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Case Report

ANOMALOUS BRANCHING PATTERN OF CORONARY VESSELS

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ABSTRACT
Anatomical variations in relation to coronary artery and its branches will help cardiac surgeons for refining imaging techniques and coronary artery bypass grafting. The knowledge of variant anatomy may be of paramount importance to anatomists for variant anatomy and to cardiac surgeon for proper diagnosis and treatment of cardiac ailments including radiologists to refine image interpretation. Anomalous branching pattern of left coronary and left coronary predominance was observed in this study which is an important variant with clinical significance.

Keywords: *Median Artery, Intermediate Artery, Coronary Vessels, Anomalous Artery*

INTRODUCTION
Rate of coronary-artery-related diseases is increasing by leaps and bounds in modern times. The anatomy of coronary artery has recently been reemphasized in association with the use of coronary arteriography. The advances made in coronary arterial bypass surgeries and modern methods of myocardial revascularization make sound and complete knowledge of the normal and variant anatomy of coronary artery indispensable and imperative. Thus the variant cardiac anatomy is of paramount importance for proper understanding and management of cardiac diseases. The heart is a highly differentiate blood vessel, with developed muscular walls. The vascular nutrition of myocardium is complex, with a number of anatomical normal variants that can involve even extracardiac vessels, such as bronchial, mammary and mediastinal arteries. The coronary arteries are conductive vessels running through the epicardial surface of the heart, embedded in adipose tissue, and showing short segments of mild penetration into the myocardial tissue. Knowledge of physiology, normal and variant anatomy, and anomalies of coronary circulation is an increasingly vital component in managing congenital and acquired pediatric heart disease. Congenital, inflammatory, metabolic, or degenerative disease may involve coronary circulation, and increasingly complex cardiac surgical repairs demand enhanced understanding to improve operative outcomes.

CASES
During the routine dissection in the department of anatomy during teaching first MBBS students it was observed that in a heart the left coronary artery main trunk trifurcated into anterior interventricular artery, median artery and common trunk dividing into left circumflex and marginal branch and further when the circumflex artery was traced it was observed that the posterior interventricular artery which usually a branch from right coronary artery in majority of cases was found arising from circumflex branch near the crux of heart which usually known as left coronary predominance.

DISCUSSION
Coronary anomalies are uncommon with a prevalence of 1%.
Early detection and evaluation of coronary artery anomalies is essential because of their potential association with myocardial ischemia and sudden death. In 65% of cases the posterior descending artery (PDA) is a branch of the RCA (right dominant circulation) (Robin Smithuis, 2008).
The Latin term *corona,* or crown, aptly describes coronary arteries that supply cardiac parenchyma with nutrient blood flow. Coronary arteries (most often 2) are normally the only vessels arising immediately above the free margin of aortic valve from the ascending aorta (Rajani singh, 2013).

Case Report

The heart is supplied by two coronary arteries, that is, right coronary artery (RCA) and left coronary artery (LCA). RCA originates from anterior aortic sinus at the root of the ascending aorta and LCA from left posterior aortic sinus at the root of the ascending aorta. RCA after arising courses between pulmonary trunk and right auricle then travels in right coronary sulcus, then winds round the inferior border of heart, then runs over the inferior surface, and ends by anastomosing with circumflex branch of LCA. LCA after coursing between pulmonary trunk and aorta divides into two branches left anterior descending and circumflex branch. The LAD courses in the anterior interventricular groove, giving rise to the anterior septal perforating branches as it extends toward the cardiac apex. Small branches may arise from the LAD and supply the anterior wall of the right ventricle. Diagonal branches arise from the LAD and course at downward angles to supply the anterolateral free wall of the left ventricle. The Cx coronary artery courses along the left AV groove, around the obtuse margin, and posteriorly toward the crux of the heart. This occurs in approximately 10% of patients. Atrial branches may arise from the Cx coronary artery and supply the sinus node in 40% of patients. Obtuse marginal branches arise from the Cx system to supply the posterolateral aspect of the left ventricle. In an estimated 70% of patients, a coronary branch (termed ramus medianus, intermedius, or intermediate branch) arises early off the left coronary system to supply an area between diagonal branches from the LAD and obtuse branches from the Cx.

