

Research article - Basic and applied anatomy

Anomalous origin of the coronary arteries

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Abstract

The arterial supply of the heart is provided by the left and right coronary arteries, which arise from the ascending aorta immediately above the aortic valve. An anomalous origin of the left coronary artery from the right aortic sinus and vice versa is reported to be between 0.6% - 5.6% and is a clinically relevant congenital coronary malformation as it can lead to sudden death.

Coronary anomalies are a poorly understood topic in modern cardiology especially in developing countries like Tanzania. Anomalous origins of coronary arteries may cause potentially dangerous symptoms and even sudden death during strenuous activity. A cadaveric study in an unsuspected population provides a basis for understanding the normal variants, which may facilitate determination of the prevalence of anomalies and evaluation of the value of screening for such anomalies. The present study describes the normal and variant anatomy of coronary arteries in a Tanzanian population.

A total of 75 hearts were studied, where 77.3% of them were obtained from male cadaverous specimens. Results revealed that in 2.7% of the hearts the left and right coronary artery had originated from a common ostium in the left aortic sinus. These variations have been reported in several case reports and studies. However, there are no such extensive studies being conducted among Tanzanians. The present study was undertaken to shed more light on this topic and it provides a basis for understanding the normal variants, for determining the incidence of anomalies, and for evaluating the value of screening for such anomalies.

Key words

Coronary sinus, coronary ostium, coronary artery, myocardial ischemia, cadaver.

Background

Among the clinically relevant congenital coronary malformations is origination of the coronary ostium from wrong positions. Congenital coronary artery anomalies are said to be of major significance in clinical cardiology and cardiac surgery today due to their association with myocardial ischemia and sudden death (Pérez-Pomares et al, 2016). The biggest clinical challenge presented by congenital coronary malformations is understanding the variability of their functional repercussions (Angelini et al, 1999).

Coronary anomalies have been reported to be implicated in patient chest pain, sudden death, cardiomyopathy, syncope, dyspnea, ventricular fibrillation, and myocardial infarction (Angelini et al, 1999). Sudden death is thought to be associated with restriction of blood flow along the anomalous artery, causing myocardial ischemia and ventricular arrhythmias, especially when the anomalous coronary artery courses between the great vessels (aorta and pulmonary artery). For instance, an anomalous

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origin of the right coronary artery from the left coronary sinus has been implicated in sudden cardiac death (Ali et al. 2011)

These congenital coronary malformations are detectable by imaging modalities and, according to various definitions, their prevalence ranges from 0.21 to 5.79% (Pérez-Pomares et al, 2016). The incidence of congenital coronary anomalies is not only relevant for conceptual and educational purposes, but even more important for public health issues (Angelini et al, 2002).

Congenital coronary artery anomalies are some of the most confusing, poorly understood and neglected topics in cardiology, not only in the developed world but also in developing countries like Tanzania. Therefore, to understand these anomalies, a cadaveric study in an unsuspected population may provide a basis to facilitate in the determination of the prevalence and evaluation of screening for such congenital anomalies. In fact, failure to recognize coronary artery anomalies may lead to incorrect diagnosis or treatment, and this may lead to unfavorable or even fatal outcomes.

Methods

A descriptive, laboratory based, observational study design was used, whereby 75 hearts from male (N = 58) and female (N = 17) human cadavers were studied. The age ranged from 30 to 60 years (mean \pm standard deviation = 45 ± 15 years) Since the cause of death was not known for all the cadavers, cause of death was not taken into consideration under any respect. Any heart which was observed to have pathological and/or traumatic lesions or surgical procedures at the roots of ascending aorta or pulmonary trunk was excluded from the study. All specimens were normally embalmed (fixed in 10% formaldehyde solution, followed by ethanol and stored in glycerin solution with phenol crystals). The hearts were dissected, the pericardium around the root of the aorta was removed, and the origins of the left and right coronary arteries were studied. The ascending aorta was transversally sectioned approximately 2 cm above the sino-tubular junction, then the aorta was longitudinally opened at the level of the posterior aortic sinus (which is a non-coronary sinus) to enable the visualization and analysis of the left and right coronary ostia. Each finding was photographed and registered. Epi-info and SPSS-17 computer packages were used for analysis of the data. These packages were developed by Centers for Disease Control and Prevention in Atlanta, Georgia (USA) and SPSS (Hong Kong) respectively.

Results

The position of the left and right coronary ostia in the left and right aortic sinuses respectively were studied, 71 (94.7%) hearts had the left and right coronary arteries originating from the respective aortic sinuses. In two hearts (2.7%) the left and right coronary arteries had origin from a common ostium in the left aortic sinus, from which a common coronary arterial trunk traveled a short distance and then bifurcated into the left and right coronary arteries (Figures 1 and 2). One heart (1.3%) had both the left and right coronary arteries ostia in the left aortic sinus (Figure 3).

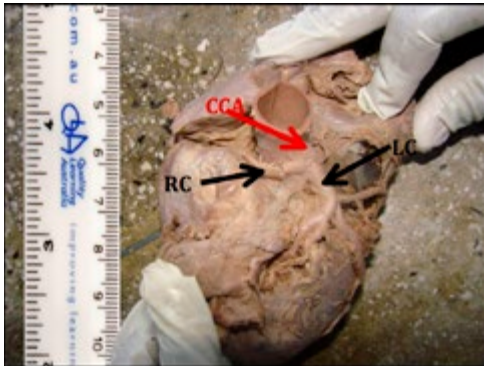


Figure 1. Photograph of a heart from a male cadaver showing common left coronary artery trunk giving out the left and right coronary arteries. CCA: common coronary artery trunk. LC: left coronary artery. RC: right coronary artery.

