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Variation in Branching Pattern of Coronary Arteries

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ABSTRACT

The present study gives knowledge of the morphological characteristics and its variation in branching pattern of coronary arteries. The study was carried out on 50 formalin fixed adult human cadaveric hearts of both sexes, were collected from the department of Anatomy. The coronary arteries and their branches were carefully dissected out and followed till their termination .The result of the present study is the right coronary ostium is present in all specimens in the right anterior aortic sinus. SANA was found originating from RCA in 80%, from both (Rt.and Lt.) in 10% , from LCA 10%.LCA in present study we got bifurcation in 35% and trifurcation in 15% out of 50 samples & termination of LCA got at different level . PIVA arise from RCA in 80 % and LCA in 20 %. This study is important for the interpretation of coronary angiography and surgical myocardial revascularization.

Introduction-

Knowledge of the morphological characteristics of the main trunk of the left coronary artery as well as its variations is essential for hemodynamic, surgical manipulation and for correctly interpreting angiographic data. This study is important in clinical and surgical practice.

Coronary anomalies are a poorly understood topic in modern cardiology. Clinicians should be aware of such anomalies, chiefly because such anomalies can result in sudden death. Patency of the left coronary artery is vital for sufficient perfusion of most of the heart [10]. The left coronary artery is responsible for irrigation not only of most of the left ventricle, but also a considerable proportion of the right ventricle [11]

The study by Kalbfleisch and Hort irrigated each of the coronary arteries using postmortem angiography. In arteriosclerotic diseases, it is common that the other main coronary arteries are also affected [12].

The coronary arteries are represent the only source of blood supply to the myocardium [8]

In addition to these branches (14%–40%), a third branch, known as the median or intermedian artery, has been reported to exist.[5,6] The median artery can arise from the LCA (trifurcation or quadrifurcation) or from the proximal part of the anterior interventricular branch or circumflex artery.[6,7] It goes obliquely around the sternocostal surface of the left ventricle and is spread around the middle area between the base and the apex of the heart.[7] The RCA begins at the right aortic sinus and goes along the coronary sulcus. It supplies the right atrium, right ventricle, atrioventricular septum and a part of the left ventricle. Along its course, it produces a conus branch, a right marginal branch and a posterior interventricular branch. [1, 2]

The dominance of the coronary artery system is defined according artery that supplies the back of the interventricular septum or produces the posterior interventricular branch. [3] In humans, it has been reported that the posterior interventricular arises from the RCA in 75% of cases (right dominance) and from the LCA in 10% of cases (left dominance), and goes around the back of the anterior interventricular branch, creating an anastomosis with the posterior interventricular branch in 15% of cases (equal dominance). [1]

This study aimed to examine the variations in LCA and RCA branches, the existence and frequency of the median artery, and the relationship between this artery and myocardial bridges

MATERIALS AND METHODS

The study was carried out on 50 formalin fixed adult human cadaveric heart of both sexes ([Formalin = 40% solution of Formaldehyde in water .10% Formalin = 10 parts of formalin + 90 parts water) Visceral pericardium and subepicardial fats were removed. The coronary arteries and their branches were carefully dissected out and followed till their termination. The arteries were painted with red fabric colour to enhance contrast. Photographs were taken. Hearts of both sexes were collected from the department of Anatomy. The heart were preserved

RESULT

Ostium was present in all the specimens in the Right anterior aortic sinus. The ostium was below The Right coronary sino tubular junction (STJ) in 40%, at STJ in 10% The RCA was divided by the crux into proximal and distal segments. Both the segments were present . The proximal segment was further subdivided into First segment (origin to inferior border) and Second segment (inferior border to crux) . The SA nodal artery (SANA) was found originating in 40% of specimens from RCA, in 5% from LCA, and in 5% from both.

The Right conus artery and the Marginal artery were present in all the specimens. The Right conus artery arising separately from the anterior aortic sinus is the Third coronary artery was present in 15% of the specimens studied. The A.V. Nodal arterty (AVNA) arises commonly from the inverted loop said to characterise the RCA at the crux where the Posterior Interventricular artery (PIVA) arises. The AVNA arose from the RCA in 35% and from LCA in 15% of the specimens.

The PIVA arise from RCA in 40% and from LCA in 10% of the specimens.

DISCUSSION

Many researchers reported different results about the branching frequency of the left coronary artery, the length of the main trunk of the left coronary artery and the length of the median artery [39-42] [Table I]. We believe that third terminal branch of the main trunk of the left coronary artery should be marked as median artery. This branch, including its anastomoses, presents important pattern of the collateral blood flow, which has special meaning under conditions of coronary insufficiency [43].

