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Study on the origin of third coronary artery in human cadavers and its clinical significance

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Abstract

Introduction: Third coronary artery supplies right ventricular outflow tract, arises from anterior aortic sinus. It is a source for collateral coronary blood flow forming a vascular anastomotic bridge between the right and left coronary systems.

Objectives: To understand coronary artery disease and for successful planning of coronary angiogram the knowledge on third coronary artery is very much necessary. The purpose of the study was to know if the origin of third coronary artery is from a separate orifice or a branch of right coronary artery as right conus artery.

Materials and Method: After an ethical approval, 49 formalin fixed human cadaveric hearts were collected from department of Anatomy and Forensic medicine, Mysore Medical College and Research Institute, Mysore, India and a study was done on the origin of third coronary artery in human cadavers by dissection method. The data was analysed using SPSS computer software.

Results: It was observed that the incidence of third coronary artery was 10.2%.

Conclusion: Complete knowledge on third coronary artery is essential to understand the advances made in coronary artery bypass surgeries and newer methods of myocardial revascularisation.

Keywords: Annulus of Vieussens, Conus artery, Coronary ostia, Third coronary artery.

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Introduction

The word 'coronary' (Latin word) means a crown like arrangement of all coronary arteries in atrioventricular sulcus of the heart. Right and left coronary arteries a vasavasorum of the ascending aorta supplies the heart.(1)

The conus artery supplying the arterial conus is a branch of right coronary in 64% of cases is commonly subjected for variations. One such is it may arise by a separate opening in the anterior aortic sinus constituting the third coronary artery. "Annulus of Vieussens" formed at the origin of pulmonary trunk is an anastomoses between third coronary artery and a similar branch of left coronary artery.(2) Schlesinger described for the first time about third coronary artery which supplies the infundibulum of the right ventricle.(3) An arterial ring formed between third coronary artery and a branch of left anterior descending artery forms a collateral blood steam in coronary insufficiency. The standard approaches for coronary angiographies fail to visualise it in many cases.(4)

Accurate interpretation of coronary angiograms, assessment of severity of coronary insufficiency and appropriate planning of myocardial revascularisation necessitates to know the incidence of third coronary artery.(5) The present study has been done to note the incidence of third coronary artery.

Materials and Method

After an ethical approval the present study was conducted on 49 formalin fixed human cadaveric hearts, collected from the department of Anatomy and Forensic Medicine, Mysore Medical College and Research Institute, Mysore, India.

Specimens were collected over a period of 18 months (October 2011 to March 2013) as block dissection of the heart along with associated structures like ascending aorta, pulmonary trunk.

Each specimen was thoroughly washed to remove blood clots and then tagged with a token having identification number and fixed in 10% formalin. Epicardium and fat was removed in piecemeal. The right, left and third coronary arteries were dissected meticulously. The ascending aorta was sectioned transversely approximately 1 cm above the commissure of aortic leaflets. Next the aorta was longitudinally opened at the level of right posterior aortic sinus to enable the visualisation and analysis of coronary ostia.

Results

It was observed that the incidence of third coronary artery was 10.2%.and it was to the left of right coronary artery. It constitutes a significant source of collateral circulation and is important in the interpretation of signs and symptoms of coronary artery occlusion.

Table 1: Master Chart

Sp. No.	Coronary Ostia	Location in AAS	Location in LPAS
1.	Right	✓	-
	Left	-	✓
2.	Right	✓	-
	Left	-	✓
3.	Right	✓	-
	Left	-	✓
4.	Right	✓	-
	Left	-	✓
5.	Right	✓	-
	Left	-	✓
6.	Right	✓	-
	Third	✓	-
	Left	-	✓
7.	Right	✓	-
	Third	✓	-
	Left	-	✓
8.	Right	✓	-
	Left	-	✓
9.	Right	✓	-
	Left	-	✓
10.	Right	✓	-
	Left	-	✓
11.	Right	✓	-
	Left	-	✓
12.	Right	✓	-
	Third	✓	-
	Left	-	✓
13.	Right	✓	-
	Left	-	✓
14.	Right	✓	-
	Left	-	✓
15.	Right	✓	-
	Left	-	✓
16.	Right	✓	-
	Left	-	✓
17.	Right	✓	-
	Left	-	✓
18.	Right	✓	-
	Left	-	✓
19.	Right	✓	-
	Third	✓	-
	Left	-	✓
20.	Right	✓	-
	Left	-	✓
21.	Right	✓	-
	Left	-	✓
22.	Right	✓	-
	Left	-	✓
23.	Right	✓	-
	Left	-	✓
24.	Right	✓	-
	Left	-	✓
25.	Right	✓	-
	Left	-	✓
26.	Right	✓	-
	Left	-	✓
27.	Right	✓	-
	Left	-	✓
28.	Right	✓	-
	Left	-	✓
29.	Right	✓	-
	Third	✓	-
	Left	-	✓
30.	Right	✓	-
	Left	-	✓
31.	Right	✓	-
	Left	-	✓
32.	Right	✓	-
	Left	-	✓
33.	Right	-	✓
	Left	-	✓
34.	Right	✓	-
	Left	-	✓
35.	Right	✓	-
	Left	-	✓
36.	Right	✓	-
	Left	-	✓
37.	Right	✓	-
	Left	-	✓
38.	Right	✓	-
	Left	-	✓
39.	Right	✓	-
	Left	-	✓
40.	Right	✓	-
	Left	-	✓
41.	Right	✓	-
	Left	-	✓
42.	Right	✓	-
	Left	-	✓
43.	Right	✓	-
	Left	-	✓
44.	Right	✓	-
	Left	-	✓
45.	Right	✓	-
	Left	-	✓
46.	Right	✓	-
	Left	-	✓
47.	Right	✓	-
	Left	-	✓
48.	Right	✓	-
	Left	-	✓
49.	Right	✓	-
	Left	-	✓

