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Fragmented QRS – A simple bedside non invasive predictor of early mortality and morbidity in STEMI

Abdul Mateen Athar[1], Zuber Suleman Kothi[2*], Basanagouda S. Patil[2], Ashok P. Yenkanchi[2], Shruthi Kulkarni[1] and Savitha Anne Sebastian[1]

[1]Department of Medicine, ST John's Medical College, Kormangala, Bangalore-560034, Karnataka, India and [2]Department of General Medicine, Al-Ameen Medical College, Athani Road, Vijayapur-586108 Karnataka, India

Abstract: *Background and objectives:* Fragmented QRS encompasses different RSR' patterns showing various morphologies of the QRS complexes with or without the Q wave on a resting 12-lead electrocardiogram. It has been shown possibly to cause adverse cardiac outcomes in patients with some heart diseases, including coronary artery disease. In view of the need for risk stratification of patients presenting with acute coronary syndrome in the most efficacious and cost-effective way, we conducted this study to clarify the value of fragmented QRS in patients presenting with STEMI in predicting complication during hospital stay. *Methods:* Fifty consecutive patients admitted to the coronary care unit with their first STEMI were enrolled in this prospective observational study. Demographic and electrocardiographic data on admission, in hospital complication and mortality were recorded. *Results:* 50 patients were divided into two groups, one consisting of patients who developed fQRS (fQRS +ve) during hospital stay and the other group those who did not developed fQRS (fQRS –ve). Patients with fQRS on admission ECG had significantly higher incidence of arrhythmias (p=0.012), heart failure (p=0.008), hypotension (p=0.002) in comparison to patients with non fragmented QRS. In addition patients with more than one myocardial site involvement had higher incidence of fQRS (p=0.004). The mortality was significantly higher in fQRS positive (p= 0.029) group compared to fQRS negative group. *Conclusion:* This study strongly suggests that fragmented QRS on initial presentation with STEMI is predictive of subsequent events and provide very useful information in the risk stratification of acute STEMI patients.

Keywords: Electrocardiography, fragmented QRS, STEMI, Mortality

Introduction

AMI is a high-risk disease whose primary cause of death is malignant cardiac arrhythmia, accounting for 50% of all deaths. Heart failure is commonly found in patients with a large area of myocardial infarction. Acute myocardial infarction (AMI) is due to the onset of stenosis or occlusion in the coronary artery that can cause severe ischemia and necrosis of myocardium resultant ST-segment elevation on the ECG and consequently result in a high mortality rate and poor prognosis. There are some other well known myocardial ischemia markers such as ST-segment depression and elevation, T-wave flattening or inversion and pathologic Q waves. The presence of pathological Q waves on the 12-lead ECG signifies a prior transmural myocardial infarction (MI) [1]. However, Q wave may regress or even disappear over time in as many as 25% to 63% of patients with a history of a Q wave MI [2]. Fragmented QRS complex is a lesser known entity and regarded as non homogeneous myocardial depolarization of the ventricles due to myocardial scar or fibrosis in patients with myocardial infarction (MI).

Fragmented QRS was more likely to be seen in areas of healed myocardial infarction (MI) 2 weeks after the index event than earlier [3]. Fragmented QRS complexes are defined as the presence of an additional R wave (R') or notching in the nadir of the S wave, or the presence of more than one R' in two contiguous leads, corresponding to a major coronary artery territory on the resting 12-lead ECG. Fragmented QRS is also defined as different RSR' patterns with or without Q waves on a resting 12-lead ECG [4-5]. Previous studies have suggested that the regional myocardial scar may be associated

with changes in QRS configuration, leading in turn to terminal conduction delay or fragmentation of the QRS complex on a 12-lead ECG [6-7]. Its association with scarring from prior MI is well documented [8-10].

The presence of fragmented QRS in susceptible patients increases the risk of adverse cardiac events, including MI, need for revascularization, cardiac death, and all-cause mortality in patients with known ischemic heart disease [11]. It has also been suggested that fragmented QRS in patients with a history of Q wave MI heralds a higher risk of recurrent cardiac events, such as fatal or nonfatal MI [12]. Unfortunately, relevant information is scarce from low and middle income countries. Considering the simplicity and cost-effectiveness of distinguishing fragmented QRS on ECG and its potential prognostic value, more research in different populations is needed to develop a stronger body of knowledge. Hence fragmented QRS, though not extensively studied yet, is probably a reliable indicator of past myocardial ischemia and also suggests increased scar burden and poorer prognosis. The aims and objectives of the present study were to study the incidence of development of fragmented QRS complexes in ECGs of patients with acute STEMI and to assess its prognostic significance during hospital stay.

