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Original Research Paper

Anatomy

ORIGINS AND BRANCHING PATTERNS OF CORONARY ARTERIES- A CROSS-SECTIONAL STUDY BY ANGIOGRAPHY

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KEYWORDS :

INTRODUCTION- CORONARY ANATOMY

The branching characteristics of the coronary arterial tree play an important role in cardiac operations, such as heart pacemaker implantation, angioplasty and even stent placement.

The left & the right coronary cusps give rise to their respective coronary arteries. The major epicardial vessels are: 1) Left main coronary artery that divides into Left anterior descending artery and Left circumflex artery 2) Right coronary artery

Left main coronary artery (LMCA)

The left main coronary artery originate from the left coronary cusp and bifurcates to give rise to left anterior descending and left circumflex arteries.

Occasionally, a third branch *ramusintermedius*arises from LMCA. In a small number of patients, the two major branch vessels arises from separate origin.

Left anterior descending artery (LAD)

LAD provides blood supply to the anterior wall of the left ventricle. It provides multiple septal branches to the interventricular septum & diagonal branches to anterolateral wall.

LAD in some patients wrap around the apex to supply a small part of posterior apex.

Left circumflex artery (LCX)

LCX courses around the lateral or left atrioventricular groove and gives rise to multiple marginal or lateral branches. These are termed **obtuse marginal branches (OM).** OM branches are sequentially numbered (OM1,OM2etc)

As the LCX courses the AV groove, it also give rise to several atrial branches and occasionally sino-atrial branches (in 40 % of population).

Right coronary artery (RCA)

RCA arises from the right coronary cusp and follows the right AV groove. The most proximal branch of the RCA isconus branch which supplies the right ventricular outflow tract and a branch that supplies the sino-atrial node(SA node)[in 60 % of population].

RCA gives off posterolateral& posterior descending branches at the crux cordis.

MATERIALS & METHOD

Source Of Data:

The present study is conducted in adults of East Singhbhum at Brahmananda Narayana Multispecialty Hospital , Jamshedpur.

Patients reporting to cardiology out patient department & cardiac emergency department fulfilling the inclusion criteria are selected for the study.

INCLUSION CRITERIA:

All patients undergoing coronary angiography for various indications.

- Stable angina unresponsive to medical management.
- Unstable angina.
- Acute coronary syndrome (ST elevations & non ST elevation MI)
- Patient of more than 40 yrsof age with valvular heart disease planned for valvular surgery.
- Left ventricular dysfunction to rule out coronary artery disease.

EXCLUSION CRITERIA:

- A patient with previous invasive cardiac procedure.
- Patients diagnosed to have severe triple vessel disease post angiography.
- Patients with coagulopathies.
- Decompensated congestive heart failure.
- Uncontrolled hypertension.
- Renal compromised patients.
- Refractory arrhythmia.
- Contrast medium allergy.
- Pregnancy.
- Active infections.

Procedure (cath lab) :

The procedure is performed in a specifically designed room, very much resembling the operating room, called the catheterization laboratory or the cath lab. Recording are made using a special x- ray machine, called cardio angiograph. These machines are completely digitalized enabling superb picture quality with the lowest possible radiation doses and some additional features such as precise measurement and quantification of the recorded angiogram , connection to additional devises such as intravascular ultrasound , easy and large capacity of data storage etc.

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The space should be intuitively organized, and the spare devices, sterile gowns, gloves, drapes etc. must be easily accessible. Defibrillator, endotracheal tubes, temporary pacemakers and leads, oxygen supply, and other cardiopulmonary resuscitation equipment must be held in the cath lab at all times. Just outside of the cath lab is the control-station with monitors for angiogram, patient data, electrocardiogram (ECG), haemodynamics etc.

OBSERVATION

The present study is carried on angiographic images of 95 human hearts in different views and observed for the origin, course and branching pattern of coronary arteries. The level of termination and the dominance of coronary arteries also studied. Any variation in relation to origin, course and branching pattern of coronary arteries are noted.

