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Correlation of Fragmented QRS Complex with Coronary Angiography to Identify the Culprit Lesion in Non-ST Elevated Acute Coronary Syndrome

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Abstract
Background: *ECG plays a valuable role in identification of culprit lesion in patients with ST elevation myocardial infarction (STEMI). But in non-ST elevated ACS, the role of ECG is not very specific. Fragmented QRS (fQRS) complexes are novel electrocardiographic signals, which reflect myocardial conduction delays in patients with coronary artery disease (CAD). fQRS can play a significant role in the diagnosis of culprit lesion in patients with non-ST elevated ACS.*
Objective: *This study was conducted to determine the correlation of fQRS with coronary angiography to identify culprit lesion in patients with non-ST elevated ACS.*
Methods: *A cross-sectional analytical study was conducted on 155 NSTE-ACS patients admitted in National Institute of Cardiovascular Diseases, Dhaka, between October 2017 to September 2018. The patients were clinically evaluated for symptoms, risk factors followed by ECG. All of them underwent ECG analysis for fQRS. All patients underwent coronary angiography in the index hospitalization and culprit vessels were identified. fQRS were evaluated with angiography to determine the ability of fQRS complexes to identify the culprit vessels.*
Results: *In the study, out of 155 patients, 78 had fQRS in the ECG, whereas 77 had no fQRS in the ECG. ST-depression and inverted-T waves were the ECG findings of non-fQRS group. fQRS in the precordial leads had the highest sensitivity (84% versus 59.3%) and specificity (90.5% versus 82%) for identifying the culprit vessel (LAD artery) compared to non-fQRS group. The diagnosis of LCX lesion by fQRS was also highly sensitive (82.6 % versus 65 %) and specific (89.1% versus 77.2 %) in comparison to non-fQRS group. For the diagnosis of RCA lesions, the presence of fQRS was more sensitive (91.6% versus 66.7%) and more specific (90.7% versus 78.6%) than non-fQRS group. And the total sensitivity and specificity of fQRS (59.1 % and 68.0%) were higher than those values for non-fQRS group.* ***Conclusion:*** *fQRS on a 12 lead ECG is a cheap, easily available and non-invasive marker to identify the culprit vessel with a high specificity and good sensitivity.*
Keywords: *Fragmented QRS complex, Coronary Artery Disease, Culprit Coronary Artery, Acute Coronary Syndrome, Electrocardiogram.*

