ABSTRACT

Introduction: The major vein draining blood from the heart is the Coronary Sinus (CS). Its significance in facilitating numerous cardiac treatments such as biventricular pacing, and the placement of a variety of cardiac devices has made the CS a therapeutically essential structure. The development of advanced invasive and interventional cardiac procedures requires a thorough understanding of CS anatomy.

Aim: To determine the location, shape, length, and width of the CS together with its left atrial muscular coverage in hearts of formalin-fixed cadavers.

Materials and Methods: The present study was a cross-sectional study in which data was collected from 90 adult human cadaveric hearts preserved with formalin. Forty cadaveric heart was obtained from Department of Anatomy, Pramukhswami Medical College, Karamsad and 50 from Dr. ND Desai Medical College and Hospital, Nadiad, Gujarat, India and study was conducted from August 2020 to July 2022. External Lengths (EL) of CS were measured using thread and Vernier Caliper at different levels (EL1-From the entry of oblique vein into CS and EL2-From the point of union of the great cardiac vein and left marginal vein up to its termination). CS width was measured: at the beginning, at the point where Middle Cardiac Vein (MCV) enters, and at the point where it terminates in the right atrium. CS walls were examined to see whether the muscles of the left atrium covered them or not. Using Statistical Package for the Social Sciences (SPSS) software, a descriptive analysis was conducted to determine the range, mean, and standard deviation.

Results: In all 90 (100%) hearts, CS was found in the posterior atrioventricular sulcus. Tubular-shaped CS was found in 80 (88.9%) hearts, while 10 (11.1%) hearts had funnel-shaped CS. The EL1 of the CS was 43.75±4.68 mm and EL2 was 40.19±5.62 mm. The width of the CS was 6.71±1.47 mm at the beginning, 8.49±1.89 mm at the entrance point of MCV, the maximum width at termination in the right atrium was 8.14±2.16 mm and the minimum width was 5.16±1.70 mm. Muscles of the left atrium covered CS in all cases.

Conclusion: The CS has a variable location, shape, length, and width despite being a constant component of the heart’s venous system. Its importance in giving access to various cardiac procedures has made it a clinically significant structure. The baseline data of this study can help the cardiologists performing various cardiac procedures in the Gujarat population.

INTRODUCTION

The literature has several descriptions of the coronary artery system. The coronary venous system, however, has received little attention [1]. The CS is a wide venous channel located in the posterior part of the atrioventricular groove which receives a majority of cardiac veins of the heart. About 60% of the venous blood from the heart is drained by CS. The length of CS ranges from 3.0-5.5 cm [2,3]. The Oblique Vein of the Left Atrium (Ovla) (oblique vein of Marshall) and the great cardiac vein unite to form the CS [4]. The CS terminates between the opening of the inferior vena cava and the right atrioventricular orifice into the right atrium; which is guarded by a semilunar valve (an endocardial fold) [5]. It is an important structure, as it provides access to different cardiac treatments such as biventricular pacing, arrhythmia ablation [6,7]. Additionally, procedures like: percutaneous mitral annuloplasty, retrograde cardioplegia delivery, targeted medication delivery, and the implantation of a CS reducer in refractory angina are all performed through the CS [2,8]. With the development of many advanced invasive and interventional cardiac procedures to treat problems like heart failure and arrhythmias, it is important to understand the morphology of CS [9,10]. In India, data regarding the morphology and morphometry of CS is available for the North Indian and South Indian populations [11-15]. Hence, the purpose of the current study was to observe various morphological and morphometric parameters of CS in formalin-fixed cadaveric hearts in Gujarat population of Western India.

MATERIALS AND METHODS

This cross-sectional cadaveric study was conducted in the Department of Anatomy, Pramukhswami Medical College Karamsad, and Dr. ND Desai Medical College and Hospital Nadiad, Gujarat, India from August 2020 to July 2022. The study was conducted after approval of Institutional Ethics Committee (IEC). Approval No: IEC/HMPCMCE/2020/EX.30/12/2022).

Inclusion criteria: A total of 90 human formalin-fixed cadaveric hearts of either sex (age range: 20-80 years) were included in the study.

Exclusion criteria: Hearts having significant pathology, postsurgical evidence or congenital defects were excluded from the study.

After removing the fat from the posterior atrioventricular groove, the CS was identified. The entire CS was cleaned properly through careful dissection. After observing CS, measurements were obtained with a vernier caliper and threads. To measure the dimensions of the coronary ostium, the interior of right atrium was exposed by dissection.

