ORIGINAL COMMUNICATION

Anatomy Journal of Africa. 2015. 4(1): 488 – 495.

LENGTH OF CORONARY SINUS IN A BLACK KENYAN POPULATION: CORRELATION WITH HEART LENGTH

Beryl S. Ominde, Beda Olabu, Julius A. Ogeng'o

Correspondence to: Beryl S. Ominde, Department of Human Anatomy, University of Nairobi. P.O Box 30197, 00100, Nairobi. berylominde@gmail.com

ABSTRACT

Length of coronary sinus is important in the design of cannulation devices used in cardiac resynchronization therapy and percutaneous mitral valve annuloplasty. It displays gender and population variations that may account for the failure rate of these procedures. Cardiac conditions requiring these procedures are common in black African populations. Studies of the coronary sinus from African populations, however, are scarce and altogether absent for Kenya. The aim of the current study was to determine the length of coronary sinus among black Kenyans. Coronary sinuses of seventy-four hearts (43 males and 31 females) of adult age range (20-70years) black Kenyans obtained during autopsy were studied at the Department of Human Anatomy, University of Nairobi, Kenya. Heart samples were classified into male and female and weighed. Lengths of the heart, left atrio-ventricular groove and coronary sinus were measured in millimeters. The mean coronary sinus length was 39.55±5.32 mm while that of heart was 139.73±13.86 mm. The length of left atrio-ventricular groove length was 66.12±9.97 mm. The sinus occupied 60% of the groove and correlated positively with the length of the groove. The coronary sinus of the study population is shorter than those reported for Caucasian populations. The length correlated with that of the atrioventricular groove and the heart.

Key words: **Length, Coronary sinus, heart, black African.**

INTRODUCTION

Coronary sinus (CS), the major venous drainage of heart, is a large channel of blood lying on the left atrio-ventricular (AV) groove (Barcelo et al., 2004). It is formed at the point of confluence of oblique vein of Marshall and great cardiac vein (GCV) (Cascade et al., 2001; Chauvin et al., 2010). The sinus terminates at the postero-inferior aspect of right atrium (Cascade et al., 2001) between eustachian valve and tricuspid annulus (Felle et al., 1994). Its length varies with heart size, gender and between populations (Silver and Rowley, 1988; Kosourov and Ivanov, 2005; Anderson et al., 2009).

Coronary sinus is usually the focus of interventional electrophysiological approaches such as pacemaker lead placement for cardiac resynchronization therapy or radiofrequency ablation (Cappato et al., 1994; Sanders et al., 2004). In addition, introduction of CS annuloplasty devices for treatment of functional mitral valve insufficiency has increased the spectrum of application of tools being inserted into it (Block, 2005; Daimon et al, 2005).

Data on CS length from African populations is scanty and altogether absent for Kenya yet heart disease requiring invasive cardiac procedures are common (Yuko-Jowi,2012; Watkins et al., 2012). Further, how the dimensions vary with gender and heart size is not clearly established. Accordingly, this

study aimed at describing length of Coronary sinus in relation to heart length and that of AV groove.

MATERIALS AND METHODS

Eighty-nine hearts (51 males and 38 females) were available for this study at the Department of Human Anatomy. Fifteen were excluded from the study due to difficulty in identification of oblique vein of Marshall (7), observable pathologies of heart valves (4) and cardiomegaly, that is >450g (4). Seventy-four hearts (43 from males and 31 from females) of adult black Kenyans (age range 20-70 years) were therefore studied. The specimens were taken from normal hearts, namely those without any observable congenital defects, valvular vegetation and obvious cardiomegaly (above 450g). The Kenyatta National Hospital-University of Nairobi-Ethics and Research Committee granted ethical approval before commencement of the study. To access the hearts, the chest cavity was opened by incisions through the costal cartilages. The sternum was then removed carefully and pericardium incised longitudinally to expose the heart. Dividing the great vessels 2cm from the superior extent of the heart's base did harvesting of the heart.

