



Original Article

A Study of Branching Pattern and Distribution of Coronary Arteries in Adult Human Heart

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Abstract

Heart receives its blood supply from the coronary vessels. This current study is done to throw light upon the number of coronary ostia, diameter of the trunk, arterial supply to S A node and A V node, termination of right coronary artery and left anterior descending branch of left coronary artery and the predominance of heart. Knowledge of dominance of artery is helpful while performing angioplasty and coronary artery bypass grafting. If there is obstruction in the left coronary artery subjects, the degree of severity of myocardial infarction is more and may lead to death in single attack also. Better anatomical knowledge about the branches of coronary artery and its variation is essential for cardiologists and interpretation of coronary angiograms by radiologist.

Keywords: Coronary ostia, S A node, A V node, myocardial infarction, angioplasty, bypass grafting.

Introduction

The heart is a roughly cone-shaped hollow muscular pump responsible for blood circulation having four chambers about the size of the owner's fist. Heart receives its blood supply from the coronary vessels. It may seem like the heart has easy access to blood, however the blood passing through the chambers of heart does not actually supply it, instead special blood vessels, called coronary arteries deliver blood into heart muscle itself. Vascular anomalies pose a great challenge to anatomists and surgeons. The coronary arteries, studied for many years to determine the pathophysiology of coronary artery disease, have been under intense scrutiny by those

attempting to revascularize areas of ischemic myocardium using grafts to bypass arteries that have become obstructed by atheroma. Global population has different types of coronary predominance and having different degree of myocardial infarction and different percentage of incidence. This current study is done to throw light upon the number of coronary ostia, diameter of the trunk, arterial supply to S A node and A V node, termination of right coronary artery and left anterior descending branch of left coronary artery and the predominance of heart. This is to help the cardiologists for a better approach to cardiac disease for a precise cure.

Materials and Methods

20 Specimens were collected in the Department of Anatomy, Alluri Sitarama Raju Academy of Medical Sciences, (ASRAM), West Godavari dist, Eluru, Andhra Pradesh. The heart is taken out after incising the fibrous pericardium and great vessels like aorta, pulmonary trunk, superior vena cava, inferior vena cava and pulmonary veins. The courses of right and left coronary artery were traced from the ostia by cleaning the epicardium and fat by dissection. The dissection was done under water. The coronary veins were removed to avoid confusion. The specimens were duly numbered, preserved in 10% formaldehyde solution. Photographs of each specimen were taken by digital camera and the arterial pattern is coloured red digitally and labelled.

Results

We observed the following variations and branching pattern and distribution of coronary arteries

We observed right coronary artery passes along the atrioventricular groove, right coronary artery gave off 3 to 4 ventricular branches, 2 to 3 atrial branches.

1) Conus artery was seen.

2) Right coronary artery at right border bifurcated into

a) One branch to posterior aspect of right ventricle.

b) Other branch continued in posterior interventricular groove as posterior descending artery.

Before continuing a small branch was given off which continued in atrioventricular groove reached beyond crux to anastomoses with left coronary artery and supplies posterior aspect of left ventricle. S A nodal and A V nodal artery were given by right coronary artery.

Left coronary artery: Divided into two branches.

1) Left anterior descending artery: It passes in anterior interventricular groove and gave off ventricular branches. Diagonal branch was seen. Diagonal artery divided into two branches of large caliber.

2) Left circumflex: Immediately divided into two

a) One crossed left border to supply the posterior aspect of left ventricle.

b) Other continued in atrioventricular groove and ends before crux to anastomoses with right coronary artery.



Fig 1: Heart-anterior view showing right conus artery, left anterior descending artery, diagonal artery, marginal artery.



Heart-posterior view showing posterior descending artery, posterior interventricular artery, left circumflex artery.

We observed separate ostia were seen each leading into two separate vessels, one of larger caliber and other of smaller caliber.

1) Smaller caliber artery, coursed on the sternocostal surface gave ventricular branch and reached till apex.

2) Larger caliber vessel continued in atrioventricular groove and gave 3 ventricular branches which ramified on ventricular surface. It gave 3 atrial branches. It continued in atrioventricular groove and turned posteriorly, Just before crux it gave

a) Posterior descending artery

b) Small branch which crossed beyond crux and anastomoses with ventricular branches of left

circumflex artery. S A nodal artery and A V nodal artery arises from right coronary artery.

