A STUDY OF BRANCHING PATTERN AND DOMINANCE OF CORONARY ARTERIES USING CORONARY ANGIOGRAM

Sanjay Kumar Revankar[1], Chitra Prakash Rao[2], Ajay Udyavar[3], Suresh Bidarkotimath[4]

[1]Assistant Professor, Department of Anatomy, A. J. Shetty Institute of Medical Sciences.
[2]Professor & HOD, Department of Anatomy, A. J. Shetty Institute of Medical Sciences.
[3]Professor, Department of Anatomy, A. J. Shetty Institute of Medical Sciences.
[4]Associate Professor, Department of Anatomy, Jazan University, KSA.

ABSTRACT

BACKGROUND AND OBJECTIVES

Knowledge of the normal and variant anatomy of coronary circulation is a vital component in the management of coronary artery diseases. The study was undertaken to know the dominance, branching pattern and luminal diameter of the coronary arteries.

METHODS

Ninety normal coronary angiograms of patients referred to A J Hospital & Research Centre, Mangalore for diagnostic coronary angiography were included. They were recorded on CDs and studied with cardiac view software.

RESULTS

Both male and females showed a higher prevalence of right coronary dominance. The right dominance was present in 78.9% and left dominance in 21.1%. Bifurcation of left coronary artery was more common than trifurcation. The present study showed that 8.89% of cases had ramus intermedius branch. The left anterior descending artery terminated at the apex in 20% of cases and beyond the apex in 80% of cases.

INTERPRETATION AND CONCLUSION

Right coronary dominance was more common than left dominance. Bifurcation was the most common branching pattern of left coronary artery. The left anterior descending artery terminated beyond the apex in majority of cases.

KEYWORDS

Coronary artery; Branching pattern; Coronary angiogram.

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INTRODUCTION: The heart consists of four chambers. The right and the left atria and the right and left ventricle are separated by the interatrial and interventricular septa respectively. It receives a constant and rich blood supply from the right and left coronary arteries.[1] The dictionary meaning of coronary is "encircling in the manner of a crown".[2]

The coronary arteries are branches of the ascending aorta and arise from the left and right aortic sinuses of the ascending aorta and lie above the valves of the aortic arch.[3] Following their origin, the coronary arteries have a tendency to distribute their larger branches on either side of the atrioventricular groove forming an oblique ring around the heart, which is likened to a crown. Hence the Latin name 'arteriae coronariae'.[3]

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Corresponding Author:
Dr. Sanjay Kumar Revankar,
Assistant Professor, Department of Anatomy,
A. J. Shetty Institute of Medical Sciences.
E-mail: sanjay_revankar@rediffmail.com
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In most organs, blood flow peaks when ventricles contract and eject blood into the arteries and diminishes when the ventricles relax and refill. The opposite is true in the coronary arteries. In coronary blood vessels, blood flow increases during ventricular relaxation.[4]

Right coronary artery typically supplies the right ventricle, the posterior part of the left ventricle and the posterior one-third of the interventricular septum, the right atrium and the interatrial septum, including the sinoatrial and the atrioventricular nodes (parts of the conducting system of the heart). The left coronary artery regularly supplies most of the left ventricle and left atrium and its anterior interventricular branch is the chief source of blood to the anterior two-thirds of the interventricular septum. This territory of supply includes the atrioventricular bundle and its branches (parts of the conducting system of the heart) as they lie in the septum. The left coronary artery may help supply, or may be the sole supply of the sinoatrial and atrioventricular nodes.[1]

The ability to demonstrate coronary arteries in life and modern surgical techniques for alleviating their obstruction have generated a terminology now commonly used among many clinicians. Before its division the left coronary artery

(LCA) is known as left main common trunk. Its two branches are the circumflex artery (LCX) and left anterior descending artery (LAD). The right coronary artery (RCA) usually terminates as the posterior descending artery (PDA). The left marginal branch is known as the obtuse marginal artery (OM) and the right as the acute marginal.[5]

