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Morphological and histological study of coronary sinus in human hearts from north-western region of Uttar Pradesh and its clinical implication

Jolly Agarwal[1], Anurag Agrawal[2], Virendra Kumar[3], Devendra Nath Sinha[4], Sudhahar Tamizhan[5], Manisha Naithani[6]

[1]Associate Professor, Department of Anatomy, [2]Professor and Head, Department of Pulmonary Medicine, Government Doon Medical College, Dehradun, [3]Emeritus Professor, Department of Anatomy, Veer Chandra Singh Garhwali Medical College, Srinagar, [4]Emeritus Professor, Department of Anatomy, Government Medical College, Haldwani, [5]Junior Resident, [6]Additional Professor, Department of Biochemistry, All India Institute of Medical Science, Rishikesh, Uttarakhand, India

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ABSTRACT

Background: Coronary sinus (CS) is the largest diameter vessel in the coronary venous network, which serves as the primary collector of cardiac venous blood. Because the coronary venous system is not prone to the effects of atherosclerotic disease, it may also serve as a potential avenue for coronary artery bypass. **Aims and Objectives:** The aim of the study was to provide morphological and histological data of CS for making an interventional device. **Materials and Methods:** The present study cross-sectional study. Thirty hearts of different ages and of both sexes (22 males and 8 females) and duration of study is 2 years procured from cadavers available in the Department of Anatomy, SRMS IMS, Bareilly, U.P, India, were taken. **Results:** The mean length of the CS is 36.83 ± 17.29 mm. The width of CS at the point of opening in to right atrium is 4.92 ± 3.53 mm. The mean length of CS in males was 41.44 ± 11.37 mm. While in females the mean length of CS was 39.29 ± 11.17 mm. Histological study by Orcein stain show different amount of elastic fibers in proximal, middle, and distal part.**Conclusion:** Morphological and histological study of the CS suggests this structure to be an independent, cardiac chamber with a mural structure similar to atrial myocardium and it may be target for study and ablation, in the future therapy of atrial arrhythmias.

Key words: Coronary; Sinus; Histology; Veins; Stain; Elastic

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INTRODUCTION

While anatomical studies of the heart began centuries ago, Herophilus (c.335–c.280 BC) was the first to observe and record differences between coronary arteries and veins. Most cardiac veins drain into the coronary sinus(CS) which is the main vein of the heart. CS lies in the posterior atrioventricular groove between the left atrium and ventricle.[1] The junction of the great cardiac vein and CS can also be defined by the existence of the vein of Marshall.

Because the coronary venous system is not prone to the effects of atherosclerotic disease, it may also serve as a potential avenue for coronary artery bypass. For example, from decades, the distribution of cardioplegia through the CS has been proven to be safe and effective in myocardial protection, and even superior to the traditional method of antegrade cardioplegia, especially in patients with coronary artery disease.[2]

Recently, since restoration of coronary blood flow before an acute myocardial infarction can significantly reduce infarct size and improve myocardial function, the administration of recombinant tissue-type plasminogen through the coronary venous system was shown to result in both shorter recovery times and significant reduction in

Address for Correspondence:
Dr. Manisha Naithani, Additional Professor, Department of Biochemistry, All India Institute of Medical Science,Rishikesh - 249 203, Uttarakhand, India. **Mobile:** +91-8475000296. **E-mail:** naithanimanisha@gmail.com

infarct size when compared to intravenous administration. The coronary venous system also can be employed to deliver cell therapy directly to the myocardium as a potential treatment for heart failure. Implantationof pacing leads throughthe coronary venous system is the most popular approach. It is less invasive.[3]

Developmentally CS and oblique vein of left atrium are derived from the left sinus horn and left half of transverse portion of embryonic sinus, after obliteration of the left common cardinal vein at 10 week.[4]

The internal appearance of CS resembles the right atrium more than the endothelium of vein. The free wall of the CS is made up of at least single layer of striated myocardial fibers along its axis forming a delicate network.[5]

Aims and objectives

The aim of present study is to provide morphological and histological data of CS for making an interventional device. This study may provide data for interventional devices in CS (e.g.,CS length, orifice, and its relationship with age and weight).

