Anatomical study of right coronary artery and its variations – Cadaveric study

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Abstract

Introduction: Knowledge of the normal and variant anatomy and anomalies of coronary circulation are vital component in the management of coronary artery disease. Any coronary artery disorder may reduce the blood supply to the heart and may lead to Myocardial infarction and death.

The aim of the study was to identify right coronary artery branching pattern and its variations. This may indirectly affect the patient's prognosis. This study describes the presence of normal arterial pattern and variations of right coronary artery in fifty heart specimens.

Materials and Method: This study was carried out on fifty formalin fixed adult human cadaveric heart specimens of both sexes. Visceral pericardium and subepicardial fats were removed. The right coronary artery and its branches were carefully dissected and followed till their termination.

Results: The right coronary artery was found to be arising from pulmonary trunk in three heart specimens in our study. Third coronary artery was found in one specimen. Sinu atrial nodal artery was arising from right coronary from right coronary artery in 94% and from left coronary artery in 6% Right dominance was observed in 35(70%) specimens. Fistula between right coronary artery and pulmonary artery was found in one specimen.

Conclusion: Branching pattern of right coronary artery is important for interpretation of coronary angiography and surgical revascularization of myocardium.

Keywords: Coronary artery, Sinu – atrial nodal artery, Fistula, pulmonary artery

Introduction

Coronary arteries represent the only supply to the myocardium. The two main coronary arteries, right and left coronary arteries arise from ascending aorta. Right coronary artery arises from right anterior aortic sinus and left coronary artery arises from left posterior aortic sinus. Patency of left coronary artery is vital for sufficient perfusion of the heart. The left coronary artery is responsible for irrigation, not only of most of the left ventricle, but also considerable portion of right ventricle.[1]

Right coronary artery runs between pulmonary trunk and right auricle and then runs downwards and is divided into two segments. First segment runs along the right border of the heart up to inferior border of heart. It gives right conus artery and supplies infundibulam of the right ventricle. If the right conus artery arises separately from the aortic sinus, then it is called as Third coronary artery. The second segment runs up to the apex as right marginal artery and supplies right ventricle. Sometimes it may runs in the posterior interventricular groove and may give rise to Posterior interventricular branch. Hence according to the origin of posterior interventricular artery, the coronary artery dominance has been considered. Right coronary artery ends in the crux by anastomosing with circumflex artery. It supplies the right atrium, right ventricle, atrioventricular septum and part of left ventricle.

Sinu atrial nodal artery may arise as atrial rami from initial segment of right coronary artery in 65% of the cases and from circumflex artery in 35% of the cases. Atrioventricular nodal artery arises as first septal ramus of posterior interventricular artery in 90% of the cases and 10% from the left coronary artery.[2]

Numerous studies on the variations of the arteries have been reported, but still it is better to study them further with respect to their clinical significance.

Coronary anomalies are a poorly understood topic in modern cardiology. Clinicians should be aware of such anomalies because some of them may produce sudden death.

The incidence of congenital coronary artery anomalies is 5–6%. By definition, the term anomalous or abnormal is used to define any variant form observed in less than 1% of the general population.[3]

The aim of the study is to identify the normal pattern of the coronary arteries and its variations. Though the modern techniques of revascularisation and coronary bypass surgeries are available, the knowledge about the anatomy of coronary arterial pattern and its variations are important for the cardiologists and cardio – thoracic surgeons.

Materials and Method

Fifty formalin fixed heart specimens of both sexes with intact coronary arterial pattern were studied in Anatomy department, PSG IMS & R, Coimbatore. The right coronary artery and its branches were carefully dissected out till their termination and were analysed for normal and abnormal patterns of coronary arteries.