The coronary arteries begin to develop in utero at the start of the third week of embryogenesis. The initiation of their development is considered to be the thickening of the myocardium in the ventricles and the subsequent need for increased vascularization of the growing heart. The arteries pass through several complex steps during their development in utero, some of which are unique to the development of the arteries in the coronary circulation. The steps include: vasculogenesis, angiogenesis, arteriogenesis and remodeling, which create the opportunity for variation to occur within the general arterial pattern although the basic coronary tree is present at the end of the vasculogenesis event. Research indicates that the arteries are apparent within the aortic sinuses before the openings of the coronary arteries become patent in the aorta, giving weight to the concept of the coronary arteries growing into the aorta, rather than forming as an out pouching from it. As the arteries grow towards the aorta, they do so as several vessels but only a single vessel on each side will penetrate through the aorta to become continuous with its lumen as a coronary artery. Due to the complex nature by which the coronary arteries develop in utero, variation is a common characteristic of the coronary anatomy (Elliot and Martin, 2012).

The heart gets bulk of its blood supply from the left coronary artery, which divides into two after a short course. Bifurcation is the rule. Left main becomes left circumflex and LAD in about in 85-90 %. Few men and women are blessed with three branches from LCA. The anatomical and physiological importance of this branching pattern is not well analysed in the literature. There could be few advantages of having a trifurcation instead of bifurcation (Venketesan, 2011).

- Left main impedence is less in trifurcation. This is due to the fact, left main empties into three distinct ostia rather than two.The combined cross sectional area of these three ostia confers a hydrodyamic advantage.
- The importance of any proximal LAD lesion in these patients, is negated by 33 % as two other vessels are there to take care the rest of the heart.
- A large Ramus usually supplies a vast area in the angle between LAD and LCX. This has a potential to protect against ventricular fibrillation during acute occlusion of LAD by providing electrical stability.

Disadvantage of Trifurcation!

It is also a fact, people with a large ramus may have a trade off by having a diminutive diagonal or OM.

A trifurcation with a small calibered ramus can often be a disadvantage, as it is prone for atherosclerosis since it restricts left main flow by venturi effect. (The first rule of atherosclerosis states its prone at branching points)

The anomalous origin and branching pattern of the left coronary artery (LCA) is more significant anatomical variation. Difficulties may occur in the diagnostic procedures, but recognition of the anomaly is essential for proper patient management, especially in patients undergoing evaluation for percutaneous coronary intervention, coronary artery surgery or prosthetic valve replacement. A high prevalence of

coronary artery disease was found in proximal vessels and especially at or adjacent to proximal points of branching (Kalpana, 2012).

Branchi: In a study described the termination of LCA varying between two or three branches with the most common pattern the bifurcation (64%). He also mentioned the possibility of the main trunk dividing into three or four branches (35% and 5%) respectively; these complimentary branches were termed as median arteries. The division of the main trunk of LCA is a controversial topic since Banchi's study; because contradictory data have been published regarding the frequency of bifurcation or trifurcation. Identification of the median artery is important clinically. Its area of distribution to the heart is small. In the absence of this artery the area is irrigated by the branches of LAD and LCx; so in the occlusion of LAD & LCx more area is affected. When this median artery (ramus intermedius) is present, its origin is frequently the site of narrowing.

Average LMCA length was 9.9 ± 4.15 (range 2–21 mm). Average angle of bifurcation between LCX and AIVA was found to be 69.3° ± 33.3° (range 14°–200°). The most frequent division of the LMCA is a bifurcation into the terminal LCX and AIVA. In 20/105 cases (19.0%) a trifurcation pattern was identified. Average cross-sectional areas at point of LMCA bifurcation were as follows for LMCA, LCX, and AIVA respectively: 12.4 ± 4.4 mm^2 (range 2.3–25.9 mm^2), 7.4 ± 3.5 mm^2 (range 1.2–23 mm^2), 8.5 ± 3.5 mm^2 (range 1.3–25.9 mm^2). Frequency of heart dominance was as follows for right dominant, left dominant, and codominant 85.7, 9.5, and 4.8%, respectively (Christensen *et al*. 2010).

PDA originated from the LCA was present in three cases (6%), and Cx originated from the RCA in 4 (8%). In one case (2%), the origin from both Cx and PDA could not be determined; this patient had Chagas' disease, the anatomy of the heart was completely altered, and the arterial histology was very similar to that of veins. Pattern of dominance was: right in 88% of the cases, left in 8%, and undetermined in 4%. Undetermined were both the case with Chagas' disease, and the case of duplicated PDA. Excluding the undetermined patterns, right was present in 91.5%, and left in 8.5% (Nordon, 2012).