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I. Introduction

Cardiovascular disease (CVD) is the number one cause of death worldwide, accounting for 17.7 million deaths per year [1]. According to an estimation by World Health Organization (WHO) in 2012, about one third of all deaths globally were attributable to CVD, and 7.4 million of those results from ischaemic heart disease [2]. Despite decreasing mortality trends of coronary artery disease (CAD) in many developed countries, increasing number is noticed in developing countries [3]. In addition, epidemiological data suggest that acute coronary syndrome (ACS) cases with Non-ST elevated Myocardial Infraction (NSTEMI) occurs more frequently than ST elevated myocardial infraction (STEMI) [4]. In the US, it is estimated that >780,000 people will experience an ACS each year, and approximately 70% of these people will have NSTEMI [5]. And similar trends is noted in different part of the world [6]. Non-ST elevation ACS (NSTEMI and UA) refers to partial or near complete occlusion of a coronary artery. As a result, blood flow of myocardium become compromised that leads to myocardial injury. Besides this, NSTE-ACS patients suffer more recurrent events and worse long-term outcomes [6,7]. The researchers observed some slurring in the ECG in 1960. Investigators tried to correlate the same with the left ventricle (LV) dysfunction. It was Flowers et al. who first discovered the presence of fragmented QRS (fQRS) complex in the patients who already had an MI. It was thus reported as a high-frequency component [8]. Fragmented QRS complexes on a 12-lead resting ECG are defined as various RSR' patterns (≥1 R' or notching of S wave or R wave) with or without Q waves lacking a typical bundle-branch block in 2 contiguous leads corresponding to a major coronary artery territory. Based on their duration, they are sub-classified into two subgroups as f-QRS complexes with QRS duration <120 ms or ≥120 ms (fragmented wide-QRS complexes, fwQRS) and they can also be found on an ECG with different QRS morphologies. Even sometimes, fQRS might be the only ECG marker of myocardial damage in patients with non-Q myocardial infarction and in patients with a resolved Q wave [9,10,11]. It is also associated with post myocardial infarction (MI) cardiac scars [12]. Following invention of single photon emission computed tomography (SPECT), it has proven that f-QRS may be a sign of detecting post MI scars. Moreover, it can detect regional perfusion abnormalities than Q waves alone and of increasing the sensitivity in detecting MI scars when combined with Q waves [13,14]. Rahman et al. showed that there is a positive correlation between fragmented QRS complexes with the severity of non-ST elevated acute coronary syndromes [15]. One study about fragmented QRS-complex was done in NICVD by Ahmed, T [16] which showed that fragmented QRS on 12 lead ECG is associated with more severe form of coronary artery disease. In addition, some other studies underwent in various geographical locations documented that, it is related with increased morbidity and mortality, sudden cardiac death, and recurrent adverse cardiac events [17-20]. ECG abnormalities such as T-wave inversion, ST-segment depression and pathologic Q waves have diagnostic value in NSTE-ACS, but their correlation with the exact anatomic location of the culprit lesion is not very high [21]. The diagnosis of ST-elevation myocardial infarction has evolved a lot from electrocardiogram to two-dimensional echocardiogram (2D echo/echo) to coronary angiogram (CAG) to comment on the culprit vessel involved in the MI. But still, the data are lacking in the correlation of non-STEMI and the culprit vessel involved. In this study, we have reviewed the ECG results in Non ST elevated acute coronary syndrome patients to evaluate the accuracy of contiguous fQRS complexes to identify culprit lesion so that early diagnosis and urgent invasive treatment can be taken and cardiologist can be able to directly pinpoint where the coronary artery occlusion is located.

II. Methods

Study design: Cross sectional observational study.

Place of study: This study was conducted in the Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh.

Study period: October, 2017 to September, 2018.

Study population: Patients admitted in the Department of Cardiology, NICVD, diagnosed as non-ST elevated ACS who would undergone coronary angiography fulfilling inclusion and exclusion criteria.

Sample size

Study subjects were divided into two groups on the basis of presence or absence of f-QRS complexes in ECG:
- f-QRS complex group (n = 78)
- Non f-QRS complex group (n = 77)

Total **155** patients were considered.

Inclusion criteria:

New or diagnosed case of non-ST elevation ACS patients (Unastable angina, non-ST elevated myocardial infraction) who would undergone coronary angiography.

Exclusion criteria:

Non-ST elevation ACS patients (Unastable angina, non-ST elevated myocardial infraction) with any of the following criteria were excluded:

- Age <18 years
- ECG without ST-T changes
- Left & right bundle branch block (complete or incomplete)
- Patients with STEMI
- Electrolyte imbalance
- Arrythmia (Permanent AF, VT, SVT, WPW Syndrome)
- Ventricular paced rhythm
- A previously implanted implantable cardioverter – defibrillator (ICD)
- Left ventricular hypertrophy
- Cardiomyopathy
- Myocarditis
- Valvular heart diseases
- Congenital heart disease
- Coronary artery bypass surgery (CABG), PCI.
- Some systemic diseases like SLE, Rheumatoid arthritis, Sarcoidosis.

Study Procedure:

Procedure for data collection

Patients with non-ST elevation ACS (UA/NSTEMI) who would undergone invasive coronary angiography for detection of coronary artery disease were included in this study considering the inclusion and exclusion criteria.

