

Location and Size of Coronary Ostia in Normal Autopsied Hearts at the University Teaching Hospital, Lusaka, Zambia

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ABSTRACT

Background: Coronary ostia are orifices located in the aortic sinuses from which coronary arteries normally arise. Knowledge of their location and size is important in diagnosis and treatment cardiovascular diseases. **Materials and methods:** A total of 125 hearts were dissected and examined during autopsy to determine the size and location of the coronary ostia in the aortic sinus, sinu-tubular junction (STJ) or tubular part of the ascending aorta. Photographs of coronary ostia were taken and a Vernier caliper was used to measure ostia. **Results:** The right coronary ostium was located in the right aortic sinus 79.3% (96/121) and on the STJ in 20.7% (25/121) of the hearts. The left coronary ostium was located in the left aortic sinus in 73.6% (89/121) and on the STJ in 26.4% (32/121) of the hearts. The left coronary ostium width range was 1.6 – 7.9 mm (4.62 ± 1.104 mm) and the height range was 1.5 – 4.9 mm (2.64 ± 0.719 mm). The right coronary ostium width range was 1.6 – 9.6 mm (3.66 ± 1.40 mm) and the height range was 1.1 – 4.9 mm (2.27 ± 0.72 mm). The estimated mean cross sectional area of the left coronary ostium was 9.70 mm^2 and that of the right was 6.99 mm^2 . The left coronary ostium was significantly larger in size than the right with a p-value < 0.05 when their means were compared using the t-test. **Conclusion:** The majority of coronary ostia were located in their respective aortic sinuses below the sinutubular junction. Knowledge of the location of coronary ostia in the ascending aorta is important during angiography and surgery around the aortic root.

Key words: coronary ostium, aortic sinus, sinutubular junction

Introduction

The right and left coronary arteries arise from orifices located in the right and left aortic sinuses of ascending aorta respectively [1]. Coronary ostia may be located at variable levels[2], in the aortic sinus, at the sinutubular junction and also in the tubular part of the ascending aorta [3], though those arising from the tubular part of the ascending aorta more than 1 cm from the sinutubular junction are considered to have ectopic origin or a high take off [4,5]. The left coronary artery is usually larger in size than the right coronary artery

and supplies a greater volume of the heart muscle except in right dominant hearts where the right coronary artery partially supplies a posterior part of the left ventricle [2]. The aim of this study was to describe the location of coronary ostia in the aortic sinus, sinutubular junction and tubular part of the ascending aorta in autopsied hearts and to also measure and compare the size of coronary ostia within the same heart.

Materials and methods

A total of 125 adult human hearts were dissected and examined during autopsy at the Pathology department of the University Teaching Hospital, Lusaka, Zambia. The hearts were obtained from people who died in road traffic accidents in which after autopsy were discovered to have had no history and evidence of cardiovascular disease. Ethical clearance was granted by Excellence in Research Ethics and Science (ERES).

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The hearts were obtained from cases of ages between 17 and 86 years with mean (SD) age of 35.05 years (± 12.54). Dissections were carried out by a Pathologist and two anatomy post graduate students. The costochondral joints were cut to remove the sternum and the cartilage part of the ribs. The pericardium was cut to expose the heart and the great vessels were cut in order to free and remove the heart. The aortic sinuses of the ascending aorta were all examined for presence and location of coronary ostia after making a longitudinal incision through the non-coronary aortic sinus to enable visualisation of the coronary ostia which are origins of coronary arteries in the aortic

sinuses. Measurements of the width and height of oval coronary ostia were taken using a digital vernier caliper. For circular coronary ostia only diameter was measured. The average of three measurements was recorded. Approximations of cross sectional area of the coronary ostia were calculated using the formula for a circle ($A = \pi r^2$, for circular ostia) and an ellipse ($Area = \pi r^2$ for oval ostia) and the cross sectional areas for the left and right coronary ostia in each heart were compared using the t-test (paired two sample for mean) at 95% confidence interval if there were significant differences.

Results

Table 1: Location of coronary ostium in hearts

Location of coronary ostium	Left coronary ostium		Right coronary ostium	
	LAS	STJ	RAS	STJ
Frequency	89	32	96	25
Percent	73.6	26.4	79.3	20.7

RAS- Right aortic sinus, LAS – Left aortic sinus, STJ – Sinutubular junction

Most of the coronary ostia were located in their respective aortic sinuses and none arose from the tubular part of the ascending aorta.

