Original Article

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Anatomy Section

Prevalence of Coronary and Extracoronary Ostia in Southern Rajasthan: A Cadaveric Study

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ABSTRACT

Introduction: A variable incidence of additional coronary ostia or third coronary ostia is found along right ostium in the Anterior Aortic Sinus (AAS). Extracoronary ostia in AAS provide third coronary artery or right conus artery which supplies pulmonary conus and upper part of right ventricle. Third coronary artery is an important bridge for collateral circulation between right and left coronary system.

Aim: To reveal the number, shape, and position of coronary and extracoronary ostia in aortic sinuses in Southern Rajasthan.

Materials and Methods: This observational descriptive study was conducted on 100 human hearts extracted from cadavers and preserved in formalin at Department of Anatomy, Medical College, Kota, Rajasthan, India from December 2019 to January 2021. Specimens were observed for numbers, shape and position of Coronary and Extracoronary Ostia. Data was entered in Microsoft Excel Worksheet and analysed in Medcalc software version 20.0.3.

Results: A total number of 100 extracted human cadaveric hearts were studied and analysed. In Anterior Aortic Sinus, single coronary ostium was found in 82% specimen, double ostia were observed in 17% specimen and triple ostia were noticed in only 1% specimen in AAS. In extracoronary ostia, 17 specimens were found round while only one specimen was found elliptical in shape and 16 specimen were found below sinu-tubular junction in position while one specimen was found above sinu-tubular junction and one specimen was at level of sinu-tubular junction.

Conclusion: The role of extracoronary ostia should always be taken into account during investigative and remedial interventions. Awareness about extracoronary ostia would provide a deeper insight about possible complications arising during various surgical procedures to avoid damage.

Keywords: Anterior aortic sinus, Right conus artery, Sinu-tubular junction, Third coronary artery

INTRODUCTION

Principal vasa vasorum of the heart are coronary arteries. Word 'coronary' (Latin word) signifies a coronet framework of all coronary arteries around the heart. The right and left coronary artery arises from anterior and left posterior aortic sinuses, respectively. Variations are rare but the two may start separately or in common from the same sinus; three or even four coronaries have been noticed. The most common variation concerns a right coronary branch, arteria coni arteriosi or conus artery, which is 64% of its first branch but often arises separately in anterior sinus and 36% as a third coronary artery [1].

Shape and location of ostia is important for cardiac catheterisation. Superior origin of coronary arteries augments risk for myocardial ischemia and sudden death due to circuitous passage of coronary artery through aortic wall [2]. The upper limit of aortic valve beyond level of free border of cusp forms circumferential sinutubular ridge which is viewed from the aortic aspect [3]. The sinutubular junction separates the aortic root and ascending aorta. Occasionally, right or left coronary ostium arises above sinotubular junction. This ostial dislocation has been termed high takeoff coronary artery, high takeoff position, or ectopic coronary ostium [4].

In current concept, coronary arteries grow into the aorta from peritruncal ring of coronary arterial vasculature. Recently, it is stated that the union of the small vessels to the developing aorta harbingers the formation of coronary artery orifices in the aortic sinus [5]. This study principally focuses on extracoronary ostia shape and position which is one of its kinds in southern Rajasthan and provides insight to the interventionalists here so that they can correctly interpret the angiographic findings. The findings of the study will be beneficial for the population of the Rajasthan. Other prevalence study of extracoronary ostia has been conducted in central India and southern India where the frequency was 32-40% and 10-18%, respectively [12-16].

Thus, the purpose of the research was to know the prevalence of extracoronary ostia as an origin for third coronary artery and number, shape, position of coronary ostia in Southern Rajasthan.

MATERIALS AND METHODS

This observational descriptive study was conducted in Department of Anatomy, Government Medical College, Kota from December 2019 to January 2021, after seeking proper approval from Institutional Review Board and Ethical Committee (approval number PNCGMC/PG/ETH/1804 dated 16/12/2019) of Government Medical College, Kota, Rajasthan, India. At 95% confidence interval and 80% beta error sample size was calculated using OpenEPI software. So this study was conducted on 100 preserved human cadaveric hearts procured from the Department of Anatomy and Department of Forensic medicine, Medical Collage Kota as per the guidelines in Cunningham's Manual of practical anatomy [6].

