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MORPHOLOGY OF CORONARY SINUS OSTIUM AND THEBESIAN VALVE

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ABSTRACT

The coronary sinus ostium in the right atrium is covered by endocardial tissue called the Thebesian valve, which can influence and cause difficulty in many cardiac procedures like cannulation and lead placements. The aim of this study is to measure the dimensions of coronary sinus ostium and Thebesian valve covering the ostium. Our study of 25 formalin fixed hearts showed the presence of Thebesian valve at an incidence of 76%. The shape of the Thebesian valve was also noted and semilunar type was found to be predominant with 42.10%, followed by remnant type. Out of the total hearts, 20% of specimens were more likely to cause obstruction, which includes fenestration and cord type. No specimen was found to have Thebesian valve completely obstructing the ostium. The mean transverse and craniocaudal diameter were significantly more in the hearts without Thebesian valve than the hearts with Thebesian valve. The dimensions of the Thebesian valves revealed the mean transverse diameter was minimum in remnant type (5.25mm) and maximum in fenestrated type (8.7mm). The minimum and maximum craniocaudal diameters of the valve were found in the remnant type (1.86mm) and the fold type (8.3mm) respectively. Knowing about the variations and careful evaluation of these diameters and Thebesian valve will be helpful for the surgeons to overcome the difficulties faced during interventional cardiac procedures.

KEYWORDS: Thebesian valve, Coronary sinus ostium, Cardiac procedures.

INTRODUCTION

The majority of venous blood from the heart drains into the right atrium through a large venous structure, the coronary sinus and its tributaries. It extends from the valve of Vieussens to the coronary sinus ostium in the right atrium. The ostium of the coronary sinus is located posteromedially between the inferior vena cava on the right and the right atrioventricular orifice on the left. A fold of endocardial tissue that covers the sinus ostium is called the Thebesian valve or valve of coronary sinus ostium. This Thebesian valve can act as a hindrance for communication between the coronary sinus and the right atrium by obstructing the ostium area.[1]

The coronary sinus ostium serves as a landmark for many diagnostic and therapeutic procedures like cardiac resynchronization therapy (CRT), mapping and catheter ablation of cardiac arrhythmias, defibrillation, perfusion therapy, mitral valve annuloplasty, targeted drug delivery, retrograde cardioplegia administration and diverse coronary outflow.[1],[2]

There occurs wide morphological variation in the Thebesian valve documented as early in 1951 which has the potential to interfere with many clinical procedures like cannulation of the coronary sinus.[3] Hence the anatomy, dimensions and variations of the coronary sinus ostium and its valve will be useful to overcome the difficulties in multiple clinical procedures and has various clinical implications in therapeutic and diagnostic cardiac interventional studies.

AIM AND OBJECTIVE

To measure the dimensions of coronary sinus ostium and to determine the presence and absence of Thebesian valve

To determine the shape and measure dimensions of Thebesian valve

METHODOLOGY

It was a descriptive study conducted with 25 formalin-fixed human cadaveric hearts from the Department of Anatomy, Indira Gandhi Medical College and Research Institute, Puducherry.

The heart specimens were removed from the cadaver by macroscopic dissection method washed in running tap water and numbered. After this process, they were stored in 10% formalin.

During the examination, the right atrium was opened by an incision made parallel and anterior to the sulcus terminalis along the right margin of the right atrium. The coronary sinus ostium and the valve covering the orifice

were identified. The heart was held in anatomical position and the dimensions of the coronary sinus ostium, which included transverse diameter and cranio-caudal diameters were measured using vernier calliper.

Transverse diameter
The transverse diameter of the coronary sinus ostium was noted as the largest dimension measured by the calliper up to the first point of resistance.

Craniocaudal diameter
It was measured from the free margin of the Thebesian valve to the first point of resistance.

If the ostium was covered by the Thebesian valve, then, the shape of the valve was noted and classified according to Holda et.al as follows.
Type I - Remnant
Type II - Semilunar
Type III - Fold
Type IV - Cord
Type V - Mesh & Fenestrated

The vertical and transverse diameters of the Thebesian valve were also measured and noted.
The measurements were done using a vernier calliper of 0.01mm accuracy.

STATISTICAL ANALYSIS
The data collected were entered in the Excel sheet and analysed using SPSS. The descriptive data were expressed in Mean ± SD. The comparison between the data was done by using student's t-test.

RESULT
A total of 25 heart specimens from cadavers were taken and the coronary sinus ostium area was examined. About 76% of specimens showed the presence of the Thebesian valve covering the coronary ostium and 24% had no valves.

