

SEX DIFFERENCES IN DIAMETER OF THE CORONARY SINUS OSTIUM: CORRELATION WITH WEIGHT OF THE HEART

Ominde Beryl S, Ogeng'o Julius A.

Correspondence to Dr. Beryl Ominde Department of Human Anatomy University of Nairobi, PO Box 30197 00100 Nairobi.

ABSTRACT

Diameter of the coronary sinus ostium is important in the designing of cannulation devices used in cardiac resynchronization therapy and percutaneous mitral valve annuloplasty. Population variation of the diameter may account for the failure rate of these procedures. Studies of the coronary sinus ostium from African populations are scarce and altogether absent for Kenya. Therefore, this study aimed at determining sex differences in the diameter of coronary sinus ostium and its correlation with the weight of the heart. Seventy-four hearts of adult black Kenyans [43 male, 31 females; age range 20 – 70 years] obtained during autopsy at the Department of Human Anatomy, University of Nairobi, Kenya were weighed. The coronary sinus ostium was identified and its transverse and supero-inferior diameters measured in millimeters. The measurements were analyzed using SPSS version 17. Sex comparison was established using student's t test. Association between diameter and heart weight was established using Pearson's correlation test and considered significant at a p-value of ≤ 0.05 . Data were presented using scatter plots. Transverse and supero-inferior diameters of the ostium were 11.04 ± 1.88 mm and 9.50 ± 1.80 mm respectively. The mean diameter was 10.27 mm. These correlated positively with weight of the heart. When corrected for weight of the hearts, the transverse and supero-inferior diameters were larger in females (0.042 and 0.036 respectively) than in males (0.034 and 0.03 respectively). The diameter of coronary sinus ostium is larger in females and shows positive correlation with weight of the heart. These data should be considered during design and use of cardiac devices introduced through the coronary sinus.

Key words: Coronary sinus, ostium, diameter, sex difference.

INTRODUCTION

The ostium of coronary sinus (CS) opens into the right atrium between eustachian valve and tricuspid annulus (Felle et al., 1994; Cascade et al., 2001). Knowledge of CS dimensions is important for invasive and interventional cardiac treatment and management tools for common cardiac disorders (Habib et al., 2009; Koragoz et al., 2013). Of these dimensions, CS ostium is a key structure in the heart from the electrophysiologist's point of view (Mlynarski et al., 2011). Further, measurements of diameter of ostium of CS may be useful in identifying the mechanism of tachycardia before invasive electrophysiology study (Ezhumalai et al., 2014).

Gender differences in heart disorders (Glomer et al., 2009) and CS blood flow rates (Zheng et al., 2013) suggest gender differences in dimensions of the ostium of CS. Morphometric data of CS from African populations is scanty and altogether absent for Kenya, though heart diseases that may require therapeutic and diagnostic intervention through the sinus are common (Yuko-Jowi, 2012; Watkins et al., 2012). Further, how the ostium diameters vary with gender and heart weight is not clearly established. Accordingly, this study aimed at describing sex differences in the CS ostial diameter and its correlation with heart weight.

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MATERIALS AND METHODS

This study was carried out at the Department of Human Anatomy, University of Nairobi. Ethical approval for the study was granted by the Kenyatta National Hospital-University of Nairobi-Ethics and Research Committee. Seventy four hearts of adults Kenyans (43 males; 31 females; age range 20 – 70 years) obtained during autopsy were studied. The chest cavity was opened through costal cartilages incisions, the sternum removed and pericardium incised longitudinally to expose the heart. Harvesting of the heart was done by dividing the great vessels 2cm from the superior extent of the heart's base. Heart specimens with any observable congenital defects, valvular vegetations, and cardiomegaly (above 450g) had been excluded from the study. The hearts were categorized according to sex and weighed in grams using an electronic weighing balance SF-00[®].

The ostium was identified as an oval opening of CS in the right atrial wall. The transverse and

supero-inferior (SI) diameters of the ostium were measured using a pair of dividers and transferred to a ruler [see figure 1]. Data were recorded, tabulated and analyzed using statistical package for social science (SPSS[®]) software Version 17.0, Chicago, Illinois and Microsoft Office Excel, 2007-Microsoft Corporation. Measurements were expressed in means and standard deviations. Association between various morphometric parameters was established using Pearson's correlation test. The diameters were standardized by dividing them with weight of heart. Using student's unpaired t-test, the standardized values obtained were used to compare sex differences. Student's t-test was used for comparison between SI and transverse diameters. A p-value of ≤ 0.05 was considered significant at 95% confidence interval. Tables and scatter plots were used for data presentation.