Measurements of the Coronary Sinus (CS)

After identifying the presence of CS, its exact location was identified. The CS was categorised into different shapes such as tubular, conical, funnel, or any other [16]. A thread was used to measure the EL. One point was marked on the thread at the site where the Ovla entered the CS, then the thread was positioned along the length of the CS, and the other point was marked at the site where
CS terminated into the right atrium. The thread was then stretched out on a level surface, and a digital vernier caliper was used to measure the distance between the two points. This reading was noted and recorded as EL1 [Table/Fig-1]. If the OVLA was absent; then the point of union of the great cardiac vein and left marginal vein was used as the landmark and this length was recorded as EL2 [Table/Fig-2].

With the use of a divider and a vernier caliper, the width of the CS was measured at three points: first at the beginning, second at the point where the MCV enters the CS, and third at the site where it opens in the right atrium (coronary ostium) [Table/Fig-3,4]. At the coronary ostium, the minimum and maximum widths were measured and documented separately [Table/Fig-4]. The minimum width was measured between the free border of the valve and opposing margin of the coronary ostium, and the maximum width was determined by taking a measurement parallel to the free border of the valve (excluding the valve). A careful inspection of the walls of CS was done to identify whether it was covered by the left atrial muscles or not. If muscle covering was found, then the extent of the covering was noted, whether it was one-third, one-third to two-thirds, or more than two-thirds of the length of CS.

STATISTICAL ANALYSIS
Data were entered in EPI INFO 7. Continuous variables were expressed with mean and standard deviation while categorical variable was presented with percentages.

RESULTS
The CS was present in all 90 (100%) hearts and all were located in the posterior part of atrioventricular groove. Tubular-shaped CS was found in 80 (88.9%) hearts while in 10 (11.1%) hearts had funnel-shaped. EL1 of CS was $43.75\pm4.68$ mm while EL2 was $40.19\pm5.62$ [Table/Fig-5]. The width of CS at the beginning and at the point of entry of MCV was $6.71\pm1.47$ mm and $8.49\pm1.89$ mm, respectively [Table/Fig-6]. In all hearts (100%), the CS was covered by <two-thirds muscles of the left atrium.

DISCUSSION
The left atrial and Left Ventricular (LV) epicardium are both accessible through the CS. For detection and treatment of arrhythmias, a wide range of diagnostic and mapping procedures are carried out through CS. Interest in the anatomy of the coronary venous system is rising due to modifications of CS geometry by cardiac resynchronisation treatment and percutaneous mitral valve replacement operations [17,18].
Bergman RA et al., and Kawashima T et al., had reported variations related to the absence of the CS [19,20]. But in this study, all cases had a complete CS, which was consistent with observations mentioned by other authors that absence variations are uncommon [2,12,13,21,22].

The shapes of CS observed by various authors are compared in [Table/Fig-7]: which indicates that different populations may have different shapes of CS [11,22-25]. In the present study of the Gujarat population, tubular-shaped CS was found among 88.9% of hearts while 11.1% of the CS was funnel-shaped.

### Table/Fig-7: Shape of the Coronary Sinus (CS) in different population [11,22-25].

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Authors publication year</th>
<th>Shape of Coronary Sinus (CS)</th>
<th>%</th>
<th>Population</th>
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<td></td>
<td></td>
<td>Funnel</td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td>Funnel</td>
<td>23.5</td>
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<td></td>
<td>Flattened</td>
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<td></td>
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<tr>
<td>3</td>
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<td></td>
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<td>Tubular</td>
<td>43.8</td>
<td></td>
</tr>
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<td>4</td>
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<td></td>
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<td>Present study (2023)</td>
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<td></td>
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[Table/Fig-8]: Comparison of the length of the Coronary Sinus (CS) in different population [2,11-15,18,22-24,26].

Limitation(s)
Because of the lack of information on the variations in CS morphology between men and women and between different ages, no conclusion can be drawn regarding the prevalence of CS in one gender over another.

CONCLUSION(S)
Through its role in providing access to modern interventional procedures such as cardiac catheterisation, biventricular pacing, arrhythmia ablation, and the implantation of cardiac pacemakers, the CS is now begun to get more attention. The selection of the appropriate devices for cannulation procedures also depends on the morphology of the CS. The baseline data of this study can help cardiologists for performing various cardiac procedures.

REFERENCES

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