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Diameter of the Orifice of the Left Coronary Artery: Angiographic Study

Diámetro del Ostio de la Arteria Coronaria Izquierda: Estudio Angiográfico

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SUMMARY: The ongoing advances in the technology of coronary artery angiograms have put high demands on the basic knowledge of coronary arteries. This study describes the angiographic morphology of the ostium (orifice) of the left coronary artery among Sudanese with respect to sex, age, length, and BMI. The study design is a cross-sectional retrospective hospital-based conducted from 2014 to 2016. The inclusion criterion of participants is adult males and females presented to the cardiac centers for elective angiograms. The exclusion criteria are age below 18 years, documented congenital heart disease, and previous coronary bypass. Angiograms were done using a digital radiographic system. Data was collected through a predesigned data collection sheet. The data were entered and analyzed using SPSS v27. A test of correlation was done between the different variables. The data were presented in the form of tables. A P-value of <0.05 was considered statistically significant. The total number of participants was 441; males and females represent 42.9 % and 57,1 %, respectively. The mean age of participants was 56.24±8.68 years. The left coronary artery originated from the left aortic sinus. The mean diameter and length of the left coronary artery were 3.8±0.70 mm and 8.1576±4.32 mm, respectively. A significant negative correlation was reported between the diameter of the orifice and both age and length of the left coronary artery. A non-significant difference between males and females in the diameter of the left coronary artery at ostium (P=0.058) and a significant difference in the length (P=0.00). Sudanese have the smallest diameter of the orifice of the left coronary artery among Africans. Sudanese males have a smaller diameter of orifice than females; females have the longest arteries. A wider orifice of the left coronary artery is associated with a short arterial length.

KEY WORDS: Left coronary artery; Ostium; Orifice; Length; Diameter; Sudanese.

INTRODUCTION

The technology of coronary artery angiogram witnessed significant advances and became the mandatory and gold standard in the management of patients with coronary heart diseases (Alhassen *et al*., 2021). Thus the presence of basic knowledge about the angiographic anatomy of coronary arteries is essential in the management and during intervention maneuvers such as stenting, balloon dilatation, or graft surgery (Taha *et al*., 2015).

The left coronary artery (LCA) arises from the left aortic sinus posterior to the pulmonary trunk, and then it passes between the left auricle and infundibulum of the right ventricle to reach the coronary sulcus. On reaching the coronary sulcus, it divides into two terminal branches, circumflex and anterior interventricular arteries. The trunk of LCA is shorter and larger than the right artery. The LCA supplies almost all the left ventricle and atrium (Williams & Bannister, 1995; Sinnatamby, 2013). The ostia of the coronary arteries develop by apoptosis on the aortic sinuses; and the main trunk by ingrowth of endothelial vascular strands that originate from the peritruncal ring of coronary vascular plexus (Bernanke & Velkey, 2002; Ajayi *et al*., 2015). The absence or shortness of the LCA may indicate the fast ingrowth of the main branches and their subsequent

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attachment to the left aortic sinus (Ajayi *et al*., 2015). The LCA has great variability in origin, course (Ayalp *et al*., 2002; Alkhalifa & Omar, 2006), diameter and length (Alhassen *et al*., 2021; Ru *et al*., 2021).

Among Sudanese, about 71.7 % were right heart dominant, 23.5 % left dominant, and 4.8 % co-dominant (Taha *et al*., 2015). Alhassen *et al*. (2021) reported that the angiographic diameter of the LCA was 3.96±0.55 mm (in the range between 2.90 and 4.90 mm) (Alhassen *et al*., 2021). The average length of the artery was 8.16 ± 3.89 mm, and females had longer arteries than males (Alhassen *et al*., 2018).

Many factors can affect the morphology of the coronary artery, such as age, sex, body weight, body surface area, the weight of the heart, and ethnicity or race (Dodge Jr. *et al*., 1992). It was also reported that there is no correlation between the length of the LCA and its diameter (Alhassen *et al*., 2021). Sufficient arterial perfusion to the heart depends on the position, shape, and morphometry of coronary ostium (Kulkarni & Paranjpe, 2015).