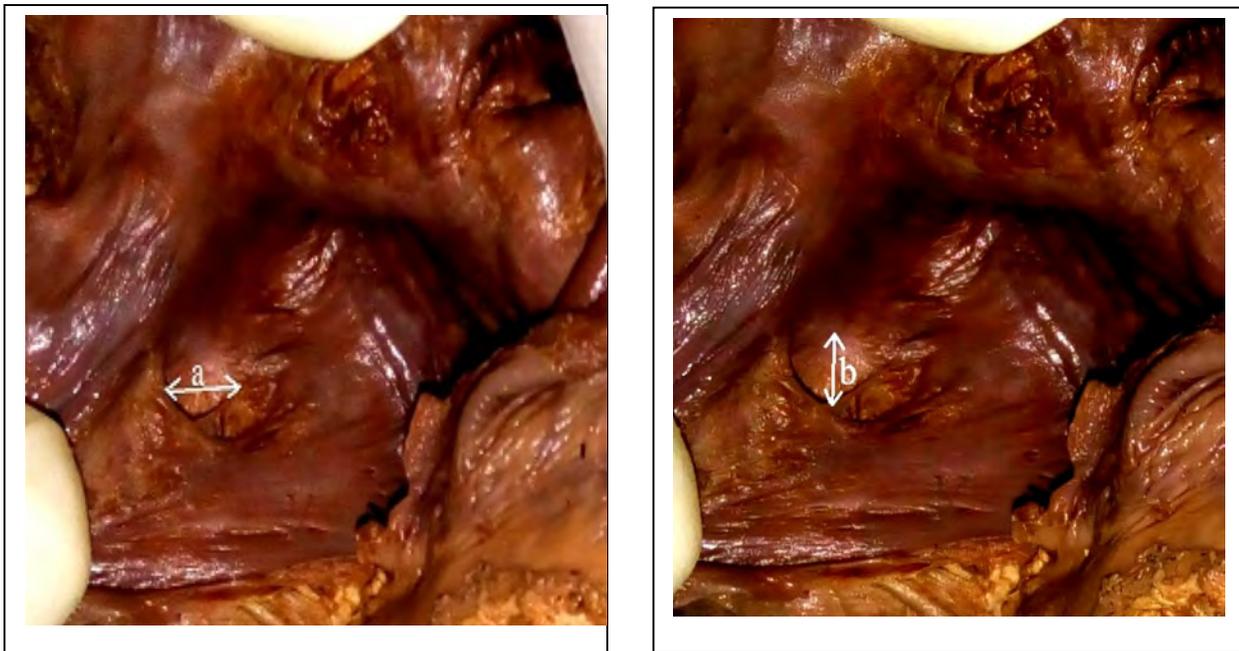


Figure 1. Coronary sinus ostium in the right atrium wall. a- transverse diameter, b-supero-inferior diameter.

RESULTS

In all cases, the CS originated at the point of confluence of great cardiac vein (GCV) and oblique vein of Marshall to terminate at the postero-inferior aspect of right atrium. The mean transverse diameter of the ostium was 11.04 ± 1.88 mm (range 8-15 mm); 11.07 ± 1.86 mm (range 8-15 mm) in males and 11.00 ± 1.94 mm (range 8-15 mm) in females ($p=0.876$). The mean supero-inferior (SI) diameter on the other hand was 9.50 ± 1.80 mm (range 6-15 mm); 9.58 ± 1.60 mm (range 7-13 mm) and 9.42 ± 2.06 mm (range 6-15) in males and females respectively ($p=0.705$). In both males and females, the transverse diameter was larger than the SI diameter ($p=0.004$ and 0.001 respectively). The mode values for transverse and SI diameters were 12 mm and 9 mm

respectively. The aggregate mean diameter was 10.27 mm. When the diameters of the ostium were corrected for weight of the hearts, the transverse and SI diameters were larger in females (0.042 and 0.036 respectively) than in males (0.034 and 0.03 respectively), giving a p-value of 0.001 and 0.014 respectively.

In females, the transverse diameter showed a negative correlation ($r = -0.171$) with the weight of heart ($p = 0.357$) while the SI diameter showed a positive correlation ($r = 0.205$) which was not statistically significant ($p = 0.269$). In males, both ostium diameters showed positive correlation with weight of heart ($r = 0.464$, $p = 0.002$ and $r = 0.175$, $p = 0.261$ respectively) [see figure below].