Observations

Right coronary artery was found to be arising from right anterior aortic sinus in forty seven specimens of the heart. Right coronary artery was arising from Pulmonary trunk in three heart specimens (Fig. 1).
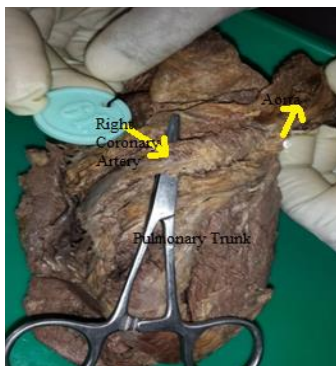

Fig. 1

Fistula between Right coronary artery and pulmonary trunk was found in two specimens in the present study (Fig. 2). Coronary fistula is said to be fistula between coronary artery or its branches with pulmonary trunk or with coronary sinus or with its tributaries.
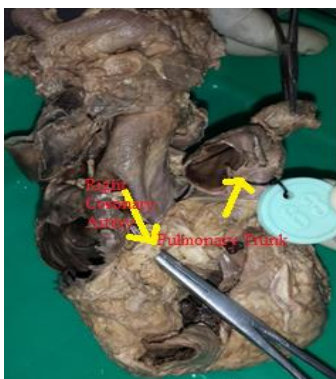

Fig. 2

Third coronary artery (First branch of right coronary artery - Right conus artery arises separately from Aorta) was observed in one specimen (Fig. 3).
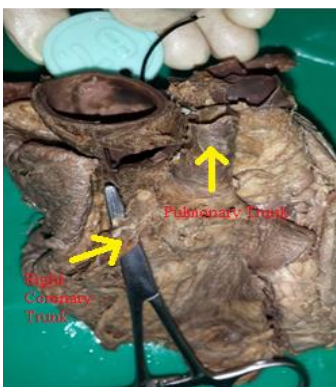

Fig. 3

Fig. 1, 2, 3 shows origin of right coronary artery from pulmonary trunk.

The second branch of first segment, the Sino - atrial nodal artery was arising from right coronary artery in 94% and from left coronary artery in 6%.

Right conus artery, A.V. nodal artery and right marginal artery were observed in all specimens (Fig. 4).
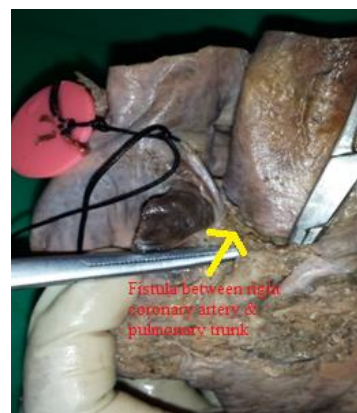

Fig. 4

Fig. 5

Fig. 4 & 5 shows fistula between right coronary artery & pulmonary trunk.

Kugel's artery was found in three specimens which had its origin from Circumflex artery and coursed posterior to the atrial wall and was found to anastomose with an atrial branch of right coronary artery(Fig. 6).
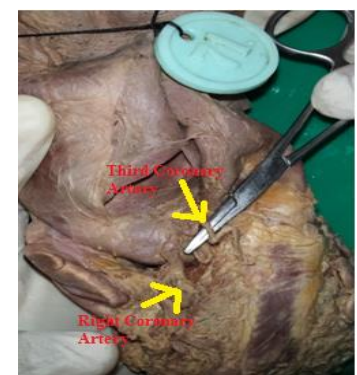

Fig. 6: Shows Third coronary artery

Posterior interventricular artery may originate from right coronary artery or from circumflex artery or from both the arteries. The dominance of the heart was decided according to the origin of posterior interventricular artery. Right dominance was observed in 35(70%) specimens (Fig. 5).

Left dominance was observed in 4(8%) specimens (Fig. 7). Co – dominance was found in 11(22%) specimens (Fig. 8).

Fig. 7: Shows Sinu atrial nodal artery

Fig. 8: Shows right dominance

Fig. 9: Shows Kugel's artery

Discussion

Splanchnopleuric mesoderm contributes to all components of heart. The mesoderm contributes to the cardiac area that occurs during 3rd week of embryogenesis. The cardiac area subsequently forms a pair of endocardial tubes which fuses to form primitive heart tube. Normal coronary artery arise from appropriate differentiation of pleuripotent cells into their respective anatomic and functional components. Anomalies of the coronary circulation result from processes that disrupt the normal differentiation and specialization of heart tube.[4] In particular, abnormal involution, position of endothelial buds or septation of truncus arteriosus may give rise to anomalous origin of coronary artery.[5]

Coronary endothelial sprouts occur at around 5th week of Intrauterine life from the bulbous card is which has not yet differentiated into the aorta and pulmonary trunk. The first evidence of coronary vessel development is the appearance of the blood islands at the beginning of the 5th week just under the epicardium in the sulci of the developing heart.