The external length of heart was measured, in millimeters from the apex to base of heart at the midpoint between the entry of left and right superior pulmonary veins. Peri-vascular fat tissue was removed to expose the great cardiac vein (GCV) in the anterior inter-ventricular groove and its course followed towards the left side in the left atrio-ventricular (AV) groove. The beginning of the CS was determined at the point where GCV is joined by oblique vein of Marshall (Figure 1). The distance from this point to the CS ostium was measured to determine the full length of the sinus. The length of the left AV groove was also measured. Morphometric data were recorded in datasheets, tabulated and analyzed using SPSS® (Statistical package for social science) 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. Standardization of CS length was done by dividing this length with that of the heart and left AV groove. The Using student's unpaired t-test, the standardized values obtained were used to compare sex differences. A p-value of ≤0.05 was considered significant at 95% confidence interval. Tables scatter plots and bar graphs were used for data presentation.

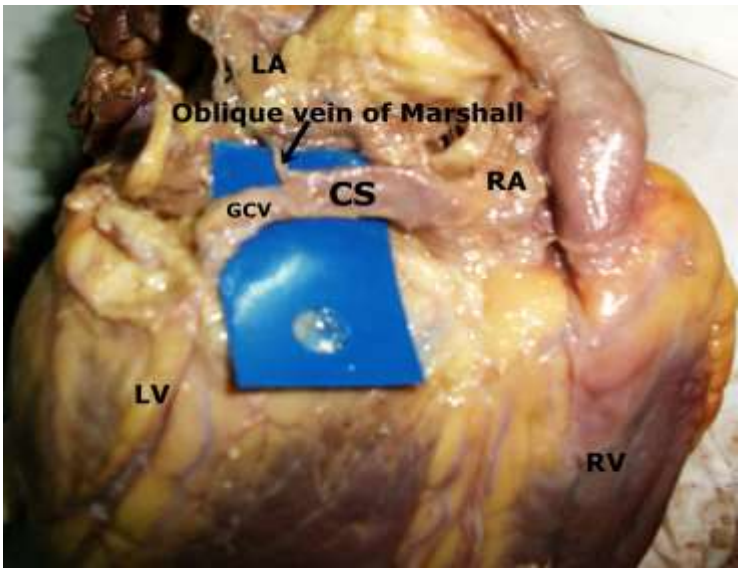

Figure 1 Photograph of heart showing the coronary sinus in the left atrio-ventricular groove.

Note that the coronary sinus is formed by the confluence of great cardiac vein (GCV) and oblique vein of Marshall. LA-left atrium, LV-left ventricle, RA-right atrium, RV- right ventricle.

RESULTS

In all cases, the CS was windsock-shaped originating 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. It coursed within the left atrio-ventricular (AV) groove and varied in morphometry depending on the region and sex.

Length of Coronary Sinus.

The mean length of CS was 39.55±5.32 mm, (range 20-53 mm); 39.63±6.60 mm (range 20-53 mm) in males and 39.45±2.80 mm (range 34-45 mm) in females (p=0.157). Fifty percent of the sinuses ranged between 36 and 40 mm (Figure 2).

Correlation between length of coronary sinus and external length of heart

The mean length of the heart was 139.73±13.86 mm (range 105-175 mm); 140.88±13.90 mm (range 105-172 mm) in males and 138.13±13.87 mm (range 105-175 mm) in females (p= 0.403). Length of CS showed a positive correlation with external length of heart (r=0.117, p=0.455) in males but no correlation between the two was observed in females (r=0.001, p=0.997) (Figure 3). When corrected for heart length, the CS length was comparable in females (0.288) and males (0.284) (p= 0.667).

