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Original article

QRS Fragmentation After Reperfusion in Patients with STEMI

[(1)] Salwa Mohammed Ghoneim, [(1)] Elsayed Mohamed Farag, [(1)] Ahmed Said El-damanhory and [(2)*] Albasheer Miftah Saleem Kindi

[(1)] Department of Cardiovascular medicine, Faculty of Medicine – Zagazig University, Egypt.
[(2)] Department of Cardiovascular medicine, Faculty of Medicine – Almergib University (Libya).

***Corresponding Author:**
Albasheer Miftah Saleem Kindi
sgarbossa1988@gmail.com

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ABSTRACT

Background: Despite advances in the diagnosis, prognosis and treatment with new approaches, STEMI remains the most common cause of cardiovascular mortality and morbidity in developing countries. Aim of the work: The aim of the work was to investigate clinical characteristics of patients with fragmented QRS and QRS distortion to determine if they can help to identify high risk STEMI patients and to determine whether they can be used as non-invasive markers to predict response to reperfusion therapy. **Methods:** The present study conducted on 150 patients who were admitted to Cardiology Department, Zagazig University, from July 2018 to December 2018, with acute STEMI and treated with thrombolytic and/or primary PCI. University, from July 2018 to December 2018, 150 p.t were selected. Patients were divided into 4 groups; **Group 1:** included patients with 15 patients, **Group 2:** included 36 patients with QRS distortion, **Group 3:** included 84 patients with fQRS and QRS distortion and **Group 4:** included 15 patients without FQRS or QRS distortion. **Results**: The present study showed no statistical significant difference between the four groups as regard to age and sex, hypertension, diabetes mellitus, smoking, dyslipideamia and family history of coronary artery disease and a significant statistical difference between patients with lateral MI, fQRS before and after reperfusion and QRS distortion before and after reperfusion and a highly significant statistical difference between different groups regarding EF and WMSI.. **Conclusions:** fQRS and QRS distortion can be used for assessment of success of reperfusion therapy.

Keywords : Percutaneous Coronary Intervention, Myocardial Infarction, fragmented QRS, reperfusion therapy

INTRODUCTION

Despite major advances in cardiac imaging techniques, the standard 12-lead electrocardiogram (ECG) continues to be the most used tool for the diagnosis, early risk stratification, triage, and determination of appropriate therapies in patients with acute ST-segment elevation myocardial infarction (STEMI) **[1]**.

Recent studies have shown that some of the newer ECG parameters can be used to determine if patients are at higher risk. The most important of these new ECG parameters are fragmented QRS (fQRS) and QRS distortion. In previous publication, **Das et al. [2]** extensively described fQRS. The authors explained that fQRS originates from abnormal ventricular depolarization caused by the nonhomogeneous electrical activation of ischemic and/or injured ventricular myocardium.

The associations between fQRS and increased morbidity and mortality, sudden cardiac death, cardiac arrhythmia, and adverse cardiac events have been investigated in previous studies **[3] [4]**.

Tanriverdi and co-workers [5] concluded that, the detailed assessment of fQRS and QRS

distortion by surface ECG is a simple, widely available, and noninvasive modality that may be useful for identifying patients at higher cardiac risk. This assessment can identify patients with larger areas of necrotic myocardium and can be helpful in choosing an appropriate treatment for patients with acute STEMI [**5, 6**].

AIM OF THE WORK

The aim of the work was to investigate clinical characteristics of patients with FQRS and QRS distortion to determine if they can help to identify high risk STEMI patients and to determine whether they can be used as non-invasive markers to predict response to reperfusion therapy.

METHODS

The present study conducted on 150 patients who were admitted to Cardiology Department, Zagazige University, from July 2018 to December 2018, with acute STEMI and treated with thrombolytic and/or primary PCI. Written informed consent was obtained from all participants and the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) **[7]** for studies involving humans.

Patients were divided into 4 groups:

Group 1: included 15 patients with fQRS

Group 2: included 36 patients with QRS distortion.

