ORIGINAL RESEARCH

Morphometric and Topographic Study of Coronary Ostia in Human Cadavers by Dissection Method

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ABSTRACT

Background: Preoperative diagnosis of coronary ostial deformities is also very crucial in congenital heart diseases such as Fallot's tetralogy and transposition of arterial supply. Anatomical understanding of coronary orifices may reduce invasive procedure morbidity and mortality.The study's objectives were:1) Measure the diameters of the coronary ostia and coronary artery roots. 2) Measure the distance between the coronary ostia and the aortic sinus.3)To measure the distance of coronary ostia to the commissures of aortic leaflets. 4) To examine the relationship between the coronary ostia and the sinotubular junction.5) Note any accessory or single ostia.

Materials and Methods: The present investigation used 40 human cadaver hearts frozen with 10% formalin from Govt Medical College, SuryapetTelngana and Viswa Bharathi Medical College, Kurnool, AP, India.The diameters of the coronary ostia and coronary artery roots were measured, as well as the distance between the ostia and the aortic leaflet commissures.

Results: The mean diameter of the left coronary ostium was statistically bigger than the right coronary ostium. The mean distance of the right coronary ostium from the aortic sinus was significantly higher than the left.It has deviated to the right commissure towards right posterior aortic sinus, and the left coronary ostium approximately to the centre. The diameter of coronary arteries decreased significantly from the ostia to the roots. From left coronary ostium to artery root, the mean diameter decreased. Most of the time, the right coronary ostium was below the sinotubular junction, whereas the left was at the junction. Anterior aortic sinus has many coronary orifices, with one (2.5%) specimen having triple ostia. Left posterior aortic sinus was the origin of one right coronary.

Conclusion: The findings of this study contribute to the body of knowledge already available on the morphology and topography of coronary ostia.This highlights the need of analyzing the diameter variations of coronary ostia and roots, their relations to sinotubular junction and aortic commissures, as well as looking for various orifices. As inability to recognise can cause issues during angiography.

Keywords: Aortic sinus of Valsalva; ascending aorta; catenoidsinotubular junction; third coronary artery; variations.

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INTRODUCTION

The cardiovascular system is the first major system to initiate to function in the embryonic stage of development. It is not until the beginning of the fourth week that the primordial heart and vascular system begin to work. Although the primordial heart and vascular system begin to appear in the middle of the third week of embryonic life, it is not until that week that the heart truly begins to function. As a result, it goes through a series of rhythmic and regular contractions and relaxations, which is known as the 'cardiac cycle,' which never ends until the heart quits working.In Latin, the term "coronary" means "coronary artery." In atrioventricular sulcus, it refers to a crown-like configuration of all coronary arteries as they encircle the heart.Specifically, the right and left coronary arteries provide blood supply to the heart. It is important to note that each artery is part of the ascending aorta's vasavasorum. It is believed that the right coronary artery originates from the right coronary sinus (anterior aortic sinus) of the ascending aorta, whereas the left coronary artery originates from the left coronary sinus (left posterior aortic sinus) of the ascending aorta.[1-3] Right and left coronary ostia are found within the aortic sinuses or at the confluence of the sinus and tubular parts of the aorta in their typical configurations. During ventricular diastole, the placement of the ostium provides for the greatest possible coronary filling. When the ostia and origin of the coronary arteries are misaligned, the risk of sudden death increases dramatically. If the coronary ostia are slit-like, the coronary arteries become pinched between the aorta and pulmonary trunk during exertion, which can result in a lack of oxygenation and myocardial ischemia, as well as sudden death1.For the clinical relationship between aberrant ostia and pathophysiological diseases to be confirmed in live people, this correlation must be evaluated in subjects who are investigated for numerous ostia using non-invasive procedures such as CT scanning. Individuals who are found to have many ostia should be monitored on a frequent basis in order to detect any associated symptoms of angina, myocardial infarction, or left ventricular failure. Despite the fact that this procedure would be extremely expensive, impractical, and time-consuming, it would eliminate any selection bias associated with cardiac patients and aid in the confirmation of any link between the existence of many ostia and clinical symptoms.[2-4]As operations such as coronary angiograms, angioplasty, coronary artery bypass grafting, and coronary arterystenting become more popular, an effort has been made to better understand the morphology and topography of coronary ostia (coronary artery ostia are the openings in the heart).

