

## Morphometric Study on the Aortic Valves in Peoples of North Bihar

Dr. Khushnuda Perween<sup>1</sup>, Dr. Umesh Prasad Sinha<sup>2</sup>, Dr. Sanjay Sah<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of Anatomy, Government Medical College, Bettiah, West Champaran, Bihar

<sup>2</sup>Associate professor & Head of Department, Department of Anatomy, Government Medical College, Bettiah, West Champaran Bihar

<sup>3</sup>Assistant Professor, Department of Anatomy, Government Medical College, Bettiah, West Champaran Bihar

Corresponding Author: Dr. Khushnuda Perween

Received:12-06-2021

Revised:10-07-2021

Accepted:13-08-2021

### Abstract

**Background:** The aortic valve have three cusps; each cusp is semilunar in shape and it acts like a parachute facing into the aorta, open up when fills with blood. There is a small thickening on the center of the free edge of each cusp, at the point where the cusps meet. This nodule ensures central valve closure. A ridge is radiating from the nodule around the free edge of the cusp is called lunules. Lunule and nodule, are important to understand the physiopathology of valve regurgitation and the possibility of surgical repair. The rapid development of the aortic valve replacement or implantation renewed interest in anatomical study of aortic valves.

**Aim of study:** The main aim of present study is to investigate the detailed morphology of aortic valves in the domiciles of North Bihar, data so collected will be useful for cardiovascular surgeons and the prosthetic valve manufacturing companies, and applicable to the resident of the North Bihar.

**Material and method:** 25 post-mortem human hearts 15 from male and 10 from female cadaver from department of Anatomy, Government medical colleges, Bettiah, Bihar have been utilized in the study. Circumference of valve orifice, diameter of valve orifice, length spread and thickness of each cusp, thickness and position of nodulus, thickness of lunula and position of each coronary orifice were calculated.

**Result:** this study showed that the various measurements of aortic valve of the hearts of the males are more than the findings of female. conclusion: In this study all dimensions are less than that of found by previous studies. The morphometric measurement of this study might help the prosthetic valve manufacturing companies to make the valves of the exact size.

**Keywords:** aortic valve; semilunar cusps; orifice; nodules; lunules

## Introduction

The Heart is a fibro-muscular organ found in middle mediastinum. It is covered with pericardium and having two functions: it collect blood from the whole body by superior vena cava and inferior vena cava in the right atrium and pump into the lungs by pulmonary arteries from right ventricles. Blood from lungs reaches the left atrium by pulmonary veins and pump to the whole body by aorta from the left ventricle. Human heart is made up of four chamber, and four valves. Cardiac valves are made up of folds of endocardium together with flat sheet of dense connective tissue. These valves are attached to the annulus fibrosus. The four valves in human heart are mitral, tricuspid, aortic and pulmonary valves. Cardiac valves are widely Studied in human as well as other animals. The present study was done on aortic valve. The left ventricle pump blood into the aorta during ventricular systole and supply to all of the tissues of the body. The aortic valve prevents back flow of blood into left ventricle during diastole. The aortic valve is consists of three cusps; which are symmetric and semilunar in shape each cusp acts like a parachute facing upside down into the aorta, opens when it fills with blood.<sup>[1]</sup> There are outward bulging of the aortic wall opposite to each cusp. These bulging were aortic sinuses of valsalva. All cusps contact each other and prevent the back flow of blood during complete filling of cusps with blood during diastole. Each cusp is firmly attached to an annulus (" fibrous ring") within the root of aorta in a manner that the cusp opens into the lumen of the aorta. The sinuses and leaflets are named as right, left and non-coronary, according to the origins of the coronary arteries. <sup>[2]</sup> There are openings called orifice from which coronary arteries arises within the sinus of valsalva. These coronary orifice are present below near the center of the sinuses (fig 1). Out of three, only two sinuses have coronary orifice. These orifices open into their corresponding coronary arteries. A small thickening present at the center of the free edge of cusp. This is called nodule (of Arantius or Morgagni) which causes central valve closure.<sup>[1]</sup> Lunules are ridges which are radiating from this nodule at the free edge of the cusp. These anatomical parts, "lunulae" and "nodule of Arantius", are important in recognising the physiopathology of valve regurgitation and the surgical repair of the valves. Aortic regurgitation is mainly due to the lack of apposition of these structures, which ca be due to tissue retraction or enlargement of the skeleton of the root annulus <sup>[3]</sup>. The recent development in the aortic valve replacement or implantation causes interest in anatomical study of aortic valves. The knowledge about the anatomical and functional structures are required to make a new valve <sup>[4]</sup>. Anatomical study has brought unexpected findings of great scientific values, highlighting the importance of anatomical research in cardiovascular surgery.

