Section: Anatomy

Original Research Article

ANATOMIC EVALUATION OF CORONARY OSTIA DIMENSIONS IN HUMAN CADAVERIC HEARTS

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ABSTRACT

Background: Understanding the anatomical variations, morphometry, and topography of coronary ostia is crucial for radiologists, as well as for cardiovascular surgeons and anatomists in interpreting findings. This study was designed to evaluate the morphometry and topography of coronary ostia in adult human cadaveric hearts.

Material and Methods: Sixty-four human cadaveric hearts without gross abnormalities and congenital abnormalities were included. Parameters including frequency and number of coronary ostia, diameter of coronary ostia, diameter of root of right and left coronary arteries, shape of coronary ostia, distance from bottom of aortic sinus distance from aortic leaflet commissure, position of coronary ostia at sinotubular junction and frequency of coronary ostia were assessed.

Results: The distance from the bottom of the aortic sinus to the coronary ostia was 13.76 ± 1.94 on the right side and 113.21 ± 1.67 on the left side. The diameters of the right and left coronary ostia were 3.81 ± 1.76 and 4.02 ± 2.14, respectively. The mean diameter of roots of right and left coronary arteries was 3.26±1.03 and 3.77±1.42, respectively. The distance from the right aortic leaflet commissure to the coronary ostia was 10.43±3.17 and 14.98±2.70 on the right and left sides, respectively. while the distance from the left commissure was 12.53±2.58 and 12.67±4.32, respectively.

Conclusion: The anatomical differences of coronary ostia could have implications for haemodynamics and potential clinical outcomes. This information is essential for comprehending the ramifications associated with coronary artery bypass grafting and various cardiovascular interventions.

Keywords: Coronary arteries, Coronary ostia, Human cadaveric heart, Aortic sinus.

INTRODUCTION

The coronary ostia are situated in proximity to the aortic root, a critical region for interventional cardiologists and radiologists.[1,2] Coronary artery disease stands as a significant contributor to mortality rates in developed nations. The prevalence of coronary artery disease is on the rise in developing nations, attributed to shifts in lifestyle, urbanisation, a more sedentary work environment, hypertension, diabetes mellitus, and a growing prevalence of type A personality traits. Coronary artery disease accounts for more than 70% of abrupt cardiac fatalities. In the youth, the leading cause of mortality is attributed to non-atherosclerotic coronary abnormalities.[4]

The spatial orientation and measurement of the coronary ostia in relation to the supravalvular ridge are critical factors to contemplate during the cannulation of coronary arteries. Research indicates that the prevalence of additional coronary ostia in central India ranges from 32% to 40%, while in southern India, it is observed to be between 10% and 18%.[5,6] Variations in the positioning of the coronary artery and coronary ostia were often linked to coronary heart disease.[7] The anomalous origin of the coronary artery is a frequently observed variation that carries significant clinical implications, including the potential for sudden

death, particularly among young athletes.[8] The superior origin of coronary arteries correlates with a heightened risk of myocardial ischaemia and infarction.[9] Understanding the anatomical variations, morphometry, and topography of coronary ostia is crucial for radiologists in interpreting radiological findings, as well as for cardiovascular surgeons and anatomists to achieve successful surgical outcomes during procedures such as coronary artery bypass grafting, angioplasty, and coronary angiogram. This study seeks to examine the morphometry and topography of coronary ostia in relation to the coronary sinus, drawing upon the aforementioned literature concerning human cadaveric hearts.

MATERIALS AND METHODS

The current cadaveric investigation was carried out in the Department of Anatomy at M.M. College of Medical Sciences and Research, located in Ambala, Haryana, spanning from June 2024 to January 2025. A collection of 64 human cadaveric hearts, preserved in formalin and exhibiting no apparent gross abnormalities or visible damage, was included in the study. Hearts exhibiting significant abnormalities, vascular malformations, and indications of congenital heart diseases were systematically excluded from consideration.

Approximately 1 cm superior to the commissures of the aortic leaflets, a transverse dissection of the ascending aorta was performed. Subsequently, the position of the posterior aortic sinus was employed to longitudinally incise the aorta, facilitating the visualisation and examination of both the right and left aortic leaflets along with their corresponding coronary ostia. Subsequently, the branches of both coronary arteries were meticulously dissected. The associated veins were excised to facilitate thorough examination. We conducted an examination of branch diversity alongside the significance of the posterior interventricular branch. The alterations in the pattern of coronary arteries, as well as the location and quantity of coronary ostia, were examined.

Parameters such as the diameter of the coronary ostia, the diameter of the roots of the right and left coronary arteries, the distance from the aortic leaflet commissure, the positioning of the coronary ostia at the sinotubular junction, and the frequency of the coronary ostia. The morphometric parameters of the coronary ostia were assessed utilising standard vernier sliding callipers. The analysis was conducted utilising SPSS 23.0, with results presented in terms of mean and standard deviation. Chi-square analysis was employed to evaluate the study parameters, with a p-value of less than 0.05 deemed statistically significant.

