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A Preliminary Study on Anatomy of the Main Trunk of Left Coronary Artery in Sri Lankans

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Abstract: Morphological and morphometrical anatomy of coronary arteries remain to be of interest because of the high morbidity and mortality associated with coronary artery disease and due to recent advances in cardiac surgery, coronary angiography and angioplasty. The clinical impression of the diameter of coronary arteries to be smaller in Asians compared to Caucasians influence the likelihood of increase prevalence of coronary artery disease among Asians. We have investigated the morphology and morphometry of main trunk of left coronary artery (LMT). Forty adult fresh (postmortem carried out within 24 hours of death) adult human hearts of Sri Lankans were obtained at autopsies with no history of coronary artery disease or other heart disease. The aortic valve was opened to identify the location of the left coronary artery ostium. The main trunk of left coronary artery was exposed under 5X magnification using a dissecting microscope. The length of the LMT was measured with a vernier caliper and the number of its terminal branches and the branching pattern was studied. Luminal diameter of the trunk was taken at its midpoint using stereomicroscope. In all hearts the left coronary artery originated in the left coronary sinus and in majority of cases (31/40) the arterial orifice was below the supravalvular ridge. With regard to the type of division of LMT, it was absent in one case where anterior interventricular and circumflex branches originated directly from the left coronary sinus. The LMT terminated by dividing into 2-4 branches. The bifurcation of the LMT into anterior interventricular and circumflex branches was the commonest (30/40). The existence of additional branches (diagonal arteries) was present in few instances (9/40). This could decreases the effects of occlusion of the major two branches of LMT. The average length of the LMT was 8.33mm ± 3.7SD (range 1.8–23mm). Short LMT (≤5mm) was present in 13 % (5/39). The average diameter at its midpoint was 3.14mm±0.4SD (range 2.6–4.1mm). The short LMT need to be borne in mind during coronary perfusion and coronary angiography. The diameter of the LMT was similar to that reported in Indians (Male 3.7mm±0.7SD, Female 3.2 mm ± 0.6 SD) and comparatively smaller than Caucasians (4.86mm±0.8SD). The findings of present study has important therapeutic implication, since smaller coronary arteries may give rise to technical difficulties during coronary bypass graft, interventional procedures and vulnerability to myocardial infarction. Extensive studies need to be carried out to confirm the results

Keywords: Main trunk of left coronary artery, Morphology, Morphometry, Sri Lankans.

I. Background and Objectives

In recent years the rapid advances in cardiac surgery and coronary angiography have stimulated further interest in the study of coronary arteries. Those performing interventions require a thorough knowledge of the normal arrangement and likely anatomic variations of coronary arterial pattern. Studies around the world have revealed an increase coronary artery disease in people of

South Asian origin than Caucasians and this has been attributed to the relative small internal diameter of coronary arteries in South Asians [3, 6]. Although morphometry of left coronary artery is documented in Indian, Pakistani and Caucasian population [5, 7, 10, 11] the data on Sri Lankan population is scarce. The left coronary artery supply a larger area of myocardium and occlusion atherosclerosis in the left coronary artery leads to serious myocardial damage than occlusion in the right coronary artery [7, 10]. Therefore the present study was undertaken to analyse the morphological and morphometric characteristics of the main trunk of the left coronary artery (LMT) and its variations in adult Sri Lankan population and to compare the relative diameters with the documented other racial groups.

The morphometry and morphology of left coronary artery is essential for correct interpretation of angiographic data as well as for surgical manipulation.

II. Methodology

Forty fresh (postmortem carried out within 24 hours of death) Sri Lankan adult hearts were obtained from medicolegal autopsies performed at Judicial Medical Office, National Hospital, Colombo on cases of accidental death with no history of coronary arterial disease or any other heart disease. Hearts where cardiac anomalies were detected at autopsy were also excluded. The average age of the sample studied was 43.83years±15SD and the gender distribution was 23 females and 17 males. The hearts were removed from the thoracic cavity and the ascending aorta was cut 1 cm above the attachment of the semilunar cusps. Aortic valve was exposed by cutting through the commissure between the right and left coronary cusps to identify the orifice of the left coronary artery. Location of the left coronary ostium was studied in relation to the supravalvular ridge/sinutubular junction (Supravalvular ridge links the highest points of semilunar valve commissures and lies between the sinus and tubular portions of the aorta).