Group 3: included 84 patients with fQRS and QRS distortion.

Group 4: included 15patients without fQRS or QRS distortion.

Exclusion criteria:

- Bundle branch block, AF and High-grade AV block
- Heart failure.
- cardiomyopathy, valvular and coronary heart disease.
- Patients on drugs affecting QT interval
- preexcitation syndrome.
- Patients on drugs affecting ST segment
- Electrolyte Imbalance

All patients subjected to:

1- Complete history taking.

2- Thorough physical examination.

3- Laboratory investigation including cardiac biomarkers, total cholesterol and triglycerides and serum electrolytes

4- ECG analysis. Standard ECG was evaluated on admission and 2 hours after reperfusion at emergency room triage, Standard 12-lead ECG recorded at 25 mm/sec paper speed and a gain of 10 mm/mv

5- Echocardiography (ejection fraction by Biplane Simpson's method)

6- Coronary angioplasty: STEMI patients underwent primary PCI if indicated.

7- Thrombolytic therapy if indicated. Patient receive thrombolytic therapy underwent coronary angiography within first 24 hours (pharmaco-invasive strategy) **[8].**

Syntax Score:

Syntax score is an angiographic scoring system that was developed to quantify the number, complexity, and location of lesions in patients undergoing coronary revascularization **[9, 10].** The Syntax score has been used to assist in deciding the optimal revascularization strategy for patients with complex coronary artery disease (CAD), because patients with a high SYNTAX score treated by percutaneous coronary intervention (PCI) have been shown to be at a high risk of adverse cardiac events **[11]**.

Statistical analysis

Data were collected, tabulated and analyzed by SPSS 20, software for Windows. The significance level was set at $P < 0.05$.

RESULTS

Table (1), showed that there was no significant statistical difference between all studied groups regarding age, gender and risk factors (P>0.05). Table (2), showed that the lateral MI for the four groups were 6 (40%) for G1, 9 (25%) for G2, 9 (10.7%) for G3 and 3 (20%) indicating that there was a significant statistical difference between all studied groups regarding lateral MI. table showed also that QRS before reperfusion were 15 (100%) for G1, 0 (0%) for G2, 84 (100%) for G3,, 0 (0%) for G4 and 6 (40%) for G1, 0 (0%) for G2, 36 (42.9%) for G3, , 0 (0%)

for G4 after reperfusion indicating that there was a highly significant statistical difference between all studied groups regarding QRS before and after reperfusion and **QRS distortion** before reperfusion were 0 (0%) for G1, 36 (100%) for G2, 84 (100%) for G3, 0 (0%) for G4 indicating that there was a highly significant statistical difference between all studied groups before reperfusion and 0 (0%) for G1, 9 (250%) for G2, 15 (17.9%) for G3, , 0 (0%) for G4 indicating that there was a significant statistical difference between all studied groups after reperfusion. (P<0.05). Table (3), showed that there was highly significant statistical difference between different groups regarding EF (P-value <0.001) and SWMA (P-value <0.001). Table (4), showed that there was a significant statistical difference between different groups regarding CK-MB (P-value <0.001) and troponin (P-value <0.001). While there were no significant statistical differences between different groups regarding serum creatinine, blood urea, FBS, Total cholesterol and Triglycerides (P-value>0.05). Table (5), showed that there was a significant statistical difference between different groups regarding Syntax score (P-value<0.001) and reperfusion result (P-value=0.012). While there was no significant statistical difference between different groups regarding type of reperfusion therapy, culprit vessel, number of affected vessels and number of revascularized vessels. Table (6), showed that there was highly significant difference between patients with fragmented QRS on admission and those without regarding SYNTAX score, reperfusion result and EF (p value <0.001). Table (7), showed that there was a significant difference between patients with distorted QRS on admission and those without regarding SYNTAX score, reperfusion result and EF (p value <0.05). Table (8), showed that there was a significant difference between G1 and G3 regarding CK-MB, troponin, SYNTAX score, reperfusion result and EF. Table (9), showed that there was a significant difference between G2 and G3 regarding CK-MB, troponin, SYNTAX score, reperfusion result and EF.