Objectives

The present study aims at making the following observations in the specimens.

1. To measure the diameters of the coronary ostia and diameters of the roots ofcoronary arteries.
2. To measure the distance between coronary ostia and bottom of correspondingaortic sinus.
3. To measure the distance of coronary ostia to the commissures of aortic leaflets.
4. To observe the relations of coronary ostia to sinotubular junction.
5. To note for accessory ostia and single ostium if any.

Source of Data

The present study was performed on 40 human heart specimens of both maleand female cadavers aged between 40 and 65 years. Specimens were collected from Department of Anatomy and Forensic Medicine Govt Medical College, Suryapet Telangana &Viswa Bharathi Medical College, Kurnool, AP over a period of 18 months (October 2019 to March 2021).

Inclusion Criteria

Human hearts from cadavers whose death were by non-cardiac disease

Exclusion Criteria

a) Any gross evidence of congenital heart disease.

b) Ostial stenosis due to causes such as syphilitic aortitis, after prostheticvalve replacement and any other pathological conditions.

MATERIALS & METHODS

1. From the cadavers

The gross dissection was done by following the guidelines Cunningham's Manual. The pericardium involving the root of aorta was removed, and the origin ofright and left coronary artery was traced. Then the ascending aorta was sectioned transversely approximately 1 cm above the commissure of aortic leaflets. Nextthe aorta was longitudinally opened at the level of right posterior aortic sinus (non-coronary sinus) to enable the visualisation and analysis of right and left aortic leaflets and their respective coronary ostia. In addition, the coronary arteries were sectioned at the level of their origin in the aortic wall.[5]

2. From the post-mortem cases

Cadaver was placed supine on the dissection table and thoracic cavity was exposed by giving the classic midline incision from the chin to the symphysis pubis.Then the thoracic wall was retracted laterally.

Specimens were collected as block dissection of the heart along with associated structures like ascending aorta, pulmonary trunk, superior venacava, inferior venacava and pulmonary veins.

Each specimen was thoroughly washed to remove blood clots and then taggedwith a token having identification number and fixed in 10% formalin. All specimenswere dissected carefully to observe the parameters of the study.

Parameters Studied

1. To measure
   a) The diameters of coronary ostia
   b) The diameters of roots of coronary arteries
   c) The distance from coronary ostia to bottom of aortic sinus
   d) The distance from coronary ostia to commissures of aortic leaflets

2. To note the relation of coronary ostia with sinotubular ridge (at, above or belowsinotubular ridge).
3. To look for anomalous coronary ostia.

Measurements were studied with help of Vernier callipers and divider, and exact measurements were noted.

Basedonthedataobtained,morphometricandtopographiccharacteristicsofcoronary ostia were analysed.

RESULTS

Table 1: Diameters of Coronary Ostia

Coronary ostia	No. of specimens	Mean(mm)	SD	P-value
Right	40	3.5	0.81	<0.0001
Left	40	4.2	0.75	

The mean diameter of left coronary ostium was greater than right coronaryostium which was statistically significant (p-value<0.0001).

Table 2: Distance of Coronary Ostia from Bottom of aortic Sinus

Coronary ostia	No. of specimens	Mean(mm)	SD	P-value
Right	40	13.9	2.1	0.001
Left	40	12.9	1.87	

The mean distance of right coronary ostium from the bottom of aortic sinus was greater than left coronary ostium which was statistically significant (p-value=0.001).

Table 3: Distance of Coronary Ostia from Commissures of Aortic Leaflets

Coronary ostia	Commissures of aortic leaflets	No. Of specimens	Mean (mm)	Sd	P- value
Right	Right commissure	40	9.69	2.91	<0.001
	Left commissure	40	14.57	3.05	
Left	Right commissure	40	11.87	2.59	
	Left commissure	40	11.21	2.87	

The right coronary ostium is deviated to right commissure which is towards right posterior aortic sinus and the left coronary ostium is almost near the centre of aortic sinus which was statistically significant (p-value<0.001).