1. A total of 155 patients were included in the study.
2. Informed written consent was taken from each patient before enrollment
3. Meticulous history was taken and detailed clinical examinations were done and recorded in predesigned preform.
4. Demographic data: Age, Sex were recorded.
5. Risk factors profiles were asked and scrutinized
6. Pulse and BP were recorded.
7. Immediately after admission, standard 12 lead ECG was recorded at a 25 mm/s paper speed and a gain of 10 mm/mV with the patient fully relaxed in the supine position. Patients were divided into two groups fQRS and non fQRS.

ECG analysis:

According to the standard distribution of the major coronary arteries in humans –

fQRS – group:

- fQRS complexes $\geq$ 2 contiguous anterior leads (V1-V5) – assigned to LAD territory
- fQRS complexes in the contiguous lateral leads (I, aVL, V6) – assigned to LCX territory
- fQRS complexes in the contiguous inferior leads (II, III, aVF) – assigned to RCA territory

Non – fQRS group:

- Inverted – T waves
- ST – segment depression

10. Serum Troponin-I concentration was determined within 12 hours of hospitalization and Troponin-I level > 1 ng/ml will be considered as positive cardiac marker.

11.Transthoracic echocardiography was done before coronary angiography. Standard echocardiographic measurements were done and averaged in 4 cardiac cycles, left ventricular ejection fraction was measured by Teichloze method.

12. Finally, all the enrolled patients would undergo coronary angiography. CAG was done as per hospital protocol.

13. Interpretations of the CAG were done by two cardiologist sitting together and location of the culprit lesion was identified. Coronary stenosis ≥ 70% was considered as significant.
14. Separate data collection sheet was used for each subject with maintaining confidentiality.
15. Highest level of confidentiality and ethical standard was maintained during storage and analysis of the data.

Statistical Methods:

Categorical data were expressed as frequency and percentage. Continuous data were expressed as mean ± standard deviation. Differences between the groups were analyzed using the X^2-test for categorical variables and the Student t-test for continuous variables. Sensitivity, specificity and predictive values were calculated. The Receiver Operating Characteristics (ROC) curve was used to test the accuracy of the findings. Statistical analyses were carried out by using **SPSS 20.** Word processing was done by the word module of Microsoft Office 2016 (Microsoft Corporation, USA).

III. Results

A total of 155 patients advised for CAG and admitted in hospital were categorized into two groups according to the presence or absence of fQRS complexes. Appropriate statistical techniques were applied to analysis the data. The results and observations are documented below.

Table I: Age distribution of the study patients (N=155)

Age in years	fQRS group (n=78)		Non- fQRS group (n= 77)		p value
	Number	%	Number	%	
≤ 40	8	10.3	9	11.6	
41 – 50	23	29.5	22	28.6	
51 – 60	27	34.6	25	32.5	
> 60	20	25.6	21	27.3	
Mean ± SD (Range)	56.4±9.3 (38-75)		53.4±9.4 (34-70)		0.11^{ns}

ns = Not significant (p>0.05)
p value reached from unpaired student t test.

Table-I shows that the mean age of the fQRS patients was 56.4±9.3 years ranging from 38 to 75 years and the mean age of the non-fQRS patients was 53.4±9.4 years ranging from 34 to 75 years. The mean age of fQRS group was higher than non-fQRS group which was statistically insignificant difference (p=0.11). It was observed that most patients in both groups were aged between 51 to 60 years.