Inclusion criteria: Both the genders, age group of more than 30 years and Indian ethnicity were taken as eligibility criterion. The age group was above 30 years as the study is mostly on hearts of donated cadavers in the Department.

Exclusion criteria: All samples with any pathology or damage were excluded.

Microdissection of 10% formalin fixed hearts was done. The parameters of coronary ostia were observed after dividing the ascending aorta transversely, one centimeter above aortic leaflet commissure. Coronary sinuses were observed and finding was noted for number, shape, position, and variation of ostia if any.

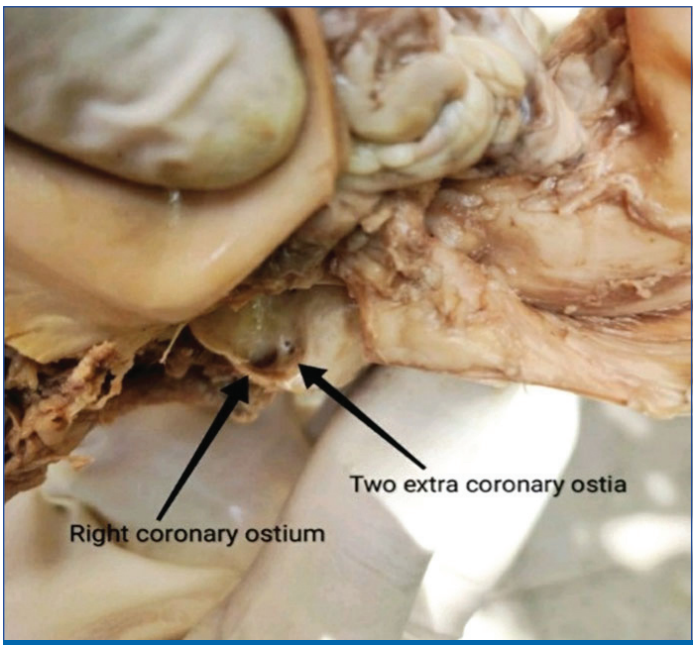
STATISTICAL ANALYSIS

The data was evaluated by Medcalc software version 20.0.3 and frequency was assessed for statistical significance by chi-square test. The p-value <0.05 was considered significant.

RESULTS

Single ostium was found in 82 specimen of hearts for right coronary artery origin. Double ostia were seen in 17 specimens and one triple ostia in AAS as shown [Table/Fig-1,2].

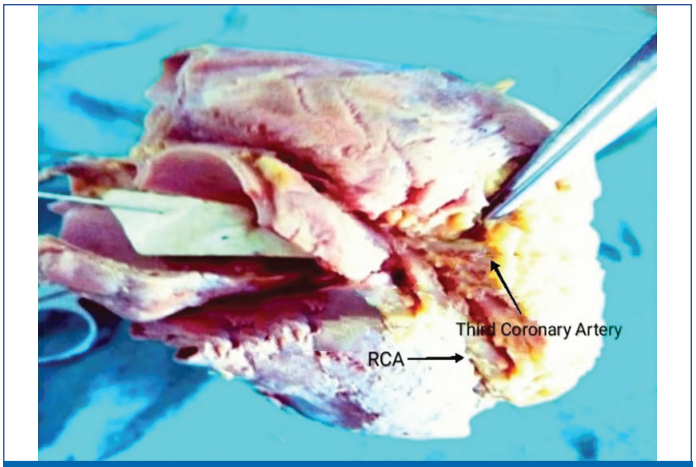
[Table/Fig-1]: Showing single round extracoronary ostium in Anterior Aortic Sinus (AAS).



[Table/Fig-2]: Showing two extracoronary ostia in AAS.

Third coronary artery commences from a separate opening as an additional coronary ostium in AAS. Then, it passes inferiorly and to the left side of right coronary artery through sub-epicardial adipose tissue of coronary sulcus for a short distance. After leaving coronary sulcus, it runs over the surface of right ventricle anteriorly to reach the pulmonary conus [Table/Fig-3].

