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Sex Differences in the diameter of coronary arteries

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Abstract

Coronary artery disease is a major cause of human mortality. It is stated that females have worse outcomes than men following myocardial infarction and coronary revascularization. Gender differences in the coronary artery diameters have also been speculated as one of the reasons for the above outcome. However, because of possible confounding effects, such as the body size and heart weight, it is unclear if there is a true sex-specific effect on coronary arterial size. The present study was undertaken to investigate the sex differences in the diameter of coronary arteries in a group of adult Sri Lankan population. The diameters of the coronary arteries and their branches were measured at predetermined sites in a total of thirty four apparently healthy hearts obtained from cadavers during routine gross anatomy dissections. All measurements were taken using a sliding caliper capable of measuring to the nearest 0.01mm. The mean coronary arterial diameters were significantly smaller in females than in males. These differences persisted even after the diameters of coronary arteries were corrected for heart weight and body surface areas. Precise knowledge of the expected normal coronary arterial diameter at a given anatomic location is the first step towards developing a quantitative estimate of the severity of the coronary artery disease. This study provides a reference data set for adult Sri Lankans against which to compare the diameters of coronary arteries in various pathological conditions.

Key words: Coronary artery, Sri Lankan, Gender differences

Introduction

Arterial blood supply to the heart is by two coronary arteries and their branches. The right and left coronary arteries arise from the aortic sinus at the beginning of the ascending aorta and then descend in the right and left atrio-ventricular grooves respectively. The anterior interventricular and circumflex arteries are the main branches of the left coronary artery whereas marginal and posterior interventricular arteries arise from the right coronary artery (Williams *et al.*, 2000).

It is often stated that females have worse outcomes than men following a myocardial infarction and coronary revascularization. The reasons for the above differences are likely to be of multifactorial origin, including the differences in size of the coronary arteries (Vaccarino *et al.*, 1995; Eaker *et al.*, 1989). There is evidence linking smaller dimensions of the coronary arteries to adverse cardiovascular events. For instance, in percutaneous revascularization, coronary arterial diameter is a strong predictor of restenosis (Mints *et al.*, 1996). Furthermore, in coronary artery bypass surgery, target vessel size correlates with long term graft patency (Fisher *et al.*, 1982). It is also known that in atherosclerotic plaque rupture, smaller lumen diameter increases the risk of total occlusion and myocardial infarction (Fuster *et al.*, 1992).

Several methods, such as, angiography, autopsy studies, intravascular ultrasound, have been occupied by various investigators to study the potential relation between the coronary artery dimensions and sex differences in prognosis of the coronary artery disease (Dodge *et al.*, 1992; Roberts and Roberts, 1980; MacAlpin *et al.*, 1973). However, it remains unclear whether sex differences in arterial dimensions simply reflect the effects of differences in body size or whether they are true sex-specific traits. Precise knowledge of the expected normal coronary arterial diameter at a given anatomic location is the first step towards developing a quantitative estimate of the severity of the coronary artery disease.

Therefore, the present study was undertaken to investigate the sex differences in the diameter of

coronary arteries in a group of adult Sri Lankan population. Such data will be valuable for the understanding of gender differences in coronary artery disease.

Materials and Method

This study was carried out on thirty four apparently healthy human hearts obtained from cadavers (22 male and 14 female) during routine gross anatomy dissections in the Department of Anatomy, Faculty of Medicine, University of Ruhuna, Galle, Sri Lanka. The age group of the cadavers varied between 48-67 years. Hearts weighing more than 370 g in males and 280 g in females were excluded from the study to avoid the possibility of hypertensive cases. The height and the weight of the cadavers as well as the weights of the hearts were recorded. Body surface areas were calculated using the method described by Dubois and Dubois, 1916 (DuBois and DuBois, 1916).

The diameters of the coronary arteries were measured at the following predetermined sites:

(i) Right coronary artery at its origin
(ii) Right coronary artery 2.5 cm away from the origin
(iii) Left coronary artery at its origin
(iv) Anterior interventricular artery 5 mm away from its origin
(v) Circumflex artery 5 mm away from its origin

The diameters were recorded using a digital sliding caliper (Mitutoyo, Japan) capable of measuring to the nearest 0.01 mm. All the measurements were repeated thrice and the mean was taken for further analysis.

Results were expressed as mean ± SD. Statistical analysis was performed using the t test. P value < 0.05 was considered statistically significant. To determine whether sex differences in coronary artery diameters are manifestations of differences in body size and heart weight, each measurement was divided by body surface area (BSA) and heart weight respectively and t test was repeated for the corrected values.

Results

Demographic characteristics of the male and female study group are presented in Table 1. The mean age, body weight and heart weights were not significantly different between the sexes. The mean height and body surface area were significantly smaller in females than in males.