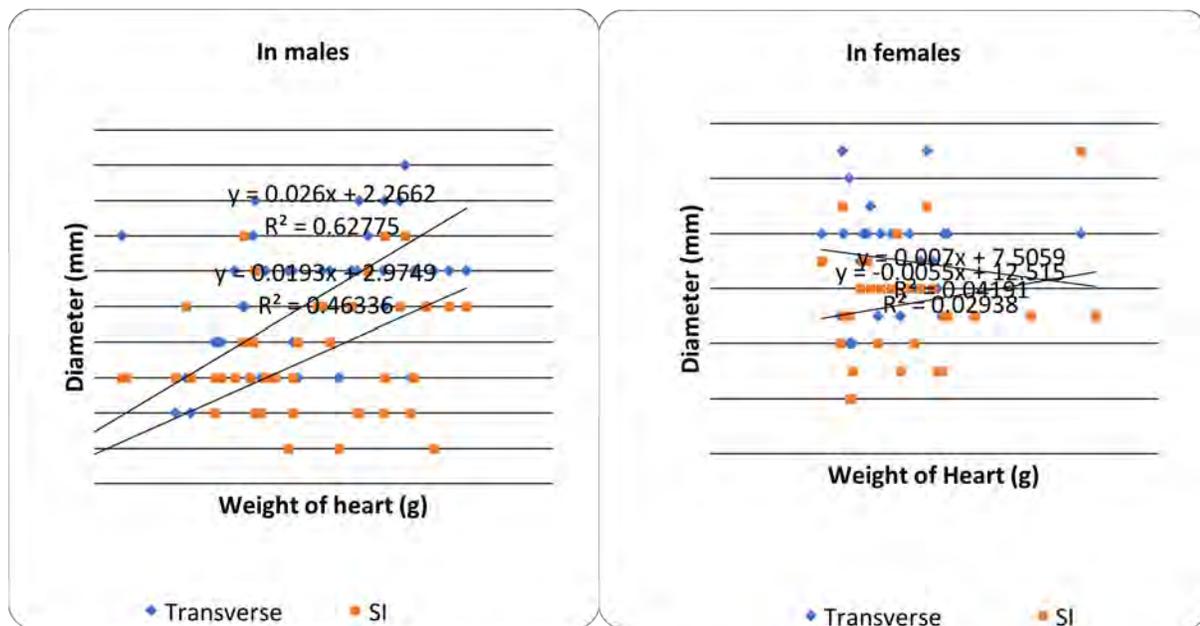


Figure 2: Correlation between ostium diameters and weight of heart

DISCUSSION

The mean diameter of CS ostium was 10.27 mm and the individual mean diameters for both genders revealed in the current study are within the range of 5 – 15 mm as reported by Habib et al (2009). The aggregate mean is comparable to 10.5 mm among the Japanese (Matsuyama et

al., 2010) but higher than 8.94 mm and 9 mm reported among Colombian and Austrian populations (Pejkovic et al., 2008; Ballestros et al., 2010). The mean transverse diameter and supero-inferior (SI) diameters of the ostium were 11.04 ± 1.88 mm (range 8-15 mm) and

9.50±1.80 mm (range 6-15 mm) respectively. This was higher than 6.6mm (3-15mm) and 8mm (3-15mm) reported by Pejko \acute{c} et al.(2008). Various studies reveal wide differences in CS ostial diameter. Although such

variations may be due to differences in methodology, comparison of findings from different studies that used similar methodology suggest that the ostium diameter varies between populations [Table 1].

Table 1: Diameter of coronary sinus ostium reported in various populations.

Reference	Populations	Diameter of Ostium (mm)	Method
Current study, 2016	Kenyan	10.27	Cadaveric
Pejko \acute{c} et al., 2008	Austrian	9	Cadaveric
Ballesteros et al., 2010	Columbian	8.94	Autopsy
Matsuyama et al., 2010	Japanese	10.5	Cadaveric
Doig et al., 1995	Canadian	8.5	Angiography
Lee et al., 2006	American	16.9	Venography
Plass et al., 2008	Swiss	9.9	Computed Tomography
Ezhumalai et al.,2013	Indian	9.9	Echocardiography
Canbay et al., 2009	Turkish	9.3	Angiography
Koragoz et al., 2013	Turkish	12.5	MDCT
Mlynarski et al., 2011	Russian	14.2	Computed tomography

The differences in body build affecting size of heart may account for this population variation (Anyanwu et al.2007). This implies that the design of cannulation devices should be based on the population.

The most remarkable observation of the current study is that when standardized using heart weight, females had significantly larger diameters ($p \leq 0.005$). This is at variance with findings of Kousorov and Ivanov (2005) which revealed larger ostium diameters in males. It is not clear whether they standardized their measurements before the comparison was made. Hoskin et al. (2009) determined CS ostium diameter using CT angiography and documented that CS ostium diameter is not significantly different between males and females. Observations of the current study

suggest that cannulation devices of similar diameters may not be applicable in both male and female subjects without major clinical consequences.

To demonstrate effect of heart weight on CS ostium diameter, Oliveira et al. (2007) reported a significant positive correlation between CS ostium diameter and heart weight in grams. Karaca et al. (2005) using formalin fixed cadaveric specimens also found that adult hearts weighing <300 g had a mean ostium diameter of 8.72 mm compared to 10.76 mm in those weighing >300 g. In the current study, the correlation between heart weight and ostium diameters in females was positive for the SI diameter ($r=0.205$). In males, both diameters increased with weight of heart. This suggests that catheterization is easier in heavier hearts.

In conclusion, the diameter of coronary sinus ostium is larger in females than in males and shows positive correlation with weight of heart. These data should be considered during design and use of cardiac devices introduced through the coronary sinus. The coronary sinus ostial diameters should be determined before introduction of the devices.

Conflict of Interest: There is no conflict of interest.

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