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Isolated left circumflex coronary artery disease: clinical, electrocardiographic, echocardiographic, and angiographic Characteristics at a tertiary care hospital

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Abstract:

Introduction: The occurrence of isolated left circumflex coronary artery disease is infrequent and is observed in only a small fraction of patients undergoing coronary angiography. Due to the rarity of this specific coronary artery disease, there is a limited body of literature available. Consequently, the clinical, electrocardiographic, echocardiographic, and angiographic characteristics of individuals with isolated left circumflex coronary artery disease remain insufficiently described**. Aim and Objective:** The goal of this study is to identify distinct electrocardiographic alterations and angiographic discoveries associated with isolated left circumflex coronary artery disease. **Methodology:** This research was carried out at Swamy Vivekanandha Medical College and Research Institute, located in Thiruchengodu, Namakkal, Tamilnadu, within the departments of cardiology and general medicine. It is a descriptive observational study encompassing a total of 55 patients. Ethical approval from the institutional ethics committee was secured to conduct this study at our hospital. All eligible study participants, meeting the predetermined inclusion and exclusion criteria, were enrolled in the current investigation. **Observation :** A study of 55 patients with isolated left circumflex coronary artery disease found that, The most common indications for angiogram were documented myocardial infarction (64%) and stable angina pectoris (36%).The most common electrocardiographic findings were Q waves (54.5%) and ischemic ST-T changes (72%). 41 patients (74.5%) had a positive treadmill test. A total of 68 stenoses were noted in the left circumflex coronary artery and its branches, with 36 (53%) central and 32 (47%) peripheral.

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43 patients (78%) had a single stenosis, 11 patients (20%) had double stenosis, and 1 patient (2%) had triple stenosis. The average number of risk factors per patient was 2.8.**Conclusion:** Isolated left circumflex coronary artery disease is uncommon (3.2%), but most patients have a good prognosis. Single central stenosis is most common, especially in patients with MI. ECG changes in lateral leads are common with proximal stenosis, and ECG changes in inferior leads are common with distal stenosis.

Key words: Left circumflex coronary artery disease, Electrocardiogram, Angiogram**,**

Introduction:

Coronary artery disease (CAD) represents a significant cause of both mortality and morbidity among women, contributing to one-third of female deaths, without regard to race or ethnicity [1,2]. The prevalence of CAD in Indian women has shown an upward trend, increasing from 3% to 10% in the urban population and remaining between 2% and 4% in rural areas from 1960 to 1995 [3]. Acute coronary syndrome (ACS), a subset of CAD, encompasses a spectrum of clinical conditions, including unstable angina, ST-elevation myocardial infarction (STEMI), and non-ST-elevation myocardial infarction (NSTEMI), all involving myocardial injury and myocardial infarction [4].

Isolated left circumflex coronary artery disease is a relatively rare occurrence, found in a small fraction of patients undergoing coronary angiography. Due to its infrequency, there is a paucity of studies in the literature focusing on isolated coronary artery disease. Consequently, the clinical, electrocardiographic, echocardiographic, and angiographic characteristics of individuals with isolated left circumflex coronary artery disease remain inadequately characterized. It's worth noting that occlusion of the left circumflex artery (LCX) can lead to an electrocardiographic pattern resembling that of an inferior myocardial infarction, similar to what is seen with right coronary artery occlusion.

Patients experiencing isolated LCx-related infarction exhibit distinct patterns of myocardial damage. The extent of myocardial involvement is directly related to the cumulative area downstream of each coronary artery lesion. The effectiveness of interventional therapy appears to be more pronounced in cases of larger myocardial injuries, regardless of the site of infarction. Therefore, it is crucial to assess the relationship between ECG patterns, the site of coronary stenosis, and left ventricular function in patients with isolated LCx disease, both with and without myocardial infarction.

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Posterior myocardial infarction (PMI) results from the occlusion of the left circumflex artery (LCX) or right coronary artery (RCA) and accounts for 15-20% of acute MIs [5]. Diagnosing PMI can be challenging, and it carries a high six-month mortality rate, especially when accompanied by other myocardial wall ischemia [6,7].

In light of the aforementioned background, this study was conducted to identify specific electrocardiographic changes and angiographic findings in cases of isolated left circumflex coronary artery disease.

AIM OF THE STUDY:

To study the clinical presentation of patients presenting with isolated left circumflex coronary artery disease.