DEVELOPMENT OF CORONARY ARTERIES: Coronary arteries are derived from two sources (a) angioblasts formed from sprouts of the sinus venosus that are distributed over the heart surface by cell migration and (b) the epicardium itself. Some epicardial cells undergo an epithelial-to-mesenchymal transition induced by the underlying myocardium. The newly formed mesenchymal cells then contribute to endothelial and smooth muscle cells of the coronary arteries. Neural crest cells also contribute smooth muscle cells along the proximal segments of these arteries. Connection of the coronary arteries to the aorta occurs by ingrowth of arterial endothelial cells from the arteries into the aorta. By this mechanism, the coronary arteries invade the aorta.[6]

Cardiovascular disease accounts for approximately 12 million deaths annually and is the commonest cause of death globally.[7] The coronary artery disease has been increasing due to the changing lifestyle, hypertension and diabetes mellitus. The study of coronary arteries has become essential due to the increasing number of deaths caused by coronary artery disease. The coronary arteries may present several anomalies in terms of both number and position.[8]

To be able to recognise an anomaly of coronary arteries, one should be well versed with normal anatomy of coronary artery and variations which are commonly seen.

Hence, the detailed study is important in view of the fact that the anomalous origin and proximal course of coronary artery pose a potential risk of myocardial infarction resulting in arrhythmias, angina and sudden death.[9] This knowledge is of great help to cardiologists, cardio-thoracic surgeons and interventional radiologists.

Thus, the knowledge of normal and variant anatomy of coronary artery circulation is an increasingly vital component in the management of congenital and acquired heart diseases. The study of coronary artery includes study of ectopic coronary ostia, aberrant and accessory arteries, angles of origin and division, intramural, intraluminal and intracavitary courses which are of great use to cardio-thoracic surgeons. The advances made in coronary artery bypass revascularisation demands thorough, sound and complex knowledge of normal and variant anatomy of coronary artery and circulation.[10]

With this aim, coronary arteries are studied with reference to dominance, branching pattern and variations.

AIMS AND OBJECTIVES:

1. To study the branching pattern and variations with respect to;
    a. Number of divisions of the left coronary artery.
    b. Number of diagonal and septal branches from the left anterior descending artery.
    c. Number of obtuse marginal branches from circumflex artery.
    d. Presence of acute marginal, posterior descending artery and posterior ventricular branch of right coronary artery.
2. To know the termination of the left anterior descending artery.
3. To know the dominance of the coronary arteries.

MATERIALS AND METHODS:

Study Type: Prospective study.

Source: The coronary angiograms of patients referred to A J Hospital & Research Centre, Mangalore for diagnostic coronary angiography between September 2011 to August 2012 were included. These patients were assessed by the cardiologist and had undergone the angiography procedure for symptoms of chest pain, angina pectoris and positive treadmill test.

Method of Collection of Data: Ninety normal angiograms were recorded on recordable compact discs. These were studied using cardiac view software. The angiograms contained both the right and left coronary arteries in various views but the ones that were used were the right and left anterior oblique views in diagonally opposite views.

The diameter of digital angiograms was performed using machine Siemens Artis.

Zee with Siemens ACOM PC LITE Software Version 2. It consists of digitalisation, calibration and contour detection.

Inclusion criteria: All angiograms which are normal with no evidence of localised atheroma or coronary spasm.

Exclusion Criteria: All coronary angiograms with evidence of localised atheroma or coronary spasm.

Method: The different parameters were studied with the following angiographic views:

1. Right coronary artery branches were studied with left anterior oblique cranial and right anterior oblique view.
2. Number of divisions of the left coronary artery was studied with right anterior oblique caudal and left anterior oblique caudal view.
3. Termination and branches of left anterior descending artery was studied with right anterior oblique cranial and left anterior oblique cranial view.
4. Branches of left circumflex artery were studied with right anterior oblique caudal and left anterior oblique cranial view.
5. Dominance was determined by whether the posterior descending artery originated from the right coronary artery (right dominant), left circumflex artery (left dominant), or both (co-dominant).