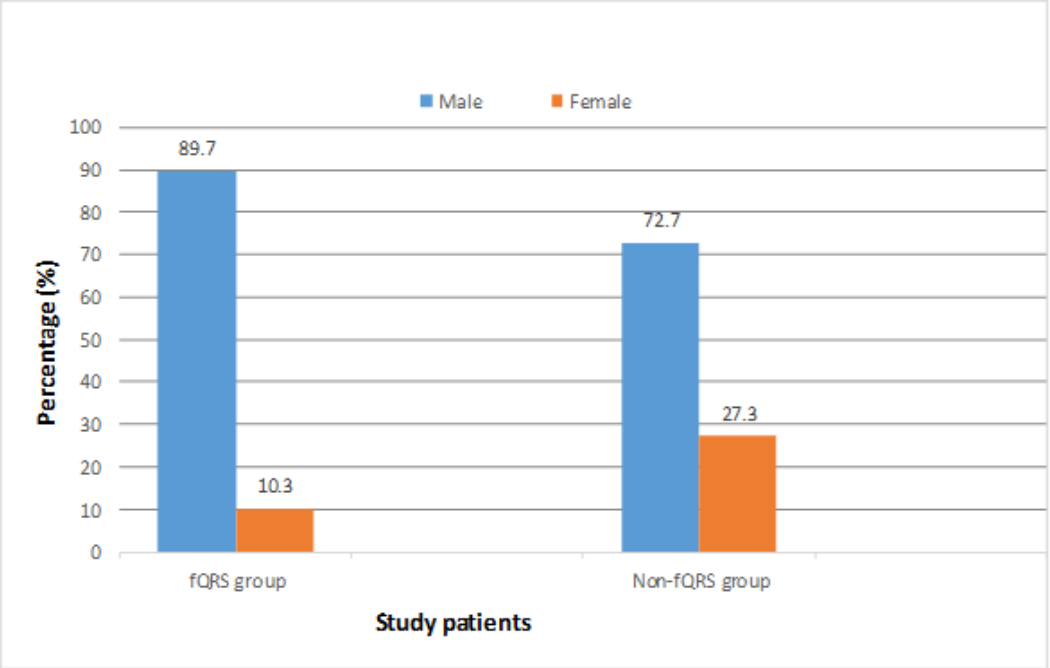

Figure 1: Sex distribution among the study patients.

Male patients were predominant in both groups. The ratio of male and female patients was 4.6:1. No significant association (p=0.05) was found between two groups in terms of sex distribution. P value reached from Chi Square (χ^2) test (fig-1).

Table II: Distribution of risk factors and study patients (N=155)

Risk Factors	fQRS group (n=78)		Non- fQRS group (n= 77)		p value
	Number	%	Number	%	
Smoking	52	66.7	50	64.9	0.76^{ns}
Hypertension	41	52.6	34	44.2	0.41^{ns}
Dyslipidaemia	56	71.8	58	75.3	0.74^{ns}
Diabetes mellitus	33	42.3	29	37.7	0.68^{ns}
Family H/O of CAD	12	15.4	14	18.2	0.81^{ns}

p value reached from Chi Square test
s= Significant (p<0.05), ns = Not significant (p>0.05)

The above table-II describes the risk factors of the study patients. Smoking, hypertension and diabetes mellitus had higher in fQRS group than non-fQRS without significant association (p>0.05). Dyslipidaemia and family history of CAD had more in non-fQRS patients than fQRS group but did not reach the level of significance (p>0.05).

Table III: Distribution of the patients by ECG findings (N=155)

ECG findings	**Frequency**	**Percentage**
fQRS	78	50.3
Inverted T-waves	51	32.9
ST-Depression	26	16.8

The ECG findings were shown in the above table-III.

Table IV: Distribution of the patients by fQRS and non-fQRS signs in ECG leads (N=155)

Leads distribution	fQRS group (n=78)		Non- fQRS group (n= 77)		P value
	Number	%	Number	%	
Anterior	26	33.3	25	32.4	0.91^{ns}
Lateral	25	32.1	26	33.8	0.82^{ns}
Inferior	27	34.6	26	33.8	0.91^{ns}

s = Significant (p<0.05), ns= Not Significant (p>0.05)
p value reached from Chi Square test.

The above table-IV shows that ECG signs were present almost similar numbers in anterior, lateral and inferior leads in both fQRS and non-fQRS group with no significant association

Table V: Distribution of the patients by LVEF% (N=155)

LVEF %	fQRS group (n=78)		Non- fQRS group (n= 77)		P value
	Number	%	Number	%	
36-44 (Moderate)	4	5.1	2	2.6	
45-54 (Mild)	23	29.5	19	24.7	
≥55 (Normal)	51	65.4	56	72.7	
mean±SD	57.7±8.3		58.9±7.5		0.50^{ns}

ns= Not Significant (p>0.05)
p value reached from unpaired t- test.