Many diagnostic and therapeutic procedures and bypass surgeries are done worldwide. In addition to this, the globalization of health services and across margins seeking treatment has put high demands on the basic anatomical knowledge and reference values of the LCA for different ethnicities or races. However, the data available regarding the diameter of the left coronary ostia amongst the Sudanese population is very scarce and lacks data about angiographic anatomy. This study aims to describe the angiographic morphology of the ostium of the left coronary artery among Sudanese in relation to sex, age, length of LCA, and BMI.

MATERIAL AND METHOD

The study design is a cross-sectional retrospective hospital-based (Rezigalla, 2020). The inclusion criterion of participants is adult males and females presented to each of the three major cardiac centers for elective angiograms (cardiac center of Khartoum hospital, Sudan heart center, and Alzaytouna Specialist Hospital). The exclusion criteria are age below 18 years and a documented congenital heart disease or previous coronary bypass.

The angiograms were carried out under x-ray control and usually took about 20-30 minutes. The catheterization was done either through brachial or femoral arteries according to the patient's medical status. Angiograms were done using a digital radiographic system (TOSHIBA DFP/8000A). The angiographic measurements were done using standardized quantitative coronary angiography (QCA) software with electronic calipers (Fig. 1). All measurements were done uniformly during diastole after injection of contrast. For the left coronary ostia, the widest dimension was taken as the ostia diameter (DLCAO). The length (LLCA) was measured in contrast filled segments of the left coronary artery free of tortuosity.

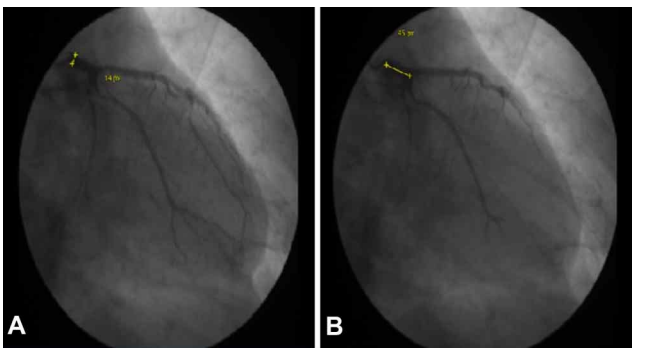

Fig. 1. Show measuring of left coronary artery ostia (A) and length (B).

Data were retrieved from 2014 to 2016. The retrieved variables were the origin, diameter of the orifice (ostia), length of the left coronary artery, and sociodemographic data. The sociodemographic data include age, sex, and body mass index (BMI). Data were collected from the records through a standardized methodology using a predesigned data collection sheet.

The study was ethically approved by the ethical board of the National Ribat University and the ethical committees of the three cardiac centers.

Data analysis. The retrieved data were entered and analyzed using SPSS v27. The data were presented in the form of tables. Correlation tests were done between the different variables, and a P-value of <0.05 was considered statistically significant. The confidence interval was set as 95 %.

RESULTS

The total number of participants was 441. Males and females represent 42.9 % and 57.1 %, respectively. The mean age of participants was 56.24±8.68 years. The mean age of male participants was 53.44±9.92 years, while that of females was 58.33±6.95 years (Table I). About 47.6 % of the participants were obese; meanwhile, 23.8 % were overweight, and only 19 % had normal BMI. The majority of females were obese (63.64 %) and represented 70 % of

the obese participants. Meanwhile, among males, 25 % were of normal BMI and the percentage overweight and obese among males is equally (37.5 %). Males represent 60 % of overall overweight.

In all the participants, the LCA originated from the left aortic sinus. The mean DLCAO among participants was 3.8±0.70 mm. While, the mean length was 8.1576±4.32 mm (Table I). A significant negative correlation was reported between DLCAO and both age (r=-0.33; P=0.00) and LLCA (r=-0.386; P=0.00). The DLCAO has a non-significant negative correlation with BMI (Table III).

