

# Anomalous origin of coronary arteries

Sunkeswari Sreepadma<sup>1</sup>, Gajapathi Vivekanada<sup>2</sup>

<sup>1</sup>Department of Anatomy, SDM College of Medical Sciences and Hospital, Dharwad, Karnataka, India

<sup>2</sup>Department of Cardiology, SDM College of Medical Sciences and Hospital, Dharwad, Karnataka, India

## Abstract

**Background:** Coronary artery disease has become one of the trending diseases in current scenario irrespective of the young age or old. Coronary angiography is one of the investigations done for both diagnostic purpose and also as curative procedure if needed. The coronary arterial system when having anomalous origin and course make the diagnosis and treatment difficult.

**Methods:** The study was undertaken by Department of Anatomy and Department of cardiology. The study included 10163 patients who underwent Coronary angiography in the department of cardiology between the years 2009-2015 were included and their coronary arteries studied.

**Results:** Results revealed anomalous origin in 0.42% of the subjects. The anomalous arteries include right and left coronary arteries and circumflex artery. Dominance pattern in these subjects resulted with right dominant pattern of 80.2%.

**Conclusion:** Complete evaluation in patients with coronary artery disease requires knowledge of normal anatomy of coronary arterial system and its variations, which aids for accurate diagnostic intervention.

**Key words:** Atherosclerosis, Coronary angiography, Aortic sinus

## Introduction

Triple vessel disease and atherosclerosis leads to impaired myocardial perfusion. Coronary angiography is performed to detect stenosis of the coronary arteries. Coronary arteries are catheterized and evaluated in variety of views to obtain a full evaluation of their anatomy and to determine the location of degree of stenosis.

Right coronary artery arises from right anterior aortic sinus, passes between right auricle and pulmonary trunk in the right side of atrioventricular groove and ends on the left of crux of heart by anastomosing with the circumflex branch of left coronary artery. Anomalous origin of right coronary artery is rare that was first described in 1948 by White and Edwards<sup>[1]</sup>.

Left coronary artery arise from left posterior aortic sinus passes between left auricle and pulmonary trunk passing on the left side of atrioventricular groove. It branches into anterior interventricular artery (left anterior descending artery) and circumflex artery.

Right coronary artery supplies all of the right ventricle (except a small region to the right of the anterior

interventricular groove); a variable part of the diaphragmatic aspect of the right and left crura.

Left coronary artery distribution is reciprocal, and includes most of the left ventricle; a narrow strip of the right ventricle; the anterior two-thirds of the inter ventricular septum; most of the left atrium.

Right coronary artery gives off, anterior and posterior atrial and ventricular branches, branch to sinoatrial node and septal branches. Left coronary artery divides into anterior descending (anterior interventricular) branch and circumflex branches, which give rise to ventricular and septal branches.

In more than 50% individuals, the right atrium is supplied only by the right coronary artery, and in the other 50%, the supply is dual. More than 62% of left atria are supplied by left coronary artery, 27% by right coronary artery and 11% are supplied almost equally by both arteries. Sinu-atrial node and atrioventricular node supplies also vary. The Sinoatrial node is supplied by right (51-65%) or left (35-45%) coronary arteries, and fewer than 10% of nodes receive a bilateral supply. The Atrioventricular node is supplied by right (80-90%) or left (10-20%) coronary arteries.

## Address for Correspondence:

**Dr. Sunkeswari Sreepadma**

Department of Anatomy, SDM College of Medical Sciences and Hospital, Dharwad, Karnataka, India

E-mail: sreepadma@gmail.com

In right dominance, the posterior interventricular artery is derived from right coronary artery; in left dominance, it is derived from the left coronary artery. In the so-called balanced pattern, branches of both arteries run in or near the posterior interventricular groove.

Left anterior descending artery gives anterior ventricular rami, septal rami. Circumflex branch gives SA nodal artery (35% subjects), left marginal artery, posterior interventricular artery (10-20% subjects)<sup>[2]</sup>. The area of supply of left coronary artery is anterosuperior two thirds of ventricular septum, left ventricle except a small part along the posterior and inferior surfaces of heart and major portion of left atrium.

