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Anatomical assessment of prevalence of origin of coronary artery in cadaveric hearts from Bihar region

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Abstract
The term right or left "Coronary Preponderance" or "Dominance" was used to show which coronary artery irrigates the heart's diaphragmatic surface, based on the origin of the 3 posterior interventricular arteries. Thus a region specific study of the coronary arteries would help both cardiac surgeons and radiologists in dealing better with the coronary heart disease. Hence the present study was planned to evaluate the origin of the coronary artery in cadaveric samples from Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya.
The present study was planned in the Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar. The study was performed from the duration of Dec 2018 to Jan 2019. The total 15 Normal hearts with age groups 20-70 years of both sexes were included, while hearts weighing more than 370 gms. in males and 280 gms. in females, heart specimens in cadavers of age more than 70 yrs. and less than 20 years, grossly abnormal hearts were excluded. Cadaveric Heart specimen was immersed in 10% formaldehyde to preserve it. The heart was dissected and the coronary arterial dominance was noted. Schlesinger's criteria was used to determine coronary dominance.
The above results prove that there are wide regional variations in dominance pattern. These variations should always be borne in mind for better cardiac care. Knowledge about the variations of coronary arteries is helpful for cardiologists and radiologists in performing various procedures like coronary angiogram, coronary angioplasty, and bypass grafting surgeries etc.

Keywords: origin, coronary artery, cadaveric hearts, Bihar region, etc

1. Introduction
The coronary arteries are the arteries of the coronary circulation, which transports blood into and out of the cardiac muscle. They are mainly composed of the left and right coronary arteries, both of which give off branches. Coronary arteries can also be categorized as epicardial (above the epicardium) and microvascular (close to the endocardium) [1]. The left coronary artery arises from the aorta above the left cusp of the aortic valve and feeds blood to the left side of the heart. It branches into two arteries and sometimes a third branch is formed at the fork, known as a ramus or intermediate artery [2]. The right coronary artery originates from above the right cusp of the aortic valve. It travels down the right coronary sulcus, towards the crux of the heart. There is also the conus artery, which is only present in about 45 per cent of the human population, and which may provide collateral blood flow to the heart when the left anterior descending artery is occluded [3, 4].
Either or both arteriosclerosis and atherosclerosis, can cause one or more of the coronary arteries or their branches to become seriously blocked, leading to angina, heart attack, or both. Percutaneous coronary interventions (such as balloon angioplasty) or coronary artery bypass surgery can be performed to decrease or bypass the blockages (respectively). The coronary arteries can constrict as a response to various stimuli, mostly chemical. This is known as a coronary reflex. There is also a rare condition known as spontaneous coronary artery dissection.
The 2 main coronary arteries are the left main and right coronary arteries [5].

- Left main coronary artery (LMCA). The left main coronary artery supplies blood to the left side of the heart muscle (the left ventricle and left atrium). The left main coronary divides into branches:
  - The left anterior descending artery branches off the left coronary artery and supplies blood to the front of the left side of the heart.
  - The circumflex artery branches off the left coronary artery and encircles the heart muscle. This artery supplies blood to the outer side and back of the heart.
- Right coronary artery (RCA). The right coronary artery supplies blood to the right ventricle, the right atrium, and the SA (sinoatrial) and AV (atrioventricular) nodes, which regulate the heart rhythm. The right coronary artery divides into smaller branches, including the right posterior descending artery and the acute marginal artery. Together with the left anterior descending artery, the right coronary artery helps supply blood to the middle or septum of the heart.

Coronary artery disease (CAD), also known as ischemic heart disease (IHD), involves the reduction of blood flow to the heart muscle due to build-up of plaque in the arteries of the heart. It is the most common of the cardiovascular diseases. Types include stable angina, unstable angina, myocardial infarction, and sudden cardiac death. A common symptom is chest pain or discomfort which may travel into

the shoulder, arm, back, neck, or jaw. Occasionally it may feel like heartburn. Usually symptoms occur with exercise or emotional stress, last less than a few minutes, and improve with rest. Shortness of breath may also occur and sometimes no symptoms are present. In many cases, the first sign is a heart attack. Other complications include heart failure or an abnormal heartbeat [6].

