

Multiple Variations of Coronary Arteries – An Anatomic study: A Case Report

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ABSTRACT

Numerous variations in the coronary arteries have been recorded and published by many authors, but in spite of it, newer ones are being found and are being reported. In this article, a spectrum

of variations in the coronary arteries and their main branches like the additional anterior and the posterior interventricular branches, one new anastomosis and a new mode of termination of the right coronary artery have been reported.

Key Words: Coronary arteries

INTRODUCTION

The myocardium of the heart is supplied by a pair of coronary arteries which arise from the ascending aorta. As the arterial supply to the myocardium is very critical for the normal functioning of the heart, the variations which exist in its branches are gaining importance, more so, because of the angiographic procedures and the numerous bypass surgeries which are being done.

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

The literature review showed the following reported variations on the coronary arteries and their branches. The important variations in the origin of the posterior interventricular artery (PIV) was studied, which was from the right coronary in 80% and from the circumflex in 20% of the specimens which were studied [1]. Another author reported 2 PIV arteries in a balanced type of heart [2]. The anomalous course and the branches of the human coronary arteries were described in one research [3]. The circumflex(CX) anterior interventricular arose separately from the aorta in 1.82% of the specimens [4]. Occurrence of the dual left anterior descending coronary artery by using CT findings have also been reported [5]. Didio (1967) described that the arterial and the ventricular rami of the coronary arteries were identified by fine dissection in 54 adults, which had no communication across the coronary sulcus [6]. The largest anterior ventricular rami was observed to be the right marginal one [7].

The origin, length, lumen dia and the right and left dominance of the coronary arteries were studied and the length of the RCA was found to be 7 cm and that of the LCA was 1.35cm. In 60% of the specimens, right dominance and in 23.33%, left dominance was observed [8]. Reports on many AIV and PIV are also there [9]. The variation in the length and different types of terminations of the right coronary artery at the right margin, or at the crux were studied in 81 human hearts after the injection and in 88.8% hearts, it was found to terminate distal to the crux and was also long [10]. Reports on abnormalities like both coronary arteries arising from the common stem, CX and AIV originating separately and AIV bifurcating into two branches have all been reported in the standard text books

like Gray's Anatomy [11]. Anastomoses in the coronary arteries were found to increase in conditions like myocardial hypertrophy, valvular diseases and anaemia. This was observed in an injection study which was done in 1050 human hearts [12]. There were also reports on the origin of CX from the right sinus of the Valsalva and of it having a retroaortic course. CX arising from the RCA ostium, single RCA and the origin of RCA and LCA from the pulmonary trunk have also been published [13]. In another study, the coronary artery anomalies were studied and classified and the conception for a normal coronary artery has been given [14].

Although numerous data on the variations of the coronary arteries have been reported, further exploration in this field would still enrich the knowledge on them and it is also essential in view of their great clinical significance.

MATERIAL AND METHODS

While dissecting formalin preserved human cadaveric hearts, we came across some variations in one of them, both in the main trunks and in the branches of both the right and left coronary arteries.

All the vessels were looking very much dilated and tortuous and were seen deeply in the myocardium. The lumen diameters of the main trunks of the specimens which were under study, were measured by using digital vernier calipers and they were tabulated. The arteries of 6 normal hearts were also taken up for the study, just for comparing the data with the abnormal ones. The luminal dia and the length of the right coronary artery (RCA), the left coronary artery(LCA), the circumflex (CX), the anterior interventricular (AIV) and the posterior interventricular (PIV) were all measured and recorded [Table/Fig 1].

The length of the anterior and posterior segments of the right and left arteries, (RCA, LCA, AIV, PIV and CX) were also measured by using an inch tape in the specimens which were under study. The heart with an anomalous arterial pattern was cleaned and all the branches of the right coronary artery and the left coronary artery and their branches and the existing anastomoses between them were all analysed in detail and recorded. The courses of the RCA and the LCA were also noted. All these details in the coronary arteries were studied in 6 normal hearts for comparison.

Name	Total length (in cm)	Length of Ant Segment (in cm)	Length of Post Segment (in cm)	Lumen diameter normal heart in cm	Lumen dia of specimen under study (in cm)
RCA	11	5	6	.294	.274
LCA	1.5			.254	.307
CX	10	3	7	.2	.23
AIV	10	–	–	.198	.202
PIV	9	–	–	.212	.128

[Table/Fig-1]: Dimensions of Coronary arteries and their branches

RCA - right coronary, LCA - left coronary, CX - circumflex, AIV - anterior interventricular, PIV - posterior interventricular.

OBSERVATIONS

Variations

All the branches had thick walls and tortuous courses.

