

**Original article**

## **Study of Anatomical Variation in coronary sinus, its tributaries and Thebesian valve**

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### **ABSTRACT:**

**Introduction:** The venous drainage systems of the heart is coronary sinus and its tributaries. The coronary sinus opens into the right atrium between the openings of inferior vena cava (IVC) and the right atrioventricular orifice. The opening is guarded by the Thebesian valve. Hence, this study was undertaken to generate the data on variations in morphology and morphometry of coronary sinus, its tributaries and Thebesian valve in cadaveric hearts.

**Material and Methods:** Using conventional dissecting techniques, 60 hearts from embalmed cadavers were dissected and studied for coronary sinus ostium for width, shape of valve any ridge, bar, network across the ostium. Also sinus was studied for length, formation & no. of tributaries.

**Results:** In 51 cases, the great cardiac vein with left marginal vein joined and formed coronary sinus. In 9 cases the great cardiac vein fused with oblique vein of left atrium to form coronary sinus. Oblique vein of left atrium and posterior vein of left ventricle was absent in 2 and 3 specimens respectively. Small cardiac vein had their opening in the coronary sinus in 10 specimens. The mean length of sinus was being 39.24 +/- 6.4 mm. The sinus ostium was oval in shape, in 49 cases it is guarded by semilunar shaped Thebesian valve. The mean width of ostium is 10.24 +/- 2.34 mm

**Conclusion:** The great cardiac vein with left marginal vein joined and formed coronary sinus. The mean length of sinus was being 39.24 +/- 6.4 mm. The mean width of ostium is 10.24 +/- 2.34 mm guarded by semilunar shaped Thebesian valve. This study may favorably add to the sparsely available data of variation in coronary sinus tributaries and ostium along with Thebesian valve in Indian population.

**Key Words:** coronary sinus, Small cardiac vein, Thebesian valve, coronary sinus ostium

### **INTRODUCTION**

One of the main venous drainage systems of the heart is the coronary sinus and its tributaries receiving about 60% of the total cardiac venous return from posterior myocardium and opens into the right atrium. Another important venous system consists of the anterior cardiac veins, which directly opens into the right atrium and majorly drains the remaining 40%.<sup>(1)</sup> The coronary sinus is 2 or 3 cm long and lies in the posterior part of the atrioventricular groove. The coronary sinus opens into the right atrium between the openings of inferior vena cava (IVC) and the

right atrioventricular orifice. The opening is guarded by an endocardial fold the Thebesian valve. The tributaries of coronary sinus are— great, small and middle cardiac veins, posterior vein of left ventricle and oblique vein of left atrium.<sup>(2)</sup>

The coronary venous system is important in many electrophysiological procedures including arrhythmia ablation, biventricular pacing and for deployment of an array of cardiac devices like Pacemakers.<sup>(3,4,5)</sup> Also new cardiological techniques are targeting catheterization of coronary sinus and cardiac veins to study various avenues in overcoming ischemic and arrhythmic conditions of heart. The cardiac venous system has been effectively used to provide retrograde perfusion of myocardium prior to the widespread use of coronary artery bypass grafting and is still applicable in "ungraftable" patients.<sup>(6)</sup> The difficulties encountered in the catheterization of coronary sinus are probably due to obstruction offered by large membranes, bars and networks.<sup>(7)</sup> Also the Thebesian valve and its variations may cause difficulties during these interventions.

As such the knowledge of variations in coronary sinus, its tributaries and the Thebesian valve, which are prevalent in population, should be studied to estimate the associated risks during the interventions. Also for a treating surgeon, this knowledge of variability useful for taking precautions in the specific condition. Hence, this study was undertaken to generate the data on variations in morphology and morphometry of coronary sinus, its tributaries and Thebesian valve in cadaveric hearts.

#### **MATERIAL AND METHODS**

This study was conducted on 60 formalin fixed cadaveric hearts of either gender in the department of anatomy, B J Govt. Medical College, Pune. Conventional techniques were used to dissect the hearts. The right atrium was opened to study the orifice of coronary sinus. The width of coronary sinus was measured by using Vernier caliper. The presence and shape of Thebesian valve was noted. Observations were made and noted for any ridges, networks or membrane across the orifice of coronary sinus. The length of coronary sinus was measured with Vernier caliper. All the tributaries were dissected and traced up to coronary sinus. Any variations in tributaries were noted. Formation of coronary sinus was noted. The cadaveric hearts with coronary bypass, angioplasty or other such surgical procedures affecting the study parameters were excluded from this study.