The main trunk of left coronary artery was dissected under 5X magnification using a dissecting microscope. Length of LMT was measured using a mechanical vernier caliper (with 0.02mm precision) and the branching pattern and number of branches from the main trunk was recorded. The main trunk of the left coronary artery usually divides into 2 branches, namely anterior descending and circumflex arteries. In the present study the branches originating from the exact angle formed by the two main branches were considered as additional branches and were named as diagonal branches.

For morphometric study, the specimens were fixed in 10% formaldehyde solution for 24 hours, as small arteries in fresh stage tend to collapse and make measurements more difficult [10]. Poruwalage, 2005 reported that the length and diameter of human renal arteries and their branches measured fresh without any preservation when compared to those preserved in 10% formaline solution for 24 hours had no significant difference ($p>0.05$) [9]. The luminal diameter of the LMT at its midpoint was measured using a Leica Mz6 stereomicroscope with eye piece graticules. Data obtained were tabulated and analysed using statistical package Minitab for Windows (version 14).

III. Results and Discussion

Location of the left coronary artery ostium: In all hearts, the left coronary artery originated in the left coronary sinus. The origin was below the supravalvular ridge in 31 (77.5%) (Figure 1), at the level of the ridge in 6 (15%), and above the ridge in 3 (7.5%) hearts (Figure 2a and 2b).

Length of left coronary artery: The distribution of length of LMT is shown in Figure 3. In one heart the left main trunk was absent (Figure 1) and the two main branches originated directly from the aortic sinus. This was not included in the graph. The average length of the main stem of the left coronary artery in 39 hearts was 8.33mm±3.7SD (range 1.8-23mm).

Diameter of left coronary artery: The mean diameter of the main stem of the left coronary artery was 3.14 mm±0.4SD (range 2.6–4.1mm) – Figure 4.

Type of division of left coronary artery: In 30 hearts (75%) the left coronary artery bifurcated into the anterior interventricular and the circumflex branch (Figure 5). In 8 hearts (20%), the left coronary artery showed a trifurcation (Figure 6). The complementary branch is the "diagonal artery" [10] and originated in the apex of the angle formed by the 2 terminal branches. In one heart (2.5%) two diagonal arteries were identified (Figure 7). In another heart (2.5%), the 2 branches of the left coronary artery arose directly from the aorta independently (Figure 1).

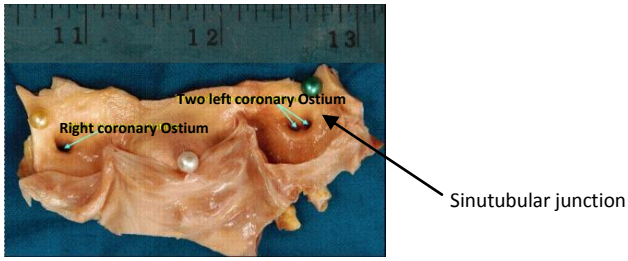
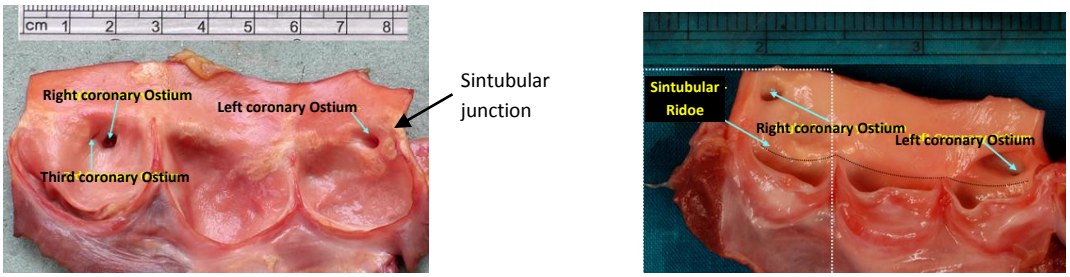


Figure 1: Location of coronary ostium below the sinutubular junction
(2 coronary ostia in the left coronary sinus)

Standard text books of anatomy generally describe that the left coronary ostium is situated in the left coronary sinus, below the supravalvular ridge [12]. Studies have categorized the location of the coronary ostium in relation to a visible ridge in the inner wall of the aorta, the supravalvular ridge. This ridge is the junction between the cylindrical ascending portion of the aorta and the aortic sinuses. They have found a variable incidence of the ostium below, at the level of and above the supravalvular ridge [2, 8, 11, 13]. Present study showed that majority of the left coronary ostium was located below the supravalvular ridge. This is in keeping with previous studies.



