

Incidence and distribution of anomalous coronary artery: analysis of 94 necropsy cases

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Abstract: *Introduction:* Present human cadaveric study was aimed to explore incidence and distribution of anomalous coronary artery. *Methods:* 10% formalin fixed ninety-four adult human hearts were studied in-vivo and in-vitro. *Result:* Incidence of anomalous coronary artery was 1.06%. There was anomalous course and distribution of left circumflex artery and posterior descending artery. Distribution of anomalous right coronary artery was right atrium, posterior surface of left atrium, right ventricle except a strip adjoining to the anterior interventricular groove, inferior surface of left ventricle, posteroinferior one-third of interventricular septum. Distribution of anomalous left coronary artery was left atrium except posterior surface, sternocostal and lateral surfaces of left ventricle, small strip of right ventricle, anterosuperior two-thirds of interventricular septum. *Conclusion:* The study findings suggest, radiologists and surgeons should be aware of anomalous origin and course of posterior descending artery as well as left circumflex artery. Variation of coronary artery knowledge is required for accurate reorganization and documentation during angiography and surgical interventions to avoid complications.

Keywords: Right coronary artery, Left coronary artery, Circumflex artery, Posterior interventricular artery, Anteriorinterventricular artery

Introduction

Variation of coronary artery is rare and ranges from 0.3% - 1.3%. The variation depends on the topography and on race [1-6]. In Indian populations the incidence is 0.95% [7]. The history of anomalous coronary artery report can be traced back in 1841 by Hyrtl [8], who was reported the absence of right coronary artery in a fetus of seven month old. Then onward many studies are being conducted on coronary arteries. Present review literature suggests that anomalous coronary artery knowledge is mandatory for angiography and surgical interventions [6-7,9-10]

Though many studies are exist on the coronary artery but human cadaveric studies are scanty except some case reports. Therefore present study was aimed to explore incidence and distribution of coronary arteries in human cadavers.

Material and Methods

10% formalin fixed ninety-four adult human hearts (63 male and 31 female, age ranged between 23-72 years) were studied. The study was done from 1999 to 2012 in the department of

Anatomy of Medical Colleges in India, Nepal, Netherlands Antilles and St. Lucia. In all cases researcher made every effort to study the case thoroughly and photographic evidence being kept (figure 1, 2 and 3).

Thoracic cavity was exposed as per the instruction of Romanes, (2003) [11]. After exposure of pericardium, all hearts were studied in-situ to explore any gross anomaly. There was no apparent anomaly observed. Individual heart was taken out by incised great vessels. Further dissection was made to clear off fat and connective tissue, to study individual coronary artery course and branching pattern. Anomalous course and distribution of individual coronary artery was carefully noted.

The study was done on the human cadavers, which were supplied for the undergraduate and postgraduate medical students study purpose. Hence, the study was not required to get ethical committee permission of the concern authority.

Results

There was presence of anomalous course and distribution of both coronary arteries only in one (01) human heart of 64 year old male. Rest of the 93 cadavers did not show any variation regarding origin, course and distribution of both coronary arteries.

Origin: The right and left coronary arteries were normal in origin from anterior aortic sinus and left posterior aortic sinus of ascending aorta respectively. The diameter of right coronary artery (RCA) was 4mm and left coronary artery (LCA) was 3mm at the proximal part (just after origin).

Course and Distribution: Right coronary artery was passing forward and to right in between right auricle and pulmonary trunk to reach atrioventricular sulcus and was descending vertically downwards to reach the right (acute) cardiac border and took a curve to approach the posterior part of the sulcus (Fig.1). Usually RCA anastomose with left circumflex (LCX) branch of LCA in the posterior part of the coronary sulcus after origin of posterior interventricular (descending) artery but in one case RCA was ending by supplying the diaphragmatic (inferior) surface of the left ventricle and posterior surface of the left atrium (Fig.2).

