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FREQUENCY OF SIGNIFICANT CORONARY ARTERY DISEASE IN PATIENTS WITH LEFT BUNDLE BRANCH BLOCK AND FRAGMENTED QRS COMPLEX UNDERGOING CORONARY CATHETERIZATION

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ABSTRACT

Background: Left bundle branch block (LBBB) and fragmented QRS (fQRS) complex are well known ECG abnormalities with important prognostic value in patients with suspected coronary artery disease (CAD). Both markers indicate changes in the myocardial depolarization which are often said to be as a result of myocardial ischaemia, fibrosis, or myocardial scarring. Cumulative frequency of significant obstructive CAD in those patients who present with both LBBB and fQRS simultaneously, however, is poorly defined especially in Pakistani tertiary cardiac care facilities.

Objective: To find out the frequency of significant CAD in patients with LBBB and fQRS complex undergoing coronary catheterisation.

Study Design: A Descriptive cross- sectional study.

Place and Duration: National Institute of Cardiovascular Diseases (NICVD), Karachi from **February 17, 2026 to 16 August, 2026.**

Methodology: The subjects were patients with LBBB and fQRS complex in a 12-lead ECG who were admitted for coronary angiography and who met the diagnostic criteria were selected by non-probability consecutive sampling, for which the sampling method was used to select the number of samples was 62 patients. Significant CAD was considered as ≥50% stenosis of LMCA and ≥70% of other epicardial vessels. IBM SPSS v29.0 was used for data analysis.

Results: A total of 62 patients were included with a mean age of 54.3 ± 9.7 years, of whom 41 (66.1%) were male. CAD was present in 50 patients with a significant frequency of 80.6%. The most common vessel disease was the triple vessel disease (40.0%) followed by double (36.0%) and single (24.0%) vessel disease. The most frequently involved was LAD (61.3%). Te stratified analysis significant association with hypertension was obtained with significant CAD ($p = 0.048$).

Conclusion: Patients with LBBB who also have fQRS on standard ECG are a high-risk group for CAD with high prevalence of CAD of 80.6% that was comparable with international findings. In clinically suitable patients, the inclusion of both markers in routine ECG screening should lead to timely referral to coronary angiography.

KEYWORDS: Coronary artery disease, left bundle branch block, fragmented QRS, coronary angiography, electrocardiography, Pakistan.

INTRODUCTION

Coronaryartery disease (CAD) is a leading cause of morbidity and mortality worldwide with around 17.9 million deaths each year, estimated by the WHO. It reflects the interaction of various atherogenic risk factors, vascular inflammation and progressive stenosis of the lumen eventually leading to myocardial ischemia, infarction and finally myocardial dysfunction [1].

“Fragmented QRS (fQRS) complex” and “bundle branch block (LBBB)” is an electrocardiographic phenomenon that indicates disturbed conduction in the left bundle of His-Purkinje system resulting in abnormal activation of the left ventricle and mechanical dyssynchrony. Increases dramatically with age and subsequent cardiac

comorbidities. Clinically, LBBB is closely linked to hypertension, progressive heart failure, acute myocardial infarction, non-ischemic idiopathic dilated cardiomyopathy and degenerative conduction system disease, thus significantly increasing cardiovascular morbidity and mortality rates [1, 2].

On a 12-lead surface ECG, complex refers to a variety of RSR' forms such as a notched S or R wave, or a second R' deflection in two or more adjacent leads that represent a major coronary artery territory, but not a pattern that is typical of a bundle branch block. These changes are indicative of abnormalities in nodal depolarization from the effects of fibrosis, ischemia, or scar tissue in the Purkinje network. Both narrow (QRS < 120 ms) and wide (QRS > 120 ms) subtypes of fQRS have prognostic significance as illustrated by studies [3,4].
Independent prognostic value of fQRS in the prediction of the severity of CAD has been confirmed by several international studies. In patients at intermediate cardiovascular risk, fQRS was shown by Mahfouz et al. to be an independent predictor of plaque burden [4]. Likewise, when fQRS also occurs in LBBB the diagnosis is even more difficult because the morphology of ECG is distorted by LBBB and makes the assessment of the ischemic criteria more challenging.