**Aim of study:** The main aim of present study is to investigate the detailed morphology of aortic valves in the domiciles of North Bihar, data so collected will be useful for cardiovascular surgeons and the prosthetic valve manufacturing companies, and applicable to the resident of the North Bihar. This study might help the prosthetic valve manufacturing companies to make the valves of the exact size.

## Material and method

Twenty five postmortem human hearts 15 from male and 10 from female cadaver were collected from department of anatomy government medical colleges Bettiah, Bihar have been utilized in the study for morphometry of the aortic valve. The study was done in the Department of Anatomy, Government Medical College, Bettiah, Bihar. There were no ethical consideration to be considered in this study. Sample size was calculated using OpenEPi software at 95% confidence interval and 80% beta error. Only normal looking hearts were considered. The hearts were washed with normal saline and examined thoroughly to rule out any evidence of

heart disease. Proximal segment of aorta was removed in such a manner that the semilunar cusps were attached to the removed segment. All measurements were done according to M B Jatene et al.<sup>[5]</sup> Circumference of aortic orifice just at the level of the free margin of the semilunar cusps was measured with a silk thread and metric scale. The diameter of aortic orifice was measured by vernier calipers at the level of attached margin of cusps. The segment of aorta containing the cusps was opened by giving an incision through the angle of union of cusps. Spread, thickness and length of each cusp were measured with the metric scale. Thickness of lunule and nodule was recorded with vernier calipers. Position of each coronary orifice was examined and measured. Statistical analysis was performed using Graph Pad QuickCalcs. A P-value of less than 0.05 was considered statistically significant.

### **Observation**

Aortic orifice was found as a circular aperture in front and to the right of the mitral orifice, from which it was separated by the anterior leaflet of the mitral valve, and guarded by the aortic valve. The aortic aperture was seen to exist above the interval between the mitral and tricuspid orifices. A portion of the root of aorta containing the valve was removed and its diameter was determined with vernier calipers. Its inner circumference was measured with a silk thread and metric scale.

#### **Circumference:-**

The circumference of the aortic orifice was measured at the level of the free border of the semilunar cusps, which composed of the aortic valve. Its mean value in the male hearts was found as  $71 \pm 4.24$ mm ranging from 65-80mm and in females  $68 \pm 3.42$ mm ranges from 60-78mm. (fig 2). Unpaired T test was done having P value equals 0.0749. which is not significant. The mean diameter of the orifice in male and female hearts was approximately 22.6mm and 21.6 mm respectively.

#### **Cusps:-**

The aortic valve consisted of three semilunar segments known as valvules or cusps, which were found attached by their convex margins to the aorta at its junction with the ventricle. Two cusps were placed anteriorly (right and left) and one cusp was posterior. Their free borders were directed upwards, and in close opposition, each valvule was found to be thicker along the attached margin and at the center of the free border. The thickness near the attached margin, its spread along the convex attached border and the length of its free border were measured. (fig3). These dimensions are shown in Table 1

The mean value of length of free margin in female  $24.37 \pm 2.5$  mm were considerably less than male  $27.9 \pm 3.6$ mm having P value equals 0.0131. which is significant.

At the root of aorta there was an outward bulging of the aortic wall opposite to each cusp. These bulging were aortic sinuses of valsalva.

