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Clinical Profile of Unstable Angina/ NSTEMI Patients Presenting With Fragmented QRS- A Hospital Based Observational Study

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ABSTRACT:

Electrocardiographic signs of unstable angina/non–ST elevation myocardial infarction (NSTEMI) are nonspecific. The utility of ST-segment and T-wave changes is limited and diagnosis of NSTEMI during acute coronary syndromes (ACS) depends mainly on cardiac biomarker levels. So clinicians have to depend on various non invasive and invasive studies, such as echocardiography, nuclear imaging, or cardiac catheterization, to confirm the presence of obstructive coronary artery disease (CAD).Fragmented QRS complex is a lesser known entity. This marker of myocardial injury may often be the only electrocardiographic marker in patients with NSTEMI. The prognostic significance of fragmented QRS is comparable to that of ST-segment depression and T-wave inversion. We postulated that the presence of fQRS might be associated with a poorer outcome in patients of acute coronary syndrome. The study included 150 consecutive patients of acute coronary syndrome. Fragmented QRS developed in 50 patients (GROUP A) while remaining 100 patients had no fragmented QRS during hospital stay (GROUP B). Both groups were followed up for a month. Group A had a higher disease burden and a poorer outcome in comparison to group B. This may prompt clinicians to act differently with more interventional approach immediately in patients of acute coronary syndrome who develop fragmented QRS on electrocardiogram, although this fact needs to be validated in large randomized trials.

Keywords: *- ECG; Fragmented QRS; Acute coronary syndrome.*

INTRODUCTION

Electrocardiographic signs of unstable angina/non–ST elevation myocardial infarction (NSTEMI) are nonspecific. T-wave inversion of <1 mm as an isolated finding is a nonspecific sign for NSTEMI that is often noted in patients in whom ACS are ultimately ruled out, and patients with isolated T-wave inversion have a similar death or MI risk at 1 year compared to those with no ST-segment and T-wave changes. Therefore, the utility of ST-segment and T-wave changes is limited and diagnosis of NSTEMI during acute coronary syndromes (ACS) depends mainly on cardiac biomarker levels. So clinicians have to depend on various non invasive and invasive studies, such as echocardiography, nuclear imaging, or cardiac catheterization, to confirm the presence of obstructive coronary artery disease (CAD).

Fragmented QRS complex is a lesser known entity. This marker of myocardial injury may often be the only electrocardiographic marker in patients with NSTEMI. The prognostic significance of fragmented QRS is comparable to that of ST-segment depression and T-wave inversion. Presence of fragmented QRS represents distortion of signal conduction and depolarization process within ventricles which is related to myocardial scar, myocardial ischemia or myocardial fibrosis. In patients with stable CAD and patients with acute MI, QRS fragmentation seems to be good predictor of cardiac events, however, does not affect mortality.[1] In patients with non-ischemic cardiomyopathy, fragmentation of narrow QRS complex seems to correlate with degree of fibrosis and dyssynchrony and importantly may influence the response for CRT.[2] Fragmented QRS on the resting surface electrocardiogram is a simple, fast and inexpensive modality of non invasive investigation that can be of great value in predicting the cardiac status and prognosis of an individual being evaluated for coronary artery disease.

So to assess whether fragmented QRS on ECG can enhance predictability of poor outcome in unstable angina/NSTEMI patients this study was planned.

MATERIAL AND METHODS

The aim of the study was to find out the incidence of fragmented QRS in unstable angina/NSTEMI patients and to assess its prognostic significance.

Fragmented QRS complex on ECG was defined by the presence of various RSR' patterns with or without a Q wave, and included

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- An additional R wave (R') or
- notching of the R wave, or
- notching of the downstroke or upstroke of the S wave ,or
- the presence of >1 R' , in 2 contiguous leads, corresponding to a major coronary artery territory, with duration of QRS ≤ 120 msec.

The present study was conducted from first may 2013 to april 30, 2014. Study participants were taken from all the consecutive patients of USA/NSTEMI who presented to our institution during this time period.