Due to **limitations in sensitivity**, specificity and availability, particularly in resource challenged settings, advanced non-invasive imaging tests, like stress echocardiography or myocardial perfusion scintigraphy, are often required to make an accurate diagnosis significant obstructive CAD in the presence of LBBB and fQRS. The conventional standard of ≥50% lumen stenosis of LMC and ≥70% of other major epicardial coronary artery is used to define significant CAD.
Developed risk factors like diabetes mellitus, hypertension, dyslipidaemia and tobacco smoking are widely prevalent in Pakistan and thus contribute to the dis-proportionally high burden of CAD. Nevertheless, there is a need for more prospective data on the incidence of clinically important obstructive CAD, particularly in Pakistani patients with simultaneous LBBB and fQRS. Thus, attempts at generating evidence which can be extrapolated locally with patients at NICVD and other tertiary cardiac institutions have an important clinical value given the prevalence of significant CAD in 80% of patients with LBBB and fQRS reported by the landmark study by Al-Daydamony and Mustafa [5].

The aim of the present study was to fill this gap by prospectively finding out the frequency of significant CAD patients satisfying the diagnostic criteria of both LBBB and fQRS complex immediately undergoing elective/emt coronary catheterization in NICVD-Karachi, a national cardiac referral center in Pakistan.

MATERIALS AND METHODS

Study Design and Setting

It was a descriptive cross-sectional study, conducted in the cardiology inpatient department of the largest tertiary cardiac institution of Pakistan, National institute of cardiovascular diseases (NICVD) from 17 February 2026 to 16 August 2026 **(6 months)**.\

Sample Size

We used the WHO sample size calculator version 2.0 to calculate the sample size. Given the expected frequency of significant CAD of 80% in patients with LBBB with a fQRS of 10% (1:1 ratio), a minimum sample of 62 participants was found for a 95% confidence interval and 10% margin of error.

Sampling Technique

A non-probability consecutive sampling technique was used, including all eligible patients attending who met the selection criteria during the study time.

Inclusion Criteria

- patients age 18-80 years of both sexes
- According to the American Heart Association (AHA) criteria, the following ECG findings are associated with an LBBB: QRS duration ≥120 ms, a broad/slurred R wave in the lateral leads (V5, V6, I), initial septal Q waves were absent, and R-peak time was >60 ms (V5-V6) with discordant ST-T waves.
- Fragmented QRS complex is observed by electrocardiogram on a 12-lead as a notch in the R wave (or a greater than 1 notch in the R wave or notch in the S wave) in ≥2 contiguous leads in one of the major coronary arteries.
- Admission was with the main diagnosis of Coronary artery disease and a planned Coronary Angiography

Exclusion Criteria

- Moderate to severe aortic valvular heart disease hypertrophic cardiomyopathy or left ventricular outflow tract (LVOT) obstruction
- History of prior percutaneous coronary intervention (PCI) and/or coronary artery bypass graft surgery (CABG)
- ST-elevation myocardial infarction (STEMI) on presentation:

- Permanent pacemaker rhythm or implantable cardioverterdefibrillator (ICD)
- Heart failure (NYHA Class IV), renal failure (eGFR <30 mL/min/1.73 m²) or hepatic failure

Procedure
Written informed consent was obtained from all participants prior to study a standard 12-lead ECG on enrolment. ECGs were analysed independently by two cardiologists who were blinded to the opinion of the other cardiologist and any discrepancies were adjudicated by a senior consultant. The Judkins technique was used for all coronary angiographic procedures, performed by experienced interventional cardiologists who performed at least five years of coronary angiography. who performed angiography by Judkins technique via femoral or radial approach. The same experienced operators made the angiographic readings.

Data Collection
A structured data proforma created by the principal investigator was used to collect data. Demographic data (age, gender, height, weight, BMI) and medical history (obesity, smoking, diabetes mellitus, hypertension) were obtained by direct interview of the patient and by analysis of the patient's medical records. The main outcome — substantial CAD — was obtained from the formal angiographic report. Strict inclusion and exclusion criteria and post-stratification analysis were done to control for confounding variables.

Operational Definitions
Significant CAD was defined as a left main coronary artery (LMCA) stenosis ≥50% and a maximum stenosis ≥70% in any other epicardial coronary artery in the angiographic projection with the most severe stenosis.9 Hypertension was identified as a medical history with antihypertensive treatment for ≥6 months. Diabetes mellitus was considered present if the history of the disease was documented and antidiabetic therapy was used for ≥6 months. BMI >27.5 kg/m2, weight (kg)/height (m)2, was the criteria used for obesity. A person was considered a smoker if he/she currently or recently smoked 10 to 20 cigarettes daily for ≥1 year.