Anomalous origin of right coronary artery from Pulmonary trunk (ALRAPA SYNDROME) is a rare congenital anomaly with an estimated prevalence of 0.002%. This is incidental anomaly. This was observed in three specimens in our study. This is in contrast with anomalous origin of left coronary artery from pulmonary trunk which is fatal during early infancy without immediate surgical management.[6]

In the present study, the first and highest branch of first segment of right coronary artery (third coronary artery) was arising in 2% of cases from a separate ostium which was not similar to Kalpana[7] and Olabu[8] study which was about 35%.

The second branch of first segment, the Sino - atrial nodal artery was arising from right coronary artery in 94% and from left coronary artery in 6%. When compared to other studies, Sino - atrial nodal artery was arising from right coronary artery in our study was found to be higher (94%).

Table 1: Sino – atrial nodal artery (SANA)

Source of SANA	Baroidi & Scomazzons 1956 Number (%)	James 1961 Number (%)	Caltano & Lopes 1995 Number (%)	Kalpana 2003 Number (%)	Present study
Right coronary artery	51(51)	57(54)	58(58)	56(56)	47(94)
Left coronary artery	41(41)	45(42)	42(42)	35(35)	3(6)
Both	8(8)	4(4)	0(0)	8(8)	-
Directly from Aorta	-	-	-	-	-
Total	100(100)	106 (100)	100(100)	100 (100)	50(100)

Table 2: Termination of Posterior interventricular artery was compared with previous studies

Point of termination	James 1961 Number(%)	Kalpana 2003 Number(%)	Present study
1Provided by right coronary artery • Hypoplastic	-	-	-
¼ way down Posterior interventricular septum	2(2)	9(9)	1(2)
½ way down Posterior interventricular septum	27(25)	46(46)	1(2)
¾ way down Posterior interventricular septum	39(37)	26(26)	10(20)
At apex	28(26)	8(8)	23(46)
Total	96(90)	89(89)	35(70)

Right dominance was found to be higher than other dominances in our study, which was not similar to other studies. The origin of Posterior interventricular artery is one of the parameters on which Schlesinger's (1940) system of arterial dominance was based.

Posterior interventricular artery may arise from right coronary artery or from Circumflex artery. Accordingly dominance may be determined. If it was arising from right coronary artery, then right dominance was applied and if it was arising from Circumflex artery, then left dominance was applied. Sometimes from both, then it was termed as co- dominance.

Table 3

Dominant artery (Posterior interventricular artery)	Cavalcanti (1995)	Kalpana (2003)	Present study
Right	88.18	89	35(70)
Left	11.82	11	4(8)
Co – dominant	_	_	11(22)
Total	100	100	50(100)

Kugel's artery was found in three specimens which had its origin from circumflex artery and coursed posterior to the left atrium and was found to have an communication with an atrial branch of right coronary artery. This artery was considered as an important collateral path for AV node.[11]

Fistula between right coronary artery and pulmonary artery was observed in two specimens in our study. A coronary fistula is a direct communication between the coronary artery and the coronary sinus or one of its tributaries, the superior vena cava, the pulmonary artery or veins close to the heart or lumen of any cardiac chambers of the heart.[12] New anastomoses is said to be indicative of hypoxia, occlusive disease, valvular disease of the heart and anaemia.[13]

Conclusion

Anatomic variations of the heart vessels are common. Hence identification of normal coronary artery pattern and its branches and variations are important for cardiologists, cardiothoracic surgeons and radiologists while performing coronary angiography and surgical procedures.

Right dominance is the most common anatomical dominant pattern which was also common in our study.

Coronary angiography is an imaging procedure which shows the identification of normal coronary arterial pattern and its variations. The study is of importance in planning Angioplasty and Coronary artery bypass surgery.

Acknowledgement

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