#### **RESULTS:**

In present study, the coronary sinus was present in all 60 heart specimens. A constant location of coronary sinus was observed and noted in all the 60 specimens i.e. the left posterior atrioventricular groove. Fig. 1

**Formation of Coronary Sinus:** In 51 (85%) cases great cardiac vein with left marginal vein joined and formed coronary sinus. In 9 cases (15%) great cardiac vein fused with oblique vein of left atrium to form coronary sinus.

**Tributaries of Coronary Sinus:** Oblique vein of left atrium, great cardiac vein, posterior vein of left ventricle and middle cardiac vein were found draining directly in the coronary sinus (Fig. 1) in all the 60 heart specimens. Similarly, anterior cardiac vein was found to be directly draining into the right atrium in all the heart specimens. While, oblique vein of left atrium and posterior vein of left ventricle was absent in 2 and 3 specimen respectively. Right marginal vein emptied into the small cardiac vein in all the specimen. As mentioned previously, 51 (85%) no. of specimen left marginal vein directly drained into the coronary sinus. In 10 (16.67%) specimens the Small cardiac

vein had their opening in the coronary sinus while in the remainder 50 (83.33%) specimens, it directly drained in the right atrium. An account of tributaries of coronary sinus was shown in Table 1.

**Length of Coronary Sinus:** Total external length of coronary sinus irrespective of veins which forms the sinus was ranged from 22.5 mm to 60.7 mm, mean being 39.24 +/- 6.4 mm. (Table 2)

**Coronary sinus ostium and Thebesian Valve:** Coronary sinus ostium was observed for its shape and for the presence of Thebesian valve. The coronary sinus ostium was oval in shape in all the specimens. The Thebesian valve (Figure 2) was present in 49 (82%) heart specimens. Valve was semilunar in shape in all the specimens. Further no membrane, network, ridges were seen at the orifice in either of the specimens.

**Width of Coronary Sinus Orifice:** The mean width of coronary sinus ostium was found to be 10.24 +/- 2.34 mm.

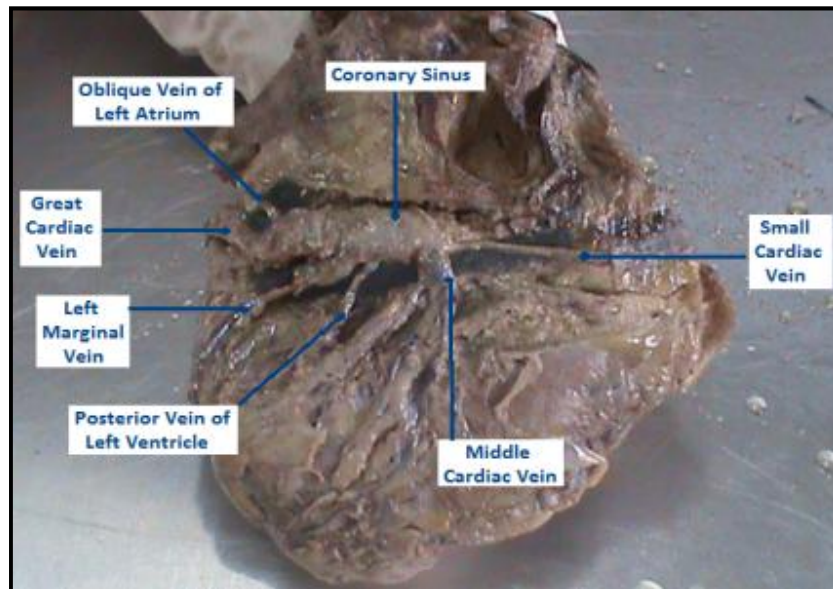
**Table 1: Tributaries of Coronary Sinus**

Sr, No.	Tributaries of Coronary Sinus	Present in number of specimens	Absent in number of specimens
1	Great cardiac vein	60	-
2	Left marginal vein	60	-
3	Oblique vein of left atrium	58	2
4	Posterior vein of left ventricle	57	3
5	Middle cardiac vein	60	-
6	Small cardiac vein	60	-