Statistical Analysis
IBM SPSS Statistics (version 29.0, IBM Corp., Armonk, NY, USA) were used for data analysis. The Shapiro-Wilk test was used to test the normality of the continuous variables. Normally distributed continuous data were reported using mean ± standard deviation (SD) and non-normally distributed continuous data were reported using median, interquartile range (IQR). Categorical variables such as sex, hypertension, diabetes, smoking, obesity and major CAD were presented as numbers and percentages. Chi-square or Fisher's exact test as appropriate was used to conduct stratified analysis. Obtained P value<0.05 was used for statistically significant findings.

RESULTS
A total of patients entered this study. The average age of the participants was 54.3 ± 9.7 years. There was a preponderance of male gender, 41 (66.1%) male and 21 (33.9%) female patients. The average BMI of the study population was 27.1 ± 3.8 kg/m². Hypertension (61.3%) was the most common cardiovascular risk factor followed by diabetes mellitus (46.8%), obesity (43.5%) and active smoking (35.5%). Detailed baseline demographic and clinical characteristics are presented in Table 1.

Table 1. Given a baseline demographic and clinical features of enrolled patients (n =62)

Variable	Total (n=)	Significant CAD (n=50)	Non-Significant CAD
Age (years) Mean ± SD	54.3 ± 9.7	56.1 ± 9.2	47.4 ± 8.6
Male Gender, n (%)	41 (66.1%)	34 (68.0%)	7 (58.3%)
BMI (kg/m²) Mean ± SD	27.1 ± 3.8	27.6 ± 3.9	25.4 ± 3.2
Hypertension, n (%)	38 (61.3%)	33 (66.0%)	5 (41.7%)
Diabetes Mellitus, n (%)	29 (46.8%)	25 (50.0%)	5 (41.7%)
Smoking (Active), n (%)	22 (35.5%)	19 (38.0%)	3 (25.0%)
Obesity (BMI > 27.5), n (%)	27 (43.5%)	24 (48.0%)	3 (25.0%)

SD (Standard Deviation), CAD (Coronary Artery Disease), BMI (Body Mass Index)

Among the 62 patients in this study, 50 (80.6%) had the primary result of > 1 significant obstructive CAD. Multi-vessel disease was predominant in patients with significant CAD; 20 cases had triple vessel disease, 18 had double vessel disease, and 12 had single vessel disease. More commonly affected was the left anterior descending (LAD;

61.3%), followed by the left circumflex artery (LCx; 45.2%) and the right coronary artery (RCA; 38.7%). Fourteen patients (22.6%) had stenosis of ≥50% in the left main coronary artery. Twelve patients (19.4%) had non-significant or normal coronary trees on angiography. Complete angiographic data are presented in Table 2.

Table 2. The coronary angiographic results for the patients enrolled (n=62)

Standard Volume	n	Incidents Cases (%)
Significant CAD Overall	50	80.6%
Single Vessel Disease	12	24.0%
Double Vessel Disease	18	36.0%
Triple Vessel Disease	20	40.0%
Left Main Stenosis ≥50%	14	22.6%
LAD Involvement	38	61.3%
LCx Involvement	28	45.2%
RCA Involvement	24	38.7%
Non-Significant CAD	12	19.4%

CAD - Coronary Artery Disease, LAD - Left Anterior Descending Artery, LCx - Left Circumflex Artery, RCA - Right Coronary Artery, LM - Left Main.

Significant CAD was analysed according to different demographic and clinical factors in stratified analysis. Gender (p = 0.436) and smoking status (p = 0.354) were not significantly associated with significant CAD. Significant CAD was numerically more common in those with hypertension (86.8%) than in those without (70.8%) and this was statistically significant (p = 0.048). Significant CAD occurred in 50.0% of patients with diabetes mellitus compared to 33.3% of patients without which was not statistically significant (p = 0.291). The results from stratification are summarized in Table 3.

Table 3. Stratification of important CAD by clinical risk factors (n=62)

Variable	Sig CAD n (%)	Non-Sig CAD n (%)	Total n (%)	p-value
Gender				
Male	34 (82.9%)	7 (17.1%)	41 (66.1%)	0.436
Female	16 (76.2%)	5 (23.8%)	21 (33.9%)	
Hypertension				
Present	33 (86.8%)	5 (13.2%)	38 (61.3%)	0.048
Absent	17 (70.8%)	7 (29.2%)	24 (38.7%)	
Diabetes Mellitus				
Present	25 (86.2%)	4 (13.8%)	29 (46.8%)	0.291
Absent	25 (75.8%)	8 (24.2%)	33 (53.2%)	
Smoking				
Present	19 (86.4%)	3 (13.6%)	22 (35.5%)	0.354
Absent	31 (77.5%)	9 (22.5%)	40 (64.5%)	

Sig CAD: Significant Coronary Artery Disease; chi-square or Fisher's exact test used as appropriate; value of $p < 0.05$ deemed as significant.