**Materials and methods**

The study was conducted in SDM College of medical sciences and hospital, Dharwad, Karnataka. The study was undertaken by Department of Anatomy and Department of cardiology. Study was done on patients who were subjected to coronary angiography in department of cardiology in the year 2009-2015 were included. The patients included were both male and female between the age group of 30-78 years.

The procedure included standard steps of preparation of patient, and during the coronary angiography, a contrast dye was injected into the arteries through a

catheter (thin, plastic tube), while the doctor watches how blood flows through the heart on the screen. The coronary arteries were studied and any anomalous artery or course noted down.

**Results**

10163 patients were included in the present study who underwent coronary angiography.

In current study, we found that there were 0.42 % of variations. There were variations in the origin of left circumflex artery in 21 cases, 19 cases of right coronary artery and 02 cases of left coronary artery.

The diagonal branches of LAD artery were short in 21 cases. The LAD in current study was given by left coronary artery irrespective of its normal origin or RCA or right coronary sinus.

**Table 1. Anomolous origin of coronary arterial system**

	LMCA	LCX	RCA
Number	02	21	19
Percentage	0.02%	0.21%	0.19%

**Table 2. Percentage of anomolous origin in males and females**

MALES	FEMALES
69 %	31 %

**Table : 3 Prevalence of coronary arterial system dominance**

	No. of Subjects	Type of Procedure	Right dominance	Left ominance	Co-dominance
Present study	10163 patients	CA	80.2%	17.4%	2.4%