INCLUSION CRITERIA:

1. Patient having chest pain (or equivalent type of ischemic discomfort) with at least one of three features: (1) occurring at rest (or minimal exertion) and usually lasting >20 minutes (if not interrupted by nitroglycerin administration); (2) being severe and described as frank pain, and of new onset (i.e., within 1 month; and (3) occurring with a crescendo pattern (i.e., more severe, prolonged, or frequent than previously).
2. Either ST-segment deviation of 1 mm or more or T inversion or elevated level of cardiac biomarkers.
3. Presence of fragmented QRS complex on ECG, as defined by the presence of various RSR' patterns with or without a Q wave and include
    - An additional R wave (R') or
    - notching of the R wave, or
    - notching of the down stroke or upstroke of the S wave, or
    - the presence of >1 R' in 2 contiguous leads, corresponding to a major coronary artery territory
    - with QRS duration ≤ 0.12 sec

EXCLUSION CRITERIA

1) Patients not giving informed consent.
2) Patients having bundle branch block on ECG (LBBB or RBBB).
3) Patients with pericardial and myocardial diseases.
4) Patients on digoxin, amiodarone which make ST-T changes difficult to interpret.
5) Patients of valvular heart diseases, infiltrative diseases and thyroid disorders.
6) Patients with fragmented QRS in old ECGs.

Study methods

All the patients of unstable angina/NSTEMI coming to ICCU were provisionally included in the study. Patients having any of the exclusion criteria were excluded from the study. On ICCU admission, detailed history and clinical examination of the patients were done. Serial 12 lead ECG of the patients were done eight hourly for initial two days and then daily till discharge, to look for appearance and disappearance of fragmented QRS. Patients having fragmented QRS at time of admission or during hospital stay were included in the study. Patients of unstable angina/NSTEMI in which fragmented QRS did not develop at time of admission or during hospital stay were not followed up further and were excluded from the study. At the time of discharge patients were subdivided into two subgroups-

Subgroup-A - Patients having persistent fragmented QRS at the time of discharge.
Subgroup-B - Patients in which fragmented QRS disappeared at the time of discharge.

TIMI risk score was calculated to risk stratify the patients
The TIMI Risk score identified seven independent risk factors:

- age >65 years
- >3 risk factors for coronary artery disease (diabetes mellitus, hypertension, smoking, hyperlipidemia, family history, obesity)
- documented coronary artery disease at catheterization
- ST deviation >0.5 mm
- >2 episodes of angina in last 24 hours
- aspirin within prior week
- elevated cardiac markers

1. Based on this scoring system patients were stratified into:

- Low risk: TIMI score 0-2
- High risk: TIMI score 3-7

2. Treatment protocol:

- General measures: Bed rest was usually prescribed initially for patients with UA/NSTEMI.
- Supplemental oxygen at 2-4 liter/min was administered to patients with UA/NSTEMI.
- Nitrates: Nitrates in the form of nitroglycerine who had got ischemic symptoms at dose of 10 to 20 microgram/min and dose was gradually increased by 10 microgram/min.
- β-Adrenergic blockers: In patients with ongoing rest pain, three intravenous injection of 5 mg metoprolol at interval of 5 minutes were given unless there was no contraindication for their use and transitioned to an oral regimen at 50 mg six hourly dose of metoprolol for 48 hours, followed by 100mg 12 hourly dosage.
- ACE inhibitors

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- Clopidogrel: 300 mg loading dose orally followed by 75 mg once daily.
- Aspirin: 160-325 mg tablet as loading dose, followed by 75-150 once daily.
- Low molecular weight heparin: 1 mg/kg body weight subcutaneous 12 hourly.
- Statins.
- Any other drug if indicated.

3. Investigations: investigations done on day one after admission were:

- CPK-MB: 0hour, 12hour, 24hour and 48 hour
- Troponin I – 12-24 hours (By chemiluminecence assay)
- Blood sugar (fasting/post prandial)
- Complete lipid profile
- SGOT/SGPT
- Blood urea
- Serum creatinine
- Serum uric acid
- ECG
- Chest X-ray PA view

4. Hospital stay: Patients included in the study were evaluated completely and were looked for any complication that may include

a. Cardiogenic shock
b. Arrthymia
c. AV block
d. Pulmonary edema
e. Heart failure
f. Cardiac arrest
g. Recurrent myocardial ischemia
h. Angina
i. Death

The patients, in whom fragmented QRS appears on serial ECGs, were selected for further follow up. Rest of the patients who do not develop fragmented QRS morphology on serial ECGs were not followed up in the study.

Incidence of fragmented QRS was calculated during first 5 days of hospital stay by the following formula:

$$\text{Incidence} = \frac{\text{Number of cases who develop fragmented QRS within first 5 days}}{\text{Total number of provisional cases included in the study}}$$

Follow up protocol

At one month

1) Patients were revaluated clinically and any complication related to unstable angina/NSTEMI was documented which may include
    - Left ventricular failure
    - Congestive heart failure
    - Angina
    - Arrhythmia
    - Shock
    - Bleeding
    - Cerebrovascular accident
    - Recurrent ischemia.