The current study revealed that 18% specimens had separate origin of right conus artery which form as Third Coronary artery. In left posterior aortic sinus, single ostium was found in all 100 specimens as shown [Table/Fig-4]. Shape of right coronary ostia were round in 92% of specimen and 8% were elliptical while in left coronary ostia 75% were round and 25% were horizontally elliptical as shown [Table/Fig-5].



[Table/Fig-3]: Showing third coronary artery.
RCA: Right coronary artery

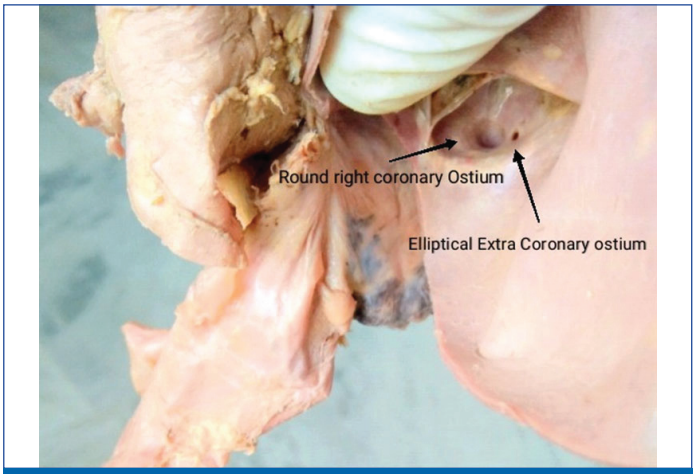
Ostia	In anterior aortic sinus			In left posterior aortic sinus
	Single ostia	Double ostia	Triple ostia	Single
Numbers (n)	82	17	1	100
Percentage	82%	17%	1%	100%

[Table/Fig-4]: Number of ostia in anterior aortic sinus.
p-value <0.0001

Shape	Coronary ostia in anterior aortic sinus (%)	Coronary ostia in left posterior aortic sinus (%)
Round	92	75
Horizontally elliptical	8	25
Vertically elliptical	0	0

[Table/Fig-5]: Shape of coronary ostia.
p-value=0.0001

Shape of extracoronary ostia was found round in seventeen specimens while one specimen had elliptical extracoronary ostia [Table/Fig-6].



[Table/Fig-6]: Showing shapes of coronary and extracoronary ostia.

The right coronary ostium was found below the sinu-tubular junction in 94% of the specimens, at sinu-tubular junction in 4% while above the sinu-tubular junction were 2% of the specimens studied as depicted [Table/Fig-7] [3].

Position	Coronary ostia in anterior aortic sinus (%)	Coronary ostia in left posterior aortic sinus (%)
Above STJ	2	2
At STJ	4	10
Below STJ	94	88

[Table/Fig-7]: Position of coronary ostia.
*STJ: Sinu tubular junction; p-value=0.2978

[Table/Fig-8] shows the shape of extracoronary ostia to be round in 94.44% of specimen and horizontally elliptical in 5.56% of specimens while vertically elliptical ostia were not seen at all in any of the specimens.

Shape	Extracoronary ostia in AAS (n)	Percentage (%)
Round	17	94.44%
Elliptical	1	5.56%

[Table/Fig-8]: Shape of extracoronary ostia.

In sixteen specimens of extracoronary ostia were found below sinu-tubular junction, single specimen had above sinu-tubular junction and one at sinu-tubular junction as shown [Table/Fig-9].

Position	Extracoronary ostia in AAS (n)	Percentage (%)
Above STJ	1	5.56%
At STJ	1	5.56%
Below STJ	16	88.88%

[Table/Fig-9]: Position of extracoronary ostia.

DISCUSSION

Variations of coronary ostia are frequent and have medical repercussion. Extracoronary artery arises customarily from right aortic sinus. Literature uses different terms for identifying right conus artery as third coronary artery which has separate origin from extracoronary ostia in anterior coronary sinus [1].