Table 1. Comparison between the studied groups regarding the demographic data.

Demographic data	G1	G2	G3	G4	**Test**	**P-value (Sig.)**
Count (%)	15 (10%)	36 (24%)	84 (56%)	15 (10%)		
Age (years)						
Mean ± SD	55.4 ± 7.4	55.0 ± 13.9	58.6 ± 10.1	60.4 ± 12.8	5.355 [K]	0.148 (NS)
Median (Range)	57 (43 – 65)	52 (39 – 81)	58 (41 – 83)	55 (46 – 81)		
Gender						
Male	9 (60%)	27 (75%)	54 (64.3%)	12 (80%)	2.777 ‡	0.427 (NS)
Female	6 (40%)	9 (25%)	30 (35.7%)	3 (20%)		
Risk factors						
HTN	12 (80%)	21 (58.3%)	51 (60.7%)	9 (60%)	2.353 ‡	0.503 (NS)
DM	11 (73.3%)	24 (66.7%)	46 (54.8%)	7 (46.7%)	3.734 ‡	0.292 (NS)
Hyperlipidemia	8 (53.3%)	11 (30.6%)	36 (42.9%)	8 (53.3%)	3.543 ‡	0.315 (NS)
Smoking	5 (33.3%)	21 (58.3%)	39 (46.4%)	10 (66.7%)	4.762 ‡	0.190 (NS)
Family history	3 (20%)	18 (50%)	36 (42.9%)	3 (20%)	6.786 ‡	0.079 (NS)

[K] Kruskal Wallis test.
‡ Chi-square test.
$p < 0.05$ is significant.
Sig.: significance.

Table 2. Comparison between the studied groups regarding the ECG data.

ECG data	G1	G2	G3	G4	**Test**	**P-value (Sig.)**
Count (%)	15 (10%)	36 (24%)	84 (56%)	15 (10%)		
Localization of MI						
Anterior	6 (40%)	9 (25%)	42 (50%)	6 (40%)	6.527 ‡	0.089 (NS)
Lateral	6 (40%)	9 (25%)	9 (10.7%)	3 (20%)	9.175 ‡	0.027 (S)
Inferior	3 (20%)	15 (41.7%)	27 (32.2%)	6 (40%)	2.623 ‡	0.453 (NS)
Antero-lateral	0 (0%)	3 (8.3%)	6 (7.1%)	0 (0%)	2.457 ‡	0.483 (NS)
QRS fragmentation						
Before reperfusion	15 (100%)	0 (0%)	84 (100%)	0 (0%)	150.00 ‡	<0.001 (HS)
After reperfusion	6 (40%)	0 (0%)	36 (42.9%)	0 (0%)	30.102 ‡	<0.001 (HS)
Test	7.111 Ɲ	<0.001 Ɲ	46.021 Ɲ	<0.001 Ɲ		
P-value (Sig.)	0.004 (S)	1.00 (NS)	<0.001 (HS)	1.00 (NS)		
QRS distortion						
Before reperfusion	0 (0%)	36 (100%)	84 (100%)	0 (0%)	150.00 ‡	<0.001 (HS)
After reperfusion	0 (0%)	9 (25%)	15 (17.9%)	0 (0%)	8.099 ‡	0.044 (S)
Test	<0.001 Ɲ	25.037 Ɲ	67.014	<0.001 Ɲ		
P-value (Sig.)	1.00 (NS)	<0.001 (HS)	<0.001 (HS)	1.00 (NS)		

‡ Chi-square test.
Ɲ McNemar's test.
p< 0.05 is significant.
Sig.: significance.

Table 3. Comparison between the studied groups regarding the echocardiographic data.