I.NUMBER OF CORONARY ARTERIES

Table No 1: Showing number and percentage of coronary arteries

No of coronary arteries	Specimen	Percentage
2	94	99%
3	1	1%
4	0	0%
Total	95	100%

Out of 95 specimens studied there are 2 coronary arteries in 75(99%) cases, 3 coronary arteries in 1 (1%) case and in none of the specimens there are 4 coronary arteries.

II.ORIGIN OF CORONARY ARTERIES

Table No 2: Showing origin of coronary arteries

Origin of	Right Anterior aortic sinus	Left posterior aortic sinus	Percentage
RCA	95	0	100%
LCA	0	94	100%

In all the 95 specimens the RCA is taking origin from right anterior aortic sinus and in 94 patients the LCA is taking origin from left posterior aortic sinus. In 1 patient LAD & LCX originating directly from left sinus with absence of LCA.

IV.DIVISION OF MAIN TRUNK OF LCA

Table No 4 : Showing division of main trunk of LCA

	No of branches	Specimen	Percentage
a	Bifurcation	89	93.7 %
b	Trifurcation	6	6.3 %
c	Quadrifurcation	0	0%
	Total	95	100%

In relation to the branching pattern of left coronary artery, out of 95 specimens we found bifurcation in 89 (93.7 %) cases followed by trifurcation in 6 (6.3 %) cases and quadrifurcation in 0 (0 %) cases.

V.PRESENCE OF RIGHT MARGINAL ARTERY

Table No 5: Showing presence of right marginal artery

Right marginal artery	Specimen	Percentage
Present	84	88.4%
Absent	11	11.6%
Total	95	100%

It was observed that the right marginal artery is present in 84 (88.4%) out of 95 cases and is absent in 11 out of 95 cases (11.6%).

I.ORIGIN OF LEFT DIAGNOL ARTERY

Table No 6 : Showing origin of left diagonal artery

	Origin	Specimen	Percentage
b	LAD	90	94.7%
c	LCX	5	5.3%
	TOTAL	95	100

The Left diagonal artery originates from LAD in 90 (94.7%) out of 95 cases, and in 5 (5.3%) cases arises from LCX.

DISCUSSION

Present study evaluated the arterial blood supply of the 95 human hearts of Jharkhand region is studied by angiography method.

The number of coronary arteries were 2 in majority of cases and in one heart conus artery was found arising directly from the aorta i.e third coronary artery. Conus artery is important because it often forms a vascular anastomostic bridge with a corresponding branch from either the LCA or proximal LAD forming the circle of Vieussens. This bridge may play a role as a collateral pathway to the LAD. In the present study there were no variations in the origin of coronary arteries.

In our study in majority of cases the RCA terminated between crux and left border. The LAD terminated by wrapping around apex and supplies inferoapical segment. The LCX terminates between obtuse border and crux. These findings explain why in some lesions of coronary arteries there is extensive myocardial ischemia. Hence knowledge of such variation is important for cardiologists.

The PIVA arising from RCA terminates ¼ way down PIVS in 21%, ½ way down PIVS in 41%, in 30% PIVA terminates ¾ way down PIVS, in 8% cases terminates at apex. PIVA arising from LCA terminates ¼ way down PIVS in 36.4%, in 18.2% PIVA terminates ½ way down PIVS, in 27.2% PIVA terminates ¾ way down PIVS, in 2 cases (18.2%) PIVA terminates at apex. As the posterior interventricular artery supplies both ventricles and posterior one third of interventricular septum, the variation in termination would be helpful for cardiac surgeons.

Bifurcation was found in 81.5%, trifurcation in 14.5% and quadrifurcation in 4% cases. Left main trifurcation coronary artery disease stenting is a challenging and complex percutaneous procedure. Hence adequate understanding and knowledge of the trifurcation pattern is vital for success of the procedure.

Right marginal artery was present in 88% cases, it terminates before inferior border in 19%, in between inferior border and apex in 78% and in 3% cases right marginal artery terminates at apex. In the presence of occlusive anterior interventricular

artery, the right marginal artery terminating at apex can irrigate the inferior third of heart, diaphragmatic area limiting the possibility of ischemic process.