In specimens with Thebesian valve, the mean transverse diameter of the coronary sinus ostium measured about 7.989 ± 1.251 mm and the mean craniocaudal diameter was 8.089 ± 2.307 mm. In hearts with absent Thebesian valves, the mean transverse and craniocaudal diameters were 9.266 ± 0.625 mm and 10.216 ± 0.844 mm respectively.

The mean transverse and craniocaudal diameters were significantly higher in hearts without the Thebesian valve than in the hearts with the presence of valves in the coronary sinus ostium. (Table 1)

Table 1: Comparison of Mean and Standard deviation between diameters of coronary sinus ostium and Thebesian valve.

Diameters (mm)	With Thebesian valve		Without Thebesian valve		P value
	Mean	SD	Mean	SD	
Transverse diameter	7.989	1.251	9.266	0.625	0.025
Craniocaudal diameter	8.089	2.307	10.216	0.844	0.0393

SD – Standard deviation

The hearts with the Thebesian valve showed morphological variations, in which the semilunar type was predominant at 42.10% followed by the remnant type with 31.57%. The incidence of fenestrated type and fold type were 15.78% and 10.52% respectively. In our study, there was no specimen with the cord or the mesh type valve. (Table 2)

Fig: 1 Remnant type of thebesian valve

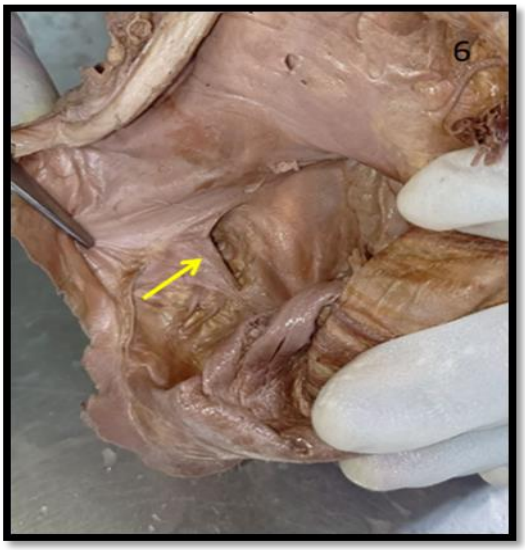

Fig: 2 Semilunar type of Thebesian valve

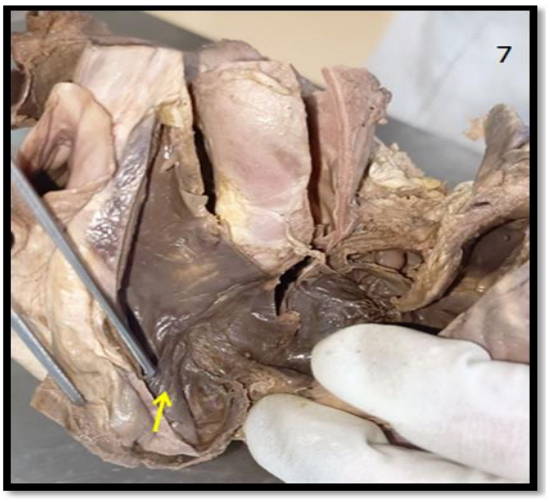

Fig: 3 Fold type of Thebesian valve

Fig: 4 Fenestrated type of Thebesian valve

Table 2: Incidence of types of Thebesian valve.

Shape of the valve	Frequency (n= 19)	Percentage
Remnant(Fig:1)	6	31.57%
Semilunar(Fig:2)	8	42.10%
Fold(Fig:3)	2	10.52%
Fenestrated(Fig:4)	3	15.78%

The dimensions of the Thebesian valve which includes vertical and transverse diameters were measured. The mean transverse diameter was minimum in the remanent type (5.25mm) and maximum in the fenestrated type (8.7mm). The minimum and maximum craniocaudal diameters of the valve were found in the remnant type (1.86mm) and the fold type (8.3mm) correspondingly. (Table 3)

Table 3: Mean diameters of Coronary sinus Ostium in various types of Thebesian valve.

Type	Transverse diameter(mm)	Craniocaudal diameter (mm)
Remnant	5.25±2.18	1.86±0.67
Semilunar	8.02±1.71	5.63±1.06
Fold	8.15±1.76	8.3±1.69
Fenestrated	8.7±1.67	6.63±2.61

The values were expressed in Mean±Standard Deviation

DISCUSSION

The coronary sinus develops from the left horn of sinus venosus and the caudal portion of the right sinoatrial valve becomes the Thebesian valve and the valve of inferior vena cava.[4] The normal variations in the configuration of Eustachain and Thebesian valve are supposed to be caused by differential growth of different portions of the valves.[5]

In previous studies, it was reported that failed access to coronary ostium may be due to hindrances caused by the Thebesian valve and Eustachian valve. Out of these, the Thebesian valve remains the potential cause, as it covers the ostium directly, which makes the cannulation more difficult. The Thebesian valve can also cause obstruction and narrowing of the ostial area of the coronary sinus and lead to failure in procedures like left ventricular lead implantation.[6]

Our study reports the incidence of Thebesian valve to be 76% which shows variability in morphology and shapes. From various other cadaveric studies in literature, the presence of the Thebesian valve accounts 64% to 85% and the degree of obstruction depends upon the shape of valve. (Table 4)

Table 4: Comparison of incidence of heart with presence of Thebesian valve with other studies.