The posterior descending artery was originated from the first segment (part of the artery between origin and right margin of the heart) just after origin of right marginal artery at right anterior part of coronary sulcus. It was passing downwards to reach the inferior surface of the right ventricle, at the junction between anterior two-thirds and posterior one-third part. The artery was having oblique course to reach the posterior interventricular groove. It was supplying anterior two-thirds inferior surface of the heart and postero-inferior part of interventricular septum (anterior two-thirds). The posterior interventricular artery was terminating by anastomosing with anterior descending branch of left coronary artery.

There was presence of three branches before termination other than usual arterial and ventricular rami from the second segment (part of the artery between right border to the crux). One was supplying inferior surface of right ventricle,

other one was supplying posteroinferior part of interventricular septum (posterior one-third) and terminal branch was supplying posterior inferior surface of left ventricle (one-third) and posterior surface of the left atrium.

Hence, inferior surface of heart was supplied by posterior interventricular artery and terminal branches of the right coronary artery. Posteroinferior part of interventricular septum was supplied by two branches of RCA; one was from first segment and other one from the second segment (Table-I).

Fig-1: Posterior interventricular artery (PIA) anomalous course

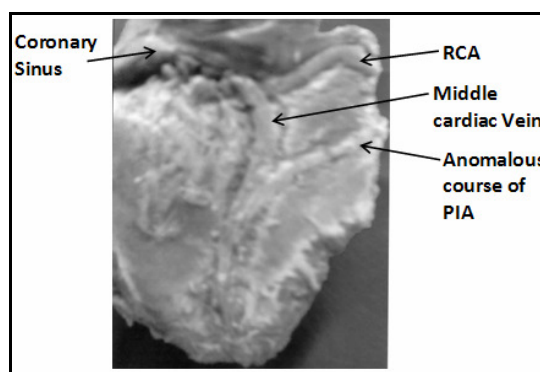
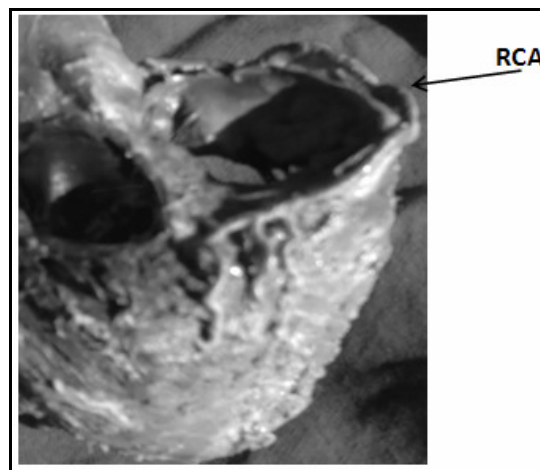


Fig-2: Distribution of right coronary artery



Left coronary artery was passing forward and overlapped by pulmonary trunk and auricular appendage, to reach the atrio-ventricular (coronary) sulcus. Normally LCA divides into 2-3 branches at the coronary sulcus. But in one case LCA was divided into two branches (Fig.3). One was passing downwards in the anterior interventricular sulcus, the anterior interventricular (descending) artery. Just after

passing around the apex anastomosed with posterior Interventricular artery. The anterior descending artery was supplying sterno-costal surface of left ventricle, adjacent part of the right ventricle and all most whole part (anterosuperior two-thirds) of interventricular septum. Other branch, after originating from LCA descends downwards along the left surface of heart, and was supplying anterior surface of left atrium and left surface of left ventricle which is considered as left circumflex artery (Fig3). Absence of LCX artery in the posterior half of the coronary sulcus was confirmed by further dissection. Therefore, posterior surface of left atrium and diaphragmatic surface of left ventricle were supplied by right coronary artery (Table-I).