Limitation of blood flow to the heart causes ischemia (cell starvation secondary to a lack of oxygen) of the heart's muscle cells. The heart's muscle cells may die from lack of oxygen and this is called a myocardial infarction (commonly referred to as a heart attack). It leads to damage, death, and eventual scarring of the heart muscle without regrowth of heart muscle cells. Chronic high-grade narrowing of the coronary arteries can induce transient ischemia which leads to the induction of a ventricular arrhythmia, which may terminate into a dangerous heart rhythm known as ventricular fibrillation, which often leads to death [7].

Typically, coronary artery disease occurs when part of the smooth, elastic lining inside a coronary artery (the arteries that supply blood to the heart muscle) develops atherosclerosis. With atherosclerosis, the artery's lining becomes hardened, stiffened, and accumulates deposits of calcium, fatty lipids, and abnormal inflammatory cells – to form a plaque. Calcium phosphate (hydroxyapatite) deposits in the muscular layer of the blood vessels appear to play a significant role in stiffening the arteries and inducing the early phase of coronary arteriosclerosis. This can be seen in a so-called metastatic mechanism of calciphylaxis as it occurs in chronic kidney disease and hemodialysis (Rainer Liedtke 2008). Although these people suffer from a kidney dysfunction, almost fifty percent of them die due to coronary artery disease. Plaques can be thought of as large "pimples" that protrude into the channel of an artery, causing a partial obstruction to blood flow. People with coronary artery disease might have just one or two plaques, or might have dozens distributed throughout their coronary arteries. A more severe form is chronic total occlusion (CTO) when a coronary artery is completely obstructed for more than 3 months [8].

Cardiac syndrome X is chest pain (angina pectoris) and chest discomfort in people who do not show signs of blockages in the larger coronary arteries of their hearts when an angiogram (coronary angiogram) is being performed [9]. The exact cause of cardiac syndrome X is unknown. Explanations include microvascular dysfunction or epicardial atherosclerosis. For reasons that are not well understood, women are more likely than men to have it; however, hormones and other risk factors unique to women may play a role [10].

As of 2010, CAD was the leading cause of death globally resulting in over 7 million deaths. This increased from 5.2 million deaths from CAD worldwide in 1990. It may affect individuals at any age but becomes dramatically more common at progressively older ages, with approximately a tripling with each decade of life. Males are affected more often than females [11].

It is estimated that 60% of the world's cardiovascular disease burden will occur in the South Asian subcontinent despite only accounting for 20% of the world's population. This may be secondary to a combination of genetic predisposition and environmental factors. Organizations such as the Indian Heart Association are working with the World Heart Federation to raise awareness about this issue [12]. Coronary artery disease is the leading cause of death for both men and women and accounts for approximately 600,000 deaths in the United States every year. According to present trends in the United States, half of healthy 40-year-old men will develop CAD in the future, and one in three healthy 40-year-old women. It is the most common reason for death of men and women over 20 years of age in the United States [13].

The term right or left "Coronary Preponderance" or "Dominance" was used to show which coronary artery irrigates the heart's diaphragmatic surface, based on the origin of the 3 posterior inter ventricular arteries. Thus a region specific study of the coronary arteries would help both cardiac surgeons and radiologists in dealing better with the coronary heart disease. Hence the present study was planned to evaluate the origin of the coronary artery in cadaveric samples from Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya.

Methodology

The present study was planned in the Department of Anatomy, Anugrah Narayan Magadh Medical College, Gaya, Bihar. The study was performed from the duration of Dec 2018 to Jan 2019. The total 15 Normal hearts with age groups 20-70 years of both sexes were included, while hearts weighing more than 370 gms. in males and 280 gms. in females, heart specimens in cadavers of age more than 70 yrs. and less than 20 years, grossly abnormal hearts were excluded. Cadaveric Heart specimen was immersed in 10% formaldehyde to preserve it. The heart was dissected and the coronary arterial dominance was noted. Schlesinger's criteria was used to determine coronary dominance [14].

The hearts were examined as per the general principles of anatomy. The coronary arteries were observed after removing visceral pericardium. The coronary arteries and their branches were dissected on the surface of the heart in the atrioventricular and inter ventricular grooves. By micro dissection the epicardium was removed, and coronary arteries were observed.

Approval of the institutional ethical committee was taken prior to conduct of this study. Following was the inclusion and exclusion criteria for the present study.

Inclusion Criteria

All the heart specimens were randomly selected. Normal hearts with no obvious gross anomalies were considered for the study.

Exclusion Criteria

The cadaveric hearts with lesions because of accidents/trauma and those hearts having gross congenital anomalies were excluded from this study.