The right coronary artery (RCA) was giving 4 posterior interventricular branches (PIV) and all the 4 were seen running parallel to each other [Table/Figs 3 and 5].

The left coronary (LCA) was giving two terminal branches as usual, the anterior interventricular (AIV) and circumflex (CX) arteries. But



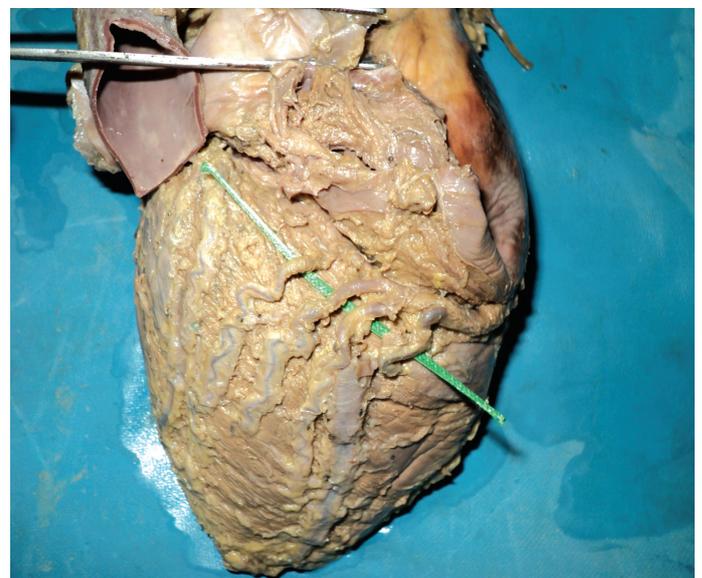
[Table/Fig-2]: Three Anterior interventricular branches



[Table/Fig-3]: RCA giving 4 PIV branches and ascending and terminating in left atrium CX descending



[Table/Fig-4]: CX descending and anastomosing with AIV Branch (green pointer)



[Table/Fig-5]: Parallel PIV branches (green pointer) from RCA

the (AIV) – divided into 3 terminal branches [Table/Fig 2] – one of them anastomosed with the posterior interventricular after curving around the apex. Another AIV – coursed diagonally and anastomosed with the terminal descending part of the CX branch near the left margin [Table/Fig 4]

The circumflex artery was not seen in the left posterior atrioventricular groove, but it descended on the posterior surface of the left ventricle and did not anastomose with the right coronary artery. But instead, it anastomosed with the left diagonal branch of the AIV artery.

The right coronary artery crossed the crux and without anastomosing with the circumflex, ascended on the posterior surface of the left atrium and ended by piercing it [Table/Fig 3].

DISCUSSION

Measurements

The measurements of the normal hearts were compared with that of the abnormal hearts. The length of the LCA was slightly more in the specimen (3mm) [Table/Fig 1] The length of the AIV in the normal hearts was 10 – 13 cm and it matched our data. The RCA in our abnormal specimen had a length of 11 cm (both the anterior

and posterior segments) and it was equal to that of a normal right dominant heart (12 to 14cms). In the normal ones, it reached upto either the crux or the left cardiac margin and in the abnormal ones, it was found to ascend on the left atrium and to terminate in it and hence the data matched.

Lumen Diameter: This was almost equal for RCA and AIV, but for LCA, the lumen diameter was found to be 0.5 mm more in the abnormal specimen. For the posterior interventricular, it was 0.84 mm less than the normal artery, probably because of the presence of 4 PIV branches instead of a single one.

Variations in the Branching Pattern

While analyzing and comparing the branching pattern in the existing variations, a maximum of 2 PIV branches have been reported so far, but in this case, 4 flanking PIV branches, all arising from the RCA, were seen. Out of four PIV arteries, one curved around the cardiac apex and anastomosed with one of the AIV branches of the LCA.

So, as we reported, both the AIV and the PIV arteries were more than 2 in number in our specimens, unlike in other studies, where only one of them was reported to be duplicated. A maximum of 2 AIV branches and only 3 PIV branches have been reported so far in the literature.

The third variation, where the anterior interventricular arose by the common stem and then trifurcated into the left diagonal and the 2 anterior interventricular branches, has also not been reported so far. As per the text books, the 2 branches may arise separately or the conus artery may arise separately and can be called the 3rd coronary artery. (Gray's anatomy—39th edition)

The RCA was shown to have 3 types of termination, at the crux, at the left margin, or at the right margin of the heart [5]. In this specimen, an entirely new type of termination was noticed. The RCA crossed the crux and without anastomosing with the CX, was seen to ascend and enter the posterior surface of the left atrium, a type which has also not been described henceforth in the literature.