Fig-3: Origin of left coronary artery and left circumflex artery

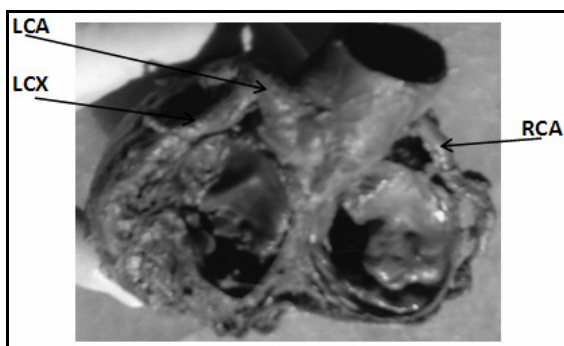


Table –I: Origin and distribution of anomalous coronary artery

Anomalous coronary art	Origin	Area of distribution
Right coronary artery	Anterior aortic sinus	Right atrium, posterior surface of left atrium, right ventricle except a strip adjoining to the anterior interventricular groove, inferior surface of left ventricle, postero-inferior one-third part of interventricular septum.
Left coronary artery	Left posterior aortic sinus	Left atrium except posterior surface and sternocostal and lateral surfaces of left ventricle, small strip of right ventricle, antero-superior two-thirds of interventricular septum.

Discussion

The incidence of anomalous coronary artery is more common in male than female [10], which agrees with present study result. Garg et al (2000) [7] in their angiographic study reported that incidence of coronary artery anomaly was 0.95% in Indian population whereas present cadaver study showed 1.06%. Susan et al, (2005) [12] described that diameter of LCA is larger than RCA and also supply greater part of the myocardium. Hence the term ‘dominant’ artery depending upon the origin of posterior descending artery is misleading. Present study showed RCA (4mm) and LCA (3mm) at their origin. Moreover, the area of distribution by RCA more than LCA and also posterior descending artery originated from RCA. Therefore in this case RCA was dominant artery in all aspects.

The right coronary artery terminal branch in spite of anastomosing with LCX, was supplying posterior surface of left atrium and inferior surface of left ventricle which differ from earlier studies [13-15]. Normally posterior descending artery gets origin from second segment of RCA on the right half of posterior atrioventricular groove and descends downward in the posterior interventricular groove [12]. In the present study 1.06% cases, posterior descending artery was originated from first segment of RCA just after origin of right marginal artery and took abnormal course on diaphragmatic surface of right ventricle to reach the interventricular groove which differs from earlier study [13]. The posterior descending artery was present only in the anterior two-thirds of the interventricular groove. There was presence of another small artery which was a branch of second segment of RCA on posterior one-third part of the groove. Presence of two branches of right coronary artery from different segments in the posterior interventricular groove not yet reported in literature in best of researcher knowledge.

The left coronary artery was normal in origin. There was variation in branching pattern and distribution (Table-I). The LCA was divided into two: anterior descending and left circumflex arteries. In 1.06% cases the LCX showed anomalous course which was passing

to the left surface on the wall of left ventricle, in spite of entering into the posterior part of coronary sulcus. The branching pattern of anterior descending artery was normal in all cases. The branching patterns of LCA in the present study differ from earlier studies [10, 14-18].

Certain factors are responsible for vascular anomalies: teratogenic chemical agents such as N-ethyl-N-nitrosourea, haemodynamic process, growth factors, genetic factor [19-20]. According to Nora and Nora (1978) [21], cause of cardiac anomalies are multi factorial. Cardiovascular anomalies becomes obvious when predisposing genetic factor (may be a single loci) interacts with environmental teratogens. Vasculogenesis and angiogenesis are the two processes by which coronary arteries are develop. The regulators of the coronary artery development are vascular endothelial growth factor, angiopoietins and their receptors, fibroblast growth factors and

epicardium-derived cells [22-24]. There should be presence of sufficient quantities of signal molecules and growth factors for the normal development. These signals should be recognized and interpreted by the developing and migrating cells [25]. Improper signaling and incorrect gradient may cause coronary artery anomalies.

Knowledge of anomalous coronary artery is necessary for clinical applications [6-7,10,15]. Based on these anatomical findings in the present study, it may be suggested that a surgeon or radiologist need to be aware of presence of posterior descending artery on inferior surface of right ventricle, two arteries in the interventricular groove and absence of left circumflex coronary artery in the posterior part of coronary sulcus to avoid fatal complications.

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