**Table 2: Length of coronary sinus:**

Sr. No.	Formation of coronary Sinus	Length of Coronary Sinus: Mean (mm)
1.	Great cardiac vein with left marginal vein (51 cases)	36.3mm
2.	Great cardiac vein with oblique vein of left atrium (9 cases)	43.4mm

**Figure1: Posterior view of heart specimen showing coronary sinus and its tributaries**



**Figure 2. Heart specimen showing Thebesian valve guarding the coronary sinus**



## DISCUSSION

The coronary sinus (CS) has been recently gaining importance for a number of clinical interventions like mapping and ablation of left-sided accessory pathways. Additionally, the CS also plays a role in automaticity and arrhythmias given the potential for spontaneous depolarization and slow conduction in the smooth muscle.<sup>(8,9,10,11,12)</sup> Also the atrial myocardial sleeve that covers the proximal CS plays a role in automaticity and arrhythmias.<sup>(13)</sup> Cannulation of the CS has been undertaken for interventional procedures like percutaneous mitral valve annuloplasty and Thebesian valves may complicate such procedures by causing obstruction.<sup>(14,15)</sup>

Although coronary venous system had attracted less attention compared to coronary arterial system, the upcoming procedures have renewed the interest in this venous approach. There are very few studies giving an account about different prospective of coronary study.

**Formation of coronary sinus:** In the present study, we observed the formation of coronary sinus in the pattern that the great cardiac vein joined with left marginal vein in 51 cases (85%) and formed the coronary sinus and in 9 cases (15%) great cardiac vein fused with oblique vein of left atrium to form coronary sinus. According to R. Manoranjitham et al and Ortale JR et al, CS was formed by oblique vein of left atrium joining with great cardiac vein.<sup>(16,17)</sup> However, according to Iyer PB, The great cardiac vein itself continues as coronary sinus at the left end of the posterior coronary sulcus.<sup>(18)</sup> These authors did not consider the left marginal vein and posterior vein of left ventricle as tributaries of CS, therefore the ambiguity arises regarding the formation of CS. However, Gathe et al have noted the formation of coronary sinus under the following types:<sup>(19)</sup> Type I- when the great cardiac vein joins with left marginal vein to form coronary sinus, (the 89.47% specimens in present study) Type II- when the great cardiac vein joins with posterior vein of left ventricle to form the coronary sinus, (not found in present study) Type III- when the great cardiac vein joins with oblique vein of left atrium to form coronary sinus. Other variety Type IV- when the great cardiac vein does not end in the CS and ends directly into right atrium or into anterior cardiac vein, however this was also not found in present study.

**Length:** The length of coronary sinus in the study done by Kavimani and Jebakani CF, ranged from 20 to 38 mm and the mean was 28 mm.<sup>(20)</sup> In the study done by Gathe et al the mean length of CS was 53.80 mm and 51.06 mm where the CS was formed by the union of great cardiac vein and left marginal vein and by the union of great cardiac vein and posterior vein of left ventricle, respectively.<sup>(19)</sup> While, another specimen of Gathe et al, in which CS was formed by the union of great cardiac vein and oblique vein of left atrium – the length was 31.50mm.<sup>(19)</sup>

In the study by Manoranjitham et al, the mean length of coronary sinus in 28 specimens was 54.98 + 12.2 mm where the coronary sinus was formed by the union of great cardiac vein and left marginal vein.<sup>(16)</sup> In the specimen in which coronary sinus was formed by the union of great cardiac vein and posterior vein of left ventricle- the length was 53.06 mm. In another specimen in which coronary sinus was formed by the union of great cardiac vein and oblique vein of left atrium – the length was 34.52mm.<sup>(16)</sup> In present study, the mean length of CS was 36.3 mm in specimens where CS was formed by the union of great cardiac vein with left marginal vein while it was 43.4 mm in cases where CS was formed by the union of great cardiac vein with oblique vein of left atrium. There seems to be quite good amount of variation seen in the reported length of CS in previous studies vis-à-vis this study.

**Orifice width:** The width of orifice of CS was found to be 9.6 mm according to Cleland JG.<sup>(21)</sup> In the study of R. Manoranjitham et al. the coronary ostium measured  $9.35 \pm 3.24$  mm while Gathe et al. reported the average width of CSO as 11.89mm.<sup>(16,19)</sup> In present study, the mean width of coronary sinus orifice was found to be  $10.24 \pm 2.34$  mm. The findings thus reveal less disparity in this parameter across similar studies.