The location of the left coronary artery may be defined according to its origin on the horizontal (anterior, middle or posterior) or the frontal (upper, middle or lower) plane [41]. Angioplasty of bifurcation lesions can lead to side branch occlusion secondary to plaque shifting (snow-flow effect) and retrograde propagation of dissection from side branch to parent vessel.

[TABLE-1] SINO-ATRIAL NODAL ARTERY (SANA)

Source Of SANA	Baroldi & Scomazzoni (1956)		James (1961)		Caetano & Lopes (1995)		Present Study	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
RCA	51	(51)	57	(54)	58	(58)	40	(80)
LCA	41	(41)	45	(42)	42	(42)	5	(10)
Both	8	(8)	4	(4)	0	(0)	5	(10)
Directly from aorta	-	-	-	-	-	-	-	-
Total	100	(100)	106	(100)	100	(100)	50	(100)

[Table-2] compares the source of SANA in our study with that of the studies of Baroldi and Scomazzoni, 1956; James 1961; and Caetano & Lopes, 1995.

James (1961)[20] had noted PIVA as a terminal branch of RCA in 80% of the cases. In our study,

PIVA arises from RCA in 40% of the specimens.
In about 35% shows bifurcation and trifurcation in 15% [Table-3]

[TABLE-3] DIVISIONS OF MAIN TRUNK OF LEFT CORONARY ARTERY (IN PERCENTAGE)

Branches	Baptista, (1991)	Cavalcanti, (1995)	Present study
One Branch	-	-	-
Bifurcation	54.7	60	35
Trifurcation	38.7	38.18	15
Quadrifurcation	6.7	-	-
Pentafurcation	-	-	-

[Table-3]compares the divisions of main trunk of LCA with the studies of Baptista, (1991)[28] and In the present study, in one specimen, an anomalous circumflex branch arise directly from anterior aortic sinus, as described earlier. specimens but more often turning around the apex into the posterior inter-ventricular sulcus, in which it traverses a third to half its length, to meet the twigs of the corresponding right coronary ramus. [Table- 4]

[TABLE-4] TERMINATION OF LEFT ANTERIOR DESCENDING BRANCH

Termination	James 1961	
	NO.	(%)
Anterior Apex	18	(17)
Posterior Apex	24	(23)
2-5 Cms up PIVS	44	(42)
> 5 Cms up PIVS	20	(18)
Total	106	(100)

[TABLE- 5] TERMINATION OF LEFT CIRCUMFLEX ARTERY

Point of Termination	James (1961)		Present Study	
	No.	(%)	No.	(%)
Before Obtuse Margin	1	(1)	1	2
At Obtuse Margin	22	(20)	6	12
Between Obtuse margin and crux	64	(60)	39	78
At Crux	9	(9)	3	6
Beyond Crux	9	(9)	1	2
Not Present	1	(1)	-	-
Total	106	(100)	50	100

The inverse relationship between the RCA and left circumflex branch is most simply expressed as right or left dominance, depending on which artery gives rise to the PIVA (James, 1961)[2o]. The origin of posterior inter ventricular artery from right coronary artery is the commonest anatomy in man, and referred to as RIGHT DOMINANCE, which occurred in 89% of the hearts in our study and a LEFT DOMINANCE, was observed in 11%. The results of the present study are compared with those of caval Cavalcanti (1995) in [Table 6].

[TABLE-6] DOMINANT CIRCULATION (% AGE)

Dominant (PIVA) Artery	Cavalcanti (1995)	Present Study
Right	88.18	42
Left	11.82	8

Clinicians and anatomists have been examining coronary artery variations for a long time. In particular, from the 1960s when the use of selective coronary angiography began, the number of investigations on this topic has increased. However, there is still no consensus on the normality or abnormality of coronary arteries. While it is generally accepted that the human heart has two main coronary arteries (right and left), some claim that the condition of possessing three or four coronary arteries is normal[7]. In general, coronary artery variations are regarded as either major or minor, important or unimportant. Minor anomalies are not clinically evident and are usually accepted as normal changes. Major anomalies that are accepted as variations are reported in less than 1% of the general population[7,8].

In angiographic and cadaver studies carried out among different ethnic groups, Garg etal reported that the most frequent coronary artery variations were observed in the RCA (62%) and the left circumflex branch (27%)[8]. while Topaz et al observed 48.71% of variations in the RCA and 35.89% in the left circumflex branch[9]. As in previous studies, it was determined that the most frequent variation (64%) was the conus branch of the RCA, which originates from the aortic sinus. Researchers have reported different results regarding the LCA branching frequency [Table 1]. While the rates of bifurcation and trifurcation in our study were very similar to each other and to the rates found by Surucu et al, the quadrification rate was similar to the results reported by Leguerrier et al[6,11]. The similarity between the bifurcation and trifurcation rates suggests that the normal division of the LCA into two branches should be reconsidere While Vilallonga reported that the external diameter of the median artery was thinner than the anterior interventricular branch and thicker than the circumflex branch, Surucu et al reported that it was thinner than both [5,6]. Our study was similar to Surucu et al.in that the average median artery thickness (2.00 ± 0.67 mm) was lower than that of the anterior interventricular branch (3.13 ± 0.64 mm) and the circumflex branch (2.89 ± 1.08 mm) [6]. The course of the anterior interventricular branch, generally found on the front surface of the heart along the posterior interventricular sulcus and surrounded by the apex of the heart, is called Mouchet's posterior recurrent interventricular artery[5]and has been observed at a frequency of 28.18%–50%[14,15].