Table I. Descriptive statistics of participants. DLCAO, diameter of the left coronary artery at the origin. LLCA, length of the left coronary artery.

	Descriptive Statistics				
	N	Minimum	Maximum	Mean	SD
Age (year)	441	43	68	56.24	8.68
DLCAO (mm)	378	2.00	4.90	3.8	.70252
LLCA (mm)	357	3.60	16.50	8.1576	4.32

Table II. Correlation between age, the diameter of the orifice, and length of the left coronary, and BMI of participants.

	Correlations			
		Age	DLCAO	LLCA
DLCAO (mm)	Pearson Correlation	-.331**	1	-.386**
	Sig. (2-tailed)	.000	-	.000
	N	378	378	357

*. Correlation is significant at the 0.01 level (2-tailed).

DLCAO, the diameter of the left coronary artery at origin; LLCA, length of the left coronary artery.

Table III. Descriptive statistics of male and female participants. DLCAO, the diameter of the left coronary artery at origin; LLCA, length of the left coronary artery.

	Descriptive Statistics			
	Males		Females	
	Number	Mean±SD	Number	Mean±SD
Age (years)	189	53.44±9.916	252	58.33±6.946
DLCAO (mm)	147	3.71±0.83	231	3.85±0.60
LLCA (mm)		6.7143±1.97318	210	9.17±5.16

Among male participants the DLCAO and length of LCA were 3.7±0.83 mm and 6.7±1.97 mm respectively. While among females DLCAO and length of LCA were 3.85±0.60 mm and 9.17±5.16 mm, respectively. On average females have a wider orifice and longer LCA than males. (Table III). Both male and females have a significant moderate negative correlation between DLCAO and both age and LLCA. Independent t-test showed no significant difference between males and females in regards to the DLCAO (P=0.058) and a significant difference in the length (P=0.00) (Table IV).

DISCUSSION

The mean age of the study group was 56.24±8.68 years. Females had the highest mean age (58.33±6.95) and represent the majority (57.14 %). Age is deliberated to be a risk factor for CHD (Genazzani *et al*., 2000). It was reported that over 40 % of CHD deaths are among people aged less than 75 years (Mirzaei *et al*., 2009). Females were reported to have more than a 10 % higher difference in mortality than males due to CHD (Keates *et al*., 2017); this report can justify the increased number of females in the study group. The BMI is a known risk factor for CHD (Umer *et al*., 2017; Powell-Wiley *et al*., 2021).

In the current study, the LCA of all participants originates from the left aortic sinus, and no acute angle takeoff was reported. This finding is in accordance with the previous work of Alkhalifa & Omar (2006). They found that about 3 % of the study group (270) had an anomaly in the LCA which were limited to the origin of the anterior descending branch (Alkhalifa & Omar, 2006). Anomalous origin of the LCA is less common and has more risk than the right coronary artery (Mery *et al*., 2018). The anomalous origin of coronary arteries is considered the second most common cause of sudden death among young athletes (Brothers *et al*., 2007; Angelini & Uribe, 2018).

Table IV. Correlation between age, the diameter of the orifice, the length of the left coronary, and BMI of males and female participants.

		Correlations							
		MALES				FEMALES			
		Age (years)	DLCO (mm)	LLCA (mm)	BMI (kg/m^2)	Age (years)	DLCAO (mm)	LLCA (mm)	BMI (kg/m^2)
DLCAO (mm)	Pearson Correlation	-.425**	1	-.516**	.008	-.480**	1	-.516**	-.069
	Sig. (2-tailed)	.000		.000	.919	.000		.000	.321
	N	147	147	147	147	231	231	210	210

DLCAO, diameter of the left coronary artery at origin; LLCA, length of the left coronary artery. BMI, body mass index.
**. Correlation is significant at the 0.01 level (2-tailed).