RESULTS

Table 1: Morphological details of coronary ostia in cadaveric heart

	Right coronary ostia		Left coronary ostia	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Shape of coronary ostia				
Circular	46	71.87%	38	59.38%
Elliptical – Vertical	03	4.68%	05	8.81%
Elliptical – Horizontal	15	23.4%	21	32.8%
Position of coronary ostia at sinotubular junction				
Above	05	7.81%	07	10.93%
At the level	15	23.43%	32	50%
Below	44	68.75%	25	39.06%
Frequency of accessory coronary ostia				
Present	02	3.12%	-	-
Absent	62	96.87%	64	100%
Number of accessory coronary ostia				
None	62	96.87%	64	100%
One	02	3.12%	-	-
Two & above	-		-	-

Table 2: Morphometric details of coronary ostia in human cadaveric hearts

	Right coronary ostia		Left coronary ostia		p-value
	Mean±SD	**Range**	**Mean±SD**	**Range**	
Distance from bottom of aortic sinus	13.76 ± 1.94		13.21±1.67		0.022
Diameter of coronary ostia	3.81 ±1.76		4.02±2.14		0.581
Diameter of roots of coronary arteries	3.26±1.03		3.77±1.42		0.038
Distance from aortic leaflet commissure					
Right commissure	10.43±3.17		14.98±2.70		0.001
Left commissure	12.53±2.58		12.67±4.32		

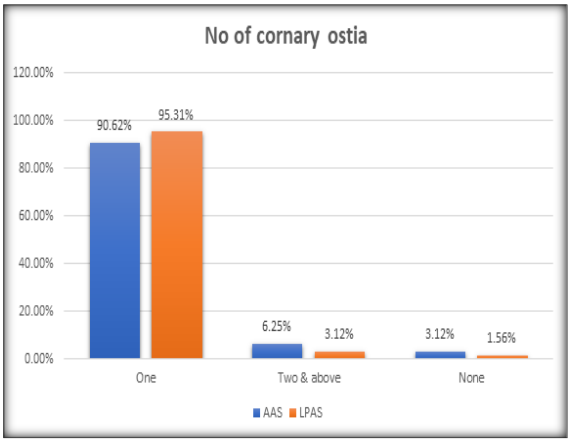

Table 2: Number of coronary ostia in aortic sinus

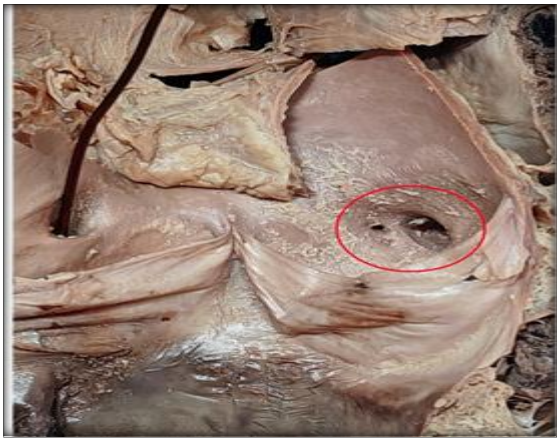

Figure 1: Cadaveric heart showing two Coronary ostia

DISCUSSION

The shape of the coronary ostia was round in 71.87% of right and 59.38% of left side, oval from top to bottom in 4.68% and 8.81%, and oval from side to side in 23.4% and 32.8% of right and left coronary ostia in cadaver hearts, respectively. The position of coronary ostia at the sinotubular junction was below in 68.75% and 39.06%; at the level in 23.43% and 50%; and above the level in 7.81% and 10.93% in right and left coronary ostia in cadaveric hearts, respectively. We observed one accessory coronary ostia in 3.12% of hearts with right coronary ostia only (Table 1).

The distance from the bottom of the aortic sinus to the coronary ostia was 13.76 ± 1.94 on the right side and 113.21 ± 1.67 on the left side, which was statistically significant (p = 0.022). The diameters of the right and left coronary ostia were 3.81 ± 1.76 and 4.02 ± 2.14, respectively. The mean diameter of roots of right and left coronary arteries was 3.26±1.03 and 3.77±1.42, respectively, which was statistically significant (p=0.038). The distance from the right aortic leaflet commissure to the coronary ostia was 10.43±3.17 and 14.98±2.70 on the right and left sides, respectively. while the distance from the left commissure was 12.53±2.58 and 12.67±4.32, respectively, which was statistically significant (p=0.001) (Table 2).

One coronary osita was commonly observed in the anterior (90.62%) and left posterior aortic sinuses (95.31%). Two or more numbers of coronary ostia were seen in 6.25% of anterior and 3.12% of posterior aortic sinuses. Coronary ostia were not seen in 3.12% and 1.56% of hearts in the anterior and left posterior aortic sinuses, respectively (Table 2).