Table 4: Diameters of Coronary Ostia and Roots of Corresponding Coronary Arteries

Coronary ostia	No. Of specimens	Diameter of coronary ostia		Diameter of roots of coronary arteries		Decrease in diameter		Average % of decrease		% of decrease	P-value
		Mean (mm)	Sd	Mean (mm)	Sd	Mean (mm)	Sd	Mean (mm)	Sd		
Right	40	3.45	0.86	3.01	0.81	0.41	0.23	13.5	7.17	12.4	0.047
Left	40	4.21	0.74	3.71	0.67	0.57	0.26	12.7	5.9	12.7	

There was decrease in diameter from coronary ostia to the roots of coronary arterieswhich was statistically significant (p-value=0.047). Decrease in diameter from left coronary ostium to root was 0.57 mm and right coronary ostium to root was 0.47 mm.

Table 5: Location of Coronary Ostia in Relation Tosinotubular Junction

Relation to sinotubular junction		No. Of specimens	Percentage (%)
Right	Left		
Below	Below	15	37.5
Above	Above	1	2.5
Above	Below	0	0
Below	Above	2	5
At	Below	1	2.5
Below	At	19	47.5
At	Above	0	0
Above	At	0	0
At	At	2	5.0
Total		40	100

In 19 specimens (47.5 %) right ostium was below STJ and the left ostium was atSTJ followed by 18 specimens (37.5 %) in which both ostia were below STJ.

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Table 6: Incidence of Various Locations of Coronary Ostiain Relation to Sinotubular Junction

Location	**% Incidence**		**P-value**
	Right coronary ostium	**Left coronary ostium**	
At STJ	3 (7.5 %)	21 (52.5%)	<0.0001
Above STJ	1(2.5 %)	4(10.0 %)	
Below STJ	36(90.0%)	15 (37.5%)	

In 36 (90.0 %) specimens' the location of the right coronary ostium was below STJ andin 21 (52.5%) specimens left coronary ostium was at STJ which was statistically significant (p-value<0.0001).

Table 7: Number of Coronary Ostia in Anterior Aorticsinus

Number of coronary ostia in AAS	**No. Of specimens**	**Percentage (%)**
0	1	2.5
1	35	87.5
2	3	7.5
3	1	2.5
Total	40	100.00

There was single ostium in 35 (87.5%) specimens, double ostia in 3 (7.5%)specimens, triple ostia in one (2.5 %) specimen and also absence of ostium in one specimen.

Table 8: Number of Coronary Ostia in Left Posterioraortic Sinus

Number of coronary ostia in Lpas	**No. Of specimens**	**Percentage (%)**
0	0	0
1	39	97.5
2	1	2.5
Total	40	100

There was single ostium in 39 (97.5%) specimens and double ostia in one (2.5%)specimen.

Table 9: Extra Ostia Seen in Anterior Aortic Sinus

Name of the artery	**Incidence per 100 heart**
Third coronary artery	10.27
Ventricular branch of RCA	2.13

The incidence of extra ostia was 10.27% in third coronary artery and 2.13% in ventricular branch of right coronary artery.

DISCUSSION

The aortic root is a frequent site of interventional procedures in both adults and children. Understanding the precise nature and relation of anatomical structures composing the aortic root, including coronary orifices is valuable in percutaneous and transcatheter therapeutic techniques. Coronary ostial diameter and its variation is also helpful in designing the coronary perfusion cannula. Knowledge of location, positionwith respect to sinotubular junction and size of coronary ostia is important for performing successful coronary angiography.