The above table-V explains that LVEF% was almost similar among the studied patents on the presence or absence of fQRS with no significant association (p=0.50).

Table VI: Distribution of the patients by CAG findings of involved arteries (N=155)

CAG characteristics	fQRS group (n=78)		Non- fQRS group (n= 77)		P value
	Number	%	Number	%	
Involved arteries					
LAD	25	32.1	27	35.1	0.73^{ns}
LCX	23	29.5	20	26.0	0.63^{ns}
RCA	24	30.8	21	27.3	0.63^{ns}

s = Significant (p<0.05), ns= Not Significant (p>0.05)
p value reached from Chi Square test.

The above explains that involved arteries were almost identical in both groups of patients with no significant association (p>0.05). RCA and LCX artery were higher in fQRS group than non-fQRS group (p=0.63) and LAD artery was higher in non-fQRS group (p=0.73) (Table-VI).

Table VII: Distribution of the patients by CAG findings of lesion severity (N=155)

CAG characteristics	fQRS group (n=78)		Non- fQRS group (n= 77)		P value
	Number	%	Number	%	
Lesion severity					
Single vessel disease	55	70.5	59	76.6	0.39^{ns}
Double vessel disease	15	19.2	7	9.1	0.07^{ns}
Triple vessel disease	2	2.6	2	2.6	1.00^{ns}
Normal	6	7.7	9	11.7	0.40^{ns}

s = Significant (p<0.05), ns= Not Significant (p>0.05)
p value reached from Chi Square test.

The above explains that lesion severities were almost identical in both groups of patients with no significant association (p>0.05). Single vessel disease were higher in both groups than double vessel and triple vessel disease (Table-VII).

Table VIII: Comparison of fQRS leads with CAG findings by involved arteries (n=78)

ECG Leads fQRS	No of Patients (n=78)	Involved arteries by CAG			
		LAD (n=25) No. (%)	LCX (n=23) No. (%)	RCA (n=24) No. (%)	Normal (n=6) No. (%)
Anterior	26	21 (84)	2 (8.7)	1 (4.2)	2 (33.3)
Lateral	25	3 (12)	19 (82.6)	1 (4.2)	2 (33.3)
Inferior	27	1 (4)	2 (8.7)	22 (91.6)	2 (33.3)

The table-VIII indicates that in fQRS group, the frequency of LAD was 21 (84%) in anterior and 3 (12%) was lateral ECG leads followed by inferior 1 (4%). The frequency of LCX was 19 (82.6%) in lateral and 2 (8.7%) in both anterior and inferior ECG leads. Finally, the frequency of RCA was 22 (91.6%) in inferior and 1 (4.2%) in both anterior and lateral ECG leads of fQRS.

Table IX: Electrocardiographic predictors of culprit lesions by fQRS

	Predictors of LAD lesion			
	Sensitivity	Specificity	PPV	NPV
fQRS in anterior leads	**84.0%**	**90.5%**	**80.7%**	**92.3%**
	Predictors of LCX lesion			
	Sensitivity	Specificity	PPV	NPV
fQRS in lateral leads	**82.6%**	**89.1%**	**76.0%**	**92.5%**
	Predictors of RCA lesion			

	Sensitivity	Specificity	PPV	NPV
fQRS in inferior leads	**91.6%**	**90.7%**	**81.4%**	**96.1%**

The sensitivity, specificity, positive predictive value (PPV) and negative predictive values (NPV) of fQRS in anterior leads to identify LAD lesion were 84.0%, 90.5%, 80.7% and 92.3% respectively and these results confirmed the high specificity of fQRS complexes in anterior leads for identifying lesion in the LAD **(p<0.001)**.The sensitivity, specificity, positive predictive value (PPV) and negative predictive values (NPV) of fQRS in lateral leads to identify LCX lesion were 82.6%, 89.1%, 76.0% and 92.5% respectively and these results confirmed the high specificity of fQRS complexes in lateral leads for identifying lesion in the LCX **(p=0.04)**. The sensitivity, specificity, positive predictive value (PPV) and negative predictive values (NPV) of fQRS in inferior leads to identify RCA lesion were 91.6%, 90.7%, 81.4% and 96.1% respectively and these results confirmed the high sensitivity of fQRS complexes in inferior leads for identifying lesion in the RCA **(p=0.001) (Table-IX)**.