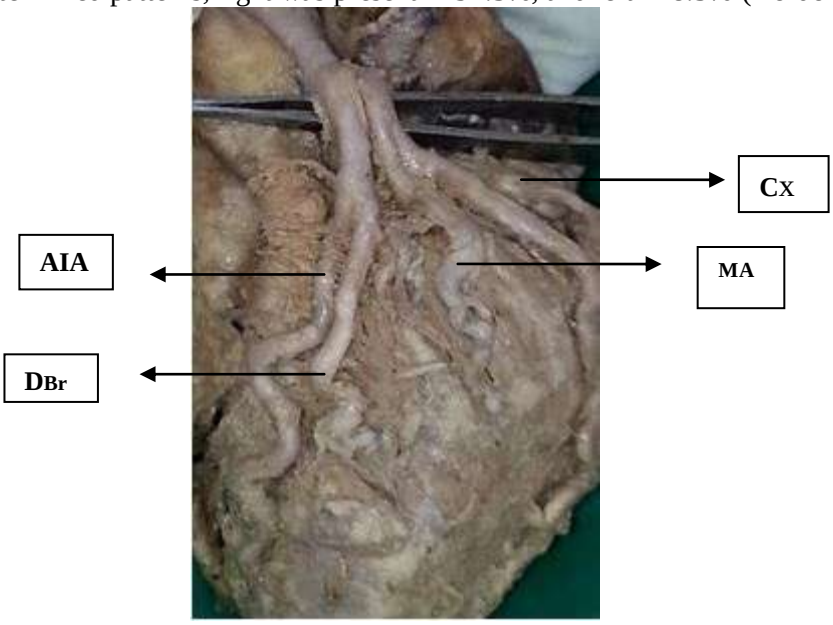

Figure 1: AIA: Anterior interventricular artery; Cx: Circumflex.A; MA: Median.A; DBr: diagonal branch.

Division of common trunk into anterior interventricular circumflex and median artery is a variation found between 25%-40% of cases. The caliber of median artery may on occasion be similar to that of the anteriorinteventricular artery or greater than circumflex artery. For this reason unlike certain hemodynamicswe should not solely focus our angiographic examination on search of lesions in normal branches but alos in median artery, since depending on its distribution it can be as dangerous as

involvement of other two arteries and sometimes depending on its distributional area median artery play an important role as collateral vessel in the deviation of the coronary circulation (Vilallonga, 2003).

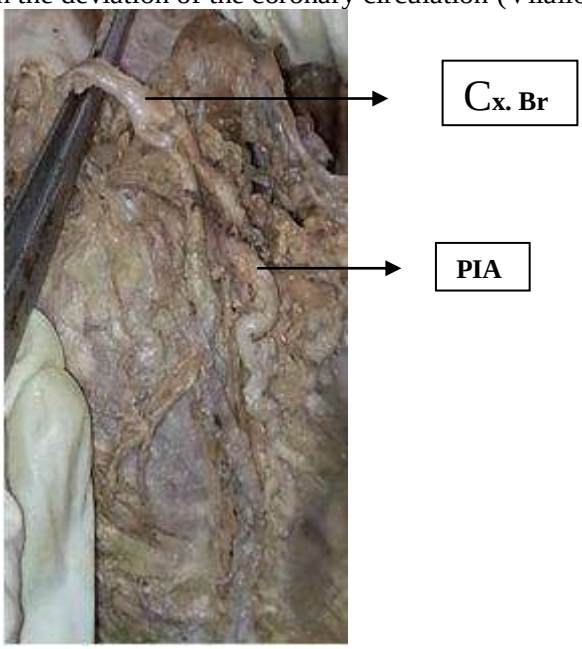

Figure 2: Cx Br: Circumflex.A; PIA: Posterior interventricular artery

Conclusion

Knowledge of coronary circulation is not only important for anatomists but also for radiologists and cardiologists performing angiographies and shunt surgeries, in diagnosis and treatment of congenital, inflammatory, metabolic and degenerative diseases involving the coronary arteries. The advances made in coronary artery bypass surgeries and modern methods of myocardial revascularization led to the reporting of present case where the left coronary is the major vessel taken up the burden of vascularisation of heart and anomalous branching pattern of this vessels itself is a matter of concern which has to be known by cardiologist to avoid undue effects.

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