Coronary blood flow may be affected by changes in morphological and topographical features of coronary ostia. An abnormal location or an accessory originof the coronary orifices may disturb performing an

1) Aortotomy incision for aortic exposure
2) Preparing a coronary button
3) In aortic root replacement
4) Direct delivery of cardioplegia through coronary orifices
5) Approaches for aortic root enlargement.36

Table 10: Comparison of Mean Diameters of Right and Left Coronary Ostia with Other Studies

Studies	Mean diameters of coronary ostia	
	Right	Left
Present study	3.5+	4.2
Cavalcanti et al.[6]	3.46	4.25
Bhimali S et al.[7]	2.38	3.17
B Pejkovic et al.[8]	3.6	4.1

In the present study, the diameter of left coronary ostium was greater than right coronary ostium which was statistically significant. This observation was in agreement with work done by Cavalcanti et al.,[6]Bhimali S et al.[7] and B Pejkovicet al.[8]

The coronary ostial dimensions is important as a slit-like opening might be flow limiting and with exercise might become more restrictive. If there is a flap-likeopening it acts as one-way restrictive valve as aortic pressure increases with exercise.

In the present study, the distance of right coronary ostium from bottom of aortic sinus was more than the distance of left coronary ostium which was statistically significant. This was in accordance with findings of Cavalcanti et al.[6] and Onan B.[9]

The anatomical feedback about the relation of coronary ostia to the aortic sinus help in choosing appropriate size of grafts for ascending aortic valve sparing techniques including non-coronary cusp extension.

In the present study, it was observed that right coronary ostium was deviatedto right commissure which is towards right posterior aortic sinus. And the left coronary ostium was almost near the center of aortic sinus. This study was same as the work done by Cavalcanti et al.[6] and Sirikonda P and Sreelatha S.[10]

The knowledge of circumferential deviation of coronary ostia will help radiologists in interpreting images of coronary angiogram and to surgeons during procedures like angiography and angioplasty.

In the present study, it was observed that there was a mean decrease of0.41 mm (12.2%) in diameter from right coronary ostium to root. And a mean decrease of 0.57mm (12.8%) in diameter from left coronary ostium to root. Whereas study done by Cavalcanti et al.6 was showing more percentage of decrease with right than left.

The proximal segment of each coronary artery is intramural, it courses through aortic wall and tapers. This should be considered when designing stents for aortic- ostial coronary lesions to achieve optimal results and to decrease restenosis.

In the present study, a statistical significance was observed in location of coronary ostia in relation to sinotubular junction, where in right coronary ostium wasmore commonly located below sinotubular junction which was in agreement with work done by Onan B.9 Whereas the left coronary ostium was more common at the sinotubular junction.

The knowledge of position of coronary ostia with respect to aortic sinuses andpossible variations in their locations will aid in carrying out coronary angiographies as well as

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interpreting them.Patients with ostium above the level of STJ, it is difficult to insert cathetertips.
In the present study the common location of right coronary ostium was belowSTJ and left coronary ostium was at the level of STJ. In Cavalcanti et al.6 study, bothostia were below STJ.
Multiple orifices were more common in anterior aortic sinus which correlateswith study of Sirikonda P and Sreelatha S.[10]
Presence of multiple ostia is a hazard in heart surgeries as the ostia of small arteries like third coronary artery are usually very small and get opacified during angiographies. Thus these arteries miss detection preoperatively and get nicked during surgeries.
In the present study, the incidence of third coronary artery was 10.27% and it was to the left of right coronary artery. It constitutes a significant source of collateral circulation and is important in the interpretation of signs and symptoms of coronary artery occlusion.
In the present study, one specimen was with right coronary ostium in left posterior aortic sinus which was same as Palimer V et al study.[12] It is clinically significant in sudden cardiac death cases as anomalous aortic origin of coronary arteries can lead to myocardialinfarction and angina pectoris.

CONCLUSION

The advances made in coronary artery bypass surgeries and modern methods of myocardial revascularisation makes it necessary for thorough complete knowledgeof coronary ostia. Understanding of variations in morphology and topography of coronary ostia should be sought before surgical interventions. The present anatomicaldata may help the cardiac surgeons to modify their surgical reconstruction of the aortic root in order to achieve satisfactory recovery. Keeping in mind the ever evolving and yet unexplored facts of this subject, the present study was undertaken toshed more light on this topic of coronary ostia.

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