Material and Methods

Sixty consecutive patients admitted to the ICCU at al ameen medical college in vijayapur in span of 12 months with their first STEMI were enrolled in this study. Out of sixty patients 10 patients were excluded because they had various blocks. All patients were followed up during their hospital stay.

Inclusion Criteria:

1. Patient with typical ischemic symptoms.
2. Following diagnostic criteria of acute STEMI on ECG
   a. >2mm ST segment elevation at the J point in at least two chest leads or
   b. >1mm ST segment elevation in at least two limb leads or
   c. Reciprocal ST segment depression (V2-V3) due to posterior wall damage.
3. Elevated cardiac biomarkers.

Exclusion Criteria: Patients with complete or incomplete bundle branch block, a prior history of MI, a prior history of revascularization (coronary artery bypass grafting or percutaneous coronary intervention), patients with valvular heart disorders, pericardial and myocardial disease, as well as those receiving cardiac glycosides, amiodarone were excluded. Patients were treated according to the current STEMI guidelines. Serial ECG recording were done at regular intervals during first 5 days of hospital stay, to look for the appearance of fragmented QRS. Based on the appearance of fragmented QRS in serial ECGs the patients were categorized as being with and without fragmented QRS.

The definition of fragmented QRS used in this study was based on the definition proposed by Das et al, [8] ie, the presence of an additional R wave (R') or notching in the nadir of the S wave, or the presence of more than one R' in two contiguous leads, corresponding to a major coronary artery territory on the resting 12-lead ECG. ECG interpretations were made by consensus between two physicians. The primary endpoint of the study was complication rate in patients presenting with STEMI with and without fragmented QRS.

Statistical analysis: Statistical analysis was performed using SPSS 16.0 for Windows. Data are expressed as means and standard deviations for continuous variable or as frequencies and percentages for categorical variables. Student t test was used for comparisons between the fQRS positive and fQRS negative groups for continuous variables. Comparison of proportions was by chi square analysis. Statistical significance was set at $p<0.05$.

The institutional review boards of Al-ameen medical college approved the study protocol, and written informed consent was obtained from all patients after full discussion of the study process with the patients and their families.

Results

Of the 60 consecutive patients who had STEMI 10 were excluded from the study as

they had various blocks (RBBB, LBBB and 1 patient had complete heart block). The data of remaining 50 patient were analyzed in this study. After excluding 10 patients 50 patients are grouped into two groups. Group A (fQRS +ve) and group B (fQRS –ve). A demographic comparison of these 2 groups is given in table-1. There was no significant statistical difference between demographic characteristics in two groups.

Table-1: Comparison of Demographic Characteristics Between Patients With and Without fQRS

Characteristic	All Patients (n=50)	fQRS +ve (n=14)	fQRS -ve (n=36)	P value
Age in year	56.12±10.27	59.57±11.33	56.58±10.09	0.432
Sex				
Male	36	10	26	0.998
Female	14	4	10	0.998
BMI	24.82±3.88	25.71±5.39	24.47±3.13	0.310
Smoking history	24	7	17	0.860
Family history of CAD	9	3	6	0.697
Diabetes	10	5	5	0.118
Hypertension	35	11	24	0.392
Dyslipidemia	24	7	17	0.858
Elevated CK-MB	35	11	24	0.170

The fQRS was present in 14 patients out of 50 cases. The mean age in our study was 56.12±10.27. Among 50 patients 36 (72%) were male and 14 (28%) were female. Out of 36 males 10 had fQRS +ve and among 14 female patients 4 had fQRS +ve. In our study out of 50 STEMI patients 25 (50%) patient had anterior wall MI, 15 (30%) patient had inferior wall MI, 1 patient had posterior wall MI and 9 (18%) patients had myocardial infarction of more than 1 site or with associated with right ventricular myocardial infarction (RVMI). In our study patients with MI of more than one site or one site with associated RVMI showed higher incidence of fQRS +ve which is statistically significant (Table 2).