    Telephonic follow up was made for patient death after discharge.
2) ECG was done to evaluate QRS morphology and appearance of fragmented QRS in new territory or disappearance and ST- T changes for myocardial ischemia.
3) Treadmill test was done to assess residual myocardial residual ischemia.
4) Echocardiography was done to assess
    - Systolic dysfunction
    - Diastolic dysfunction
    - Regional wall motion abnormality

The ECG changes, TMT findings, echocardiographic findings and complications of both the subgroups were compared and was analysed with an appropriate statistical method to reach a conclusion.

STATISTICAL ANALYSIS

Continuous variables were given as mean ± standard deviation; categorical variables were defined as percentages. Continuous variables were compared by student t-test and the chi-square test was used for the categorical variables between two groups. All tests with regards to significance were two tailed. Statistical significance was defined as $p<0.05$.

OBSERVATIONS

A total of 150 patients of unstable angina/NSTEMI admitted in ICCU from first may 2013 to 30thapril, 2014 were screened for appearance of fragmented QRS during hospital stay and fragmented QRS appeared in fifty patients out of these 150 patients during hospital stay. Incidence of fragmented QRS in unstable angina/NSTEMI=50/150 x 100 = 33.33%

The patients were then divided into two groups- group A consisting of patients who developed fragmented QRS and group B consisting of those who did not.

The mean age of our study group was 56.88 years. Standard deviation was 13.34 years. Maximum number of patients were in age group 60-69 years (40%). Total number of male patients were thirty seven while female patients were 13 in study population. So seventy four percent of patients were males in study population, with male female ratio of 2.84:1

Main presenting symptom was precordial chest pain in study population. Ninty two percent of patients presented with chest pain while dyspnoea was presenting complaint in 24%

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of patients. Other atypical presentation like epigastric pain was present in 10% of patients. Hypertension was most common risk factor in study population seen in 33 patients (66%). Other common risk factors were smoking seen in 29 patients (58%), diabetes mellitus seen in 6 patients (12%), family history of coronary artery disease seen in 10 patients (20%), past history of IHD seen in 16 patients(32%) and obesity seen in 11 patients (22%).

Most common ECG changes observed in study population was ST depression seen in 31 patients (62%) while deep symmetrical T inversion was seen in 20 patients (40%). Most common territory of ischemia based on ECG changes was anterior wall seen in 32 patients (64%). Other territory includes lateral wall seen in 22 patients (44%), and inferior wall seen in15 patients (30%). Fragmented QRS at discharge persisted in 37 patients(74%).These 37 patients constitute subgroup-A while fragmented QRS disappear in 12 patients at time of discharge and they constitute subgroup-B. Hemodynamic profile of both subgroups-A and B were comparable at time of admission (p value n.s.). Risk factor profile in both study subgroups was comparable at admission (p value n.s.). In subgroup-A most common risk factor was found to be hypertension while in subgroup-B most common risk factor found was smoking. In both study subgroups A and B most common ECG finding at admission was ST depression seen in 70% patients in subgroup-A and 75% in subgroup-B. Increased rates of post MI rest angina, and major cardiac arrhythmias were seen in high risk patients during hospital stay (p value<0.05). Increased rate of rest angina was found in subgroup-A than subgroup-B after discharge from hospital (p value<0.05). Exercise stress test was positive in higher number of patients in subgroup-A than subgroup-B as well as in high risk patients as compared to low risk (p value<0.05). The results and characteristics of study groups have been enumerated in table 1 and 2.

TABLE1. COMPOSITE RESULTS OF STUDY POPULATION AND STUD SUB GROUPS (0-30DAYS)

