



# Anatomic variations in the origin of the left circumflex coronary artery with angiography in Northern Indian population

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## Abstract

**Introduction:** Knowledge of the normal and variant anatomy and anomalies of coronary circulation is definitely a crucial component in the management of heart diseases. Complex cardiac surgical repairs demand enhanced understanding of the basic anatomy to improve the operative outcomes.



**Material and methods:** The present study was planned by Department of Anatomy and was executed in collaboration with Department of Internal Medicine and Cardiology during 2010 to 2014 at a tertiary care teaching hospital located in western Uttar Pradesh. The angiographic data of 5,532 patients who underwent coronary angiography were considered for anomalous origin of the left circumflex coronary artery (LCx).

**Results:** The incidence of anomalous origin of the LCx was found to be 0.36%. The LCx arose from the left coronary sinus of valsalva (there was separate orifice for the LCx and the left anterior descending coronary artery) in 45.0% patients, from the right coronary sinus of valsalva, (there was a separate orifice for the LCx and the right coronary artery) in 25.0% patients, from the proximal part of right coronary artery in 30.0% patients.

**Conclusion:** On the basis of findings of the current study it can be concluded that, the anomalous origin of the LCx may not be benign all the time. In cases where ischemia does not resolve accurately after successful treatment of a coronary stenosis, anomalous coronary arteries must be considered.

### Key words

Origin, Left circumflex coronary artery, Angiography, Northern India.

### Introduction

A considerable progress has been made in the last few decades than in all foregoing medical history in the management of cardio-vascular diseases. More and more advanced interventional techniques are being introduced nowadays. Knowledge of the normal and variant anatomy and anomalies of coronary circulation is definitely a crucial component in the management of heart diseases [1].

The arterial supply of the heart is provided by the right and left coronary arteries. They are located between the epicardium and myocardium; these vessels arise from the bulbus aorta as two branches of the ascending aorta [2, 3]. The left main coronary artery originates from the left coronary sinus of valsalva. It usually has a short common stem, which bifurcates or trifurcates. Its branches are the anterior descending (inter ventricular) coronary artery, the left circumflex coronary artery and median branch (merely a left ventricular branch which happens to originate from the main artery) [3, 4].

The branches of the left main coronary artery may vary in origin, distribution, number and size. The left circumflex coronary artery (LCx) may arise from

- The left coronary sinus of valsalva (separate ostium of the LCx and left anterior descending coronary artery within the left sinus of valsalva) [5]
- The right coronary sinus of valsalva through an own orificium [6]
- The right coronary artery (proximal or distal part) [7]
- The pulmonary artery [8]
- It may be absent [9]

Most patients with coronary artery anomalies are asymptomatic. Unfortunately, sudden death or complication after performing valvular replacements in the patients with the anomalous origin of LCx has been described in the literature.

Various diseases may involve the coronary circulation and increasingly complex cardiac surgical repairs demand enhanced understanding of the basic anatomy to improve the operative outcomes. The knowledge of



these variations may be important with regard to invasive catheter treatment or bypass surgery. Therefore present study was planned with an objective of to examine the anatomical patterns and frequency of occurrence of the anomalous LCx coronary artery in the northern Indian population.

## Material and methods

The present study was planned by Department of Anatomy and was executed in collaboration with Department of Internal Medicine and Cardiology during 2010 to 2014 at Major S. D. Singh Medical College, Fatehgarh; a tertiary care teaching hospital located in western Uttar Pradesh. Data from Medical Records Department (MRD) revealed that the patients seeking care and admitted for chest pain, palpitation or effort angina. The catheterization reports were analyzed, and those with anomalous LCx were selected for further evaluation. All the patients who underwent coronary arteriography from January 2010 through to May 2014 were included. Those patients who had coronary anomalies due to congenital heart disease were excluded from the study. Data of 5,532 such patients was captured and analyzed.

Two independent investigators reviewed the films of Coronary angiography performed, which were selected for further evaluation, preceding the final classification. The course of an anomalous artery was defined according to the guidelines of Yamanaka and Hobbs [10] and Serota [11]. When the LCx and the left anterior descending coronary artery arised from the left sinus of valsalva, anterior angulation of the catheter resulted in selective injection of the left anterior descending coronary artery [left anterior oblique (LAO) projection], posterior angulation of the catheter resulted in selective injection of the LCx [right anterior oblique (RAO) projection]. When the LCx and the left anterior

descending coronary artery could not be observed, they considered to be totally obstructed or congenitally absent [10]. When the left circumflex coronary arteries arose from the right sinus of valsalva or right coronary artery on RAO ventriculography or aortography, the contrast column of the LCx would be seen "on end" posterior to the aorta [11]. During LAO projection the LCx coursed to the left with a caudal-posterior loop [10].