Left coronary artery: It divided into four branches after a short course

1) Left anterior descending artery passes along the anterior interventricular groove crossed apex to reach upto lower $1/3^{\text{rd}}$ of posterior interventricular groove.

2) Left diagonal artery a branch to the sternocostal surface of left ventricle.

3) Branch along the left border of heart, the left marginal artery was seen.

4) Left circumflex artery continued in atrioventricular groove and end by anastomoses with ventricular branches of right coronary artery.

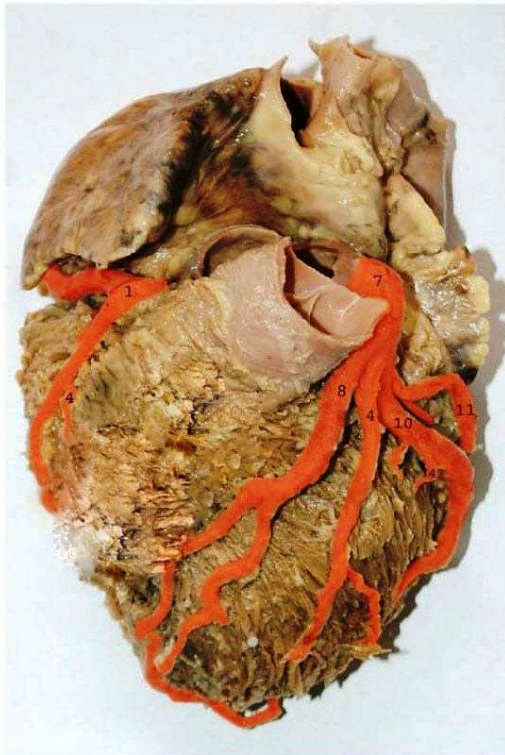
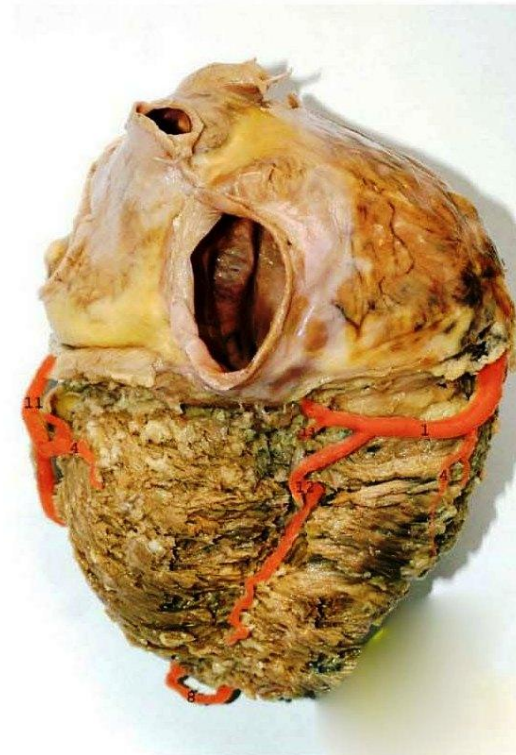


Fig 2: Heart-anterior view showing right coronary artery, left anterior descending artery, diagonal artery, marginal artery, right marginal artery.



Heart-posterior view showing posterior ventricular branches posterior interventricular artery left circumflex artery.

We observed right coronary artery passes along the atrioventricular groove

- 1) Conus artery was seen.
- 2) Right coronary artery gave off 3 to 4 ventricular branches and 3 to 4 atrial branches and continued in atrioventricular groove.

It ends between right border and crux of heart to anastomoses with terminal branches of left circumflex artery.

Left coronary artery: It divided into

- 1) Left anterior descending passes along the anterior interventricular groove and gave off acute ventricular branches.

- 2) Diagonal artery was seen which further divided into two crossing left border.

- 3) Left circumflex artery crossed left border in atrioventricular groove and gave ventricular branches to posterior aspect of left ventricle. It gave off posterior descending artery which coursed in posterior groove.

- 4) S A nodal and A V nodal artery arises from left coronary artery.