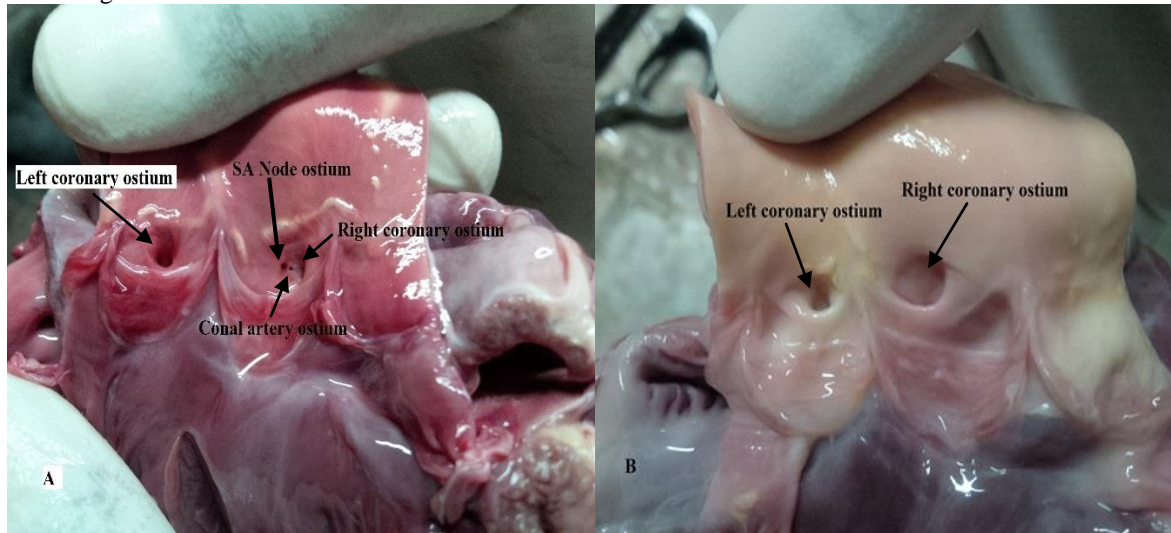


Fig 1A: Left coronary ostium in left aortic sinus; Right coronary, conal artery and sinuatrial node artery ostia in the right aortic sinus.

Fig 1 B: Left and right coronary ostia located on the sinutubular junction of respective aortic sinus

Table 2: Size of left and right coronary ostia

Our study (127 hearts)	Left coronary ostium		Right coronary ostium	
	Width (mm)	Height (mm)	Width (mm)	Height (mm)
	1.6 – 7.9 (4.62 \pm 1.104)	1.50 - 4.90 (2.64 \pm 0.719)	1.6 – 9.6 (3.66 \pm 1.40)	1.1 - 4.9 (2.27 \pm 0.723)

The mean dimensions of the left coronary ostia were greater than those of the right coronary ostia.

Table 3: t-Test (Paired Two Sample for Means)

	C/A LCO	C/A RCO
Mean	9.701175	6.9858
Variance	19.16559	27.431
Observations	125	125
Hypothesised Mean Difference	0	
df	124	
t Stat	7.4825	
P(T<=t) one-tail	5.84E-12	
t Critical one-tail	1.657235	
P(T<=t) two-tail	1.17E-11	
t Critical two-tail	1.97928	

Table 3 shows that the difference in the means is statistically significant between the mean cross sectional area of the left and right coronary ostia within each heart with p - value less than 0.05 at 95% confidence interval. Using the t-test, t statistic observed is greater than t critical hence the mean cross sectional areas of the left and right coronary ostia differ significantly.

Discussion

Location of coronary ostia

The study described origin (location of coronary ostia) of coronary arteries in adult autopsied hearts. It also measured the size of the left and right coronary ostia and compared their cross sectional areas. The hearts dissected and examined in this study were obtained from the ages between 17 and 86 years with a mean (SD) age of 35.05 years (± 12.54). The location of coronary ostium in this study were described as those arising within the aortic sinus (Figure 1A), sinutubular junction (Figure 1B) and in the tubular part of the ascending aorta. The left coronary ostium was located in the left aortic sinus in 89 (73.6%) and on the sinutubular junction 32 (26.4%) hearts. The right coronary ostium was located in the right aortic sinus 96 (79.3%) and on the sinutubular junction in 25 (20.7%) hearts (Table 1). None of the two coronary ostia arose from the tubular part of the ascending aorta. Our results on coronary ostia located in the aortic sinus are similar to those reported by Muriago et al.[3] in which of the 23 normal hearts they examined the left coronary ostium was located within the left posterior aortic sinus

