patients of 106 patients with LAD lesions.The highest correlation was detected in patients with LAD lesions (Table 4).

Table 3. Specificity and sensitivity of fQRS and ST segment depression/T wave inversion in the study

Coronary Artery	fQRS Sensitivity %	ST /T Sensitivity %	fQRS Specificity %	ST/T Specificity %	fQRS Area	ST/T Area	fQRS %95 CI	ST/T %95 CI
RCA	76	12	46	93	0.611	0.523	531-691	441-608
LCx	44	34	83	74	0.582	0.533	494-670	446-620
LAD	34	38	82	81	0.578	0.597	498-659	517-678
RCA: Right coronary artery, LCx: Left circumflex coronary artery, LAD: Left anterior descending coronary artery, fQRS: fragmented QRS								

Table 4. The ECG findings which were associated with coronary artery lesions

Lesion (N)	fQRS N (%)	ST /T N (%)	fQRS + ST /T N (%)
LCx (65)	122(%34)	28(%43)	3(%5)
RCA (83)	62(%75)	10(%12)	6(%7)
LAD (106)	37(%35)	40(%38)	12(%11)
RCA: Right coronary artery, LCx: Left circumflex coronary artery, LAD: Left anterior descending coronary artery, fQRS: fragmented QRS			

DISCUSSION

ST depressions, pathological Q-wave, T-wave inversion are used as ECG markers in Non-STEMI patients. Recently, fragmented QRS has gained interest. In many studies, fQRS has been found to be moderately sensitive and highly specific for myocardial scarring in CAD patients (9-14). In a study myocardial scar was detected with SPECT, the study demonstrated that fQRS in the anterior leads (V1-V5) defined scar tissue on the anterior wall (LAD) and fQRS in the lateral leads (V6, DI, aVL) defined scar tissue in the lateral area (LCx), and fQRS in the inferior leads (DII, DIII, and aVF) defined scar tissue in the inferior area (RCA) (11).

In a study on NSTEMIs, fQRS has been detected in 60.1% patients with CAD. ST segment depression or T wave inversion has been observed in the rest of the patients. The sensitivity of fQRS to predict RCA lesion was 92%, while the sensitivity of fQRS to predict LAD lesion was 58%. Furthermore, in a study, it was determined that the sensitivity of fQRS was higher than the sensitivity of T inversion to predict RCA lesion in Non-STEMI patients (2).

In a study investigating the effects of fQRS on mortality in patients with ACS, fQRSwas most commonly detected in inferior leads on ECG and there was no difference on mortality in patients with CAD between the anterior wall, lateral wall, and right wall leads (15). In a similar study, mortality and re-infarction rates in ACS patients with fQRS sign on ECG were higher than ACS patients without fQRS sign on ECG (15,16). In another study in patients with ACS,

fQRS, ST segment depression and T wave inversion were found to be independent predictors of mortality in the 34 +/- 16 month period. Again in this study, the sensitivity of fQRS in STEMI and Non-STEMI patients was 55%, 50%, respectively, but the specificity of fQRS was 96% (6).

In our study, 80% of patients had ACS. In the study, hs-TnT levels were found to be very high values in patients with CAL versus patients with no-CAL.Significant fQRS was revealed in 73% of the ACS patients and ST/T was detected in 41% of the ACS patients.In addition, fQRS was the most common pathological ECG sign (63%) in inferior leads on 12-leads ECG.However, ST/T presence rate was the lowest (9%) in inferior leads on 12-leads-ECG.The presence rate of ST/T on ECG was highest in the anterior leads (29%).

In a study conducted on 74 patients considered to have ACS, pathologic Q wave and ST segment depression were compared with fQRS. In this study, the sensitivity (49.0% vs. 36.7%, 17.3%) and specificity (92.0% vs. 78.2%, 80%) of fQRS to pre-diagnose of LAD lesions were found to be higher than others. The sensitivity of fQRS (67.5% vs. 27.5%, 12.5%) was found to be higher than the others topre-diagnose of LCX lesions. However, the highest sensitivity of fQRS was detected topre-diagnose of RCA lesions (78.4% vs. 55.4% and 41.9%) (17).

In our study, fQRS has higher sensitivity than ST/T to predict cCAL.The sensitivity of fQRS is highest in patients with RCA lesions. The highest sensitivity of ST/T to estimate cCAL was in patients with LAD lesions. We

suspect that the sensitivity offQRS and ST/T findings on ECG was very low in patients with LCx lesions, due to the anatomical follow-up of the LCx in the posterior wall of the heart. TheST/T have poor sensitivity in RCA lesions but the specificity of ST/T in RCA lesions is higher than fQRSand both of fQRS and ST/T have poor sensitivities but high specificities in patients with LCx and LAD lesions. The high specificity of fQRS in patients withLCx and LAD lesions and the high specificity of ST/T in patients with RCA lesions are important findings to exclude ACS in clinical practice.

CONCLUSION

In a conclusion, correct diagnosis and treatment of ACS at the emergency department is very important for morbidity and mortality. Differential diagnosis may be difficult, especially in patients who have atypical chest pain and silent ischemia. In this case, the ECG findings are important indicators. Therefore, evaluation of fQRS findings in addition to ST / T findings in ECG is more valuable in terms of predicting the culprit coronary artery lesion in patients who admitted to emergency department with cardiac ischemia symptoms. However, further studies are needed on the subject.

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