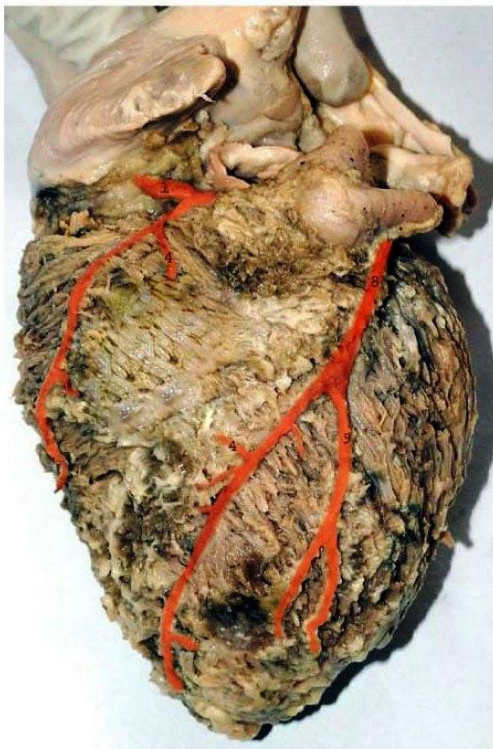
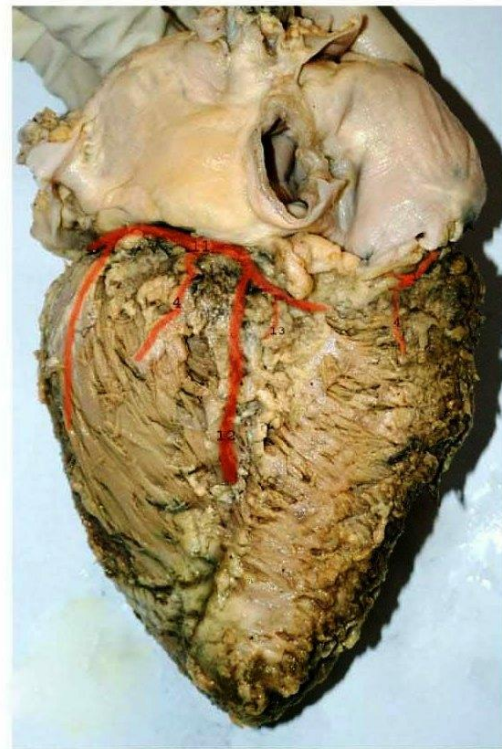


Fig 3: Heart-anterior view showing right coronary artery, left anterior descending artery, diagonal artery crosses the left border, atrial branches, S A nodal artery.



Heart-posterior view showing posterior ventricular branches from left circumflex artery, posterior interventricular artery.

We observed right coronary artery passes along the atrioventricular groove.

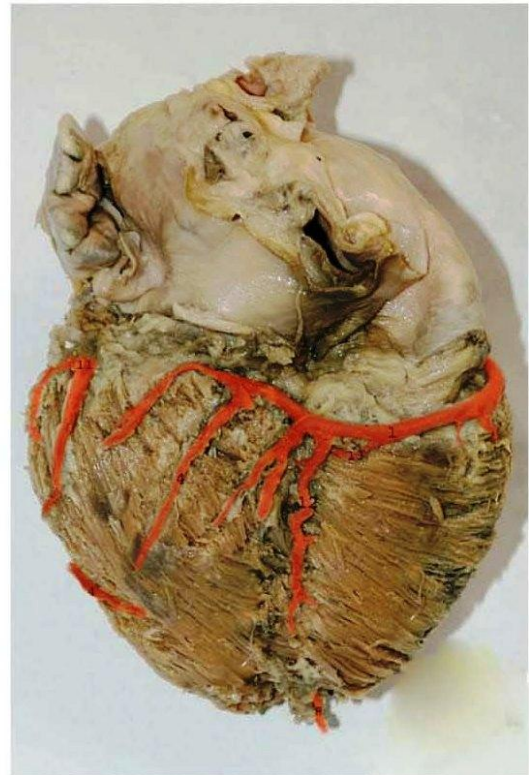
- 1) Conus artery was observed which is first branch from right coronary artery.
- 2) Perpendicular ventricular branches about 3 to 4 ramifying over right ventricle are observed, It gave 2 to 3 atrial branches.
- 3) Right coronary artery crossed right border ran along posterior part of atrioventricular groove and reached crux. At crux it divided into 2 branches.
 - a) Continued into posterior interventricular groove as posterior descending artery. A V nodal artery arises before continuing in posterior interventricular groove.
 - b) Other branch crossed crux and end by anastomoses with left circumflex artery.