1. To determine the specific electrocardiographic changes in isolated left circumflex coronary artery disease.
2. To determine the relationship between site of stenosis (central vs peripheral) and electrocardiographic patterns.
3. To determine the association between the location and extent of stenosis in isolated left circumflex coronary artery disease and left ventricular systolic function.
4. To study the Echocardiographic features associated with left circumflex coronary artery disease.
5. To study the prevalence of risk factors in patients with isolated left circumflex coronary artery disease.

MATERIALS AND METHODS:

This study was conducted out in Swamy Vivekanandha Medical College and Research Institute, located in Thiruchengodu, Namakkal, Tamilnadu, within the departments of cardiology and general medicine. This study is a Descriptive observational study involving 55 patients. Institutional ethics committee clearance was obtained to conduct this study in our hospital. All study subjects fulfilling the inclusion and exclusion criteria were included in the present study.

We screened angiograms conducted over a span of two years for our study, ultimately including only 55 patients who met the eligibility criteria. Among these participants, 50 were male, constituting 91% of the cohort, while 5 were female, making up the remaining 9%. The

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mean age within the study population averaged 52.5 years, with an age range spanning from 34 to 70 years.

Inclusion criteria:

Patients whose coronary angiogram showed isolated left circumflex coronary artery disease.

Exclusion criteria:

Patients with left anterior descending coronary artery disease,Patients with multi vessel coronary artery disease, Patients with right coronary artery disease,Patients with advanced heart failure,Chronic kidney disease,Resting oxygen saturation less than 90% , Acute stress (within 6weeks of any acute illness).

Of the 55 patients selected for the study, 35 underwent coronary angiograms due to documented myocardial infarction, which accounted for 64% of the cases. The remaining 20 patients, approximately 36%, had undergone coronary angiograms primarily for the indication of angina on effort.

In the subset of patients whose coronary angiograms revealed isolated left circumflex coronary artery disease, we examined several parameters, including:

1) The mode of clinical presentation, which encompassed unstable angina (UA), non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI).

2) Electrocardiographic findings, with a focus on their distribution and patterns across various leads.

3) Echocardiographic analysis, which involved assessing regional wall motion abnormalities, ejection fraction, and the presence of mitral regurgitation (MR).

4) Coronary angiogram analysis, specifically evaluating the number, severity, and distribution of stenosis.

5) Lastly, we conducted a thorough analysis of risk factors among the study participants.

Clinical Presentation Analysis:

We examined the manner in which the study population presented clinically, categorizing it based on factors such as effort angina, unstable angina, non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI). Additionally, we evaluated the presence of rhythm disturbances during the acute

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presentation, particularly in cases of STEMI. Moreover, in patients presenting with STEMI, we specifically assessed their hemodynamic parameters.

Electrocardiographic Observations

We meticulously examined the electrocardiograms (ECGs) of the study population, paying close attention to the presence or absence of Q waves and the presence or absence of ischemic ST-T changes. Furthermore, we analyzed the location and magnitude of the ST-T changes. In particular, we specifically searched for combinations of Q waves and ST-T changes, especially in patients who presented with ST-segment elevation myocardial infarction (STEMI).

We also scrutinized the location of these ECG changes in relation to the leads used. These ECG alterations were then correlated with the specific location of lesions in the left circumflex coronary artery (LCX). Additionally, we examined patterns associated with high lateral myocardial infarction (MI) and right ventricular MI (RV MI).

The assessment of posterior MI involved the use of posterior leads in addition to the standard ECG leads. Meanwhile, RV MI was evaluated using right-sided chest leads in conjunction with the standard chest leads. We further investigated the patterns of ECG changes in relation to the various locations of stenosis in the LCX. Additionally, we conducted an analysis of other associated features, such as left bundle branch block (LBBB), right bundle branch block (RBBB), and left ventricular hypertrophy (LVH).

Echocardiographic Evaluation

We conducted a comprehensive echocardiographic assessment, beginning with the baseline evaluation of left ventricular (LV) systolic function using the modified Simpson's method for all study participants. LV dysfunction was categorized as follows: mild if the LV ejection fraction (EF) fell within the range of 46 to 55%, moderate when the LV EF ranged from 30 to 45%, and severe if the LV EF was less than 30%. Normal LV function was characterized by an LV EF exceeding 55%.

Additionally, all members of the study population underwent color flow imaging to detect the presence of mitral regurgitation, which was subsequently graded as mild, moderate, or severe in accordance with the guidelines set by the American Heart Association (AHA).