Table 1. Characteristics of the study population

Characteristic	Male	Female
Age (yrs)	57.5 ± 12.5	57.0 ±10.8
Height (cm)	160.88 ± 4.22*	139.5 ± 10.47
Heart weight (g)	183.78 ± 68.29	150.69 ± 65.87
Body weight (Kg)	44.63 ± 7.52	40.25 ± 7.41
Body surface area (Kg/cm^2)	1.430 ± 0.10*	1.238 ± 0.14
Heart weight/body weight	4.134 ± 1.394	3.757 ± 1.566
Heart weight/Body surface area	128.34 ± 46.572	120.74 ± 47.606

Mean coronary arterial diameters are presented in Table 2. There was a definite trend in coronary artery diameters. Females showed a significantly smaller arterial diameters in both right and left coronary arteries compared to that of the males ($P<0.05$). Female coronary arterial diameters of the anterior interventricular and circumflex arteries were also smaller than that of the males although the differences were not statistically significant between the sexes ($P>0.05$).

Table 2. Coronary artery diameters

Coronary artery	Diameter (Male)	Diameter (Female)
Right coronary artery at its origin	5.99 ± 1.23*	4.73 ± 1.82
Right coronary artery 2.5 cm away from the origin	5.28 ± 1.45*	4.32 ± 1.92
Left coronary artery at its origin	4.79 ± 1.06*	4.12 ± 0.77
Anterior interventricular artery 5 mm way from its origin	3.96 ± 0.99	3.72 ± 1.18
Circumflex artery 5 mm away from its origin	3.94 ± 1.34	3.725 ± 0.78

Mean coronary arterial diameters after adjusting for body surface area and heart weight are presented in Tables 3 and 4 respectively. Females demonstrated smaller coronary arterial diameters than males even after normalization for body surface area and heart weight.

Table 3 Coronary artery diameters corrected for body surface area

Coronary artery	Diameter (Male)	Diameter (Female)
Right coronary artery at its origin	4.21 ± 0.94	3.79 ± 1.34
Right coronary artery 2.5 cm away from the origin	3.72 ± 1.09	3.45 ± 1.44
Left coronary artery at its origin	3.37 ± 0.77	3.38± 0.81
Anterior interventricular artery 5 mm away from its origin	2.79 ± 0.81	3.11 ± 1.30
Circumflex artery 5 mm away from its origin	2.79 ± 1.07	3.07 ± 0.87

Table 4 Coronary artery diameters corrected for heart weight

Coronary artery	Diameter (Male)	Diameter (Female)
Right coronary artery at its origin	0.037 ± 0.016	0.032 ± 0.005
Right coronary artery 2.5 cm away from the origin	0.032 ± 0.015	0.029 ± 0.006
Left coronary artery at its origin	0.029 ± 0.011	0.031 ± 0.014
Anterior interventricular artery 5 mm away from its origin	0.024±0.010	0.030 ± 0.018
Circumflex artery 5 mm away from its origin	0.025 ± 0.012	0.029 ± 0.013

Discussion

This study highlights the sexual dimorphism in coronary arterial diameters in a group of adult Sri Lankans. There was a definite trend in the diameters of the coronary arteries, i.e., the diameters were smaller in females compared to males. This result was consistent with the previous findings (Dodge *et al.*, 1992; Roberts and Roberts, 1980; MacAlpin *et al.*, 1973). It has been shown previously that the diameters of the coronary arteries are not affected by the age or the vessel tortuosity (Dodge *et al.*, 1992).

Body surface area and heart weight were shown to have a positive correlation with the size of the coronary arteries (Stuart *et al.*, 2000). However, results of the current study shows that after correcting for these two factors (body surface area and heart weight), coronary arterial diameters were still smaller in females though they have lost the significant sex differences. This suggests an association between coronary arterial diameter and sex that was independent of body surface area or heart weight. The sex-specific influence on coronary artery size, in turn, provides a possible explanation for the sex differences in coronary outcomes. Our findings are in agreement with results obtained from previous studies on coronary arterial dimensions (Roberts and Roberts, 1980; MacAlpin *et al.*, 1973; Kornowski *et al.*, 1997).The mechanisms that underlie the sex differences are unknown. It may be attributed to the differences in levels of hormones such as estrogen. Estrogen is known to affect the endothelial function and coronary vasomotion (Gilligan *et al.*, 1994). Identification of specific mechanisms for sex differences in coronary heart disease could lead to the development of novel therapies aimed at increasing the coronary artery size. Given that the size of the coronary arteries has prognostic implications, such therapies may hold the potential to improve outcomes of females with coronary artery disease.

The current study addressed only the major coronary arteries and proximal parts of their branches. Therefore, conclusions regarding the other branches of the coronary arteries and their distal parts are limited. In addition, this study was also limited by the lack of history regarding the presence or absence of coronary heart disease of the subjects. Further investigations should be performed to corroborate these findings.

Precise knowledge of the expected normal coronary arterial diameter at a given anatomic location is the first step towards developing a quantitative estimate of the severity of the coronary artery disease. This study provides a reference data set against which to compare the diameters of coronary arteries in various pathological conditions.

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