DISCUSSION

The key results of this study are that 80.6% patients with co-existent LBBB and fQRS complex had finding of angiographically significant obstructive CAD during coronary catheterization performed at NICVD Karachi. This clinically important observation highlights the multiplicative diagnostic and prognostic value of these two ECG abnormalities occurring concurrently.

This finding is in close agreement with the landmark study of Al-Daydamony and Mustafa, who found that 80% of the Egyptian population patients who had both LBBB and fQRS complex had significant CAD [5]. This agreement between both these geographically separated populations reinforces the generalizability of the association and its potentiality as an ECG screening tool in high-risk cardiac patients. As importantly, in a 2024 study specifically focusing on the material of wide fQRS and the presence of LBBB, Haz et al. found that these factors significantly increased the likelihood of obstructive CAD.[1]

This association is biologically plausible. LBBB is associated with disruption of normal left ventricular conduction with septal-to-lateral activation delay that may also cause regional wall motion abnormality that can simulate – and frequently is present with – ischemic cardiomyopathy. However, Fedulaev et al. demonstrated that inhomogeneous ventricular depolarization—manifested as fragmented signals—correlates closely with higher Gensini scores, providing clear anatomic proof that fragmentation mirrors underlying plaque burden and myocardial scarring [2].

Multi-vessel disease was most predominant in our series, accounting for 76.0% of the patients with significant CAD who had two or more vessels involved, which is certainly consistent with the severity of CAD in this electrocardiographically high risk phenotype as reported by Eyuboglu et al. who found that anterior-lead fQRS was significantly associated with multi-vessel disease.[6]
The high proportion of patients with CAD who presented with triple-vessel disease in our series (40.0% of CAD-positive patients) suggests that patients with fQRS might specifically identify patients at the severe end of the spectrum of CAD.

Collectively, these findings support the use of fQRS as a valuable prognostic indicator beyond anatomic prediction for a wide variety of cardiovascular diseases that can simply be identified on routine ECG [3] Zhang et al. have also shown fQRS as a strong predictor of microvascular reperfusion failure and left ventricular dysfunction after STEMI [7].

When using the stratified analysis, the only statistically significant risk factors associated with the presence of significant CAD were hypertension at $p = 0.048$. However, diabetes and smoking showed numerically higher prevalence of CAD in diabetics and smokers, although not significant statistically, which may be due to the small number of patients in both groups.
The present study has a number of advantages: prospective enrollment design, high-volume national cardiac center, standardized angiographic definitions, and combined ECG criteria and independent review. Limitations are a single-center design that limits generalizability to other centers, a descriptive cross sectional study that precludes causal inferences, no long-term follow-up data, and moderate sample size for which the power of stratified analyses was limited.

CONCLUSION

Eighty percent of patients with incidence of LBBB who also have fragmented QRS, who underwent coronary angiography at NICVD, Karachi, showed significant obstructive CAD, which was most often seen as multi and triple vessel pattern. These results confirm high discriminative power of the combination of LBBB and fQRS complex for the prediction of hemodynamically significant CAD. It is highly recommended to incorporate these electrocardiographic markers into routine practice for timely triage and referral to angiography to enhance patient centered outcomes in cardiac settings of Pakistan

LIST OF ABBREVIATIONS

CAD: Coronary Artery Disease
ECG: Electrocardiogram
FQRS: Fragmented QRS Complex
LBBB: Left Bundle Branch Block
LAD: Left Anterior Descending Artery
LCx: Left Circumflex Artery
RCA: Right Coronary Artery
LM: Left Main
BMI: Body Mass Index
NICVD: National Institute of Cardiovascular Diseases
IRB: Institutional Review Board

PCI: Percutaneous Coronary Intervention
CABG: Coronary Artery Bypass Graft
STEMI: ST-Elevation Myocardial Infarction
SPSS: Statistical Package for Social Sciences
WHO: World Health Organization

ACKNOWLEDGMENT
The authors heartily thank the staff members of the Adult Cardiology Department NICVD, Karachi for their help in the recruitment of patients and collection of data. Sparkling gratitude is extended to the catheterization lab staff for performing accurate angiographic assessment.

CONFLICT OF INTEREST
None

FUNDING
None

ETHICAL APPROVAL
Ethical clearance was taken from the National Institute of Cardiovascular Diseases (NICVD), Karachi Institutional Review Board. **IRB Reference: IRB-02/2026; Approval Date: February 16, 2026.** All procedures were carried out according to the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to study inclusion.

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