MATERIALS AND METHODS

The sample size was thirty. The sampling technique was convenient sampling and the duration of study was 2 years from 2012 to 2013. The study type was observational cross-sectional study. The study was approved by ethical committee of SRMS IMS, Bareilly. These hearts were taken from cadavers of different ages and both sexes (22 males and 8 females) from the Department of Anatomy, SRMS IMS, Bareilly, U.P. They were divided into5-yearage groups. Therefore, to standardize the observation the mean was considered and S.D was calculated by Microsoft office Excel 2007 accordingly and the due error was taken into the consideration to make the study more authentic. The diseased, decomposed,and hearts with congenital anomaly were excluded from the study.

The hearts were cleaned, washed, and fixed in 10% formalin. The CS was meticulously dissected. The coronary orifice in the right chamber of heart was observed after dissection of right atrium. The length of CS and width of CS at the site of opening into right atrium was taken with the help of digital Vernier calipers.

The CS was divided into three parts- proximal, middle and distal. Each part was stained by Hematoxylin and Eosin stain and by special stain (Orcein stain). Special staining was done to compare the contents of elastic fibers within the tunica media of CS. The sections of histology were examined by three different experts for the intensity of H and E and Orcein staining.[6] The grading for intensity of staining was done such as-

- + Traces
- ++ Mild staining
- +++Moderate staining
- ++++ Severe staining.

RESULTS

The mean length of the CS was 36.83±17.29 mm (Figure 1). The maximum length of the CS was 52.29±17.05 mm and minimum length was 17.37±19.61 mm. There is weakly positive correlation and was present in between age and length of CS (correlation coefficient is 0.2 and P=0.271). And also weakly positive correlation (=0.294) was present in between the weight of cadaver and length of CS (Table 1).

The width of CS at the point of opening into right atrium was 4.92±3.53 mm (Figure 2). The relationship between width of CS and age was statistically significant (r=0.42, P=0.0203). While,the relationship between the weight of cadaver and width of CSwas found insignificant (r=0.08, P=0.682) (Table 1). The weakly positive coefficient of correlation between length and width of CS was present (=0.105).

Out of 30 hearts, the shape of CS in 22 hearts was cylindrical and in 8 was conical.The present study showed that the Besian valve of CS was present in 86.7% hearts and absent in 13.3% hearts.

The mean length of CS in males was 41.44±11.37 mm, while in females the mean length of CS was 39.29±11.17 mm. Therefore, the length of CS was less in females as compared to males (Table 2).

Figure 1: Measurement of coronary sinus

Table 1: Various parameters of coronary sinus

Age group (years)	No. ofhearts	Length (mm)	Width of coronary sinus at point of opening into right atrium (mm)	Average weight of person (kg)
16–20	2	17.37±19.61	0.75±0.07	50±2.83
21–25	2	21.5±26.16	0.7±0.28	52±2.82
26–30	2	52±18.38	2.8±3.11	64±11.31
31–35	5	38.104±8.38	6.48±4.75	50.6±5.77
36–40	4	39.09±6.25	4.65±0.81	49±10.73
41–45	3	34±9.53	6.26±5.34	58.66±3.21
46–50	5	36.25±24.07	5.005±2.48	60.8±11.69
51–55	2	46±5.65	5.5±6.36	63.5±2.12
56–60	3	52.29±17.05	6.12±2.13	70.66±18.58
61–65	2	22±25.45	7.5±3.53	68±11.31

Table 2: Length of coronary sinus in male and female heart

Sex	Number of hearts (n)	Mean±SD	Minimum	Maximum
Male	22	41.44±11.37mm	17.37±19.61mm	52±18.38mm
Female	8	39.29±11.17mm	24mm	43.18±0.80

Figure 2: Measurement of orifice of coronary sinus

The mean width in male was 4.55±3.63 mm and in female was 5.78±3.68 mm.Therefore, width at the site of opening into right atrium was more in female as compared to male. The relationship between the weight of cadaver and width of CS at the point of opening into right atrium was found significant in heart of males (r=−0.787, P=0.00001), whereas in females it was found insignificant (r=0.223, P=0.595) (Table 3).

On special staining, with Orcein stain the elastic fibers of the CS appeared orangish black. In the proximal part of CS the intensity of H and E staining in cardiac muscles of CS was found to be significantly reduced with the increasing order of the age (r=−0.737927 and P=0.0148) (Figure 3).The intensity of cardiac muscle in the middle part of CS also had the significant correlation with the age group as above (r=−0.726519 and P=0.0173) (Figure 4). The intensity of cardiac muscle in the distal part of CS also showed the variation with the age but not so marked and the statistical analysis showed insignificant variation (r=0.429153, P=0.2159) (Figure 5).