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In patients who presented with documented ST-segment elevation myocardial infarction (STEMI), we meticulously assessed regional wall motion abnormalities.

Angiographic Examination

We gathered and meticulously assessed the diagnostic coronary angiograms of the study population. Our analysis focused on the precise location and severity of stenosis within the left circumflex coronary artery (LCx), examining multiple angiographic perspectives. Additionally, we conducted an analysis of the number of stenotic lesions within the LCX.

To define significant stenosis, we used criteria of stenosis equal to or greater than 70% in the left anterior descending artery (LAD), LCX, and right coronary artery (RCA). For the left main coronary artery (LMCA), significant stenosis was defined as a severity of 50% or more.We also studied the presence of nonsignificant stenosis in the RCA and LAD, classifying it as stenosis with a severity of less than 50%. In the case of the LMCA, nonsignificant stenosis was characterized by a severity of less than 30%. Additionally, we assessed coronary artery dominance.

For analytical purposes, we divided the LCX into proximal and distal segments. The proximal segment comprised the portion above the origin of OM1, while the distal segment was defined as the portion below the origin of OM1. In patients with high lateral myocardial infarction (MI), we specifically examined the presence of stenosis in the obtuse marginal arteries (OMs).Furthermore, we evaluated collateral circulation in patients displaying total or near-total occlusion of the LCX.

Evaluation of Major Risk Factors for CAD in the Study Population

We conducted an assessment of the study population to determine the presence of significant risk factors for coronary artery disease (CAD). These risk factors encompassed hypertension, diabetes mellitus, a family history of coronary artery disease, smoking, and hypercholesterolemia. Following this assessment, we computed the average number of risk factors per patient. Additionally, we categorized the patient population based on the number of risk factors present, distinguishing between those with single, multiple, or no risk factors.

Statistical analyses:

Data were analyzed using the SPSS software for Windows (version 16.0) (SPSS Inc., Chicago, IL). To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous

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variables. To find the significant difference between the bivariate samples in Independent groups the Unpaired sample t-test was used for normal data and Mann-Whitney U test was used skewed data. To find the significance in categorical data Chi-Square test was used. In all the above statistical tools the probability value <0.05 is considered as significant level. The pvalue is considered highly significant when it is <0.01, no significant >0.05.

RESULTS:

Statistical analysis was performed on 55 patients who met both the inclusion and exclusion criteria. The variables analyzed included age, sex, indication for coronary angiogram, ECG abnormalities, distribution of stenosis, LV function, and risk factors. The most common indication for coronary angiogram was documented myocardial infarction (64%), followed by angina pectoris on effort (36%).

Among the 55 individuals in the study cohort, 50 were male (constituting 91%), while the remaining 5 were female (accounting for 9%). Hypertension was prevalent in 40 patients (approximately 72.7%) within the study group. Furthermore, the majority of participants, 42 patients (around 76.3%), were smokers. Hypercholesterolemia was documented in 36 patients (about 65.4%). Additionally, a family history of coronary artery disease was reported by 20 patients (equating to approximately 36.6%), and 20 patients were diagnosed with type 2 diabetes mellitus (representing roughly 36.4%). On average, each patient had 2.8 risk factors.

Regarding the distribution of risk factors, only 2 patients (approximately 4%) had no identified risk factors, 5 patients (about 9%) had a single risk factor, while the majority, 48 patients (approximately 87%), exhibited multiple risk factors.

In the resting ECG, 30 patients (54.5%) showed Q waves, 40 patients (72%) showed ischemic ST-T changes, and 15 patients (27.3%) showed RV pattern of ECG changes. 12 patients (21.8%) had a normal ECG. LBBB was noted in 1 patient (2%), RBBB was noted in 3 patients (5.4%), and LVH was noted in 7 patients (12.7%). 27 patients (49%) showed both Q waves and ischemic ST-T changes in their resting ECG, while 13 patients (23.6%) showed only ischemic ST-T changes.

In simpler terms, a statistical analysis was performed on 55 patients with coronary artery disease. The most common reason for having a coronary angiogram was a heart attack. The ECGs of these patients showed a variety of abnormalities, including Q waves, ischemic

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ST-T changes, and RV pattern of ECG changes. Some patients also had LBBB, RBBB, or LVH.