**Thebesian valve:**

The Thebesian valve is named after the physician and anatomist Adam Christian Thebesius (1686–1732). It is an endocardial tissue guarding the coronary sinus opening. In fetal life, the Thebesian valve probably have the role of directing blood flow from the coronary sinus. Another hypothesis states that the Thebesian valve is formed due to the interaction between different hemodynamic currents from the right atrium and the coronary sinus. These valves occluding more than 65-75% of the coronary sinus ostium are considered as “potential complicating factors” in cannulation of the sinus.<sup>(6,22)</sup> According to Hellerstein HK and Orbison JL the orifice of coronary sinus appeared mostly oval in shape and was guarded by the thebesian valve.<sup>(23)</sup> Mainly 6 types of variations in the valve of coronary sinus have been reported by them:

- Absent in 14.7%
- Small and crescent in 38%
- Large and covering the entire orifice of coronary sinus in 30.7%
- Bars and bands in 5.7%
- Threads and networks in 5.3%
- Common Eustachian and thebesian valves in 6%

In the study by Manoranjitham et al, the thebesian valve was present in 93.33% specimens and it was semilunar in shape.<sup>(16)</sup> In one specimen, there was a network of fibers in the ostium of coronary sinus and in another specimen, the valve was absent. Gathe et al also found that the Thebesian valve was semilunar in shape in 37 specimens & it was remnant in 1 specimen. While in present study the Thebesian valve was present in 49 (82%) hearts.<sup>(19)</sup>

**Tributaries:**

One of the main venous drainage systems of the heart is the coronary sinus and its tributaries receiving about 60% of the total cardiac venous return from posterior myocardium and opens into the right atrium. Another important system consists of the anterior cardiac veins, which directly opens into the right atrium and majorly drains the remaining 40%.<sup>(1)</sup>

In the present study, oblique vein of left atrium, great cardiac vein, posterior vein of left ventricle and middle cardiac vein were found draining directly in the coronary sinus in all the 60 heart specimens. While, Oblique vein of left atrium and Posterior vein of left ventricle was absent in 2 and 3 specimen respectively. Also, anterior cardiac vein was found to be directly draining into the right atrium in all the heart specimens. Right marginal vein drained into the small cardiac vein in 100% of cadaveric hearts. Left marginal vein drained into the great cardiac vein in 51 (85%) specimens, while in 9 (15%) cases it directly drained into the coronary sinus. The finding is quite similar to the observations made by Ortale et al where left marginal vein drained in 81% & 19% cases in great cardiac vein and coronary sinus respectively.<sup>(17)</sup> Small cardiac vein had their opening in the coronary sinus in 10

(16.67%) specimens while in the remainder 50 (83.33%) specimens, it directly drained in the right atrium. Iyer PB reported a case of great cardiac vein directly draining into the right atrium.<sup>(18)</sup>

#### **CONCLUSION:**

In Present study, majority of specimen had fusion of great cardiac vein with left marginal vein joined and formed coronary sinus. The mean length of sinus was being 39.24 +/- 6.4 mm. The mean width of ostium is 10.24 +/- 2.34 mm, and in 42 specimen it was guarded by semilunar shaped Thebesian valve. Oblique vein of left atrium, great cardiac vein, posterior vein of left ventricle and middle cardiac vein were found draining directly in the coronary sinus in all the 60 heart specimens. In 10 (16.67%) specimens the Small cardiac vein had their opening in the coronary sinus. Oblique vein of left atrium and Posterior vein of left ventricle was absent in 2 and 3 specimen respectively.

Hence, the knowledge of variation pattern of formation of coronary vein, its tributaries along with the prevalence of pattern of Thebesian valve in the population and the associated risks is of prime importance for a treating surgeon. Also, it is useful for the precautions to be taken in the specific conditions. The findings in this study may favorably add to the sparsely available data of variation in coronary ostia variables in Indian population.

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**Conflict of interest:** None

**Contribution of Authors:** Shubhangi Mutyal was involved in designing and conduct of the study, data collection and formulating the manuscript. Swati Pandhare was involved in conduct of study and formulating the manuscript. Anjana Gaikwad and Nutan Mandke were involved in writing the manuscript.

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