DISCUSSION

Our study reveals that the incidence of shape of CS was cylindrical in 73.33% and conical shape in 26.66%. The CS was cylindrical in female hearts (100%) and in males it was cylindrical in 63.63% while conical in 36.36%. The high incidence of cylindrical shape of CS was also observed by Maros et al.,[7] and Ballesteros et al.,[8] Kosourov and Ivanov observed that the shape of CS changed with age from cylindrical to conical,[9] but we did not find any change.

We found that the mean length of CS was 36.83+/-17.29 mm. Maros et al., reported that the CS has 36 mm length and 9 mm in diameter.[7] Zhaoming reported that the mean length of CS was 38.487±7.81mm[10] in Chinese people. El Maasarany et al., observed that the average length of CS was 48.4±5.2 mm.[11] Habib et al., found that the length of CS varies from 3 to 5.5 cm.[12] Ballesteros et al., reported the average length of CS 25.9±6.34 mm in Colombian subjects.[8]

The maximum length of CS in males was found to be 52±18.38 mm and in females 43.18±0.80 mm which showed the length of CS greater in males as comparison to females. Kosourov and Ivanovalso found that length of CS was larger in males.[9]

We observed in our study that the width of CS at the site of opening into right atrium was 4.92±3.53 mm and it was

Table 3: Width of coronary sinus in male and female heart

Sex	Number of hearts (n)	Mean±S.D	Minimum	Maximum
Male	22	4.55±3.63mm	0.5 mm	6.55±5.48mm
Female	8	5.78±3.68mm	0.9 mm	6.2mm

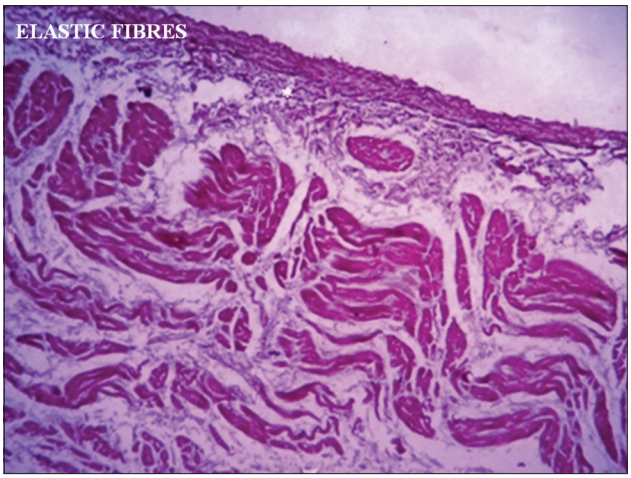

Figure 3: (×10) Transverse section of proximal part of coronary sinus (stained with orcein), white asterisk -shows elastic fibres

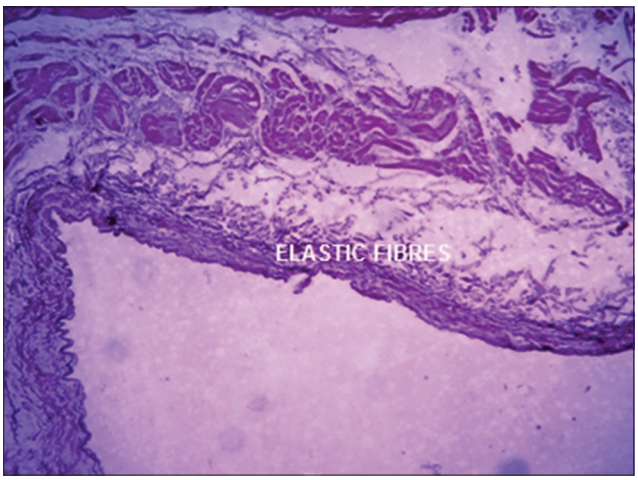

Figure 4: (×10) Transverse section of middle part of coronary sinus (stained with orcein) showing good amount of elastic fibers

having statistically significant relationship with age (r=0.42 P=0.023). The maximum width was found as 7.5±3.53 mm. Zhaoming found that the diameter of CS at three different sites at front, middle, and back end 6.51±1.97,7.99±2.65, and 9.79±2.48, respectively, in Chinese subjects.[10] El Maasarany et al., observed that the average diameter of CS was 9.3±5.3[11] and Ballesteros et al., observed that the distal diameter of CS was 8.94±1.66 mm.[8]