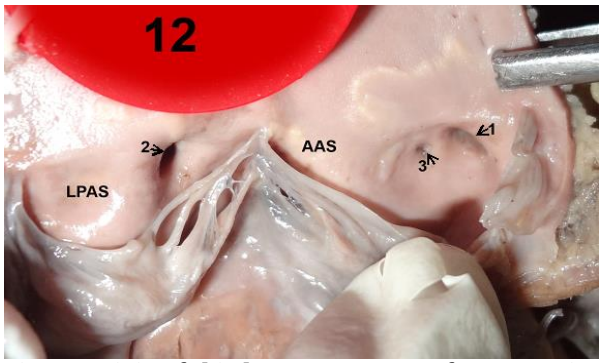

Fig. 1: Origin of third coronary artery from anterior aortic sinus
1. Right coronary ostium 2. Left coronary ostium 3. Ostium of third coronary artery

Fig. 2: Red arrow indicating right coronary artery. Red line with shadow indicating third coronary artery

Discussion

The first ventricular branch of right coronary artery is called the right conus artery or the third coronary artery when it arises directly from the aorta.[3]

Dhobale MR et al.[4] have stated in their study that out of 150 hearts the total incidence of third coronary artery was 32%(48 hearts). In 42 hearts (28%) single third coronary artery and in 6 hearts (4%) double third coronary arteries were noted. The study done by Sirikonda P and Sreelatha S[6] showed the incidence of third coronary artery was 19%. They explained that ostia of third coronary artery are small it gets opacified during angiographies which is a major hazard in coronary surgeries and gets nicked in undetected cases. The study of Bharambe VK[7] found the incidence of third coronary artery to be 22%. They explained its importance while cannulating the vessels during procedures like open aortic surgery and coronary arteriography. The number of coronary arteries can be outlined by a preliminary aortic root injection which helps the interventional cardiologist. Stankovic I, Jesic[10] studied 23 hearts and found third coronary artery in 34.8% of heart specimens. The difference in the frequency of third coronary artery between the sexes was statistically insignificant. In all the specimens, the ostium of the third coronary artery was to the left and superior to ostium of right coronary artery. Edwards BS et al.[11] studied 305 necropsy specimens and reported the conus coronary artery arising independently from aorta in 45% of hearts. In 14-24% of specimens from patients under the age of 2 years conus artery arose from aorta independent of the right coronary artery, whereas in older patients it occurred in 41-63%. This suggests at the time of birth development of coronary arterial pattern is not completed. Uflacker[12] described a small branch may arise directly from right coronary sinus in an isolated ostium supplying the right ventricle infundibulum called as the third coronary artery. Joshi SD et al.[13] described the difficulties faced by radiologist to interpret images and cardiac surgeons during procedures like angiography, angioplasty and coronary artery bypass grafting in the presence of multiple ostia. Kaur D et al.[14] found that out of 77 heart specimens minute accessory coronary ostia for third coronary artery was observed in anterior aortic sinus in 12 specimens(15%).

Development of semilunar valves and sinuses, coronary vasculature and its ostia are dependent on the interaction between endocardial derived and neural crest cell derived tissues.[15] The physiological development of the embryonic coronary arteries has been explained by two theories. Outgrowth theory is budding of the endothelial aortic sinus running towards the adjacent tissue. Ingrowth theory explained by Bogers and Co-workers that before the appearance of coronary arterial orifices, the major coronary arteries are found in the walls of aortic sinuses stating ingrowth of arterial channels rather than outgrowth. Insufficient unification during ingrowth of third coronary artery and right coronary artery towards ascending aorta leads to separate orifices.[16] A study should be conducted in live subjects and investigated with help of CT for multiple ostia to confirm the association between anomalous ostia and related pathophysiological conditions. Individuals with multiple ostia are followed up regularly to look for any symptoms of angina and left ventricular dysfunction. The above process would be expensive and time consuming but will not lead to any kind of selection bias and will help to correlate between presence of multiple ostia and clinical symptoms.[17]

The present study has been compared with other studies as shown in Table 2.

Table 2: Comparison of incidence of third coronary artery with other studies

Studies	Incidence
Present study	10.2%
Dhobale MR et al.[4]	32%
Sirikonda P and Sreelatha S[6]	19%
Bharambe VK[7]	22%
Kalpana R[8]	24%
Lujinovic et al.[9]	32%
Stankovic I and Jesic M[10]	34.8%
Olabu BO[3]	35.1%
Edward BS et al.[11]	45%

Conclusion

Third coronary artery takes part to perfuse apical and septal area by anastomosing with branches of left anterior descending artery. Hence considering third coronary artery during cardiac interventions is very much necessary.

The knowledge on third coronary artery plays a major role in the interventional cardiology and coronary surgery.

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