Left coronary artery: left coronary artery divided into

- 1) Left conus artery
 - 2) Left anterior descending after coursed in anterior interventricular groove.
 - 3) Along left border of heart left marginal artery of small caliber aroused.
 - 4) A branch supplied the posterior aspect of left ventricle was given off.
 - 5) Left crux which in turn divided into two
 - a) Supplied posterior aspect of left ventricle.
 - b) Supplied left atrium.
- S A nodal artery arise from left coronary artery.



Fig 4: Heart-anterior view showing right conus artery, ventricular branches, atrial branches, left anterior descending artery, S A nodal artery from left coronary artery.



Heart-posterior view showing posterior ventricular branches from right coronary artery supplies both ventricles.

We observed the branching pattern of the right coronary artery

- 1) Conus artery was seen which ramifies on infundibulum of right ventricle.
- 2) Right coronary artery runs in atrioventricular groove and gave off 3-4 ventricular and 2-3 atrial branches.
- 3) Large caliber ventricular branch along the right border was observed as right marginal branch, S A nodal artery was given.
- 4) At crux right coronary artery gave a branch which continued along the posterior aspect of left ventricle. Right coronary artery further continued

as posterior descending artery in posterior interventricular groove and reached till apex, before continuing A V nodal artery arised.

Left coronary artery: After a short course gave

- 1) Left anterior descending after short course bifurcated into two branches which ramified on the ventricular surface of left ventricle. Acute ventricular branches were given off.
- 2) Left circumflex continued in atrioventricular groove for short distance and at left border descended as left marginal artery.

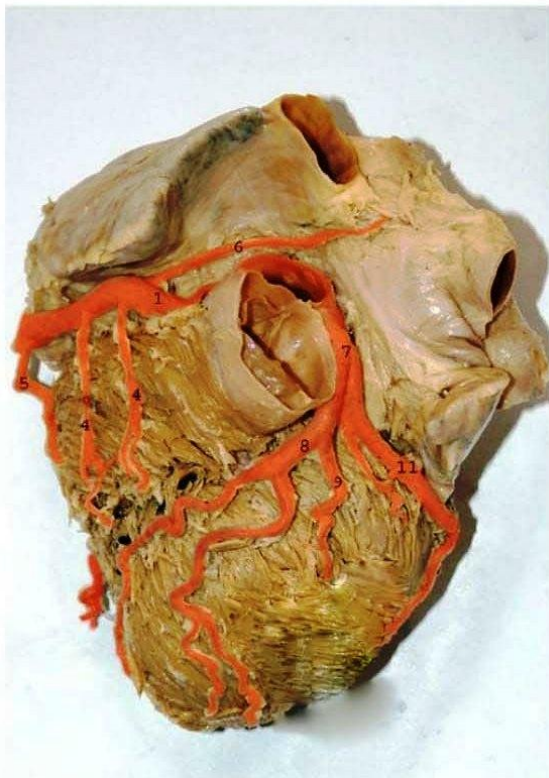
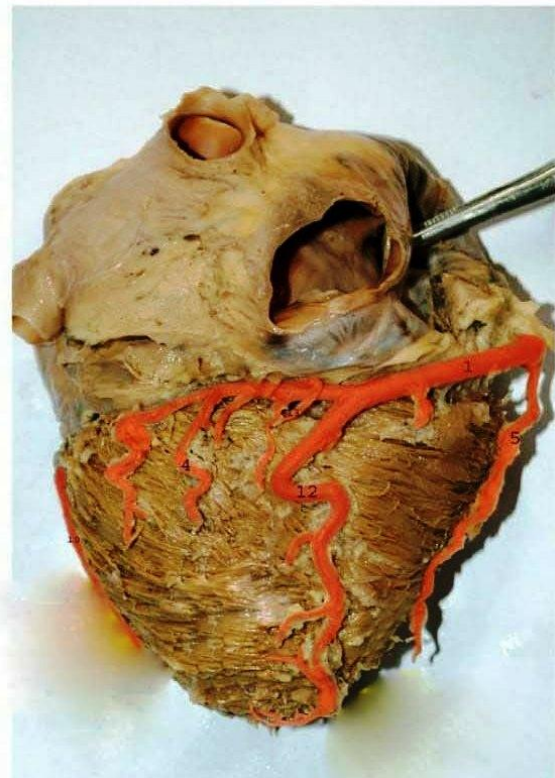


Fig 5: Heart-anterior view showing ventricular branches, atrial branches, left anterior descending artery, S A nodal artery from right coronary artery, right marginal artery, marginal and diagonal arteries.