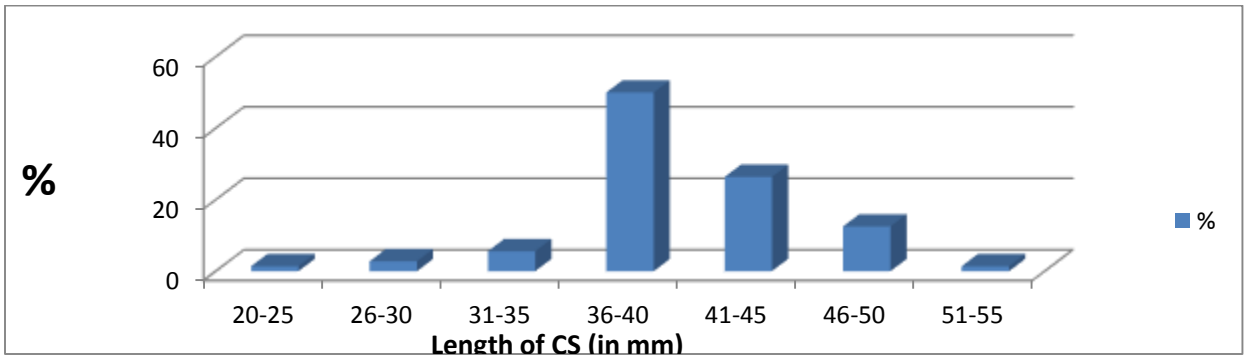

Figure 2: Distribution of length of coronary in a black Kenyan population

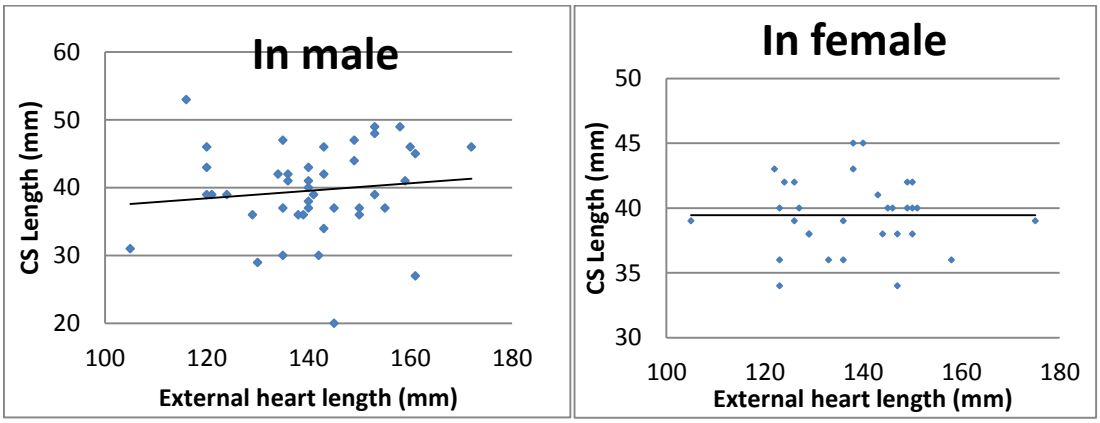

Figure 3: Average CS Length / Heart Length =0.284 (males) and 0.288 (females).

Correlation between coronary sinus length and left atrio-ventricular groove length

The mean length of left AV groove was 66.12±9.97 mm (range 46-94 mm); 66.35±11.01 mm (range 46-94 mm) in males and 66.16±8.75 mm (range 51-83 mm) in females (p= 0.819). The length of CS showed a positive correlation with that of left AV groove in both males (r=0.470, p=0.001) and females (r=0.364, p= 0.044 respectively) (Figure 4). The ratio of length of CS to length of left AV groove was 0.606 and 0.605 in males and females respectively (p= 0.962). In both sexes, the CS occupied 60% of the left AV groove.