Table-2: Site of myocardial infarction based on ECG and its association with fQRS

Site of Myocardial Infarction	Total	fQRS -ve	fQRS +ve	P value
Anterior	25	20	5	0.529
Inferior	15	13	2	0.179
Posterior	1	1	0	1.000
>1 site or 1 site associated with RVMI	9	2	7	0.004
Total	50	36	14	-

Patients with fQRS demonstrated a significant higher incidence of complication like arrhythmias, hypotension, heart failure compared with fQRS –ve group (Table-3). In our study there was 4 death among 50 patient and out of 4 patients 3 patients had fQRS +ve and 1 patients was fQRS negative. Thus in our study there was significantly increased rate of heart failure, hypotension, arrhythmias and mortality in group A patients compared to group B Patients which is statistically significant.

Table-3: Incidence of various complications and its association with fQRS

complication	fQRS +ve (n=14)	fQRS-ve (n=36)	P value
Heart failure	7	1	0.008
Arrhythmias	6	4	0.012
Hypotension	9	7	0.002
Death	3	1	0.029

Discussion

The objective of risk evaluation immediately after admission is to provide early risk stratification of patients with AMI and to identify high-risk patients and predict complications. There are some other well-known myocardial ischemia markers such as ST-segment depression and elevation, T-wave flattening or inversion, and pathologic Q waves, but fragmented QRS may be the only convenient marker of myocardial scar and ischemia evaluated by 12- lead ECG. QRS wave is a comprehensive vector of ventricular depolarization. Regional myocardial scar and ischemia may lead to nonhomogeneous myocardial electrical activation, resulting in multiple spikes within the QRS complex, thus appearance of fQRS in the ECG record [3]. Recent studies demonstrated that fQRS represents not only prior occurrence and diagnosis of MI and silent MI [13] but also an independent predictor of cardiac events in patient with coronary artery disease [11, 14].

Fragmentation of QRS (fQRS) complex is an easily evaluated non-invasive bedside electrocardiographic parameter. Presence of fQRS has been associated with alternation of myocardial activation due to myocardial scar and myocardial fibrosis. The importance of fQRS was first suggested by Das et al. [8]. In the past there have been very few studies which evaluated the significance of development of fragmented QRS in STEMI patients especially in the immediate period following the myocardial infarction. Fragmented QRS was associated with higher cardiac CPK-MB level in study conducted by Cetin et al.[14] Kocaman *et al*, [15].

In this study the frequency of fQRS complex was found to be 28% in STEMI. The frequency of fQRS on ECG has been previously reported to be ranging from 34.9% to 60% in patients with acute coronary syndrome [8]. In this study it was found that patients with more than one myocardial site involvement had higher incidence of fQRS positivity (p=0.004). In other study it was found that incidence rate of fQRS was significantly higher in the inferior wall leads than in the other two leads (anterior and lateral) conducted by Yao et al [16]. But in our study there was no significant changes in any leads was noticed. This may be probably due to the small sample size and further research with a larger population of subjects might be required to prove it.

There is strong correlation between fQRS and malignant cardiac arrhythmia as observed by Erdogan et al [17]. In our study, it was observed that patients with fragmented QRS had increased number of major adverse cardiovascular events (MACE) than patients without fragmented QRS during hospital stay. In predicting immediate outcome of fragmented QRS in STEMI patient during hospital stay no data is available to compare our results.

Studies on long term outcome are very few as study conducted by Ari *et al* [18], there was significantly higher frequency of MACE (major adverse cardiac event) among the patients with fragmented QRS as compared to those who did not have fragmented QRS (29.4% vs 5.9%; p <0.01). In another study conducted by Das et al it was found that fragmented QRS is an independent predictor of mortality in patients with ACS [19].

Conclusion

This study suggests that fragmented QRS on presentation is predictive of subsequent events in STEMI patients. Complication was higher when fragmented QRS was present. Fragmentations on admission ECG and prolonged QRS duration may be useful for identifying patients with higher long-term risk who will need more intense treatment and close follow-up. Early revascularization in patients with positive fQRS could lower the incidence of the cardiovascular events. Further studies are needed to clarify these inter relation. It can provide very useful information in the risk stratification of acute STEMI patients. It also helps to identify the evidence of infarction in patients without a Q wave on surface ECG. These all features make fragmented QRS an area to explore in the field of electrocardiography in the near future in large randomized clinical trials.

Study limitations: This study is limited by its small patient population analyzed. Larger clinical studies are necessary to confirm these findings.

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*All correspondences to: Dr. Zuber Suleman Kothi, Assistant Professor, Department of Medicine, Al-Ameen Medical College, Athani Road, Vijayapur-586108, Karnataka, India. E-mail ID: drzuberkothi@yahoo.com