Left diagonal artery originates from main trunk of LCA in 25%, in 67% arises from LAD, and in 8% cases arises from LCX. It terminates before apex in 79% and at apex in 21% cases. The left diagonal is important for the vascularization of the myocardium in cases of obliteration of the branches of left anterior descending artery. In the present study the right coronary artery in all the hearts originated from right anterior aortic sinus and left coronary artery arises from left posterior aortic sinus.

Table No 10: Showing comparison of number of coronary arteries

Author & No of specimens	Single coronary artery	Two coronary arteries	Three coronary arteries	Four coronary arteries
AlmiraLijonovic et al n=32	-	64%	32%	4%
Patel MP et al n=210	0.48%	89.52%	10%	-
Present study n=76	-	99%	1%	-

In the present study majority (99%) cases showed the presence of 2 coronary arteries which was similar to the observations of AlmiraLijonovic et al (64%) and Patel M Pet al (89.52%).

The incidence of single coronary artery is 0.48% as observed by Patel M P et al, however in the present case none of the specimen showed the presence of single coronary artery.

In the present study the third coronary artery is present in one of the specimen (1%), which is lower when compared with the studies of AlmiraLijonovic et al (32%) and Patel MP et al (10%). In the present study none of the specimens showed the presence of 4 coronary arteries, whereas AlmiraLijonovic et al showed the presence of 4 coronary arteries in 4% of cases.

Table No 12: Showing Comparison of the branching pattern of LCA

Authors, Year and No of specimens	1branch %	Bifurcation %	Trifurcation %	Qudrifurcation %	Pentafurcation %
Baptista et al, 1991 n=100	1.8%	60%	38.18%	_	_
Surucu et al ,2003 n=40	_	47.5%%	47.5%;	2.5%	2.5%
Kalpana 2003 n=100	1%	47%	40%	11%	1%
Reig J et al, 2004 n=100	_	62%	38%	_	_
Ballesteros L.E et al, 2008 n=154	_	52%	42.2%;	5.8%	_
Das Hirak et al, 2005 n=100	_	60%	35%;	5%	_
Dattatray D. Dombe et al , 2012 n=64	1.6%	54%	35.9%	7.8%	_
Present study n=76	_	93.7%	6.3%	0%	_

In majority of cases the common pattern of branching of LCA is bifurcation. The results of bifurcation of our study are consistent with earlier reports. The frequency of quadrifurc ation of LCA in present study is 0 Trifurcation of the LCA is less common and lowest reported in our study (6.3%) when compared with Surucu et al (47.5%), Ballesteros L.E et al (42.2%), Das Hirak et al(35%). Surucu et al (47.5%) and Kalpana (47%) reported lower incidence of bifurcation of LCA as compared to other studies.

The incidence of pentafurcation was only reported by Surucu et al as 2.5% and by Kalpana R as 1%.

Table No 13: Showing comparison of the presence of Right Marginal Artery

Right marginal artery	A Hossain et al (n=60)	Sarker et al (n= 54)	Present study (n=76)
Present	90%	91%	88.4%
Absent	10%	9%	11.6%
Population	Bangladesh	Bangladesh	Jharkhand (India)

In our study it was observed that the right marginal artery is present in 88% cases and is absent in 12% cases which was similar to the authors reported earlier.

All the authors tabulated above showed similar observations of absence of right marginal artery.

Left Diagonal Artery

In the present study the Left diagonal artery originated from main trunk of LCA in 25% cases, in 67% cases arises from LAD, in 8% cases arises from LCX. Whereas Maria TerezaJordao et al studied the diagonal arteries in the hearts of pigs and reported the incidence of the diagonal artery as of 20%. The criterion used for the identification of left diagonal artery by Maria TerezaJordao et al was: The vessel arising from the angle formed by the anterior descending branch and the circumflex branch. The authors that in case of absence of the diagonal artery the circumflex artery gives rise to many branches, possibly to play the role of irrigation supply of the left ventricle.

Baroldi & Scomazzoni et al (1976) stated that the diagonal artery is always a branch from the anterior descending artery and had apparent origin on the left coronary artery as a false trifurcation of the common trunk. Mac Alpin et al (1973) reports that the diagonal artery arises as an early branch of the circumflex artery and was observed in 1/3 of the cases. The incidence of left diagonal artery arising from LCX in our study is 8%.

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