CS Length/ AV groove length=0.606 (male) and 0.605 (female)

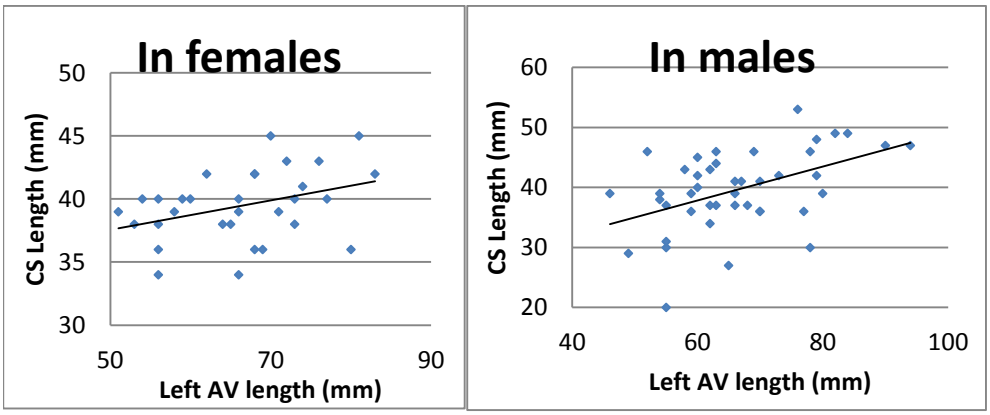

Figure 4: Correlation between coronary sinus length and that of left atrio-ventricular groove.

DISCUSSION

The complete coronary sinus (CS) was present in all cases, consistent with literature reports that absence or the unroofed variants are rare (Foale et al., 1979; Bergman et al., 1988; Kong and Ahmad, 2007). They are described in association with congenital heart defects (Raghib et al., 1965). In the present study, only normal hearts were used. Rationale use of these devices and procedures require knowledge of CS dimensions including absolute and relative length.

Length of Coronary Sinus

Observations of the current study revealed a mean length of 39.55 mm, within the reported range of 30-55 mm (Habib et al., 2009). It was however higher than 25.96±6.34 mm in a Columbian study where fresh autopsy specimen were used (Ballesteros et al., 2010) and lower than 108.9±18mm in the Swiss (Plass et al., 2008) (Table 3). The wide difference between findings of the current study and those of Plass et al. (2008) may be explained by differences in the nature of specimen and methodology used namely, *in vivo* measurements using computed tomography (CT) as opposed to formalin fixed cadaveric specimen used in the current study. El Maasarany et al. (2005) in a cadaveric study reported a mean length of 48.4±5.2 mm. This is higher than in the current study probably due to different landmarks used: from Vieussens valve of GCV to CS ostium as opposed to confluence of GCV and oblique vein of Marshall to CS ostium in the current study. Cascade et al. (2001), however, reports that the confluence of these veins is at the location of Vieussens valve.

It is evident that despite the methodological differences, CS length varies with population. For instance, using imaging, Doig et al. (1995) reported a length of 62.8 mm by angiography in a Canadian study while Plass et al. (2008) reported a length of 108.9mm by computed tomography (CT) in a Swiss population. The cadaveric and autopsy studies also report varying length of sinus; 25.96 mm in a study among the Columbians (Ballesteros et al., 2010), 39.55 mm in the current study and 48.4 mm among the British (El Maasarany et al., 2005) (Table 1). This population variation could be attributed to differences in stature which may affect the size of heart and its vessels. This therefore suggests that the design of CS cannulation devices should be population specific for safe cannulation.

Table 1: Length of coronary sinus in different populations.

Author	Populations	Length(mm)	Study method.
Present study, 2014	Kenyan	***39.55***	Cadaveric
Doig et al., 1995	Canadian	62.8	Angiography
El Maasarany et al., 2005	British	48.4	Cadaveric
Lee et al., 2006	American	86.5	Venography
Plass et al., 2008	Swiss	108.9	Computed Tomography
Ballesteros et al., 2010	Columbian	25.96	Autopsy

Sun et al., 2012	American	109	MOCT
Ankolekar et al., 2013	Indian	28	Cadaveric
Zhaoming et al., 2013	Chinese	38.7	Cadaveric

The CS length was 39.63 mm and 39.45 mm in males and females respectively implying that cannulation devices of similar lengths may be used in both males and females without major negative clinical outcome. The modal range of CS length was 36 to 40 mm suggesting that devices of lengths ranging between 36 mm to 40 mm may be used to safely cannulate the CS in most adults of both sexes. Knowledge of CS length prior to cannulation may help in selecting devices of appropriate length enhancing the ease of cannulation hence reducing procedure time (Loukas et al., 2009). It also helps in understanding the likelihood of a device dislodging after initial implantation (Anderson et al., 2009).