Echocardiographic data	G1	G2	G3	G4	**Test**	**P-value (Sig.)**
Count (%)	15 (10%)	36 (24%)	84 (56%)	15 (10%)		
Ejection fraction (%)						
Mean ± SD	57.9 ± 8.8	59.7 ± 4.6	52.6 ± 8.4	63.4 ± 8.3	35.906 K	<0.001 (HS)
Median (Range)	63 (37 – 65)	62 (48 – 65)	52 (35 – 73)	67 (45 – 70)		
WMSI						
Mean ± SD	1.25 ± 0.21	1.24 ± 0.15	1.39 ± 0.26	1.16 ± 0.18	26.222 K	<0.001 (HS)
Median (Range)	1.15 (1.04 – 1.79)	1.19 (1.07 – 1.93)	1.32 (1.00 – 1.97)	1.11 (1.00 – 1.58)		

K Kruskal Wallis test.
p< 0.05 is significant.
Sig.: significance.

Table 4. Comparison between the studied groups regarding the laboratory data.

Laboratory data	G1	G2	G3	G4	**Test**	**P-value (Sig.)**
Count (%)	15 (10%)	36 (24%)	84 (56%)	15 (10%)		
CK-MB (IU/L)						
Mean ± SD	41.4 ± 14.4	46.1 ± 16.0	74.9 ± 21.9	25.8 ± 8.1	75.096 [K]	<0.001 (HS)
Median (Range)	46 (18 – 55)	45 (14 – 76)	75 (14 –122)	24 (15 – 39)		
Troponin (ng/mL)						
Mean ± SD	3.07 ± 1.80	3.02 ± 1.67	5.37 ± 3.21	1.94 ± 2.24	29.109 [K]	<0.001 (HS)
Median (Range)	2.81 (1.09 – 7.43)	2.57 (0.55 – 8.05)	5.88 (0.60 – 12.44)	0.87 (0.55 – 8.98)		
Serum creatinine (mg/dL)						
Mean ± SD	1.02 ± 0.34	1.11 ± 0.36	1.15 ± 0.39	1.09 ± 0.27	1.030 [K]	0.794 (NS)
Median (Range)	1.0 (0.7 – 1.6)	1.0 (0.6 – 1.8)	1.05 (0.6 – 2.1)	1.2 (0.7 – 1.45)		
Blood urea (mg/dL)						
Mean ± SD	39.8 ± 8.3	33.3 ± 12.9	35.9 ± 17.8	39.4 ± 5.9	7.443 [K]	0.059 (NS)
Median (Range)	35 (32 – 50)	34.5 (10 – 55)	35 (10 – 99)	38 (31 – 55)		
FBS (mg/dL)						
Mean ± SD	137.4 ± 39.1	146.3 ± 83.5	149.9 ± 76.6	116.2 ± 42.5	5.406 [K]	0.144 (NS)
Median (Range)	133 (85 – 185)	103 (75 – 309)	110 (70 – 367)	89 (72 – 166)		
Total cholesterol (mg/dL)						
Mean ± SD	194.4 ± 44.1	206.4 ± 41.2	191.0 ± 48.4	205.8 ± 41.3	5.121 [K]	0.163 (NS)
Median (Range)	190 (123 – 240)	209.5 (107 – 248)	186 (107 – 284)	183 (179 – 284)		
Triglycerides (mg/dL)						
Mean ± SD	117.4 ± 12.4	130.3 ± 26.8	146.4 ± 37.2	140.6 ± 53.6	6.999 [K]	0.072 (NS)
Median (Range)	117 (102 – 138)	135 (83 – 193)	154.5 (95 – 213)	122 (83 – 213)		

[K] Kruskal Wallis test.
p< 0.05 is significant.
Sig.: significance.

Table 5. Comparison between the studied groups regarding the reperfusion method and CA data.