S no	Author	Year & country	Samples (n)	% of heart with Thebesian valve
1	Hellerstein et.al[3]	1950 (Ohio)	150	85%
2	Pejkovic et.al[7]	2008 (Austria)	150	80%
3	Mak et.al[6]	2009 (USA)	75	73%
4	Randhawa et.al[8]	2013 (India)	50	64%
5	Holda et.al[1]	2014 (Poland)	273	82%
6	Gosh et.al.[9]	2014 (India)	150	79%
7	Pitrowska et.al[2]	2015 (Poland)	301	81.40%
8	Present study	2023 (Puducherry)	25	76%

In the study conducted by Holda et.al, the valves with fold and mesh/fenestration types that cover >75% of the ostium are found obstructing the orifice and cause difficulty in cardiac procedures.[1] In our study, 5 specimens (20%) are found to cause obstruction, of which 3 specimens are of fenestration type and 2 are of fold type. In literature, the cadaveric study done by Karaca et.al (2005)[10] in Turkey documented the least incidence of 8%, and higher incidence was noted in Hellerstein et.al (1950) with 24.6% incidence.[3] Some samples with large Thebesian valve completely obstructing the ostium were also documented in literature like Holda et.al study(2014) with the incidence of 2.6%.[1] No such complete obstruction of sinus ostium is found in our study.

In our study, the semilunar shape is predominant at 42.10% followed by the remnant type at 31.57%. This result coincides with other studies conducted by Holda et.al, Pitrowska et.al, Gosh et.al and Zhivadinovik et.al, which showed an increased incidence of semilunar type of valve with 32.6%, 24.3%, 55%, and 74.42% respectively.[1],[2],[9],[11] Many authors have reported numerous anatomical variations in coronary sinus ostium and Thebesian valve and inferred that the presence of valve at the entrance of coronary sinus could pose difficulties in cannulation of the coronary sinus.[11]

Thebesian valves with fenestrations may lead to a difficult introduction of the delivery system in the procedure of left ventricular lead placement in Cardiac Resynchronisation Therapy. Our study shows the incidence of fenestration type with 12 % which is similar to Pejkovic et.al with 11%.[8] Others studies like Zhinadinovik et.al and Karaca et.al showed decreased incidence with 8.3% and 5.3% correspondingly.[11],[10] Ghosh et.al, reported a higher incidence of this type at 30.5% in his study.[9]

Few surgeons use a haemodynamic approach for placing a delivery system for the left ventricular lead in which they use wire for sliding the delivery system into the sinus. When the wire enters the fenestration, the sheath may cause damage to the valve. To overcome this, electrophysiological approach is followed where the electrophysiologic catheter is used for sliding delivery sheath. As there is minimal or no difference between the diameter of the catheter and the sheath, there is a lower risk of damage.[12]

In the present study, the mean craniocaudal diameter and transverse diameter are significantly higher in the hearts without the Thebesian valve when compared to hearts with Thebesian valve which coincides with other studies like Mak et.al, Zhivadinovik et.al.[6],[9]

The presence of a prominent Thebesian valve will remain an under-recognized problem during coronary sinus cannulation. They provide significant challenges in multiple procedures like coronary venous lead placement for cardiac resynchronization therapy, mapping & catheter ablation in arrhythmias. Though the difficulty in cannulation of coronary sinus is very infrequent, the true incidence of this problem is greater than reported.[7]

CONCLUSION

Based on our study, the incidence of the presence of Thebesian valve was 76% and the most common type of valve encountered was the semilunar type with 42.10% followed by the remnant type. The subtypes of valve causing obstruction were fenestration and fold type which was about 20% of total specimens in our study and no specimen had Thebesian valve causing complete obstruction in the ostium. There occurs a significant increase in the mean value of both craniocaudal and transverse diameter of coronary sinus ostium in the hearts with the absence of the Thebesian valve. This study can give an idea about the functional anatomical features and barriers of human coronary sinus ostium which can give better outcome for many diagnostic and therapeutic procedures of heart.

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