CLINICAL PROFILE	**TOTAL (N=50)**	***SUB GROUP-A (N=37)***	**SUB GROUP-B (N=12)**	**P VALUE**
RISK FACTORS				
a) Smoking	29(58%)	*21(57%)*	8(67%)	NS
b) Diabetes	6(12%)	*5(14%)*	1(8%)	NS
c) Hypertension	33(66%)	*25(67%)*	7(58%)	NS
d) Family history	10(20%)	*7(19%)*	3(25%)	NS
e) Obesity	11(22%)	*7(19%)*	3(25%)	NS
f)Past h/o IHD	16(32%)	*8(22%)*	6(50%)	NS
ECG FINDINGS AT ADMISSION				
a) ST depression	31(62%)	21(57%)	9(75%)	
b) T Inversion(>0.3mv)	20(40%)	14(38%)	6(50%)	
TOTAL NUMBER OF PATIENTS WITH ≥1 MACE				
a) 0-30 days	9(18%)	6(16%)	2(17%)	N.S
b) 0-5 days	4(8%)	3(8%)	1(8%)	N.S
c) 5-30 days	2(4%)	2(5%)	0(0%)	N.S
POST MI ANGINA				
a) 0-30 days	20(40%)	17(46%)	3(25%)	N.S
b)0-5 days	10(20%)	8(22%)	2(17%)	N.S
c) 5-30 days	17(34%)	16(43%)	1(8%)	**<0.05**
LEFT VENTRICULAR FAILURE				
a) 0-30 days				
b) 0-5 days	12(24%)	9(24%)	2(17%)	N.S
c) 5-30 days	11(22%)	8(22%)	2 (17%)	N.S.
	4(8%)	3(8%)	1(8%)	N.S
TOTAL MACE*				
A)0-30 days	40	31	7	
B)0-5 days	29	21	6	
C)5-30 days	21	19	2	
TMT				
a) Positive	24(60%)	22(68%)	2(25%)	**<0.05**
b) Negative	16(40%)	10(32%)	6(75%)	**<0.05**
ECHOCARDIOGRAPHY				
a)Systolic dysfunction	11(22%)	7(19%)	4(33%)	N.S
b)Diastolic dysfunction	21(42%)	14(38%)	7(58%)	N.S
c) RWMA	30(61%)	24(64%)	6(50%)	N.S

*some patients had more than one MACE

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TABLE-2 COMPOSITE EVENTS OF RISK STRATIFIED GROUPS IN USA/NSTEMI IN STUDY POPULATION

CLINICAL PROFILE	TOTAL(N=50)	*LOW RISK(N=22)*	HIGH RISK(N=28)	P VALUE
MAJOR CARDIAC ARRYTHMIA				
a)0-30 days	5(10%)	0%	5(18%)	**<0.05**
b)0-5 days	5(10%)	0%	5(18%)	**<0.05**
c)5-30 days	0	0	0	
TOTAL NUMBER OF PATIENTS WITH ≥1 MACE				
a) 0-30 days				
b) 0-5 days	9(18%)	3(14%)	6(21%)	N.S
c) 5-30 days	4(8%)	0%	4(14%)	N.S
	2(4%)	1(5%)	1(4%)	N.S
POST MI ANGINA				
a) 0-30 days	20(40%)	6(46%)	14(50)%	N.S
b)0-5 days	10(20%)	1(5%)	9(32%)	**<0.05**
c) 5-30 days	17(34%)	6(27%)	11(39%)	N.S
LEFT VENTRICULAR FAILURE				
a) 0-30 days				
b) 0-5 days	12 (24%)	5(22%)	7(25%)	N.S
c) 5-30 days	11 (22%)	5(23%)	6 (22%)	N.S.
	4 (8%)	1(5%)	3(11%)	N.S
TOTAL MACE*				
a)0-30 days	40	11	29	
b)0-5 days	29	6	23	
c)5-30 days	21	7	14	
TMT				
a)Positive	24(60%)	8(42 %)	16(76%)	**<0.05**
b)Negative	16(40%)	11(58 %)	5(24%)	**<0.05**
ECHOCARDIOGRAPHY				
a)Systolic dysfunction	11(22%)	4(18%)	7(25%)	N.S
b)Diastolic dysfunction	21(42%)	6(28%)	15(56%)	N.S
c) RWMA	30(61%)	10(45%)	20(74%)	N.S

*some patients had more than one MACE.