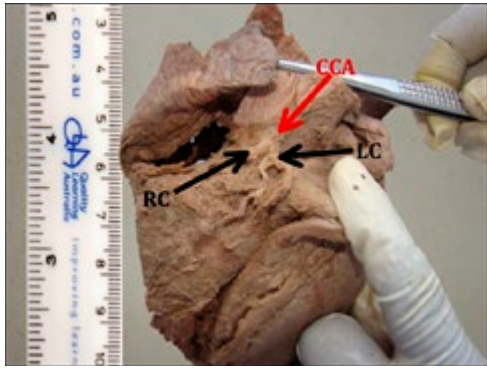


Figure 2. Photograph of a heart from a female cadaver showing a common left coronary artery trunk giving out the left and right coronary arteries. CCA: common coronary artery trunk. LC: left coronary artery. RC: right coronary artery.

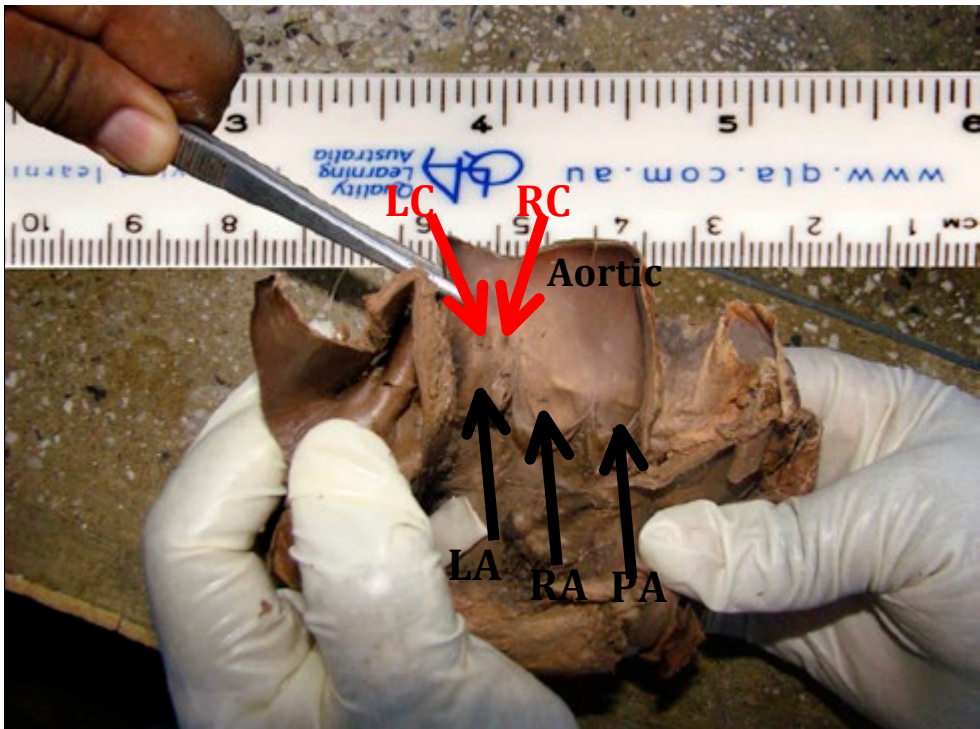


Figure 3. Photograph of a dissected heart from a male cadaver showing the anomalous position of the right coronary ostium in the left aortic sinus. LC: left coronary ostium. RC: right coronary ostium. LA: left aortic sinus. RA: right aortic sinus. PA: posterior aortic sinus.

Discussion

The finding of a common left coronary ostium in two cases and two separate ostia both located in the left aortic sinus in a further case suggest that the prevalence of anomalous origin of a coronary artery from the opposite sinus in a Tanzanian population is 4%.

Based on the number of specimens used in the present study, the incidence of anomalous origin of a coronary artery from the opposite sinus among Tanzanians can be estimated to be of the same magnitude as that reported in the literature. The prevalence of anomalous origin of the coronary artery in a large population of Chinese adults, estimated on the basis of dual-source CT angiography, was reported to be 3% (Modi et al., 2011). Frescura et al. (1998) found such a condition in 27 (2.2%) of 1,200 specimens studied. However, in a series of over six million military recruits in the United States, 21 (33%) of 64 cardiac deaths which occurred during extreme physical training were found to have occurred in subjects with such anomaly (Angelini et al., 2003). The differences in the prevalence of this anomaly among different populations might suggest that genetic factors may contribute to the variations in the origin of coronary arteries (Garg et al., 2000).

Given that 4% specimens were found to have an anomalous origin of a coronary artery from the opposite sinus and that Tanzanian population is of more than 45 million persons, there should be about 1.8 million Tanzanians carrying this anomaly, which is a remarkable number. If one concludes that this anomaly is a risk for cardiac death, therefore a good number of the 1.8 million Tanzanians who might be carriers of this anomaly would be expected to succumb to cardiac death related to anomalous origin of a coronary artery from the opposite sinus.

Conclusion

Anatomical variations in the position of the coronary ostia of the left and right coronary arteries are extremely important as they may contribute to myocardial ischemia and sudden death. Anomalous origin of coronary arteries have been reported in several case reports and studies. However, there are no such extensive studies among Tanzanians, which may be relevant on account of the significance of knowledge of the coronary arterial pattern in cardiac surgery and of the ever evolving and yet unexplored aspects of coronary artery anatomy and pathophysiology. The present study was undertaken to shed some light on this topic and provides a basis to the understanding of the normal variants, determine the incidence of anomalies, and estimate the value of screening for such anomalies. As it is shown from this study, congenital coronary artery anomalies exist in up to approximately 4 percent of all Tanzanians. Hopefully the results of this study will encourage other scientists to do more research on the variations in the origin of the left and right coronary arteries.

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