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Morphometry of Aortic Cusps: A Cadaveric Study in South India

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Abstract

Introduction: Aortic valve prevents the back flow of blood into the left ventricle. The valve consists of the three semilunar cusps attached to the aortic root. The valvular function depends primarily upon the semilunar attachments of the cusps and thus, the cusp dimensions are of clinical relevance for aortic valve reconstruction and repair in the surgical treatment of valvular diseases. **Aim:** The aim of the present study was to measure the width of free margin and height of aortic cusps.

Materials and Methods: The present study was undertaken in 68 adult human heart specimens which had been fixed in 10% formalin solution. The specimens were obtained from adult cadavers dissected for undergraduate students in the dissection hall of anatomy department and autopsy specimens of Kasturba Medical College, Manipal. Aortic valves were tricuspid in all specimens. Aortic valve was cut opened between the two cusps so that each cusp remained intact with the aortic root. Width of free margin and height from midpoint of free margin(nodule) to the saortic valves were tricuspid. Average width of right, left coronary, noncoronary cusps was 2.48±0.303, 2.42±0.280 &2.39±0.275 cm respectively. Average height of right left coronary & non coronary cusp was 1.47±0.236, 1.48±0.238 &1.55±0.195cm respectively. Conclusion: Average width of right coronary cusp was greatest followed by left coronary and noncoronary and average height of noncoronary cusp was largest. These dimensions might be helpful for valve reconstructive and repair surgeries.

Keywords: aortic valve, cusps, height, right coronary, left coronary and non-coronary.

Introduction

Aortic valve, the smooth left ventricular outflow tract consists of three semilunar cusps, supported within the three aortic sinuses of Valsalva. The cusps are attached in part to the aortic wall and in part to the supporting ventricular structures. Parts of the cusps take origin from the fibrous subaortic curtain and are continuous with the aortic cusp of the mitral valve. The semilunar attachments incorporate segment of ventricular tissue within the base of each aortic sinus. These sinuses and cusps are conveniently named as right, left and non-coronary, according to the origins of the coronary arteries. The basal attachments of each cusp are thickened and collagenous at their ventricular origins, there is no continuous collagenous skeleton supporting, in circular fashion, all the attachments of the cusps of the aortic valve. The cusps are folds of endocardium with a central fibrous core. Each cusp has a thick basal border, deeply concave on its aotic aspect, and a horizontal free margin. The latter is slightly thickened, except at its midpoint, where there is an aggregation of fibrous tissue, the valvular nodule of the cusp. Valvular function depends primarily upon the semilunar attachments of the cusps. (1). It prevents the backflow of the blood into the left ventricle. For the proper circulation of blood, valve should be intact. Apart from congenital anomalies, acquired heart diseases can damage the valves of the heart. In such conditions, they need to be repaired or replaced by prosthesis (2).

Normal values of the aortic root dimensions have been obtained by direct and echocardiographic examination. (3,4,5) But less is known about the normal data for cusp dimensions. For this purpose, the present study was conducted to measure the width and height of each cusp of aortic valve.

Materials and Methods

The present study was undertaken in 68 adult human heart specimens which had been fixed in 10% formalin solution. The specimens were obtained from adult cadavers dissected for undergraduate students in the dissection hall of anatomy department and autopsy specimens of Kasturba medical College, Manipal. Specimens were washed and cleared off from any clots. These specimens were numbered serially from one to 68.The aortic valve was examined with regard to the morphologic features of the orifice and number of cusps. Aortic valves were tricuspid in all specimens. Aortic valve was cut opened between the two cusps so that each cusp remained intact with the aortic root. Following measurements were taken in cm with the help of digital Vernier caliper capable of measuring accurately upto 0.01mm and cotton thread:

1. Width of free margin of cusp: by stretching the cotton thread.
2. Height of each cusp was measured from midpoint of free margin(nodule) to the midpoint of attached margin by stretching the cotton thread (Figure).