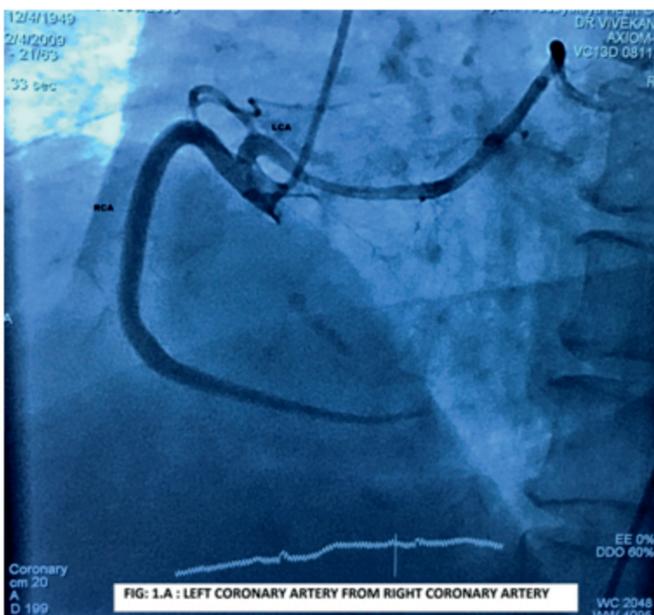


FIG:1.A : LEFT CORONARY ARTERY FROM RIGHT CORONARY ARTERY

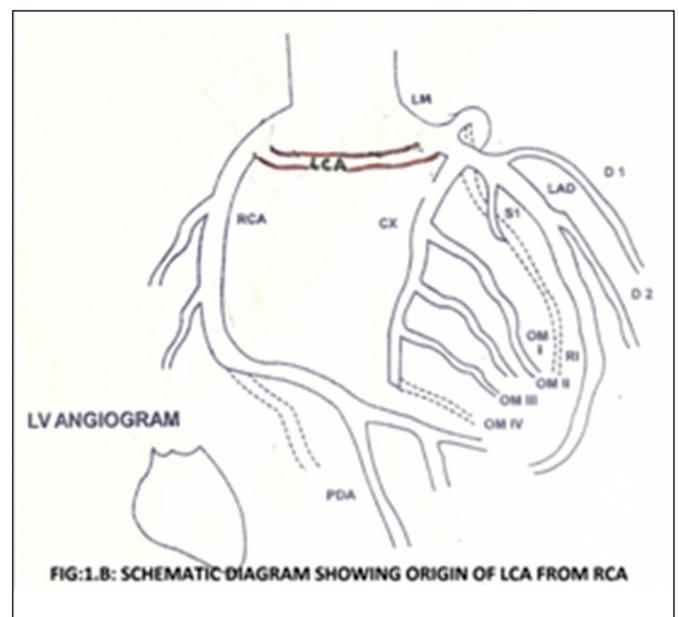
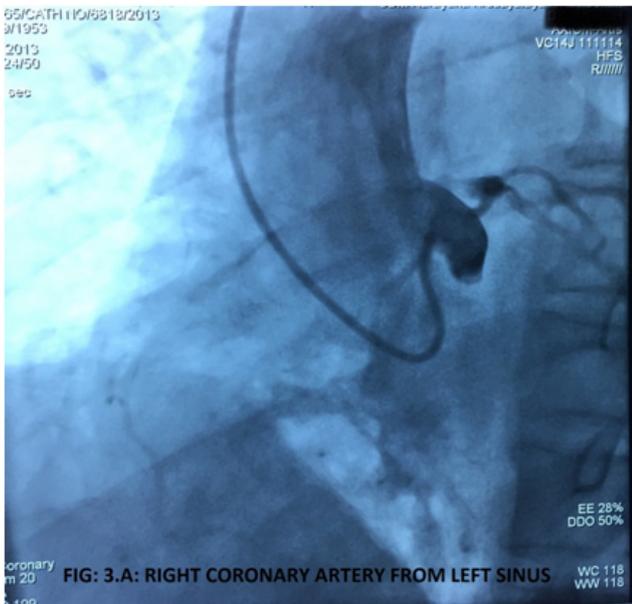


FIG:1.B: SCHEMATIC DIAGRAM SHOWING ORIGIN OF LCA FROM RCA



**Discussion**

The definition of the abnormal versus normal anatomy of coronary arteries presents a complex problem. Angelini and colleagues have proposed the following terms to define these categories: Normal-any morphological feature observed in greater than 1% of an unselected population. Normal variant: an alternative, relatively unusual, morphologic feature seen in greater than 1% of the population. Anomaly-a morphologic feature (number of ostia, proximal course, termination) rarely encountered (<1%) in the general population.<sup>[5]</sup>

The right coronary artery gave left circumflex artery in 12 cases % and 09 cases from the right sinus.

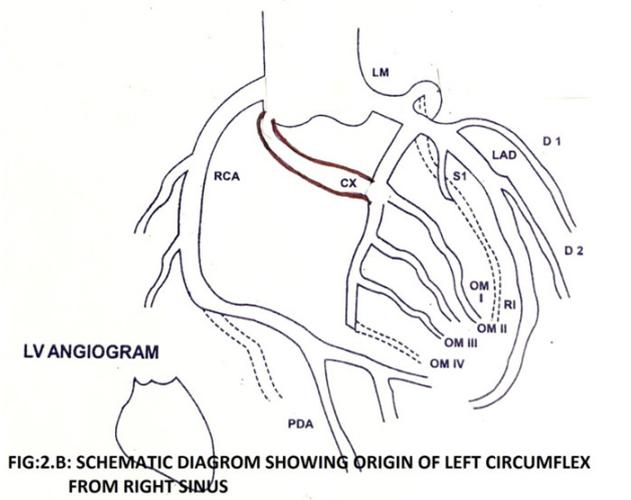
The anomalous origin of the circumflex artery is important for its possible surgical implications. When the vessel originates from the right sinus of Valsalva and follows a retroaortic course, it may be damaged by sutures placed in the mitral annulus during valve replacement or annuloplasty, thus causing infarction.<sup>[6,7]</sup> In some cases, Circumflex artery abnormally arises from right coronary sinus, it may lead to misdiagnosis as it may not be possible to provide sufficient contrast to the anomalous vessel due to its proximity to the right coronary artery ostium, leading to wrong conclusions, that Circumflex artery may be absent or completely occluded at its origin<sup>[8]</sup>

The circumflex artery originated from right coronary sinus in 1 case(0.1%) and circumflex artery was absent in absent 1 case (0.1%) ; and the right coronary artery arising from left coronary sinus in 4 cases( 0.5%)<sup>[9]</sup>.