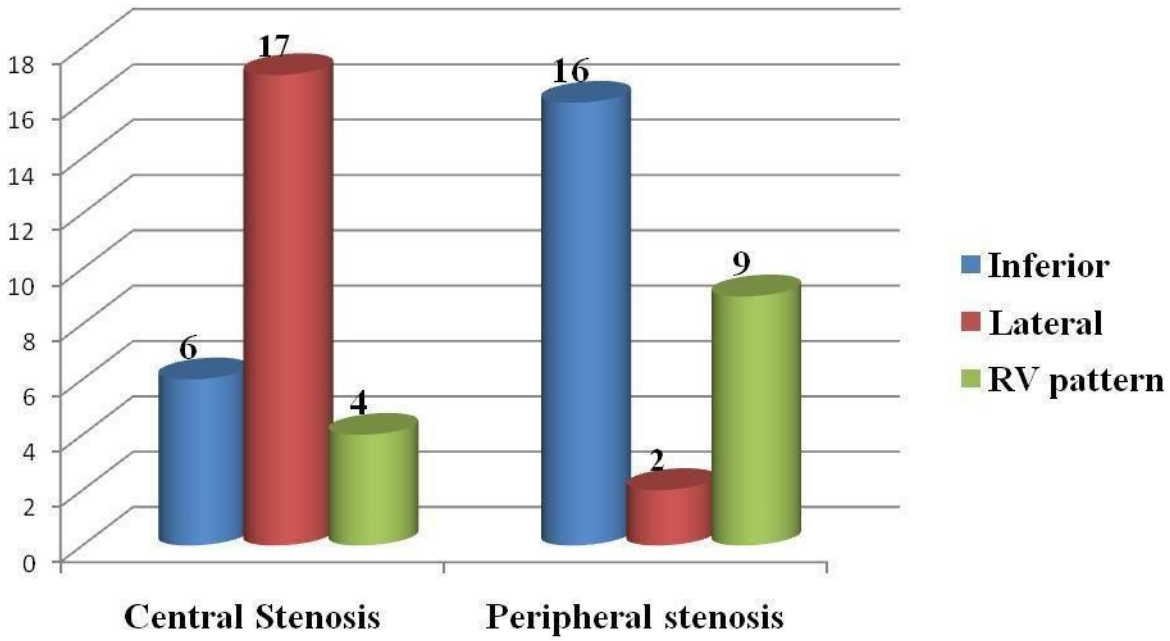

Fig:1 Inferior and lateral patterns of ECG abnormalities in patients with solitary stenoses in segments of the left circumflex coronary artery