RESULTS: Ninety normal coronary angiograms were studied and following observations were made:

The acute marginal branch arose from RCA in all the cases.

Right Coronary Artery:

Number of branches	Number of cases	%
0	19	21.11
1	64	71.11
2	7	7.78

Table 1: Number of cases with posterior ventricular branches from RCA

No. of posterior ventricular branches from RCA	Right dominance	Left dominance	Codominance
0	0	19	0
1	64	0	0
2	7	0	0

Table 2: Association between posterior ventricular branches given from RCA with Dominance

	Number of cases	%
Right coronary artery	71	78.9
Left coronary artery	19	21.1
Both	0	0

Table 3: Origin of Posterior Descending Artery

Observations on the origin of PDA revealed that 78.9% were branches from RCA and 21.1% were branches from LCA. There were no angiograms where PDA arose from both RCA and LCA. The most common mode of origin of PDA was from RCA.

Left Coronary Artery

Number of divisions of LCA	Number of cases	%
2 divisions	82	91.11
3 divisions	8	8.89

Table 4: Number of divisions of LCA

Termination of LAD	Number of cases	%
Before apex	0	0
At apex	18	20
Beyond apex	72	80

Table 5: Termination of Left anterior descending artery

Number of septal branches	Number of cases	%
2 branches	49	54.44
3 branches	37	41.11
4 branches	4	4.44

Table 6: Number of septal branches from left anterior descending artery

Number of diagonal branches	Number of cases	%
0 branch	1	1.11
1 branch	66	73.33
2 branch	23	25.56

Table 7: Number of diagonal branches from left anterior descending artery

Number of branches	Number of cases	%
One branch	69	76.67
Two branches	21	23.33

Table 8: Number of obtuse marginal branches from left circumflex artery

Dominant Circulation: In the present study, 78.9% of angiograms showed right dominance and 21.1% showed left dominance. None of the angiograms showed co-dominant circulation.

Dominance	Number	%
Right	71	78.9
Left	19	21.1
Co-dominant	0	0
Total	**90**	**100**

Table 9: Dominant circulation

	Males		Females	
Dominance	**Number**	**%**	**Number**	**%**
Right	40	74.7	31	86.11
Left	14	25.3	5	13.89
Codominance	0	0	0	0
Total	**54**	**100**	**36**	**100**

Table 10: Comparison of dominance in males and females

DISCUSSION: There are many variations which have been reported in the branching pattern of coronary arteries by many workers. The present study was conducted using normal coronary angiograms to study the branching pattern and variations in coronary arteries, dominance and also the diameter of the coronary arteries.

In the present study the parameters which were studied using coronary angiograms are;

	Right (%)	Left (%)	Balanced (%)
Kalpana R[11]	89	11	0
Kosar P[12]	62.5	12.5	25
Abdellah AA[13]	77	8	15
Bhimalli[14]	60	23.33	16.67
Reddy V[15]	86.25	11.26	2.5
Present Study	78.9	21.1	0

Table 13:Comparison of coronary dominance in the present study with previous studies

CONCLUSION: The following conclusions can be made from the present study.

- Both males and females showed a higher prevalence of right coronary dominance. There was no significant variation of dominance with sex. The severity of myocardial infarction is more in left dominant circulation as it supplies more area of myocardium.
- Bifurcation is the most common branching pattern of left coronary artery than trifurcation with presence of ramus intermedius. Since ramus intermedius doesn't lie in any anatomical groove, stent deployment in a stenosed vessel would have poor support and prone for mobilisation and migration.
- The most common site of termination of left anterior descending artery was beyond the cardiac apex in the posterior interventricular groove. The level of termination of left anterior descending artery indicates the length of the artery and hence its clinical significance. Coronary interventions in a stenosed long left anterior descending artery may have a greater influence since it supplies a larger mass of myocardium than in a short left anterior descending artery.

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