[Table/Fig-10] shows the comparison of frequency of extracoronary ostia by different authors [7-16]. In present study, extracoronary ostia in the AAS were found in 18% specimen of heart while Wolloscheck T et al., accounted presence of additional ostia in 65% of subjects in an anatomical and trans-thoracic echocardiographic study [7]. Kalpana R et al., ascertained the incidence of third coronary artery in 24% of specimens [8]. Stankovic I and Jesic M and Blake established incidence of third coronary artery 34.8% and 23.5% while Joshi SD et al., and Bharambe VK et al., found incidence of third coronary artery to be 29.52% and 22%, respectively [9-11] . Chhaparwal R et al., Dhobale MR et al., Jyothi SR et al., Dakhaneprafulla S et al., and Saminathan S et al., observed frequency 40%, 32%, 10.2%, 18% and 17%, respectively [12-16].

Studies	Place	Prevalence (%)
Wolloscheck T et al., [7] (2001)	German	65
Kalpana R et al., [8] (2003)	India	24
Stankovic I and Jesic M [9] (2004)	Romania	34.8
Joshi SD et al., [10] (2010)	Maharashtra, India	29.52
Bharambe VK and Arole VA, [11] (2012)	Zambia, Southern Africa	22
Chhaparwal R et al., [12] (2015)	Madhya Pradesh, India	40
Dhobale MR et al., [13] (2015)	Maharashtra, India	32
Jyothi SR et al., [14] (2017)	Karnataka, India	10.2
Dakhaneprafulla S et al., [15] (2018)	Maharashtra, India	18
Saminathan S et al., [16] (2020)	Tamil Nadu, India	17
Present Study	Rajasthan, India	18

[Table/Fig-10]: Comparison of frequency of extracoronary ostia.

Additionally, this study revealed shape and position of extracoronary ostia. This data from other authors was not amply available for comparison.

Data obtained for location in relation of sinutubular junction of Right Coronary Ostia (RCOS), Left Coronary Ostia (LCOS) in the studies by Kalpana R; and that by Saminathan S; were comparable to the present study as mentioned [Table/Fig-11] [8,16]. In their study, most of 90%, 89% in right and 80%, 92% in left were below STJ and 1% and 5% above STJ in right ostia respectively. In case of left ostia, they had not found above STJ while 2% specimen in present study was above STJ.

Authors	Total sample size (N)	RCOS location (relation with STJ) (n)			LCOS location (relation with STJ) (n)		
		Below	At	Above	Below	At	Above
Kalpana R et al., [8] (2003)	100	90	9	1	80	20	0
Saminathan S et al., [16] (2020)	100	89	6	5	92	8	0
Present study	100	94	4	2	88	10	2

[Table/Fig-11]: Comparison of location of ostia with other studies.
*RCOS: Right coronary ostia; LCOS: Left coronary ostia

Comparing the shape of coronary ostia, Mobin N et al., found round shape in 70.9% specimens in right ostia, 52.7% in left ostia while 92% round shape was found in present study in right ostia [17]. In horizontally elliptical shape, Mobin N et al found 27.3% in right, 40.9% in left but in present study, 8% and 25% were horizontally elliptical in right and left ostia respectively as shown [Table/Fig-12] [17,18].

Authors	Place	RCOS n (%)			LCOS n (%)		
		Round	Horizontally elliptical	Vertically elliptical	Round	Horizontally elliptical	Vertically elliptical
Mobin N et al., [17] (2021)	Karnataka India	78 (70.9%)	30 (27.3%)	02 (1.8)	58 (52.7%)	45 (40.9%)	07 (6.4%)
Kulkarni JP and Paranjpe V, [18] (2015)	Maharashtra India	15 (16.6%)	69 (76.6%)	6 (6.6%)	21 (23.3%)	66 (73.3%)	9 (10%)
Present study	Rajasthan India	92 (92%)	8 (8%)	0	75 (75%)	25 (25%)	0

[Table/Fig-12]: Comparison of shape of ostia with other studies.
*RCOS: Right coronary ostia; LCOS: Left coronary ostia

This knowledge is important for anatomist, radiologist, interventional cardiologist and cardiothoracic surgery. Panaromic information and dimensional analysis of the of the coronary ostium is essential for numerous interventional cardiovascular procedures such as catheterisation of coronary arteries, percutaneous aortic root valve replacement, aortotomy, incision for aortic valve exposure, aortic root enlargement and surgical ostioplasty [18].