Based on the origin, course and termination of the coronary arteries the minimum criteria for normality and criteria for abnormality have been stated by M.Trivellato, Paolo Angelini and Robert D Leachman.<sup>[10]</sup>

**Minimal Criteria for Normal Coronary Arteries** (By M.Trivellato, Paolo Angelini and Robert D Leachman)<sup>[10]</sup>

- (1) The aorta arises dually from the right and left coronary cusps (the ones adjacent to the aortopulmonary septum).
- (2) The right coronary artery follows the atrioventricular groove.
- (3) The left coronary artery lies behind the pulmonary artery and has a main trunk of variable length that divides into two branches: the left anterior descending (LAD) and the circumflex (Cx) coronary arteries. The LAD follows the interventricular groove and forms septal perforator branches, and the Cx follows the left atrioventricular groove.



- (4) The posterior descending branch originates from either the right or left coronary artery, follows the posterior interventricular groove, and divides into septal perforator branches.
- (5) The major coronary branches flow epicardially (extramurally).
- (6) The coronary arteries terminate at the capillary (myocardial) level.

Right coronary artery in current study had anomalous origin from left coronary sinus in 19 cases. High take off of RCA was present in 4 of cases. Left coronary artery originated from right coronary sinus in 2 cases. The coronary ostia are located above the sinotubular junction, usually by only a few millimeters. A high take-off coronary artery is the artery, when arising at least 1 cm in adults or 20% the depth of the sinus in children above the sinotubular junction, is considered of greater clinical relevance.

There was anomalous origin of RCA from opposite sinus in 0.5% of cases and high take off of RCA accounted for 0.1%; LCA originated from the right coronary sinus in 0.2% in the study done by Kosar P, Ergun E, Ozturk C and Kosar U. Out of 4,250 patients studied by selective coronary arteriography, one or more major elements of the coronary arterial system originated from the sinuses of Valsalva in an ectopic manner. The RCA originated from Left sinus in 3 cases whereas MLCA in one case from right sinus and one case from pulmonary artery. Failure to recognize variations in

coronary arterial origin can prolong arteriography procedures and lead to errors in interpretation of coronary artery anatomy and pathology.<sup>[11]</sup>

Some studies showed that intense and prolonged physical exercise, with an increase in systemic and pulmonary pressures and dilatation of the great arteries, may cause compression or kinking of the anomalous vessel, resulting in obstruction of blood flow.<sup>[12,13]</sup>

The cardiac pattern of dominance was defined as the artery that supplied the posterior interventricular groove on macroscopic analysis, and could be either right, if it were the posterior descending artery or the right marginal artery, or left, if it were the anterior descending artery or the circumflex. Posterior descending artery originated from right coronary artery, and hence it was right dominance in present study.

Origin of the left coronary artery from right coronary sinus which runs anterior or posterior to pulmonary artery before it divides into circumflex and left anterior descending arteries. Such abnormal origin could cause compression of the vessel between pulmonary artery and aorta leading to sudden death. The branches of left coronary artery when directly arising from right coronary artery may be severed in operations to widen the right ventricular outflow tract as in Fallot's tetralogy<sup>[14]</sup>.

**Table 4. Normal Versus Abnormal Coronary Artery Anatomy<sup>[10]</sup>**

Normal	Abnormal
(1) Dual aortic origin	1) Single coronary artery (right or left) Anomalous origin of right and/or left coronary artery from pulmonary artery
(2) Right coronary artery in right atrioventricular groove	(2) Origin of part of right coronary artery from left ostium
(3) Left coronary artery in left atrioventricular groove + anterior interventricular groove	(3) Anomalous origin of left anterior descending coronary artery or circumflex coronary artery from right coronary artery
(4) Posterior descending coronary artery from right coronary artery or circumflex coronary artery	(4) Posterior descending coronary artery from left anterior descending coronary artery
(5) Major vessels course epicardially	(5) Muscular bridges (intramural major coronary branches)
(6) Arteries terminate in myocardial capillary bed	(6) Coronary fistula connects with right atrium, right ventricle, pulmonary artery, pulmonary vein, left atrium, ventricle or mediastinum