Heart-posterior view showing right coronary artery supplies both ventricles via ventricular branches, parallel branch from right coronary artery supplies the posterior aspect of right ventricle.

We observed right coronary artery passes along the atrioventricular groove and gave off 3-4 ventricular branches to the sternocostal surface of right ventricle. Conus artery was observed.

2) Right coronary artery at right border divided into two

a) One branch supplies posterior aspect of right ventricle.

b) Another branch gave posterior descending artery. It further continued in atrioventricular groove beyond crux to anastomoses with ventricular branches from the left circumflex artery.

A V nodal artery arises before giving posterior descending artery.

Left coronary artery: after short course divided into

1) Left anterior descending artery runs in anterior interventricular groove and gave off ventricular branches and ends at lower 1/3rd of posterior interventricular groove. Left anterior descending artery gave diagonal branch which bifurcated and supplied till apex.

1) Left marginal branch which ran till apex along left border was seen.

2) Left circumflex branch, gave a branch for posterior aspect of left ventricle and other to anastomoses with ventricular branches of right coronary artery. SA nodal artery arises from left coronary artery.

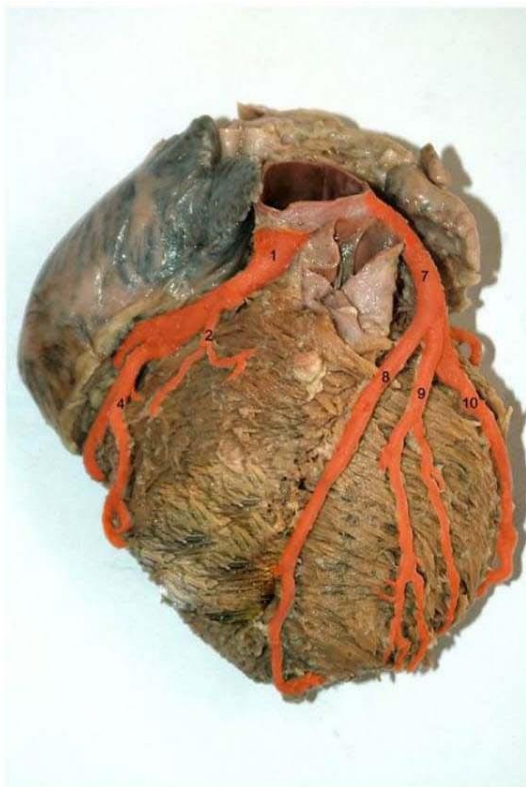


Fig 6: Heart-anterior view showing Right conus artery, ventricular branches, marginal and diagonal arteries, left anterior descending artery.



Heart-posterior view showing circumflex artery provide branches to left ventricle. Right coronary artery supplies the posterior aspect of right ventricle.

We observed the right coronary artery carises from the right anterior aortic sinus from a single ostium. After a very short course it ends by supplying the sternocostal surface of right ventricle. It passes till apex.

- 1) It gave off 3 to 4 ventricular branches and 2 to 3 atrial branches before ending.
- 2) Conus artery was observed which ramified on the infundibulum of right ventricle. S A nodal artery arises from right coronary artery.

Left coronary artery:

Left anterior descending arises from the left posterior aortic sinus and continued on the sternocostal surface of left ventricle in anterior interventricular groove. It gave off acute ventricular branches. Diagonal branch was observed which divided into two and supplies sternocostal surface of left ventricle.

Left circumflex artery:

A branch arises from the separate ostium from right aortic sinus passes in atrioventricular groove towards left and emerged below the left auricle. It gave off ventricular branch which ramified on the sternocostal and posterior surface of left ventricle. It continued in atrioventricular groove and in the posterior interventricular groove as posterior descending artery and anastomoses with terminal branch of left anterior descending artery before continuing as posterior descending artery, A V nodal artery was given.