(a) (b)

Figure 2: Location of left coronary artery ostium.
(a) At the level of sinutubular junction (b) Above the sinutubular junction

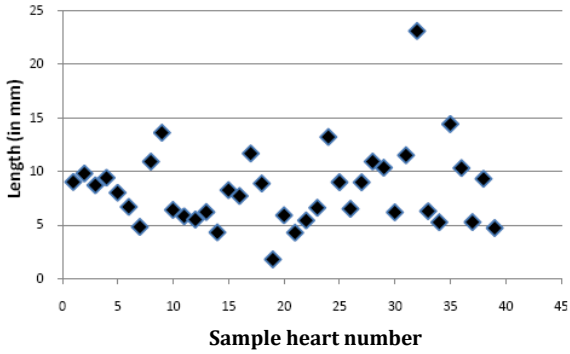


Figure 3: Distribution of length of left main coronary artery

The average length of LMT reported by Reig and Petit [10] for Western population is 10.8±5.52mm [10]. These values are higher than the results of present study for Sri Lankans (8.33mm±3.7SD). Considering the length of the LMT it can be divided into 3 categories; a short main trunk if it is ≤ 5 mm, a long main trunk if it is > 15 mm and a trunk of medium length (5-15mm). The results of present study show short main trunks in 5 out of 39 cases (13%). A long main trunk was found in 1 out of 39 cases (2%) and a main trunk of medium length 33 out of 39 cases (85%). Reig and Petit, 2004 [10] has reported a short main trunk found in 7.4% (7/95) hearts, a long main trunk in 18.9 % (18/95) and a main trunk of medium length in 73.7% (70/95) hearts of Caucasians. Green *et al.*, 1967 [4] reports that length in 48% of cases is ≤10 mm and in 24% ≤5mm in Caucasians.

One of the advances in aortic valve surgery is maintaining the perfusion through the coronary arteries by direct cannulation during valve replacement. It has been suggested that a short left main coronary artery or a wide angle between its two main branches may result in insertion of catheter into one of the terminal branches. This leads to ischaemia of the territory of the other branch which may cause ventricular arrhythmia and myocardial infarction. Also short LMT make carrying out coronary angiography more difficult because when the catheter is inserted into one of the terminal branches, the opacification of the other branch does not occur [10].

No association has been described between a long main trunk and types of pathology or technical complications.

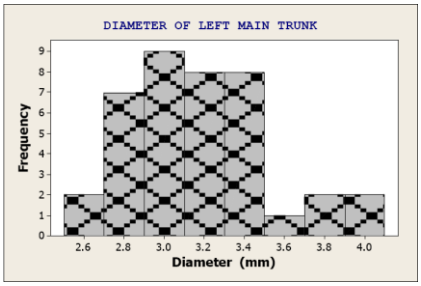


Figure 4: Distribution of diameter of the main trunk of left main coronary artery

The documented mean diameter of the LMT in the Western population is 4.86±0.8, ranging from 3-7mm [10]. The mean diameter of the main stem of the left coronary artery in the present study is lesser (3.14mm±0.4SD, range 2.6–4.1mm) than that reported for Caucasians. In Pakistan population the reported average diameter was 4.28mm±0.82 [5]. The conclusion of their study is that diameter of coronary artery in Pakistan population is similar to that of Caucasian. In West Indian population the mean diameter being 3.6mm, in males 3.7mm±0.7SD (range 3.0–5.5mm) and in females 3.2mm±0.6SD (range 2.5–4.5mm) [11], which is statistically smaller than that documented with Western population.

Studies have compared the diameter of coronary arteries between the Caucasians and South Asian immigrants to their country and concluded that diameter of coronary arteries are small in South Asians compared to Caucasians. They also indicated that coronary artery diseases are more extensive in people of South Asian origin and infarcts and cardiac failure are commonly associated with coronary arteries with relatively small internal diameter, but seldom found in hearts with larger coronary arteries [3, 6, 14].