Relationship between coronary sinus length and external heart length

After standardization, although the mean external heart length was longer in males (140.88±13.90 mm) than in females (138.13±13.87 mm) (p= 0.403), the females had longer sinuses though not statistically significant (p=0.667). The CS length in males increased with external heart length though not statistically significant (r=0.117, p=0.455) while no correlation existed between these two lengths in females (r=0.001, p=0.997). These findings suggest that the size of heart in males may be used to estimate the CS length and this may assist in selecting a cannulation device of appropriate length.

Relationship between length of coronary sinus and left atrio-ventricular groove

The left AV groove length was comparable in males and females - 66.35±11.01 mm and 66.16±8.75 mm respectively. The CS length showed a positive correlation with AV groove length in both males and females (r=0.470 and 0.364 respectively). This may be of clinical utility implying that the length of AV groove can be used to estimate the CS length. Standardization using left AV groove length revealed that the males have longer sinuses than females but the sex difference was not statistically significant (p=0.962). The CS occupied about 60% of the left AV groove in both sexes. The findings of this study may be important in determining the extent of CS on the left AV groove from its ostium at right atrium in spite of the different sizes of adult hearts.

In conclusion the coronary sinus of the study population is shorter than those reported for the Caucasian population. The length correlated with that of the AV groove and the heart.

Limitations : The measurements were taken manually and this affects the accuracy.
Conflict of Interest: There is no conflict of interest.

Acknowledgment: I would like to acknowledge Acleus Murunga and Martin Inyimili of the Department of Human Anatomy for their support in harvesting the heart specimens.

REFERENCES

1. Anderson SE, Lahm R, Laizzo PA. 2009. The coronary vascular system and associated medical devices. Handbook of cardiac anatomy, physiology and devices. 2nd edition. *Springer*: pg 117.
2. Ankolekar VH, Quadros LS, D'souza AS. 2013. Morphometric and morphological variations of coronary venous system and its tributaries- An anatomical study. *J Pharm Biomed Scie*. 34:1663-1669.
3. Ballesteros, Luis E, Ramirez, Luis M, Forero, Pedro L. 2010. Study of the coronary Sinus and its tributaries in Columbian subjects. *Revista Colombiana de Cardiologia*. 17:19-15.
4. Barcelo A, De La Fuente L & Stertzer S. 2004. Anatomic and histologic review of the coronary sinus. *International Journal of Morphology* .22:331-338.
5. Bergman RA, Thompson SA, Saadeh FA. 1988. Absence of coronary sinus. *Anatomischer Anzeiger*. 166:9-12.
6. Block PC. 2005. Percutaneous mitral valve repair: are they changing the guard? *Circulation.* 111: 2154-2156.
7. Cappato R, Schluter M, Weiss C, Willems S, Meinertz T, Kuck KH. 1997. Mapping of the coronary sinus and great cardiac vein using a 2-French electrode catheter and a right femoral approach. *Journal of Cardiovascular Electrophysiology.* 8:371-376.
8. Cascade PN, Sneider MB, Koelling TM, Knight BP. 2001. Radiographic Appearance of Biventricular Pacing for the Treatment of Heart Failure. *American Journal of Roentgenology*. 177:1447-1450.
9. Chauvin M. 2010. Difficulties in implantation of a cardiac resynchronization therapy system: causes of failure and importance of operators' experience. *European Society of Cardiology*. 12:1059-1060.
10. Daimon M, Shiota T, Gilinov AM, Hayase M, Ruel M, Cohn WE, Blacker SJ, Liddicoat JR. 2005. Percutaneous mitral valve repair for chronic ischaemic mitral regurgitation: a real-time three dimension echocardiographic study in an ovine model. *Circulation*. 111:2183-2189.
11. Doig JC, Saito J, Harris L, Downar E. 1995. Coronary sinus morphology in patients with atrioventricular junctional reentry tachycardia and other supraventricular tachyarrhythmia. *Circulation* 92:436-441.
12. El-Maasarany S, Ferrett C, Firth A, Sheppard M, Henein M. 2005. The coronary sinus conduit function: Anatomical study (relationship to adjacent structures) *European Heart Journal.* 7:475-481.
13. Felle P, Bannigan JG. 1994. Anatomy of the valve of the valve of the coronary sinus (Thebesian valve). *Clinical Anatomy*. 7: 10-12.
14. Foale RA, Baron DW, Richards AF. 1979. Isolated congenital absence of coronary sinus. *British Heart Journal*. 42: 355-358.
15. Habib A, Lachman N, Christensen KN, Asirvatham SJ .2009. The anatomy of the coronary venous system for the cardiac electrophysiologist. *Eurospace* 11: V15-V21.
16. Kong PK, Ahmad F. 2007. Unroofed coronary sinus and persistent left superior vena cava. *European Journal of Echocardiography*. 8:398-401.
17. Kosourov AK, Ivanov VA. 2005. Structural features of heart coronary sinus in adult humans. *Morfologia*. 128:33-7.