## Results

The angiographic data of 5,532 consecutive adult patients who underwent coronary angiography was analyzed for anomalous origin of the left circumflex coronary artery. The mean age of patients was  $52 \pm 4.4$  years with a range of 25-88 years. Sixty-two percent were males and remaining were females. The incidence of anomalous origin of the LCx was found to be 0.36% (20 of 5,532 patients). Of 20 patients who had anomalous origin of the LCx, 11 were men and 9 were women. The LCx arose from the left coronary sinus of valsalva (there was separate orifice for the LCx and the left anterior descending coronary artery) in 9 (45.0%) patients (**Figure - 1**), from the right coronary sinus of valsalva, (there was a separate orifice for the LCx and the right coronary artery) in 5 (25.0%) patients (**Figure - 2**), from the proximal part of right coronary artery in 6 (30.0%) patients (**Figure - 3**).

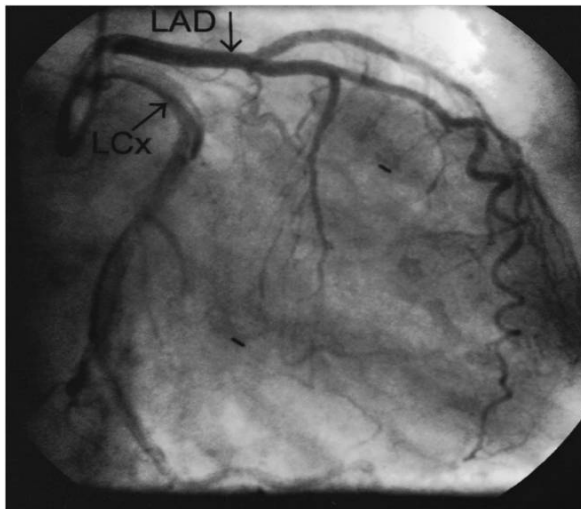
Among 27 patients with the anomalous LCx, 12 (60.0%) had significant atherosclerotic disease; and the remaining 8 patients (40.0%) had only variations in the origin of the LCx without any other coronary artery diseases.

## Discussion

There are some studies in the literature in which the incidences of different congenital coronary anomalies were reported. On angiographic

studies, the incidence of anomalous origin of the LCx in adults ranged from 0-1% as presented in **Table – 1** [12, 13, 14, 15]. The angiographic incidence of the anomalous LCx was highest (1%) in a Central European population while the overall incidence of the congenital coronary anomalies was 1.3% in the same study [8]. The angiographic incidence of the anomalous LCx was lowest (0%) in Japan while the overall incidence of the coronary anomalies was 0.3% as the right coronary artery being affected most commonly [10]. The angiographic incidence of the anomalous LCx in a Turkish population was 0.3%.

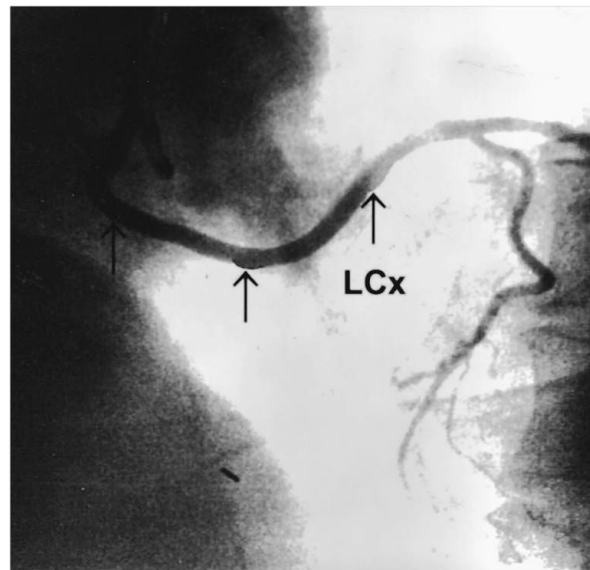
**Figure – 1:** Separate origin of left circumflex and anterior descending artery from the left coronary sinus of valsalva (absent left main trunk). [LCx - the left circumflex coronary artery, LAD - the left anterior descending coronary artery]