Reperfusion and CA data	G1	G2	G3	G4	Test	P-value (Sig.)
Count (%)	15 (10%)	36 (24%)	84 (56%)	15 (10%)		
Reperfusion						
1ry PCI	0 (0%)	3 (8.3%)	12 (14.3%)	0 (0%)	5.159 ‡	0.161 (NS)
Thrombolytic + PCI	15 (100%)	33 (91.7%)	72 (85.7%)	15 (100%)		
Culprit vessel						
LAD	9 (60%)	21 (58.4%)	63 (75%)	12 (80%)	4.762 ‡	0.190 (NS)
LCX	3 (20%)	3 (8.3%)	9 (10.7%)	0 (0%)	3.492 ‡	0.322 (NS)
RCA	3 (20%)	12 (33.3%)	12 (14.3%)	3 (20%)	5.714 ‡	0.126 (NS)
SYNTAX score						
Mean ± SD	9.4 ± 2.3	9.2 ± 2.6	12.4 ± 5.0	7.6 ± 2.8	21.969 ^{K}	<0.001 (HS)
Median (Range)	8.5 (6 – 13.5)	8.75 (4 – 14)	13.75 (3 – 20.5)	7 (5 – 13)		
N. of affected vessels						
One vessel	6 (40%)	15 (41.7%)	27 (32.1%)	9 (60%)	9.221 ‡	0.162 (NS)
Two vessels	9 (60%)	15 (41.7%)	48 (57.2%)	6 (40%)		
Three vessels	0 (0%)	6 (16.6%)	9 (10.7%)	0 (0%)		
N. of revascularized vessels						
One vessel	15 (100%)	24 (66.7%)	57 (67.9%)	12 (80%)	7.533 ‡	0.057 (NS)
Two vessels	0 (0%)	12 (33.3%)	27 (32.1%)	3 (20%)		
Reperfusion result						
Failure reperfusion	3 (20%)	7 (19.4%)	41 (48.8%)	1 (6.7%)	10.903 ‡	0.012 (S)
Successful reperfusion	12 (80%)	29 (80.6%)	43 (51.2%)	14 (93.3%)		

‡ Chi-square test.
^{K} Kruskal Wallis test.
p< 0.05 is significant.
Sig.: significance

Table 6. Comparison between patients with fragmented QRS on admission and those without regarding SYNTAX score, reperfusion result and EF.

SYNTAX score	QRS fragmented	QRS not fragmented	Test	P-value (Sig.)
Count (%)	99 (66%)	51 (34%)		
SYNTAX score				
Mean ± SD	11.9 ± 4.8	8.8 ± 2.7	3.955 •	<0.001 (HS)
Median (Range)	12 (3 – 20.5)	8.5 (4 – 14)		
Reperfusion result				
Failure reperfusion	44 (44.4%)	8 (15.7%)	12.291 ‡	<0.001 (HS)
Successful reperfusion	55 (55.6%)	43 (84.3%)		
EF (%)				
Mean ± SD	57.2 ± 4.1	50.2 ± 8.2	4.790 *	<0.001 (HS)
Median (Range)	61 (48 – 65)	52 (35 – 73)		

• Mann Whitney U test.
‡ Chi-square test.
p< 0.05 is significant.
Sig.: significance.

This table showed that there was highly significant difference between patients with fragmented QRS on admission and those without regarding SYNTAX score, reperfusion result and EF (p value <0.001).

DISCUSSION

Early risk stratification in patients with acute STEMI is important to identify appropriate treatments, predict high-risk patients, and improve outcomes. Therefore, the risk evaluation should be performed as soon as possible after the hospital admission. Because 12- lead ECG is a simple, inexpensive, and easily accessible tool, a lot of parameters on the admission ECG have been used to date to perform risk stratification in acute STEMI **[12].**

In the present study, the mean age of the patients included in this study was 57.6 ± 11.2 years, with 68% of them male. 10% of patients underwent primary PCI, whereas 90% of patients underwent thrombolytic treatment and secondary PCI. Before reperfusion, fQRS was detected in 99 (66%) patients, QRS distortion was detected in 120 (80%) patients. While after reperfusion, fQRS was detected in 42 (28%) of patients, QRS distortion was detected in 24 (16%) patients. Both FQRS and QRS distortion were present in 84 patients (56%).