**Table 5. Comparison of anomalous origin of coronary arteries**

	LMCA	RCA	LCX
Present study	02	19	21
Kosar et al	02 (0.2%)	04 (0.5%)	1 (0.1%)
Nordon DG	-	-	8%
Angelini P et al	0.15%	0.92%	0.67%

**Table 6. Comparison of Prevalence of coronary arterial system dominance**

	No. of Subjects Type of Procedure	Right dominance	Left dominance	Co-dominance
Kosar et al	700 patients CTA	76%	9.1%	14.8%
Angelini P et al 3	1950 angiograms	89.1 %	8.4%	2.5%
Nordon DG 4	50 cadavers	91.5	8.5	-
Present study	10163 patients CA	80.2%	17.4%	2.4%

**Conclusion:** Conventional Coronary angiography and CT Coronary angiography reveal the anatomy of the vessels with regards to its origin, course, variations and termination and area of supply. Complete evaluation in patients with coronary artery disease requires knowledge of normal anatomy of coronary arterial system and its variations, which aids for accurate diagnostic intervention.

## References

1. Ho JS, Strickman NE. Anomalous origin of right coronary artery from the left coronary sinus. *Tex Heart Inst J.* 2002;29:37-39
2. Gray's anatomy : the anatomical basis of clinical practice. *Standring, Susan. Forty-first edition. New York: Elsevier Limited, 2016; 978-980*
3. Angelini P, Villason S, Chan AV, Diez JG. Normal and anomalous coronary arteries in humans. In: Angelini P, ed. *Coronary Artery Anomalies: A Comprehensive Approach. Philadelphia: Lippincott Williams &Wilkins; 1999;27-150.*
4. Nordon DG, Rodrigues Junior OF. Variations in the anatomy of coronary arteries. *J Morphol Sci* 2012;29(3):178-181
5. Vincent HO, Reddy GP. *Cardiovascular Imaging. Volume 1. First edition. China: Saunders Elsevier Limited; 2011. p.38-55*
6. Mikaeloff P, Loire R, Amiel M, Saint-Pierre A, Allouache K, Leoni F, Delahaye JP. Anomalie de naissance de l'arterecirconflexe. Incidence sur l'risque du remplacement valvulaire mitral et mitral-aortique. *Arch MalCoeur* 1979;72: 895
7. Roberts WC, Morrow AG. Compression of anomalous left circumflex coronaries by prosthetic valve fixation rings. *J Thorac Cardiovasc Surg.* 1969;57;834
8. Trivellato M, Fuertes A. Origine anomala dell' arteriacoronaria circonflessa sinistra. *Giorn It Cardiol.* 1974;4;623
9. Kosar P, Ergun E, Oztürk C. and Koşar U. Anatomic variations and anomalies of the coronary arteries: 64-slice CT angiographic appearance. *Diagnostic and Interventional Radiology, 2009; 15: 275-83.*
10. Trivellato M., Angelini P. and Leachman RD. Variations in coronary artery anatomy: Normal versus abnormal. *Cardiovascular Diseases 1980; 7(4):357-370.*
11. Engel HJ, Torres C, Page HL. Major variations in anatomical origin of the coronary arteries: angiographic observations in 4,250 patients without associated congenital heart disease. *Jr Cathet Cardiovasc Diagn.* 1975;1(2):157-69.

12. Benson PA. Anomalous aortic origin of coronary artery with sudden death: Case report and review. *Am Heart J.* 1970;79:254
13. Cohen LS, Shaw LD: Fatal myocardial infarction in an 11-year-old boy associated with a unique coronary artery anomaly. *Am J Cardiol.* 1967;19;420
14. Decker GAG, Lee McGregor's Synopsis of surgical anatomy. Varghese publishing house, Bombay. *Heart and great vessels. 12th edition. 1999; 284*

Date received: September 15<sup>th</sup> 2018

Date accepted: November 30<sup>th</sup> 2018

**Conflict of interest: Nil**

**Source of funding: Nil**