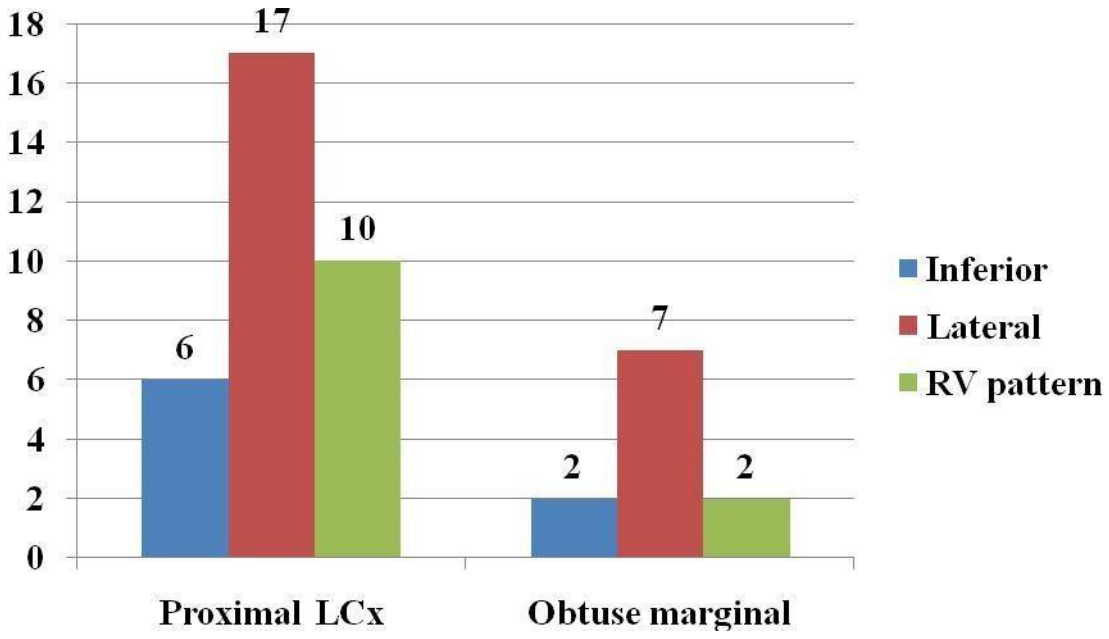

Fig:2 ECG abnormalities in patients with single stenosis centrally

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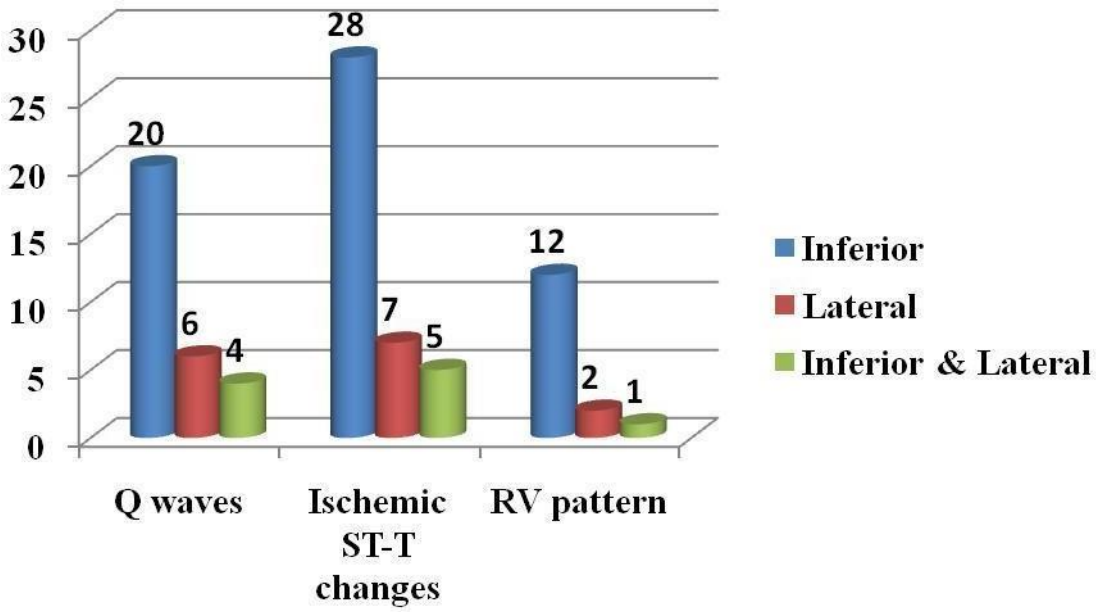

Fig: 3 ECG CHANGES WITH RESPECT TO LEADS

In the study group, 41 patients (74.5%) had positive treadmill test results. Within this group, 21 patients had documented myocardial infarction, while the remaining 20 underwent the treadmill test due to angina pectoris upon exertion. It's worth noting that 14 patients (25.5%) did not undergo the treadmill test. (Figure-1)

Among the study population, a total of 68 stenosis events were identified in the left circumflex coronary artery and its branches. Out of these, 36 (53%) were categorized as central stenosis, and 32 (47%) were considered peripheral stenosis. The distribution of central stenosis included 20 cases (29%) in the proximal LCx, 14 (21%) in the obtuse marginal branches, and 2 (3%) in the intermediate branches. Meanwhile, the peripheral stenosis distribution consisted of 30 cases (44%) in the distal LCx and 2 cases (3%) in the posterolateral branches (Figure- 2 &3).

	Electrocardiographic changes			
	Total	**Inferior**	**Lateral**	**Inferior & Lateral**

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Q waves	30	20	6	4
Ischemic ST-T changes	40	28	7	5
RV pattern	15	14	0	1
LBBB	1	-	-	-
RBBB	3	-	-	-
LVH	6	-	-	-

Tabl:1 ECG CHANGES WITH RESPECT TO LEADS

Among the study participants, 43 patients (78%) exhibited single stenosis in the left circumflex coronary artery and its branches, while 11 patients (20%) had double stenosis, and a single patient (2%) presented with triple stenosis.