The variation where the CX terminated as few posterior left ventricular branches and the last one of this, which was the continuation of the circumflex artery which anastomosed with the left diagonal branch which arose from the anterior interventricular at the left margin of the heart, is also quite a rare type of variation and has not been recorded so far. As per the other reports, the CX was described to terminate at the crux normally and to end by anastomosing with the RCA.

The following variations in the branches of the coronary arteries were shown in the existing records, the CX arising from right coronary ostium, the presence of a single coronary artery, the right and left coronary arteries arising from the pulmonary trunk, etc.(13). But the occurrence of new additional branches (AIV and PIV), one new anastomosis between the CX branch and the AIV branch, and the anomalous oblique ascending course and the termination of the RCA on the posterior surface of the right atrium, were observed in this cadaveric heart and to our knowledge, all these have not been documented so far. Not much change was observed in the dimensions of the vessels, except for a small increase in the luminal diameter of the LCA (0.5mm) and a decrease in the PIV (0.84).

As any new anastomosis is said to be indicative of hypoxia, occlusive coronary artery disease, valvular disease of the heart and anaemia (12), our finding is very significant, as these anastomoses help in detecting the disease if the diagnosis is done with prior knowledge of such reports. The knowledge of such anomalies helps in an early diagnosis and also in guiding the surgeon in identifying such variations and in correcting them surgically if needed. Each reported anomaly should be analyzed critically to prevent errors in the diagnosis. As many normal subjects also possess such variations, all these anomalies are important in order to prevent complications in the cardiac procedures and they serve as an index of existing anomalies, even in normal cases.

Even though numerous anomalies and a very high percentage of variations in the branching pattern of the coronary arteries have been reported in earlier studies, ours showed a few additional ones apart from the existing ones. These are of great clinical importance and value, as the indication for coronary artery surgeries and the prognosis of such occlusive diseases are dependent on such additional new intercoronary anastomoses. Such reports would help in preventing diagnostic errors and in the interpretation of such anomalies if they are present, in many investigative procedures like angiograms.

REFERENCES

- [1] Nerantzis CE, Lefkidis CA, Smiroff TB, Devaris PS. Variations in the origin of the posterior interventricular artery with respect to the crux cordis and the posterior interventricular groove-An anatomical study. *Anat.Rec.* 1980 ;252(3):413-17.
- [2] Das H, Das G, Das D C, Talukdar K. A study of coronary dominance in the population of Assam. *J. Anat. Soc.India* 2010; 59(2):187-91.
- [3] Kumar K. Anterior interventricular artery replacing the left coronary artery with the absence of arterial anastomosis in the human heart. *J.Anat.Soc.India.* 2006; 55(1):42-44.
- [4] CavalcantiJS. Anatomic variations of the coronary arteries. *Arq Bras Cardiology.* 1995; 65(6):489-92.
- [5] Aggarwal P, Kazerooni EA. Dual left anterior descending coronary artery.CT findings . *AJR Am.J.Roentgenol.* 2008;191:1698-1701.
- [6] Liberato J.A. Didio. Atrioventricular branches of the human coronary arteries. *Journal of Morphology.*1967; 123(4): 397-403.
- [7] BaroldiG, Mantero O, Scomazzoni G. The collaterals of the coronary arteries in normal and pathological hearts. *Circulation.*1961;4:223.
- [8] Bhimalli S, Dixit D, Siddibhavi M, Shirol V.S. A study of the variations in the coronary arterial system in a cadaveric human heart. *World Journal of Science and Technology.* 2011;1(5):30-35.
- [9] James J. Anatomy of coronary arteries. New York;Paul Noeber.1961; 12-150.
- [10] Baptista CA, Didio LJ, Teofilovski-Parapid. Variations in the length and termination of the right coronary artery in men. *JPN Heart. J.* 1989 Nov; 30(6):789-98.
- [11] Standring S (Chief editor), Gray's Anatomy. In heart and great vessels. 39th ed, Edinburg, London. Elsevier, Churchill Livingstone 2005; 1014-18.
- [12] Zoll PM, Wessler S, Schlesinger MJ. Interarterial anastomoses in the human heart, with particular reference to anemia and relative cardiac anoxia. *Circulation* 1951; 4:797.
- [13] Schlesinger MJ. An injection plus dissection study of coronary occlusions and anastomoses. *Am.Heart.J.* 1938; 15:528.
- [14] Trivellato M, Angelini, Leechman R. Variations in the coronary artery anatomy; Normal versus abnormal. *Cardiovasc. Dis.* 1980; 7(4): 357-70.

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