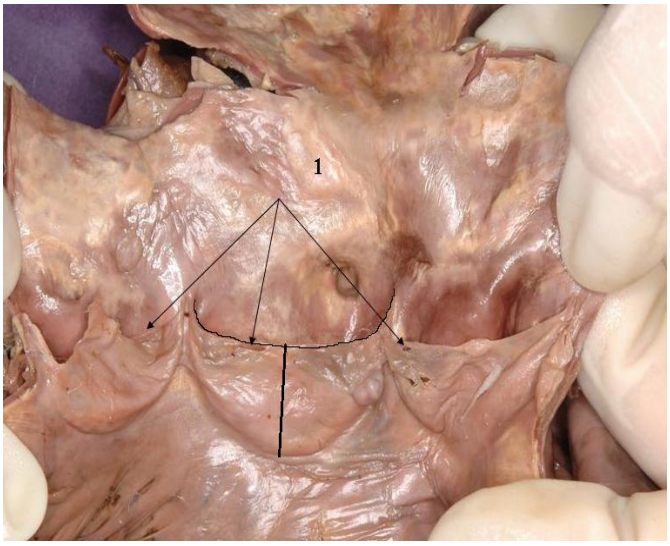

Figure 1: Showing open aortic valve, cut at the margin between the left coronary and right posterior

noncoronary cusp. 1. Ascending aorta. Arrow shows free margins of cusps and vertical line shows height of cusp from attach margin below to free margin above. On left side - left coronary cusp, middle- anterior and on right side noncoronary cusp.

Results and discussion

All the aortic valves were tricuspid. Average width of free margin of right, left coronary, noncoronary cusps was 2.48±0.303, 2.42±0.280 &2.39±0.275 cm respectively.

Table1: Range of Width of free margin of cusps for number of specimens for each cusp

Width range in cm	Right coronary cusp Frequency (percentage)	Left coronary cusp Frequency(percentage)	Non coronary cusp Frequency(percentage)
1.5-2.0	5(7.35%)	8(11.76%)	4(5.88%)
2.1-2.5	38(55.88%)	43(63.23%)	46(67.64%)
2.6-3.0	23(33.82%)	16(23.52%)	17(25%)
3.1-3.5	2(2.94%)	1(1.47%)	1(1.47%)

Average height of right coronary left coronary & noncoronary cusp was 1.47±0.236, 1.48±0.238 &1.55±0.195cm respectively.

Table2: Range of Height of cusps from nodule to attached margin for number of specimens.

Height range in cm	Right coronary cusps-frequency (percentage)	left coronary cusps frequency(percentage)	Non coronary cusps frequency(percentage)
0.5-1	3 (4.41%)	2(2.94%)	1(1.47%)
1.1-1.5	42(61.76%)	42(61.76%)	33(48.53%)
1.6-2.0	23(33.82%)	24(35.29%)	34(50.0%)

Discussion

The incidence of bicuspid aortic valve is 2%.It is the most common congenital malformation of heart during development and valvular stenosis is the most frequent complication of a congenitally bicuspid aortic valve (6). The present study comprises of all the tricuspid aortic valves.

Cusp size is very important for normal functioning of the valve. The inequality of cusp size could account for early cusp degeneration and ultimately stenosis (7). But Vollebergh &Becker et al revealed that cusps of unequal size were the rule than the exception (8). In only 10% of hearts, cusps are truly equal in size. In two thirds of heart, either the right or left posterior cusp is larger than the two(9). Vollebergh &Becker et al measured both width and height of cusps in isolated aortic valves both in normal and stenotic valves. Those heart specimens were in an unfixed state. In normal heart valveswidth of right, left coronaryand non-coronary cusps were 2.59, 2.50& 2.55 respectively. Height measured was 1.41, 1.41 & 1.42cm for right, non-coronary and left coronary respectively (8). Width of cusps measured in present study was similar to normal aortic cusps measured by Vollebergh et al. Whereas both width and height measured in stenotic valves were more for all cusps than the normal ones (8).Jatene MB et al in 1999, measured the heights of cusps from the heart specimens which were fixed in 10% formalin in Brazil.They measured in wide age group and reported mean height of Left coronary, Right coronary, non-coronaryto be 15.2

mm,15.0mm, 14.9mm respectively.In their study, left coronary cusp had the largest dimensions, followed by the right coronary and noncoronary (10). Whereas; in the present study, non-coronary had the largest height followed by left coronary and right. Holda M et al in his study also measured height of cusps and found non coronary cusp to be largest with respect to height (11). Height of cusps measured in present study was closer to that measured by Jatene MB et al. Cusp height was more in the aortic valve measured by Schafers HJ et al intraoperatively in tricuspid valve (12) and also found that height of noncoronary cusp was significantly greater than other two cusps similar to our study.

Conclusion

Anatomic knowledge of the aortic cusps, mean values with standard deviation of width and height of aortic cusps is mandatory in every surgical approach.

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