Within the study group, 43 patients (78%) exhibited a solitary stenosis in the left circumflex coronary artery and its associated branches. Among these 43 stenoses, 23 were classified as central, and 20 were categorized as peripheral. Among the central stenoses, 13 were specifically located in the proximal left circumflex coronary artery, while the remaining 10 were situated in the obtuse marginal branches. Regarding the peripheral stenoses, 19 of them were identified in the distal LCx, with the remaining one being found in the posterolateral branches.

Site of Stenosis	No. of Stenosis	% of total
Central	36	53
Proximal LCx	20	29
Obtuse marginal	14	21

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Intermediate	2	3
Peripheral	32	47
Distal Cx	30	44
Posterolateral	2	3

Table:2 DISTRIBUTION OF STENOSIS

DISCUSSION:

Isolated left circumflex coronary artery disease (CAD) is rarely seen on angiography, with a prevalence of 3.2% in this study. Most patients in this study had a history of myocardial infarction and underwent coronary angiography due to higher risk stratification scores. This may explain the lower incidence of treadmill test-positive effort angina in the study population[7].

Isolated left circumflex CAD does not appear to cause severe left ventricular dysfunction, as the mean ejection fraction in our patients was 53.16%, which is consistent with previous reports. Patients with isolated left circumflex CAD may have electrocardiographic abnormalities in the inferolateral leads (inferior pattern in leads II, III, aVF, V5, and V6), anterolateral leads (lateral pattern in leads I, aVL, V5, and V6), and right precordial leads (RV pattern in leads V1 and V2). The lateral pattern and RV pattern are more specific for circumflex disease[8].

To determine whether these more specific patterns of ECG changes correlated with disease in specific segments of the circumflex coronary artery, the left circumflex coronary artery was divided into proximal and distal segments. Inferior electrocardiographic changes can also occur in patients with isolated right coronary artery disease and are not specific for left circumflex coronary artery disease.

Gensini et al. suggested that most stenoses are proximal. In our study, the sites of stenoses also reflect the sites of predilection for atherosclerosis in patients with isolated circumflex disease, including proximal and distal circumflex segments and proximal portions of the major branches The portions of the branches of circumflex coronary artery beyond the major bifurcation were usually free of segmental stenosis[9,10].

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In contrast to the findings of Gensini et al., no ostial or ostioproximal lesions involving the left circumflex coronary artery were noted in our study[10].

CONCLUSION:

The prevalence of isolated left circumflex coronary artery disease stands at 3.2%. Among patients with isolated LCX disease, the most frequently observed anomaly in coronary angiograms is a single stenosis. Central stenosis affecting the proximal left circumflex coronary artery is more prevalent than peripheral stenosis affecting the distal LCX. Patients with documented myocardial infarction tend to exhibit central stenosis in the proximal LCX more frequently. The majority of individuals with isolated LCX disease display normal left ventricular function. Notably, ECG alterations in lateral leads are commonly observed in individuals with proximal LCX stenosis. On the other hand, ECG changes in inferior leads are prevalent among patients with distal LCX stenosis. On average, each patient carries 2.8% risk factors.

Clinical implications:

Isolated circumflex coronary artery disease (CAD) can be suspected based on clinical and electrocardiographic criteria, but definitive diagnosis requires coronary angiography. Patients with isolated circumflex CAD typically have preserved left ventricular function, with most patients having normal ejection fraction and left ventricular function.

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Conflicts of interest: There are no conflicts of interest.

Author's contribution: ***Dr.Priya Jeevanandam M.D. , DNB (cardio)***- conceptualization, data curation, investigation, methodology, project administration, visualization, writing—original draft, writing—review and editing; ***Dr.Arthanareeswaran S M.D.(Gen.Med)***- conceptualization, methodology, writing—original draft, writing—review and editing; ***Dr. Santhoshkumar. S.P M.D. , DNB (cardio).,*** conceptualization, visualization, supervision,

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writing—original draft; ***Dr. Sujeetha Chandrababu M.D.(Gen.Med).,*** and ***Panneerselvam Periasamy*** - methodology, writing—original draft, writing, review and editing. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY:

All datasets generated or analyzed during this study are included in the manuscript.

IEC APPROVAL:

Intuitional Ethical Committee approved the protocol. The study was approved by the institutional Ethical committee from Swamy Vivekanandha Medical College and Research Institute , Thiruchengodu, Namakkal,Tamilnadu. Informed written consent was taken from all the patients after full explanations of the nature and purpose of the procedure used for the study. Anonymity was maintained throughout the study, and none of the names was used in the database.

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