(of Valsalva) in 16 (69%) specimens and at the level of the sinutubular junction in 2 (9%) specimens and above the sinutubular junction in five (22%). The right coronary ostium was located within the right anterior aortic sinus in 18 (78%) specimens, at the sinutubular junction in 2 (9%) and above the sinutubular junction in 3 (13%). Cavalcanti et al.[6] in Brazil examined 51 human hearts in which the left coronary ostium was located below the intercommissural line in 42% of cases, above that line in 40% of cases, and at the level of that line in 18% of cases and the right coronary ostium was located below the intercommissural line in 60% of cases, above that line in 28% of cases, and at the level of that line in 12% of cases. The study done by Cavalcanti et al.[6] found that the proportion of left coronary ostia located in the aortic sinus and above the sinutubular junction were almost equal whilst for the right coronary ostia most of them were located in the right aortic sinus and followed by those located above the sinutubular junction and then those located on the sinutubular junction. Kulkarni and Paranjpe[7] in India after examining 90 hearts found that the right coronary artery was located in the right aortic sinus in 26%, sinutubular junction in 56.6% and tubular location in 16.6% whilst the left coronary artery was located in the left aortic sinus in 17.7 %, at sinutubular junction in 52.2% and tubular location in 30%. The study done by Kulkarni and Paranjpe[7] in an Indian population shows that majority of coronary ostia are located on the sinutubular junction whilst in our study and that done by Muriago et al.[3] most coronary ostia are located in their respective aortic sinuses (Table 4).

Table 4: Comparison of location of coronary ostium with other studies

	Left coronary ostium			Right coronary ostium		
	LAS	STJ	Above STJ	RAS	STJ	Above STJ
Our study (122 hearts)	89 (73.6%)	32 (26.4%)	0	96 (79.3%)	25 (20.7%)	0
Muriago et al. (1997) (23 hearts)	16(69%)	2(9%)	5 (22%)	18(78%)	2(9%)	3 (13%)
Kulkarni and Paranjpe (2015)(90 hearts)	17.7%	52.2%	30%	26%	56.6%	16.6%
Cavalcanti et al. (2003)(51 hearts)	42%	18%	40%	60	12%	28%

Size of coronary ostia

The left coronary ostia ranged in width from 1.6 – 7.9 mm (mean 4.62 ± 1.104 mm) and the height ranged from 1.50 – 4.90 mm (mean 2.64 ± 0.719 mm). The right coronary ostia ranged in width from 1.6 – 9.6 mm (3.66 ± 1.40 mm) and the height ranged from 1.1 - 4.9 mm (2.27 ± 0.723 mm). These measurements (Table 2) are similar to what McAlpine[8] found after analysing

sizes of coronary orifices in 100 hearts in which the width of the right coronary ostia ranged from 0.5 to 7.0 mm (mean 3.7 ± 1.1 mm) and the height ranged from 0.5 to 5.0 mm (mean 2.4 ± 0.9 mm). The left coronary ostia ranged from 1.8 mm to 8.5 mm (mean 4.7 ± 1.2 mm) in width and 1.0 to 8.5 mm (mean 3.2 ± 1.1 mm) in height. In our study the mean sizes of the coronary ostia are within this range (Table 5).

Table 5: Comparison of coronary ostia width and length with findings of McAlpine (1975)

	Left coronary ostium		Right coronary ostium	
	Width (mm)	Height (mm)	Width (mm)	Height (mm)
Our study (127 hearts)	1.6 - 7.9 (4.62 ± 1.104)	1.50 - 4.90 (2.64 ± 0.719)	1.6 - 9.6 (3.66 ± 1.40)	1.1 - 4.9 (2.27 ± 0.723)
McAlpine (1975) (100 hearts)	1.8 - 8.5 (4.7 ± 1.2)	1.0 - 8.5 (3.2 ± 1.1)	0.5 - 7.0 (3.7 ± 1.1)	0.5 - 5.0 (2.4 ± 0.9)

Due to the different shapes coronary ostia may assume, other studies have measured the diameter of coronary arteries at a distance about 1cm from the ostium and the mean diameters were as indicated in Table 6.