In a study by Tanriverdi et al. [5], they found that the mean age of the patients was 63.2 ± 11.9 years. One hundred and thirty-two patients underwent primary PCI, whereas 116 patients underwent thrombolytic treatment. fQRS was detected in 91 (36.7%) patients, QRS distortion was detected in 98 (39.5%) patients, and both fQRS and QRS distortion were detected in 51 (20.6%) patients.

Tanriverdi et al. (13) found that the mean age of study population was 61.3 ± 11.8 years. 454 patients were included in the study Fragmented QRS was detected in 149 (32.8%), and QRS distortion was detected in 186 (41%) patients. Both fQRS and QRS distortion on admission ECG were available in 83 (18.3%) patients

In the present study, regarding number of vessels affected one vessel affected (38%), two vessels affected was more frequent (52%) while three vessels affected was less common (10%). In disagreement with this study, **Tanriverdi et al. [5]** who found that the rate of three vessels disease was 31.9%. Also, **Tanriverdi et al. [13]** found that frequency of three-vessel disease was significantly higher in patients with fQRS than in those with no-fQRS. This may be because our study had a lower number of patients (150 patients).

The present study showed no statistically significant difference between the four groups as regard to age and sex, hypertension, diabetes mellitus, dyslipidemia, family history and smoking. This was concordant with previous studies. In agreement with this study, **Tanriverdi et al. [5]** who found that there was no statistically significant difference between the different groups regarding basal demographic characteristics.

Our study showed statistically significant difference between the four groups regarding CK-MB and troponin. When comparing group with both fQRS and QRS distortion(G3) VS group with fQRS(G1) or distorted QRS (G2) was found that CK-MB and troponin was significant $p<0.001$ with group of both fQRS and QRS distortion compared with each other group. In agreement with this study, **Tanriverdi et al., [5]** found that troponin was higher in fQRS group than in non fQRS with highly statistically significant difference (62.8 ± 53.5 vs 29.7 ± 16.2; $P < 0.001$, respectively) and in distortion group (54.5 ± 52.6) was higher than in non-distortion group (33.5 ± 21.2) with P value < 0.001).

In our study, there was no significant statistical difference regarding culprit artery. This was concordant with **Yıldırım et al. [14]** who found that the culprit lesion being LMCA, n (%) 0 (0%) in non-fQRS group versus 1 (0.4) in fQRS group with p value 1, LAD, n (%) 57 (48.3) in non-fQRS group versus 94 (43.3) in fQRS group with p value 0.422, LCX, n (%) 18 (15.2) in non-fQRS group versus 45 (20.7) in fQRS group with p value 0.244 and RCA, n (%) 42 (35.5) in non-fQRS group versus 66 (30.4) in fQRS group with p value 0.392.

In our study, there was significant statistical difference between the 4 groups as regard reperfusion success. This was in agreement with **Tanriverdi et al. [5]** who found that reperfusion success was lower in fQRS group than non fQRS group but in disagreement without result.

The fundamental treatment strategy for acute STEMI is fibrinolytic treatment or primary PCI. Patients who underwent both primary thrombolytic treatment and or PCI were investigated in our study. When all patients were considered together, the total ST segment resolution was lower in fQRS group and/or QRS distortion group than in patients without these features. In consisted to our findings, **Wolak et al. [15]** found that both electrocardiographic and angiographic reperfusion were worse in the STEMI patients who had QRS distortion and underwent primary PCI, and **Kocaman et al. [16]** found the same in STEMI patients with fQRS who underwent primary PCI. These aforementioned studies, together with this study, indicate that acute STEMI patients with fQRS and/or QRS distortion may continue to have reperfusion disorder at the cellular level, even though vessel patency is maintained, regardless of the treatment.

CONCLUSION

fQRS and QRS distortion can be used for assessment of success of reperfusion therapy.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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