18. Lee MS, Atman PS, Ninh D, Daniel B, James F, Prediman KS, Joseph A, Faizi J, Raj RM. 2006. Coronary Sinus is Dilated and Outwardly Displaced in Patients With Mitral Regurgitation: *Catheterization and Cardiovascular Interventions*. 67:490–494.
19. Loukas M, Bilinky S, Bilinsky E, El-sedfy A, Anderson RH. 2009. Cardiac Veins: A review of the literature. *Clinical anatomy*. 22:129-145.
20. Plass A, Valenta I , Gaemperli O, Kaufmann P, Alkadhi H, Zund G, Grunenfelder J, Genoni M. 2008. Assessment of coronary sinus anatomy between normal and insufficient mitral valves by multi-slice computer tomography for mitral annuloplasty device implantations. *European Journal of Cardio-Thoracic surgery*. 33:583-589.
21. Raghib G, Ruttenberg HD, Anderson RC, Amplatz K, Adams P Jr, Edwards JE. 1965. Termination of left superior vena cava in left atrium, atrial septal defect and absence of coronary sinus; A developmental complex. *Circulation.* 906-918.
22. Sanders P, Jais P, Hocini M, Haissaguerre M. 2004. Electrical disconnection of the coronary sinus by radiofrequency ablation to isolate a trigger of atrial fibrillation. *Journal of Cardiovascular Electrophysiology*. 15:364-368.
23. Silver HA and Rowley NE. 1988. The functional anatomy of the human coronary sinus. *American Heart Journal*. 115:1080-1084.
24. Sun JP, Yang XS, Lam YY, Garcia MJ, Yu CM. 2012. Evaluation of coronary venous anatomy by multislice computed Tomography. *World J cardiovasc Surg.* 2:91-95.
25. Watkins DA, Sebitloane M, Engel ME, Mayosi BM. 2012. The burden of antenatal heart disease in South Africa: a systematic review. BMC Cardiovascular Disorder. 12:13.
26. Yuko-Jowi CA. 2012. African experience of humanitarian cardiovascular medicine: a Kenyan perspective. *Cardiovasc Diagn Ther.* 2:231-239.
27. Zhaoming Z. 2013. Applied anatomical study of coronary sinus and its tributaries. *J Luzhou Med Coll.* 2003-02.