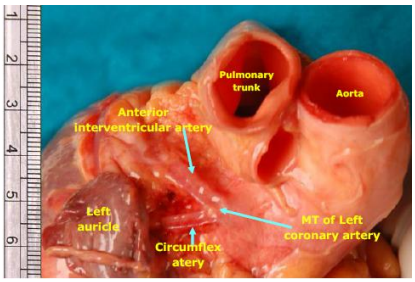


Figure 5: Bifurcation of main trunk of left coronary artery

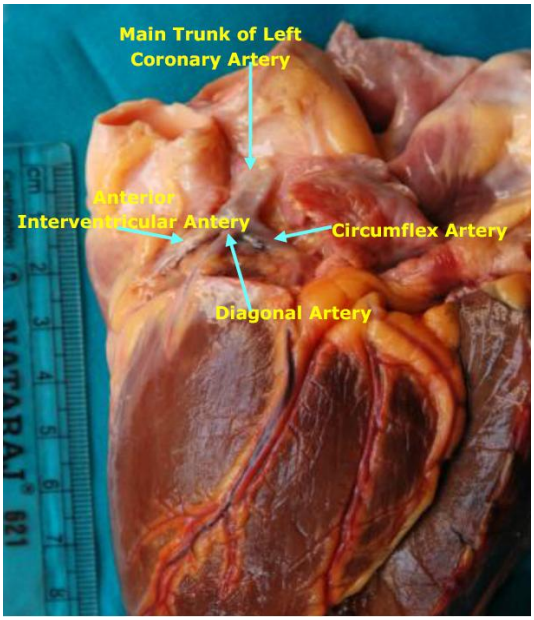


Figure 6: Division of main trunk of left coronary artery into three terminal Branches

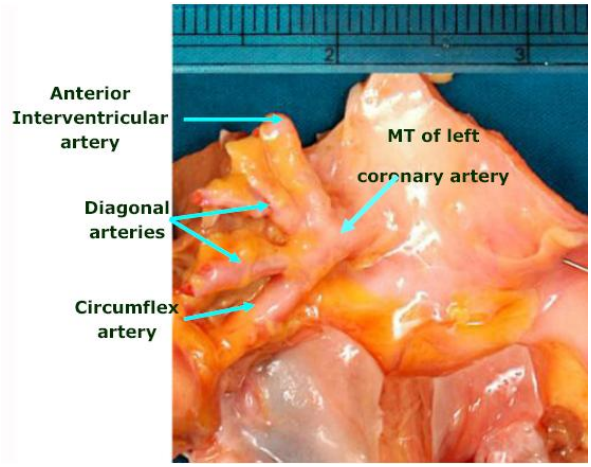


Figure 7: Division of left main trunk into 4 terminal branches

The division of the main trunk is a controversial topic because of the contradictory data published regarding the frequency of various types of divisions. This apparent discrepancy may be explained by the different criteria used to define the diagonal (additional) branches. Some authors consider the diagonal artery as the artery located at the exact angle formed by the two terminal branches [10]. Those originating within the initial millimeters of these branches are considered to be collateral branches. Others use a wider criterion, taking the diagonal artery as the one originating in the vertex of the angle formed by the terminal branches or their initial millimeters, provided it is of a sufficient size [1]. In our study, we have followed the stricter criterion as we felt that the wider criterion leads to some degree of subjectivity in the analysis of data.

It has been clear from the literature that bifurcation is the commonest type of division [1, 3, 4, 10] The identification of the diagonal artery may be of clinical importance because although its area of distribution is usually small, it irrigates areas that in the absence of trifurcation of the left coronary artery, are irrigated by the anterior descending and circumflex branches and its existence may decrease the effects of occlusion of the main arteries.

IV. Conclusion

In conclusion, the length of left main coronary artery prior to its division is particularly important because it may lead to improper coronary perfusion during surgical procedures and incomplete image of left coronary artery during coronary angiography. The presence of diagonal arteries may decrease the effects of occlusion of the main branches of left coronary artery, the anterior interventricular and circumflex arteries. Sri Lankans has smaller diameter of left coronary artery compared to Caucasians. This finding has important therapeutic implications, since smaller coronary arteries may give rise to technical difficulties during bypass graft and intervention procedures. Also in smaller arteries the development of atheroma may cause more severe effects than on larger diameter arteries. More extensive studies need to be carried out in Sri Lankan population to confirm these findings which definitely has much clinical relevance.

ACKNOWLEDGMENT

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