DISCUSSION

Electrocardiographic signs of unstable angina are nonspecific. The utility of ST-segment and T-wave changes is limited, therefore the diagnosis of NSTEMI during acute coronary syndromes (ACS) is to be confirmed by cardiac biomarker levels. Clinicians have to depend on various non invasive and invasive studies, such as echocardiography, nuclear imaging, or coronary angiography, to confirm the presence of obstructive coronary artery disease (CAD). Fragmented QRS is an easily evaluated non invasive electrocardiographic parameter. This marker of myocardial injury may often be the only electrocardiographic marker in patients with USA/NSTEMI. Presence of fQRS has been associated with alteration of myocardial activation. The importance of fQRS complexes on surface ECG was first suggested by Das et al,[3] in 2006. Presence of myocardial ischemia result in inhomogeneous activation of ventricles which alter ventricular depolarisation, which probably results in fragmentation in QRS complex.[4] Fragmented QRS was associated with intra-ventricular systolic dyssynchrony in patients with narrow QRS.[5] Different morphologies of fragmented QRS waves, such as notching in the initiation, the mid portion, or the terminal portion of QRS complexes on 12-lead ECG, may represent the sum of various altered depolarization vectors or myocardial activation patterns, depending on the extent and location of ischemic tissue in the ventricles.

The present study was done to evaluate the number of patients who develop fragmentation in QRS on surface ECG in immediate period following unstable angina or NSTEMI and to predict the association of this fragmentation in predicting major adverse cardiac events (MACE) in these patients. All patients were managed according to standard protocol of unstable angina/NSTEMI. In the past very few studies had been conducted to evaluate the prognostic significance of fragmentation of QRS complex in these

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patients. This study revealed very important observation regarding persistence of fragmentation in QRS in USA/NSTEMI is associated with various future adverse cardiac events. So this marker on surface ECG was evaluated in risk stratifying the patients of unstable angina/NSTEMI.

In this study fragmented QRS appeared in 50 patients out of 150 patients of unstable angina/NSTEMI patients admitted in ICCU during hospital stay. Thus incidence of development of fragmented QRS was calculated to be 33.33% in unstable angina/NSTEMI patients in this study. There have been very few studies conducted in the past to calculate incidence of fragmented QRS in unstable angina/NSTEMI patients. Most of the studies have assessed the incidence of development of fragmented QRS in acute coronary syndrome as a whole and not separately for unstable angina/NSTEMI. However in one of the study done by Das et al,[6] fragmented QRS developed in 24% of patients with unstable angina/NSTEMI. In another study done by Ari et al,[7] fragmented QRS developed in 40% of NSTEMI patients. Rong et al,[8] found frequency of fragmented QRS in NSTEMI patients to be 60%. So percentage of the patients who developed fragmented QRS in unstable angina/NSTEMI was slightly lower in our study than observed with previous studies.

Most common involved leads to develop fragmented QRS were inferior leads (64%) followed by anterior leads (29%) (fig-4). In a previous study by Das et al, [6] fragmented QRS appeared more commonly in inferior leads (23%) followed by anterior leads (16%),which was just similar to the observation seen in our study. There were 14 patients (28%) who develop fragmented QRS in two leads while fragmented QRS appeared in more than three leads in 36 patients (72%) in our study (Table-16). In a previous study done by Torigoe et al, [9] 34.7% patients developed fragmented QRS in 3 or more leads while in 65.3% patients; it was observed in 2 or lesser leads. In our study higher number of patients had fragmentation of QRS in 3 or more leads. It has been considered that fragmented QRS results from the presence of significant myocardial necrosis, with islands of viable myocardial tissue interspersed in abundant fibrous tissue in coronary artery disease.[6] It would be expected that a larger number of fragmented QRS may be associated with a larger size of myocardial scar, and intraventricular systolic dyssynchrony.[10] It was hypothesized that a larger number of leads with fragmented QRS would be associated with poorer cardiac outcome.

ST depression and T wave changes occur in up to 50% of patients with UA/NSTEMI.[11-12] New ST-segment deviation (≥0.1 mV) is a useful measure of ischemia and prognosis. When electrocardiograms preceding the acute event are available, further ST depression of only 0.05 mV is a sensitive although nonspecific finding of UA/NSTEMI. T wave changes are sensitive but not specific for acute ischemia unless they are marked (>0.3 mV). In one study of nearly 10000 patients admitted with unstable angina/NSTEMI, ST segment depression and T wave inversion were significant clinical predictors of death or myocardial infarction.[13] In our study ST depression was found in 62% of patients of unstable angina/NSTEMI while deep symmetrical T inversion(>0.3mv) was found in 40% of patients in patients admitted in ICCU (table-12). In the previous study by Das et al,[6] patients with unstable angina/NSTEMI having fragmented QRS had ST segment depression in 24% of patients while deep T inversion was found in 28% patients of unstable angina/NSTEMI having fragmented QRS. So in our study ST segment depression and deep T wave inversion was most common ECG abnormality found in UA/NSTEMI patients similar to results of previous study. However incidence of ST depression and deep symmetrical T wave inversion was much higher in our study than observed in previous studies in these patients