Table 6: Mean diameters of coronary ostia in other studies

Authors	Mean diameter of left coronary ostium (mm)	Mean diameter of right coronary ostium (mm)
Standring[2]	1.5 - 5.5	1.5 – 5.5
Cavalcanti et al. [6]	4.75 ± 0.93	3.46 ± 0.94
Kulkarni & Paranjpe[7]	2.8 ± 1.0	2.5 ± 1.0
Nerantzis et al. [9]		3.1 ± 0.52
Reig and Petit [10]	4.86 ± 0.80	
Dodge et al. [11]	4.5 ± 0.5	3.9 ± 0.6 and 2.8 ± 0.5

The cross sectional areas of the coronary ostia within the same heart were compared (Table 3). The mean cross sectional area for the left coronary ostia was found to be 9.70 mm^2 and that of the right coronary artery was 6.99 mm^2 . The mean cross sectional areas for ostia within the same heart were then compared and were found to differ significantly with a p-value 0.0000. The cross sectional area of the left coronary ostium was greater than the right coronary ostium in

106 (84.8%) of the hearts whilst in 17 (13.6%) of the hearts the cross sectional area of the right coronary ostium was great than that of the left coronary ostium and both coronary ostia cross sectional area were equal in 1 (0.8%) heart. Standring[2] in Grays Anatomy states that the left exceed the right in 60% of hearts, the right being larger in 17%, and both vessels being approximately equal in 23% and that diameters of the coronary arteries may increase upto the 30th year. The

left coronary artery is considered to be larger in calibre than the right coronary artery and the findings in this study also show similar results after comparing their cross sectional areas.

Conclusions

The majority of the coronary ostia were located in their respective aortic sinus. The left coronary ostium was found to be significantly larger than the right coronary ostium when ostia within same heart were compared. Knowledge of the location and size of coronary ostia is vital for radiologists performing angiographies for diagnostic purposes and also for cardiac surgeons implementing interventional and therapeutic measures when managing cardiovascular diseases [7, 12]. Attention to potential variations in the origin of the major coronary arteries can greatly enhance clinical outcomes [5]. Coronary ostium size is very important as it will give insight when designing or acquiring of catheters for coronary angiography suitable for the same population.

Acknowledgements

The authors would like to acknowledge the families who allowed us to use the deceased bodies in our research.

References

1. Agur AMR, Dalley AF. *Grants Atlas of Anatomy*. 13th ed. Lippincott Williams and Wilkins, 2013
2. Gatzoulis MA, Collins P. Heart and great vessels. In: Standring S, editor. *Gray's Anatomy*. 40th ed. Edinburgh: Elsevier Churchill Livingstone; 2005. p. 978-981.
3. Muriago M, Sheppard MN, Ho SY, Anderson RH. The location of the coronary arterial orifices in the normal heart. *Clin Anat* 1997;10:297-302.
4. Vlodayer Z, Neufeld H, Edwards J. Variation in the Number of Coronary Ostia. *Coronary Arterial Variations in the Normal Heart and in Congenital Heart Disease II*. Academic Press Inc. Vol. 2. 1975
5. Loukas M, Groat C, Khangura R, Owens D.G, Anderson R.H. The Normal and Abnormal Anatomy of the Coronary Arteries. *Clin Anat* 2009;22:114-128
6. Cavalcanti JS, de Melo NC, de Vasconcelos RS. Morphometric and Topographic Study of Coronary Ostia. *Arquivos Brasileiros Cardiologia* 2003;81:359-62
7. Kulkarni JP, Paranjpe V. Topography, morphology and morphometry of coronary ostia - a cadaveric study. *European Journal of Anatomy* 2015;19(2):165-170.
8. McAlpine W. The Course and Relations of the Coronary Arteries. *Heart and Coronary Arteries*. Springer. 1975.
9. Nerantzis CE, Papaciiristos JCH, Gribizi JE, Voudris VA, Infantis GP, Koroxenidis GT, Functional Dominance of the Right Coronary Artery: Incidence in the Human Heart. *Clin Anat* 1996;9:10-13
10. Reig J, Petit M. Main Trunk of the Left Coronary Artery: Anatomic Study of the Parameters of Clinical Interest. *Clin Anat* 2004;17:6-13
11. Dodge JT, Brown BG, Bolson EL, Dodge HT. Lumen diameter of normal human coronary arteries. Influence of age, sex, anatomic variation, and left ventricular hypertrophy or dilation. *Circulation* 1992;86:232-246.
12. Mamatha Y, Sridhar C. Anomalous Branching Pattern of Coronary Vessels. *Journal of Surgery* 2014;3:169-173.

Source of Support: Nil

Conflict of Interest: None