Results & Discussion

Considering clinical significance of coronary arterial dominance, number of studies has been conducted all across the world till date. Different methods have been employed for the same. Dissection method is one of them and is considered to be better as compared with other methods by many of the Anatomists. In 1938, Schlesinger [4] considered the reference point indicating dominance consisted of determining which coronary artery supplied the posterior inter ventricular branch and which branches went beyond

the crux cordis. Other criteria's like lengths [15] of right coronary artery and left marginal artery, layout [16] of arteries at the apex of heart, length [17] of paraconal inter ventricular artery, number [18] of branches to ventricles are also stated in the literature.

The original concept of coronary artery predominance was based on which artery crossed the crux of heart which is the point where the coronary sulcus, atrio ventricular and inter ventricular sulci meet. If none of the arteries crossed the crux then heart was said to have a balanced circulation [19-20].

Table 1: Myocardial Bridges Occurrence

Myocardial Bridges	Males	Females	Total
Right Coronary Artery	3	2	5
Left Coronary Artery	7	3	10
Both	0	0	0
Total	10	5	15

Table 2: Number of Single myocardial bridge over right coronary artery branches

	Males	Females	Total
Right Marginal Branch	2	0	2
Proximal segment of RCA	2	2	4
Posterior inter ventricular Branch	0	0	5

Table 3: Number of Single Myocardial Bridges over left coronary artery branches

	Males	Females	Total
Left anterior descending Branch	2	0	2
Diagonal Branch	2	0	2
Left Marginal Branch	1	0	1
Circumflex Branch	0	0	0
Posterior inter ventricular branch	5	0	5

Table 4: Previous Reported Literature

Authors	Study Area	Right Coronary Artery (%)	Left Coronary Artery	Both Right & Left coronary Artery
Hussein Ali Fakhir *et al.* [21]	Iraq	76	13	11
Fazliogullari Z *et al.* [22]	Turkey	42	14	44
Fazlul Aziz Mian *et al.* [23]	Pakistan	60.5	19.5	20
Jose Roberto Ortale *et al.* [24]	Brazil	88	8	4
MA El Sayed [25]	Egypt	80	10	10
Hirak Das *et al.* [26]	Assam	70	18.5	11.5
Vasudeva Reddy J *et al.* [27]	South India	86.5	11.25	2.5

Posterior descending artery branch of the right coronary artery supplies part of the left and right ventricle, posterior portion of inter ventricular septum and AV node [28]. Coronary artery giving posterior descending artery branch is termed as the dominant artery. Eren *et al.* [29] in 2008, Koser *et al.* [3] in 2009 and Ozturk *et al.* [31] in 2011 have observed the right coronary artery as the most common dominant artery. Prevalence of the right coronary artery dominance was observed to be the most common dominance pattern in the present study a finding similar to others.

The RCA supplies the right ventricle (except a small region to the right of anterior inter ventricular sulcus), a small part of left ventricular diaphragmatic surface, right atrium, part of left atrium and postero-inferior third of inter ventricular septum. Thus obstruction of RCA in a RCAD heart will affect these regions of heart but much of left ventricle, left atrium and inter ventricular septum supplied by left coronary artery will remain unaffected.

LCAD is also found to be associated with increased prevalence of atherosclerosis and aortic stenosis. Myocardial bridges are predominantly found on branches of left coronary arteries and higher incidence of myocardial bridges is seen in LCAD hearts [32].

Dominance also plays an important role in inferior infarcts of the heart. Inferior wall infarcts although less extensive than anterior infarcts are more important as they can cause various degrees of atrio ventricular block in approximately 30% of cases. The dominant RCA usually supplies the atrio ventricular (AV) node. Therefore an inferior wall infarct caused by occlusion 9 of the RCA will have higher risk of AV block [33].

The branching pattern and distribution of coronary arteries have been studied by various workers in the past. Coronary artery disease is one of the most common causes of death due to changing dietary habits, sedentary habits, smoking etc, in developing countries like India. With the advancement of medical technology, the incidence of coronary angiography and coronary bypass surgeries, stunt, balloon angioplasty is also increasing.

Conclusion

The above results prove that there are wide regional variations in dominance pattern. These variations should always be borne in mind for better cardiac care. Knowledge about the variations of coronary arteries is helpful for cardiologists and radiologists in performing various procedures like coronary angiogram, coronary angioplasty, and bypass grafting surgeries etc.

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