Two separate ostia in left posterior aortic sinus was observed. Each ostia lead into two separate vessel i.e. left anterior descending and left circumflex vessel take origin from separate ostia instead from the main trunk.

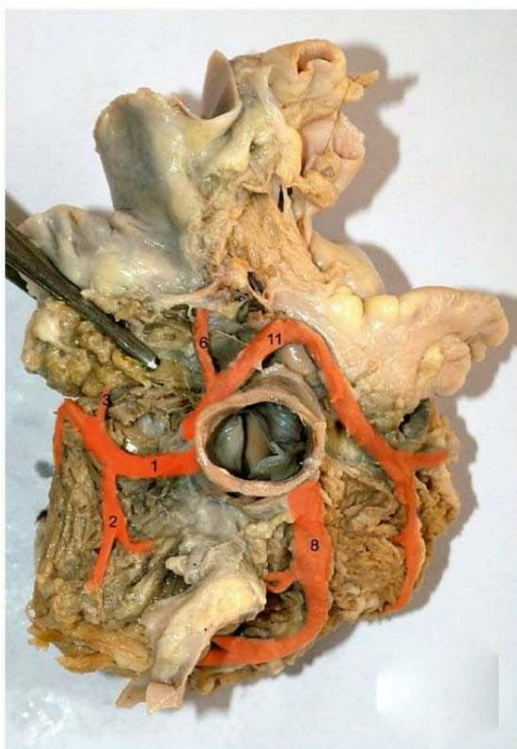
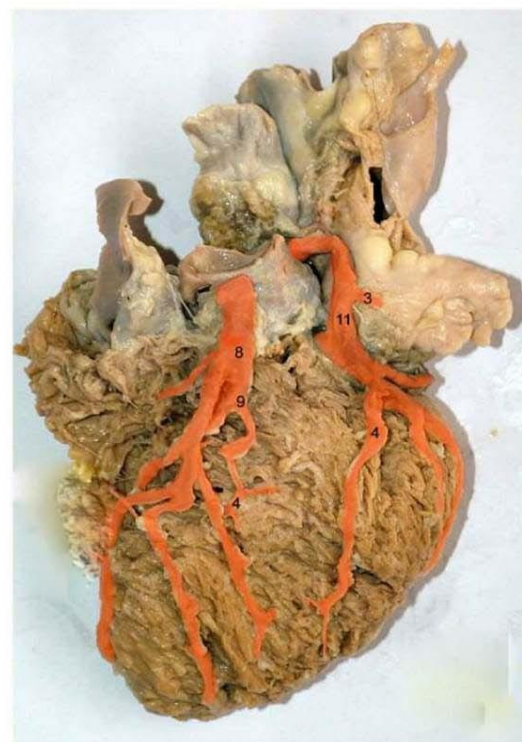


Fig 7: Heart-superior view showing 3 separate ostia from aortic sinus.



Heart-lateral view showing marginal artery Diagonal and Circumflex artery

Table No 1: Diameter of Main Trunk In mm

Coronary arteries	2mm	3mm	4mm	5mm	6mm
Right	5	7	6	2	-
Left	4	6	5	4	1

Observation derived from the measurements of the diameter of the coronary arteries immediately after their origin revealed that the diameter of left coronary artery was less than right coronary artery in only 2 specimens. In all the rest of the hearts (80%) left coronary artery diameter was more than right coronary artery. Diameter of right coronary artery ranged from 2 to 5 mm only and left coronary artery from 2 to 6 mm only.

Table No 2: Level of Termination of Right Coronary Artery

Termination	No. of specimens	Percentage
Before right border	3	15
Before crux	6	30
At crux or beyond crux	11	55

Observation on the level of termination of right coronary artery revealed that it terminated at crux or beyond crux in 11 out of 20 (55%) specimens, before crux in 6 specimens (30%) and before right border in 3 (15%) specimens.

Table 3 Blood Supply to S A Node and A V Node

	Artery to SA node		Artery to AV node	
	Number	%	Number	%
Right coronary artery	16	80	12	60
Left coronary artery	4	20	8	40

Observations on the blood supply to the S A node and A V node revealed that right coronary artery supplies 16 out of 20 specimens (80%) and 12 out of 20 specimens (60 %) respectively.