Limitation(s)

The main limitation of the study was its small sample size and gender differentiation was not considered. The hearts used were not freshly procured which might affect the dimensions of the study. This knowledge is important for anatomist, radiologist, interventional cardiologist and cardiothoracic surgery.

CONCLUSION(S)

Role of extracoronary ostia should always be taken into account during investigative and remedial interventions. Awareness about extracoronary ostia would provide a deeper insight about possible complications arising during various surgical procedures to avoid damage. Present study revealed variation in number and shape of coronary and extracoronary ostia, knowledge of which is also important for cannulation of vessels during procedure like open aortic surgery and coronary arteriography. Present anatomical study also focuses on position of coronary as well as extracoronary ostia. So, it may help the cardiac surgeons to reconstruct aortic root and their satisfactory recovery.

The study samples should be more and freshly procured which would yield accurate dimensions. Study would be more valid if done in living subjects using angiography. Individuals with multiple ostia should have regular follow up to watch out for any coronary artery disease related symptoms extracoronary though correlation of multiple ostia and clinical symptoms is not much studied.

REFERENCES

[1] Standring S, Ellis H, Healy J, William A, Jonn D. Gray's Anatomy: The anatomical basis of clinical practice. 39 edition. 2006; 996-997.
[2] Gittenberder-de Groot AC, Sauer U, Quaegebeur J. Aortic intramural coronary artery in three hearts with transposition of great arteries. J Thorac Cardiovasc Surg. 1986;91(4):566-71.
[3] Joshi SD, Joshi SS, Athavale SA. Origins of the coronary arteries and their significance. Clinics. 2010;65(1):79-84.
[4] Sievers HH, Hemmer W, Beyersdorf F, Moritz A, Moosdorf R, Lichtenberg A, et al. The everyday used nomenclarture of the aortic components: Aortic root components: The tower of babel? EJCTS. 2012; 41:478-82. Doi: 10.1093/ejcts/ezr093.
[5] Bogers AJJC, Gittenberger-de-Groot AC, Poelmann RE, Peault BM, Huysmans HA. Development of the origin of the coronary arteries, a matter of in growth or outgrowth? Anatomy and embryology. 1989;180(5):437-44.
[6] Koshi R et al. Cunnighum Manual of Practical Anatomy: Oxford Univercity Press.15th edition.1986; 13-89.
[7] Wolloscheck T, Zipfel J, Konerding MA. Aortic valve structures as landmarks for determining coronary artery ostia in transthoracic echocardiography. 2001;26(7):461-67.
[8] Kalpana R. A study of principal branches of coronary arteries in human. J Anat Soci Ind 2003;52 (2):137-40.
[9] Stankovic I, Jesic M. Morphometric characteristics of the conal coronary artery. MJM. 2004;8(1):02-06.
[10] Joshi SD, Joshi SS, Athavale SA. Origins of the coronary arteries and their significance. Clinics (Sao Paulo). 2010;65(1):79-84.
[11] Bharambe VK, Arole VA. Study of variations in coronary ostia. J Anat Soc India. 2012;61(2):221-28.
[12] Chhaparwal R, Joshi SS, Joshi SD. Study of coronary ostia, their variation and clinical significance. JEMDS. 2015;85(4):14806-61.
[13] Dhobale MR, Puranik MG, Mudiraj NR. Anatomical study of right coronary artery and its variations in adult human cadavers: Developmental basis and clinical significance. IJARS. 2018;37646:2441.
[14] Jyothi SR, Dakshayani KR. Morphometric study of coronary Ostia in human cadavers by dissection method. IJCAP. 2017;4(2):130-32.
[15] Dakhane Prafulla S, Patil tushar R. study of coronary ostia in preserved human cadaveric heart specimens in western Maharashtra y dissection method. Int J Anat res. 2018;6(3):5400-04.
[16] Saminathan S. Morphological study of coronary ostia, IJAR 2020; 8(02),102-106.
[17] Mobin N, basavanagowdappa H, madhu B. A Cross-sectional study of anatomical variations of coronary ostia in the adult human hearts and its clinical significance. JCDR. 2021,15(2):05-09.
[18] Kulkarni JP, Paranjpe V .Topography, morphology and morphometry of coronary ostia- a cadaveric study. Eur J Anat. 2015;19(2):165-70.

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