The majority of morphometric work on coronary arteries described the average diameter of the vessels. Some articles focused on the diameter of the orifice of the left coronary artery (Nasr & El Tahlawi, 2018; Luckrajh *et al*., 2019; Sirikonda & Sreelatha, 2021). In the current findings, the DLCAO among Sudanese is comparable to South African (3.87 mm) (Luckrajh *et al*., 2019), smaller than Egyptian (Nasr & El Tahlawi, 2018) as African races. Among African races, according to literature, Sudanese have the smallest diameter of the orifice of the left coronary artery, and Zambians have the widest (Silitongo *et al*., 2016). Worldwide, Sudanese are in the middle range to Indian (Kulkarni & Paranjpe, 2015; Sirikonda & Sreelatha, 2021) and smaller than Erubian (Köhler *et al*., 1981) and South Americans (Cavalcanti *et al*., 2003; Ballesteros & Ramirez, 2008).

In general, LCA was reported to have wider Ostia than the right (Silitongo *et al*., 2016; Thakre *et al*., 2017). Also, the ostial diameters are subject to differences in ethnicity and geographic location (Kulkarni & Mehta, 2012; Kulkarni & Paranjpe, 2015). These findings force cardiologists and coronary angiographer to know the average diameters of the LCA within each specific population, and also, the designing or selection of catheters should consider the ostial diameter (Nasr & El Tahlawi, 2018; Luckrajh *et al*., 2019).

The current findings reveals that among participants, a wider orifice of the left coronary artery is associated with the short arterial length and vice versa. Also, the advance in age leads to a decrease in the diameter of the orifice. Sudanese males have a smaller orifice diameter than females; females have the longest arteries. According to Bhele *et al*. (2017) classifications of coronary arteries length, Sudanese have long arteries. Using age as a fixed factor, an increase in age leads to a decrease in the orifice of the left coronary artery among all participants.

Study limitation. A Few sample sizes and limited literature included Sudanese participants.

Study strength. The multicentral study provides a reference value for the diameter of the orifice of the left coronary artery.

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RESUMEN: Los avances en la tecnología de los angiogramas de las arterias coronarias constituyen importantes exigencias al conocimiento básico de las arterias coronarias. Este estudio describe la morfología angiográfica del ostio de la arteria coronaria izquierda (ACI) entre los sudaneses respecto al sexo, la edad, la longitud y el IMC. El estudio es un diseño hospitalario retrospectivo transversal realizado entre 2014 y 2016. El criterio de inclusión de los participantes, hombres y mujeres adultos, fue aquellos que se realizaron angiografías electivas en los centros cardiológicos Los criterios de exclusión fueron: edad menor de 18 años, cardiopatía congénita documentada y bypass coronario previo. Los angiogramas se realizaron utilizando un sistema radiográfico digital. Los datos se obtuvieron a través de una ficha de datos prediseñada. Estos fueron ingresados y analizados con SPSS v27. Se realizó una prueba de correlación entre las diferentes variables. Los datos se presentaron en forma de tablas. Un valor P de <0,05 se consideró estadísticamente significativo. El número total de participantes fue de 441; Hombres y mujeres representanron el 42,9 % y 57,1 %, respectivamente. La edad media de los participantes fue de 56,24±8,68 años. La arteria coronaria izquierda se originaba en el seno aórtico izquierdo. El diámetro medio y la longitud de la arteria coronaria izquierda fueron 3,8±0,70 mm y 8,1576±4,32 mm, respectivamente. Se encontró una correlación negativa significativa entre el diámetro del ostio, la edad y la ACI. Además se encontró una diferencia no significativa entre hombres y mujeres en el diámetro del ostio de la ACI (P=0,058) y una diferencia significativa en la longitud (P=0,00). Los sudaneses tienen el diámetro del ostio de la arteria coronaria izquierda más pequeño entre los africanos. Los hombres sudaneses tienen un diámetro del ostio de la arteria coronaria izquierda más pequeña y las mujeres tienen las arterias más largas. Un ostio más ancho de la arteria coronaria izquierda se asocia con una longitud arterial corta.

PALABRAS CLAVE: Arteria coronaria izquierda; Ostio; Longitud; Diámetro arteria coronaria izquierda; Sudanés.

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