The maximum width of CS was greater in males as compared to females in 31–35-year age group. Kosourov and Ivanov also reported that both length and width of CS at the point of its entrance into the right atrium were

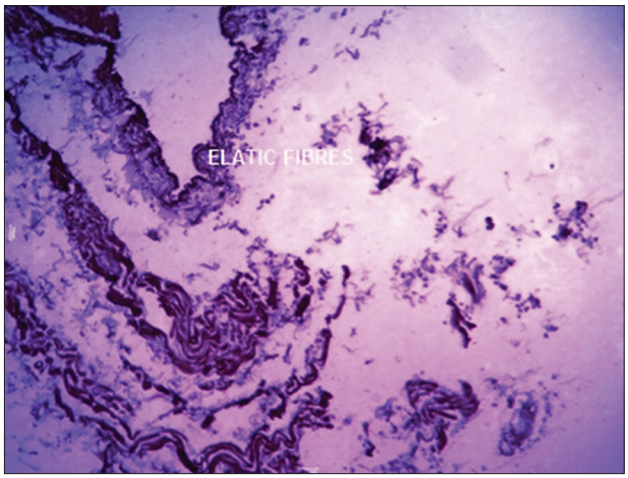

Figure 5: (×10) Transverse section of distal part of coronary sinus showing mild elastic fibers (stained with orcein)

dependent on the gender of the patients and were larger in males.[9]

Hellerstein and Orbison[13] observed that the mean maximum diameter of CS orifice was lesser in the hearts weight <400 g as compared to the heart weight more than 400 g, this observation also endorsed our findings. Karaca et al., reported that the significant correlation between heart weight and CS ostium diameter and according to this result, catheterization in greater hearts should be easier.[14]

The incidence of the Besianvalve is 86.7%. Maros et al., reported 81% presence of the Besian valve in their study.[7] But Karaca et al., found that the Besian valves were observed in 67% hearts.[14] Pejković et al., reported 80% presence of the Besianvalve.[15] Mak et al., found 73% presence of theBesianvalve.[16]

In our study, we observed 66.66% presence of membranous, 13.33% fenestrated, and 3.33% muscular and fibrous types of the the Besian valve. Zhaoming reported that the valves of CS are semilunar (59.57%), sieves (8.51%), or cords (6.38%).[10] Mak et al., reported that most the Besian valves are membranous (46%), followed by fibrous (24%), fibromuscular (11%), and muscular (18) and these studies endorsed our findings.[16]

The intensity of cardiac muscle in the middle part of CS also has a significant correlation with age group and the intensity of cardiac muscle in the distal part of CS also showed the variation with age but not significant

statistically. Kosourov and Ivanov observed that the thickness of tunics forming the walls of CS in 21–92 years age group was independent of gender and age.[9]

Limitations of the study

The sample size of the present study was small, hence multicentric studies on a larger sample size are necessary to endorse the findings of this study.

CONCLUSIONS

This study presents data for interventional device for CS in Indian setting and also suggests that the CS is an independent, cardiac chamber with a mural structure similar to atrial myocardium and it may be target for study and ablation, in the future therapy of atrial arrhythmias.

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Authors Contribution:
JA- Study concept and design, drafting of manuscript; **AA**- Acquisition of data, analysis and interpretation of data and statistical analysis; **VK**- Study concept and design; **DNS**- Drafting of the manuscript administrative, technical, and material support; **ST**- Drafting and revision of the manuscript; **MN**- Critical revision of the manuscript for important intellectual content.

Work attributed to:
Government Doon Medical College, Dehradun - 248 001, Uttarakhand, India.

Orcid ID:
Dr. Jolly Agarwal - https://orcid.org/0000-0002-0379-1296
Dr. Anurag Agrawal - https://orcid.org/0000-0002-2548-5820
Dr. Sudhahar Tamizhan - https://orcid.org/0000-0002-0852-1404
Dr. Manisha Naithani - https://orcid.org/0000-0002-0984-4176

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