Table X: Electrocardiographic predictors of culprit lesions by fQRS and non-fQRS group

	Predictors of culprit lesion				
	Sensitivity	Specificity	PPV	NPV	Accuracy
fQRS group	**59.1%**	**68.0%**	**79.5%**	**44.2%**	**61.9%**
	Predictors of culprit lesion				
	Sensitivity	Specificity	PPV	NPV	Accuracy
Non-fQRS group	**41.0%**	**32.0%**	**55.8%**	**20.5%**	**38.1%**

Total sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of fQRS group to identify culprit lesion were 59.1%, 68.0%, 79.5%, 44.2% and 61.9% respectively and these results confirmed the high sensitivity and specificity of fQRS group for identifying culprit lesion. In contrary, total sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of non-fQRS group to identify culprit lesion were 41.0%, 32.0%, 55.8%, 20.5% and 38.1% respectively. These results confirmed that fQRS group can predict culprit artery with a high sensitivity, specificity and accuracy and assumes better than non-fQRS group. In the study, out of 155 patients, 78 had fQRS in the ECG, whereas 77 had no fQRS in the ECG. ST-depression and inverted-T waves were the ECG findings of non-fQRS group. fQRS in the precordial leads had the highest sensitivity (84% versus 59.3%) and specificity (90.5% versus 82%) for identifying the culprit vessel (LAD artery) compared to non-fQRS group. The diagnosis of LCX lesion by fQRS was also highly sensitive (82.6 % versus 65 %) and specific (89.1% versus 77.2 %) in comparison to non-fQRS group. For the diagnosis of RCA lesions,the presence of fQRS was more sensitive (91.6% versus 66.7 %) and more specific (90.7 % versus 78.6%) than non-fQRS group. And the total sensitivity and specificity of fQRS (59.1 % and 68.0%) were higher than those values for non-fQRS group (Table-X).

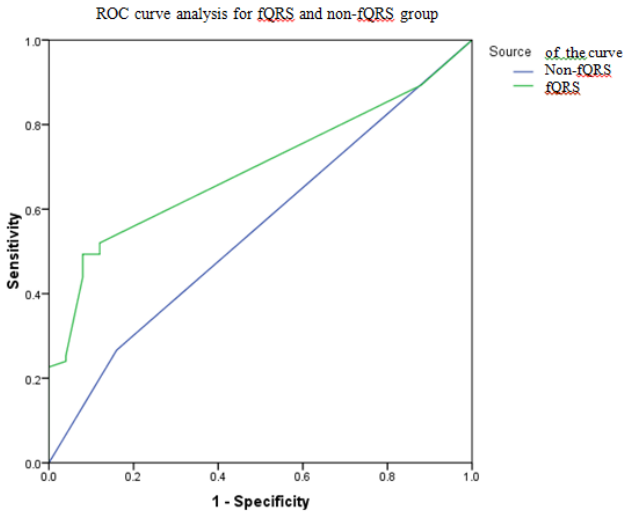

Figure 2: ROC curve analysis to determine the accuracy of fQRS complexes and non-fQRS group to identify culprit lesion.

The area under the ROC curves for fQRS and non-fQRS were 0.698 (95% CI, 0.594-0.801) and 0.553 (0.427-0.680) respectively. Thus the total diagnostic accuracy was significantly higher for fQRS than that of non-fQRS group (p=0.003) (fig-2).