A study by Jyothi SR et al. involving 49 human cadaveric hearts revealed that the mean diameter of the coronary ostia was measured at 3.43mm and 4.27mm, while the mean diameter of the root of the coronary arteries was found to be 3.00mm and 3.72mm on the right and left sides, respectively. 87.75% and 98% of hearts exhibited single coronary ostia in the anterior and left posterior aortic sinus, respectively.[10] Priti Sinha et al. conducted a review of 20 cadaveric human hearts, noting that single coronary ostia were observed in 95% of cases for both the right and left coronary arteries.[11]

Jyoti PK et al. conducted a study on 90 cadaveric human hearts, revealing that 76.6% of the right coronary ostia and 73.3% of the left coronary ostia exhibited a horizontally oval morphology. Sixteen percent of RCO and twenty-three percent of LCO exhibited a circular form, while seven percent of RCO and ten percent of LCO displayed a vertically oval configuration. The average diameter of RCO and LCO was measured at 2.5±1 mm and 2.8±1 mm, respectively. The mean diameter of the coronary ostia measured 2.5 mm.[12] The average diameter of the right coronary ostia, measured at 3.7mm, was notably smaller than that of the left coronary ostia, which measured 4.1mm (p=0.0318). The average diameter of the roots of the right and left coronary arteries measured 3.12mm and 3.84mm, respectively. The right coronary ostia were positioned below the sinotubular junction in 80 hearts, while the left coronary ostia were noted at the level of the sinotubular junction in 50% of the hearts examined. Instances of single coronary ostia were frequently noted in the anterior (92.5%) and left posterior aortic sinus (97.5%).[13]

Nasr AY and others studied 60 cadaver hearts and found that the anterior aortic sinus (AAS) had one opening for the right coronary artery (RCA) in 77.5% of male hearts and 80% of female hearts. This opening also served as a common starting point for the right coronary artery (RCA) and the third coronary artery (TCA) in 15% of male hearts and 20% of female hearts. This ostium provided a shared origin for the right coronary artery (RCA) and the third coronary artery (TCA) in 15% of male hearts and 20% of female hearts. Nonetheless, the observation of two distinct ostia for the origins of the right coronary artery and the left coronary artery was noted in 20% of male hearts and 15% of female hearts. Furthermore, three ostia were observed in the hearts of both a male and a female within the AAS. In the left posterior aortic sinus, a singular ostium for the left coronary artery (LCA) was observed in 97.5% of male hearts and 95% of female hearts,

while two ostia were identified in one male and one female heart. The measurement from the base of the aortic sinus to the ostium of the left coronary artery was greater than that of the right coronary artery. The internal diameter of the RCA ostium was notably narrower ($P < 0.05$) compared to that of the LCA, with no significant difference observed between the sexes.[14] Cavalcanti JS et al. conducted a study on 51 hearts, revealing that the left coronary ostium was situated below the intercommissural line in 42% of instances, above that line in 40% of instances, and aligned with that line in 18% of instances. The average distance from the left coronary ostium to the base of the corresponding sinus measured 12.6 mm. The positioning of the right coronary ostium was observed to be below the intercommissural line in 60% of instances, above that line in 28% of instances, and aligned with that line in 12% of instances. The average distance from the right coronary ostium to the base of the associated aortic sinus measured 13.2 mm. The average diameters of the left and right coronary ostia were 4.75 mm and 3.46 mm, respectively. The average diameters of the juxtamural segments of the left and right coronary arteries were measured at 3.7 mm and 2.9 mm, respectively. In a particular instance, both ostia were situated within the left coronary sinus.[15] In a study conducted by Joshi SD et al. involving 105 human cadaveric hearts, it was observed that a significant majority of the ostia were positioned below the sinotubular ridge (89%) and at or above the level of the upper margin of the cusps (84%). The left ostial openings predominantly exhibited a central positioning, accounting for 80%, while the ostia of the right coronary artery were frequently displaced towards the right posterior aortic sinus.

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Turner K et al. conducted an evaluation of 37 cadaveric heart specimens, revealing that the majority of ostia were located on or just below the supravalvular ridge. The ostia are arranged in a manner that corresponds closely to the peak curvature of the sinus. In the solitary specimen exhibiting a bicuspid aortic valve, both ostia were positioned approximately symmetrically within the sinus above an anterior cusp, which displayed indications of development from two distinct components.[17]

CONCLUSION

These findings suggest a notable prevalence of single coronary ostia in the majority of observed cases, highlighting the anatomical variations that can occur within the aortic sinuses suggesting that anatomical differences may influence haemodynamics and potential clinical outcomes. This information is crucial for understanding the implications for coronary artery bypass grafting and other cardiovascular interventions. Further studies are warranted to explore the implications of these variations on surgical approaches and interventions for aortic valve pathologies.

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