Most common territory of ischemia based on ECG changes was in anterior wall (64%). In previous study by Das et al,[6] most common territory of ischemia based on ECG changes in unstable angina/NSTEMI patients having fragmented QRS was anterior wall (29%) which was just similar to observation seen in our study. In our study we stratified the patients of unstable angina/NSTEMI having fragmented QRS to low risk and high risk group based on TIMI score. Till date no study have been conducted in patients of unstable angina and NSTEMI having fragmented QRS in which patients were risk stratified based on TIMI score. Since no data is available of risk stratification of patients of unstable angina/NSTEMI with fragmented QRS results of our study could not be compared. In our study it was found that 28 patients (56%) were in high risk subgroup based on TIMI score and 22(44%) patients were in low risk subgroup. Till date no study has evaluated the immediate outcome of fragmented QRS in unstable angina/NSTEMI patients. In our study it was found that patients having persistence of fragmented QRS at time of discharge were having higher incidence of angina at subsequent follow up than in patients in whom fragmentation disappear (43% vs8% p value<0.05) .In a previous study, done by Das et al,[1] demonstrated that the presence of fQRS was associated with higher cardiac event rate defined as MI, and need for revascularization (50% *vs.* 28% in patients with fQRS than in patients without fQRS). Pietrasik et al,[14] studied effect of fragmented QRS on the risk of recurrent cardiac events defined as unstable angina, recurrent MI or cardiac death and found that fQRS was associated with higher risk of recurrent cardiac events. So result of our study matched with previous studies in term of recurrent angina. Probable explanation of this is that fragmentation of QRS represents myocardial ischemia and

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fQRS may identify ischemic myocardium and myocardial scar.[14] In our study it was found that persistence of fragmented QRS is not associated with any major cardiac arrhythmia in short term. There was one study done by Cheema et al,[15] to evaluate the association between fQRS complex and primary end-point of all cause mortality, secondary end-points specific cause mortality and appropriate ICD shocks in the patients with LV dysfunction of both ischemic and non-ischemic aetiology and it was found in that study that there was no significant difference in fQRS, and mortality and arrhythmic events and fQRS was not proven to be useful factor in risk stratification of patients eligible for ICD therapy. As this study was done in patients of LV dysfunction of both ischemic and non-ischemic etiology and it was a long term study as well so results of this study could not be fully compared with our study. However result of this study matched observation seen in our study suggesting that fragmentation of QRS is not associated with major cardiac arrhythmia in short term. In our study it was also found that patients in high risk group had higher incidence of major cardiac arrhythmia as compared to low risk group (18% vs. 0%p value<0.05). This observation in our study is similar to observation seen in grace study in which risk was estimated to be higher in the high risk patients with NSTEMI.[16]

In our study there was no significant association between persistence of fragmented QRS and mortality in short term. In a study done by Das et al,[6] mortality was significantly higher in the fQRS group than the non-fQRS group in long term in all patients of acute coronary syndrome including STEMI. So as the number of patients included in our study was small and most of previous studies long term follows up was made so results of our study did not match with previous study.

On analysis of total MACE it was found that a total of 40 MACE occurred in study population after admission. There was substantial difference of total MACE on subgroup analysis. It was found that patients having fragmented QRS at discharge had a total of 31 MACE while patients without fragmented QRS at discharge had only 7 MACE. No data is available from previous studies regarding total MACE to compare our results. In our study we also found that in patients with high risk a total of 29 MACE were observed after admission till 30 days which was significantly higher than low risk subgroup in which only 11 MACE were observed.

CONCLUSION

Fragmented QRS, which may be derived from the effects of the individual risk factors, and perfusion related factors on myocardial electrical conduction at cellular level, can represent increased cardiac risk by different causative mechanisms in patients with USA/NSTEMI. Twelve-lead surface ECG, which is an inexpensive, non-invasive, and easily apprehensible method, is presently the gold standard in differential diagnosis, determining treatment methods, and performing risk stratification of USA/NSTEMI. This study highlighted the usefulness of fragmented QRS in identifying patients at higher cardiac risk with larger areas of ischemic jeopardized or necrotic myocardium, and it can provide very useful information in the risk stratification of USA/NSTEMI patients. These all features make fragmented QRS an area to explore in the field of electrocardiography in the near future in large randomized clinical trials.

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