IV. Discussion

This observational study was carried out with an aim to find out correlation of fQRS on 12 leads ECG to identify culprit lesion as evidenced by coronary angiography in non-ST elevated ACS patients. A total of 155 patients of non-ST elevated ACS admitted in the department of Cardiology, NICVD were evaluated considering inclusion and exclusion criteria. Patients were divided into two groups on the basis of presence or absence of f-QRS complex in 12 lead ECG. 78 patients were included in f-QRS group and 77 patients were included in non-fQRS group. Among the non-fQRS group, 51 patients had inverted T-waves and 26 patients had ST-Depression in their ECG. The mean age of fQRS patients was 56.4±9.3 years and the mean age of non-fQRS patients was 53.4±9.4 years. The patients in fQRS group in the present study had a higher mean age as compared with non-fQRS, but this was not stistically significant mean (p = 0.11). The maximum number of patients were found in the age range of 51- 60 years in both fQRS and non-fQRS group. Mean age of both groups was 55.1±9.4 years ranging from 34 to 75 years. However, Guo et al [21] found the association of age with fQRS as significant but Sharma et al [22] found no significat association of age with fQRS and non-fQRS. Guo et al [21] included 183 patients and mean age for fQRS and non-fQRS were 64.±1.0 and 59±1.0 years respectively. In the study of Sharma et al [22] regarding the correlation of fQRS with coronary angiography to identify the culprit lesion, the mean age of study population was 59.22±8.80 years. In this study, male patients were predominant. Among the 155 patients, 81.3% were male and 18.7% were females. In fQRS group, 70 (89.7%) patients were male and 8 (10.3%) patients were female. In non-fQRS group, 56 (72.7%) patients were male and 21 (27.3%) were female. Male patients were predominant in both groups. Male female ratio was 4.6:1. No significant association (p=0.05) was found between two groups in terms of sex distribution. Similar male preponderance was found in almost all studies on fQRS complex and coronary artery disease. In the study of Gou, et al [21] the percentage of male and female patients having fQRS complex were 63.6% and 36.4% respectively which are very similar to this study. Dabbagh et al [23] in their study showed, from 269 female patients 93 (34.57%) had fQRS and 176 (65.42%) did not have fQRS in their ECG. The fQRS was found in 50.3% patients. In other studies, like Guo et al [21], fQRS was 60% whereas in another study by Li et al [17] fQRS was 56% which is almost comparable to our study. As we know that the fQRS complex is normally formed when there is scarring of the myocardium, but having angina is an indication of ongoing ischemia or still viable myocardium which should be dealt with more aggressively in order to prevent the further LV dysfunction. Past history of HTN, DM, and DLP was insignificant in both the groups. Although we know that the presence of these risk factors leads to CAD, here these risk factors are insignificant in both the groups, similar to the study by Li et al [17]. The findings by Guo et al [21]and Dabbagh et al [23]. contrary to ours have significant DM patients in the fQRS group. In our study, the family history of CAD was found insignificant similar to Das et al [11]. Family history of CAD which was not sought out in the studies like Li et al [17] Sharma et al [22] and Guo et al [21]. In our study, smoking was found non-significant similar to Guo et al [21]. Dabbagh Kakhki et al [23] and Sharma et al [22] reported increased incidence of smoking in their positive fQRS group. LVEF% was almost similar among the studied patients on the presence or absence of fQRS with no significant association (p=0.50) similar to Guo et al [21]. But Sharma et al [22] found significant association of LVEF% in fQRS group. Dabbagh et al [23] ECG signs of the study population showed that fQRS and non-fQRS signs (Inverted-T waves and ST-segment depression) were similar numbers in anterior (P = 0.91), lateral (P = 0.82) and inferior (P = 0.91) leads with no significant association. Our study also showed that involved arteries were almost identical in both groups of patients with no significant association (p>0.05). In fQRS group, the most common artery involved was LAD with 32.1% followed by RCA 30.8% and LCX 29.5% which is comparable to study by Sharma et al [22]. LAD artery was higher in non-fQRS group than fQRS group which was not significant (p=0.73). LCX and RCA were higher in numbers in fQRS group. In the study of Sharma et al [22] and Guo et al [21] showed that all categories of involved arteries were higher in fQRS group than non-fQRS group. In our study lesion severities were almost identical in both groups of patients with no significant association (p>0.05). Among the 155 patients, single vessel disease were in 114 patients, 22 patients had double vessel disease and only 4 patients had triple vessel disease. Patients with normal coronaries had lower incidence of in both groups (P = 0.40) which was not significant. In our study, patients with fQRS had higher incidence of SVD (P = 0.39) and DVD (P = 0.07) which was not consistent with the findings in the study by Guo et al [21] and Sharma et al [22] in which higher incidence were DVD and TVD. On comparing fQRS in each ECG leads territory with corresponding CAG lesions, it was found that the association of fQRS in anterior leads was highly specific for LAD lesion with a specificity of 90.5 % whereas fQRS in inferior leads was associated with RCA lesions with a high sensitivity of 91.6 % and specificity of 90.7%. Similarly, the presence of fQRS in lateral ECG leads was associated with LCX lesions in CAG with a high specificity of 89.1 %. Guo et al [21] reported a sensitivity and specificity of 62% and 81% for LAD lesions, 92% and 65% for RCA lesions and 89% and 71% for LCX