that this artery originates from a location proximal to the RCA (64.1% and 59%) or the aortic ostium and aorta (33.9% and 39%, respectively)(22,23). Our study, in contrast, found the branching of the conus branch from the aortic ostium and aorta in 68% of cases, and its branching from the RCA in 32% of cases. Kurjia et al noted that establishing the location and origin of the conus artery in relation to the right ventricular outflow tract radiologically prior to surgery is essential for the treatment of tetralogy of fallot[20].

CONCLUSION

The coronary arteries and their main branches present a great quantity of variations with regard to source, trajectory and anastomoses. This knowledge is important for the interpretation of coronary angiography and surgical myocardial revascularization.

[TABLE – 1] The right coronary ostium is present in all specimens in the Right anterior aortic sinus.

RCA				LCA			
Below STJ		At STJ		Below STJ		At STJ	
NO.	%	NO.	%	NO.	%	NO.	%
40	80	10	20	30	60	20	40

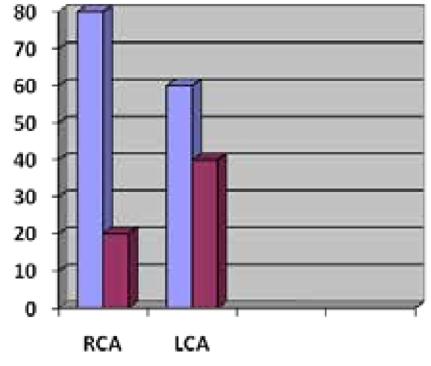
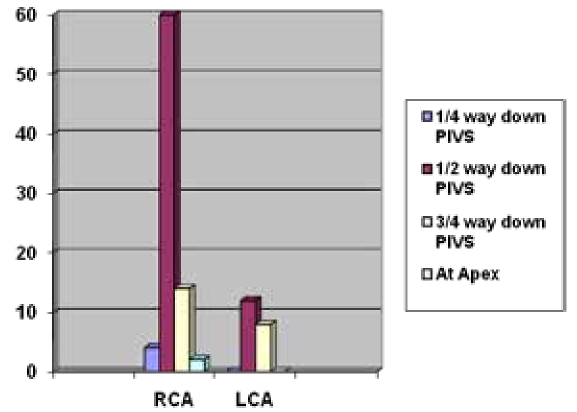


TABLE- 6] PRESENCE OF PIVA I – RCA

Point of termination	No.	%
¼ way down PIVS	2	4
½ way down PIVS	30	60
¾ way down PIVS	7	14
At Apex	1	2
Total	40	80 %

PIVA arise from RCA in 80 %
PIVA arise from RCA in 20 %

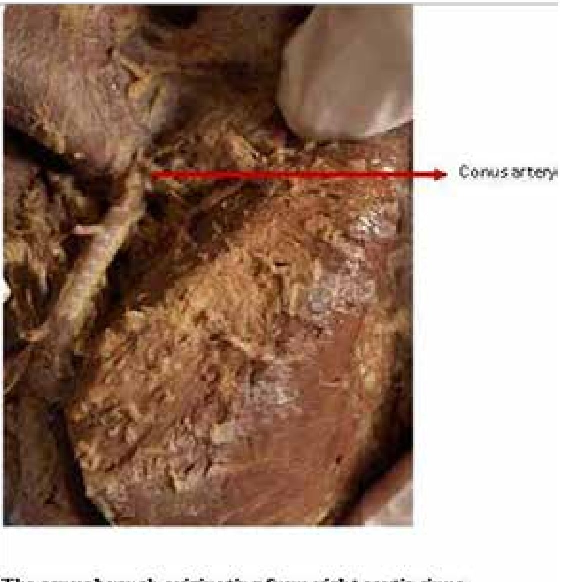
Point of termination	No.	%
¼ way down PIVS	-	-
½ way down PIVS	6	12
¾ way down PIVS	4	8
At Apex	-	-
Total	10	20 %



[Figure -1]

[Figure-3]

[Figure-2]



The conus branch originating from right aortic sinus

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