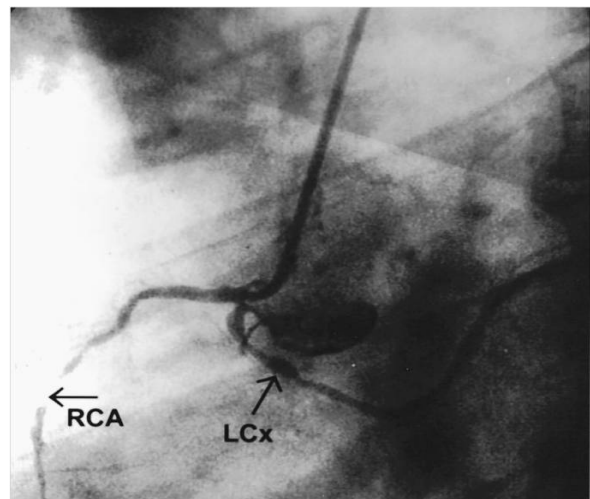
The angiographic incidence of the anomalous LCx is classically dissimilar among European, German and Indian population. Angiographic incidence of the anomalous LCx was observed to be tune of 0.6% and 1.1% according to German and European study respectively [13, 14]. This discrepancy could be due to genetic and geographic variations. In autopsy studies, the incidences of the anomalous LCx were 0.2 in

Italian population and 0.8% in Iraq population according to Frescura, et al. [16] and Kurjia, et al. [17]. These data suggest that the incidence of anomalous LCx is variable in different populations.

**Figure – 2:** Ectopic origin of the LCx from the right coronary sinus of valsalva - The anomalous LCx courses to the left with a caudal posterior loop. [LCx - the left circumflex coronary artery, LAO - left anterior oblique]



**Figure – 3:** Ectopic origin of the left circumflex coronary artery from the right coronary artery - The anomalous LCx courses to the left with a caudal posterior loop. [LCx - the left circumflex coronary artery, RCA - the right coronary artery, LAO - left anterior oblique]



The patients with a separate orifice of the left anterior descending coronary artery and LCx within the left sinus of valsalva (absent left main trunk) were not taken into consideration in some related studies [16]. However, when these variations were also considered, a separate orifice of the left anterior descending coronary artery and LCx within the left sinus of valsalva was the most common anomalies of the LCx with the reported incidences of 52.1%, 65.8% and 56% by Yamanaka and Hobbs [10], Kardos, et al. [13], and Cieslinski, et al. [14]. In the present study, however, this type of anomalous LCx was the most common anomaly. Another study reported only one case that had its own separate orificium for the LCx and left anterior descending coronary artery within the left sinus of valsalva [17]. Yamanaka and Hobbs reported absence of the LCx in only 0.1 % subjects [10].

It was observed in this study that neither the absence of LCx nor a LCx originating from the pulmonary artery. A LCx originating from the left sinus of valsalva, right coronary artery or right sinus of valsalva, or its absence are considered benign anomalies of the LCx [10, 16] while a LCx originating from the pulmonary artery is a serious condition [18] however, the anomalies of LCx, can rarely lead to serious conditions. Because, when performing valvular replacement, a LCx with benign anomaly can be compressed, thereby resulting in serious morbidity [9]. Another author [7] followed up 30 patients who had anomalous origin of the LCx for an average  $6.1 \pm$  years.

Rozenman, et al. [19] reported anomalous origin of the LCx from the right sinus of valsalva that caused myocardial ischemia and infarction at old age. Rivitz and Garratt [20] reported that a patient with evidence of persistent inferior wall ischemia after successful PTCA of a solitary right coronary artery lesion was had an anomalous LCx arising from the ostium of the right coronary

artery. A thorough search for such vessels is necessary in a patient with abnormal diagnostic tests and no evident obstructive lesions in the normally positioned arteries.

### Conclusion

On the basis of findings of the current study it can be concluded that, the anomalous origin of the LCx may not be benign all the time. In cases where ischemia does not resolve accurately after successful treatment of a coronary stenosis, anomalous coronary arteries must be considered. Recognition of this anomaly is obligatory to prevent the risk of infarction or sudden death. Special surgical considerations may be needed to perform when an anomalous LCx is observed during valvular replacement surgery.

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**Table - 1:** A comparison of the frequency of left coronary artery branching types among various studies.

Author	No. of participants	Incidence of anomalous LCx (%)	Anomalous LCx				Population studied
			1	2	3	4	
Garg, et al. [12]	4100	0.3	14	-	12	2	Indian
Kardos, et al. [13]	7694	1.1	83	54	29		Central European
Cieslinski, et al. [14]	4016	0.6	26	12	2	12	German
Topaz, et al. [15]	13010	0.2	22	-	9	13	Hispanic
Current study	5,532	0.36	10	-	9	1	Indian