lesions, respectively. Sharma et al [22] also reported a sensitivity and specificity of 19% and 96% for LAD lesions, 59% and 84% for RCA lesions and 12% and 94% for LCX lesions, respectively. So there was similarities between our study and those studies. In our study, the presence of fQRS in anterior leads for the diagnosis of LAD lesion was highly sensitive (84% versus 59.3%) and specific (90.5% versus 82%) compared with non-fQRS group. The diagnosis of LCX lesion by fQRS was also highly sensitive (82.6 % versus 65 %) and specific (89.1% versus 77.2 %) in comparison to non-fQRS group. For the diagnosis of RCA lesions, the presence of fQRS was more sensitive (91.6% versus 66.7 %) and more specific (90.7 % versus 78.6%) than non-fQRS group. Sharma et al [22] also found the same result in their study. Our result showed that the association of positive fQRS with CAG lesions of corresponding culprit artery had higher total sensitivity of 59.1% as compared to the association of non-fQRS group (41.0 %). fQRS had also higher total specificity of 68.0 % as compared to non-fQRS group (32.0 %). Diagnostic accuracy was also higher in fQRS group (61.9 %) than non-fQRS group (38.1 %). So the presence of the fQRS complexes had better diagnostic accuracy than ischemic T-waves for the identification of culprit vessels (Figure 5, p=0.003).

V. Conclusion

In non-ST elevated ACS only few patients have inverted-T waves and/or ST-segment depression in their ECG. fQRS in non-ST elevated ACS has not been well established in day to day practice, but about half of patients of non-ST elevated ACS have fQRS in their ECG. So we can predict culprit coronary artery by analyzing fQRS complex in the ECG in maximum numbers of non-ST elevated ACS patients. In our study, we found that presence of fQRS in ECG leads could identify the culprit vessel with high sensitivity and specificity. In addition, the diagnostic accuracy of fQRS complexes was significantly higher than that of non-fQRS group for the diagnosis of culprit coronary artery.

Limitations of the Study

Though the findings in this study are mostly in agreement with previous studies on fQRS complex and ischaemic heart disease, some findings were insignificant or inconsistent. This may be due to the following limitations:

- Single centered study.
- Result of the study might be influenced by relatively smaller sample size.
- For sampling, randomization could not be done.

VI. Recommendation

ECG is a widely used non-invasive tool for evaluation of coronary artery disease. fQRS is an important ECG finding that can identify culprit coronary artery successfully. Inceased awareness among physicians regarding fQRS may help in better management of CAD patients. Further large scale, multi-centered study is recommended to validate the findings of this study before its inclusion in regular clinical practice.

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