The remaining 4 specimens (20%) S A nodal artery arises from left coronary artery and in 8 specimens (40%) A V nodal artery was from left coronary artery.

Table No 4: Coronary Artery Dominance

Right dominance		Left dominance		Balanced	
Number	%	Number	%	Number	%
13	65	5	25	2	10

Observations on the dominance of heart revealed that 13 out of 20 specimens (65%) were right dominant, 5 out of 20 specimens (25%) were left dominant and the 2 (10%) were having balanced circulation.

Discussion

In this study, a note on the origin of coronary arteries, diameter of the main trunk, branches to (i) S A node (ii) A V node and posteriori interventricular groove, to know the dominance of the heart.

In this study, a note on the origin of coronary arteries, diameter of the main trunk, branches to (i) S A node (ii) A V node and posteriori interventricular groove, to know the dominance of the heart, the termination of right coronary artery and left anterior descending branch was done.

In the present study the diameter of the main trunk revealed that in majority of hearts i.e., in 80% the diameter of left coronary artery was more than that of right coronary artery, in 10% of the hearts the diameter of right coronary artery was more than left and in remaining 10% both right and left coronary artery diameter were equal.

The average diameter of the right coronary artery was 4 mm (1.5 to 5.5 mm; Paulin 1964). left coronary artery the initial section is dilated, elsewhere it has a diameter of 2 to 7 m Baroldi and Scmazzone (1967) gave means of 4 mm and 3.2 mm in case of coronary artery diameters at their origins the left exceeds the right in about 60% of hearts, the right being larger in 17%, the vessels approximately equal in 23%.

In present study the equal lumen circumference of left and right coronary arteries resemble with the findings of Baroldi and Scmazzone (1967) where in case of 23% hearts diameters of both the coronary arteries was equal. In the present study right coronary artery terminated at crux or beyond

crux in 55%, before crux in 30% and right border in 15%. In three specimens it terminated before right border.

The S A node is supplied in 55% of hearts by an artery that arises from the right coronary artery fairly close to its origin, in the remaining 45% it arises from the circumflex branch of the left coronary artery. The A V node is usually supplied by a branch that arises from the apex of a definite upward loop of the right coronary artery as it crosses the crux of the heart in relation to the coronary venous sinus. In present study S A nodal artery was found originating in 80% of specimens from right coronary artery, in 20% from left coronary artery.

The right coronary artery is dominant in approximately 70% of people. If the circumflex branch of the left coronary artery terminates in the posterior interventricular groove, left dominance is present. This occurs in about 65% of people. In the remainder the posterior septum is vascularised either by descending branches from both the right coronary and left circumflex arteries, or by a network of small branches from these two passing obliquely, so that there is no posterior interventricular branch. In such hearts the circulation is said to be 'balanced' as the posterior interventricular branch is either bilateral or absent.

Conclusion

The present study on branching pattern and distribution of coronary arteries shows some difference with respect to the results. Diameter of right coronary artery ranges from 2 to 5 mm only and left coronary artery from 2 to 6 mm only.

The level of termination of right coronary artery showed that 55% terminated at crux or beyond. The level of termination indicates that right coronary artery supplies major part of right atrium, right ventricle and the length of right coronary artery in the atrioventricular groove beyond the crux will show the blood supply to the left ventricle adjacent to the posterior interventricular groove, the posterior 1/2 of the interventricular septum hence the conducting

system, the S A node, A V node and atrioventricular bundle including right bundle of his is supplied by right coronary artery in mainly right dominant heart. Whereas in the left dominance except for the S A node the rest of the conducting system of heart is supplied by left coronary artery.

The present study on the predominance of heart shows 65% were right dominant, 25% were left dominant. The degree of severity of myocardial infarction is more if it is left coronary artery dominance. Incidence of dominance showed that 65% were right dominant, 25% were left and 10% had balanced circulation. Knowledge of dominance of artery is helpful while performing angioplasty and coronary artery bypass grafting. If there is obstruction in the left coronary artery subjects, the degree of severity of myocardial infarction is more and may lead to death in single attack also.

Better anatomical knowledge about the branches of coronary artery and its variation is essential for cardiologists and interpretation of coronary angiograms by radiologist.

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