#### **Nodule:-**

A thickening at the center of the free border of each cusp was observed. This thickening, the nodule, was measured with vernier calipers. Its thickness in all the three cusps in both sexes is given in table 2

In 82% specimen the position of nodule was central that is in the middle of free margin of the cusps; in 18% its position was shifted to one side or other by 1-3mm

Lunule:-

The part of each cusp on each side of nodule was thinner than the rest of the cusps and was termed the lunule of its semilunar outline. The thickness of each lunule was measured and shown in the table 3

Orifice of coronary artery:- The opening of the right coronary artery was found in the right sinus, about 1-2mm above the free edge of the cusp. This orifice was found central in position in hearts of 12 males and 6 females. In the rest of the heart the orifice was slightly shifted to one side (0.5-2mm).

The left coronary orifice was seen in the left sinus of the aorta 1-2mm above the free margin of the cusp. Central in position in 22 hearts, it was found slightly shifted to one side in 3 male specimens only. In one specimen two orifice was found in left sinus. (fig 4)

**Table 1: Length, spread and thickness of aortic cusps**

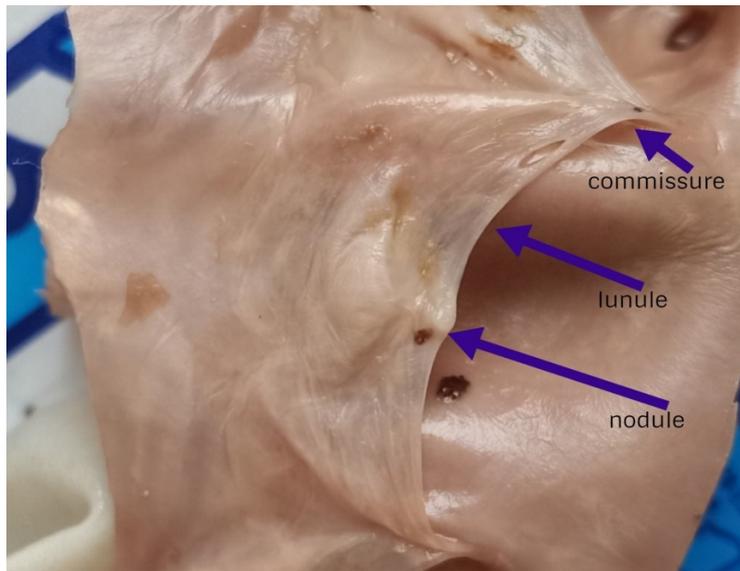
| Dimensions                       | Type of cusps | sex    | range    | mean  | Standard deviation | P Value |
|----------------------------------|---------------|--------|----------|-------|--------------------|---------|
| Length of free border(in mm)     | Non coronary  | Male   | 20-35    | 27.9  | ± 3.6              | 0.0131  |
|                                  |               | female | 20-31    | 24.37 | ± 2.5              |         |
|                                  | Right         | Male   | 19-36    | 26    | ± 3.5              | 0.26    |
|                                  |               | female | 18-32    | 24.5  | ± 2.7              |         |
|                                  | Left          | Male   | 21-34    | 25.8  | ± 3.1              | 0.130   |
|                                  |               | female | 19-30    | 24    | ± 2.3              |         |
| Spread of attached margin(in mm) | Non coronary  | Male   | 30-48    | 37.8  | ±4.9               | 0.406   |
|                                  |               | female | 31-43    | 36.2  | ± 4.2              |         |
|                                  | Right         | Male   | 32-46    | 36.8  | ±4.7               | 0.8246  |
|                                  |               | female | 33-43    | 36.4  | ± 3.8              |         |
|                                  | Left          | Male   | 31-48    | 38.3  | ±4.5               | 0.63    |
|                                  |               | female | 30-43    | 37.5  | ±3.4               |         |
| Thickness(in mm)                 | Non coronary  | Male   | 0.2-0.55 | 0.36  | ±0.11              | 0.152   |
|                                  |               | female | 0.15-0.5 | 0.3   | ±0.08              |         |
|                                  | Right         | Male   | 0.25-0.4 | 0.32  | ±0.09              | 0.23    |
|                                  |               | female | 0.2-0.4  | 0.28  | ±0.06              |         |
|                                  | Left          | Male   | 0.2-0.55 | 0.34  | ±0.10              | 0.184   |
|                                  |               | female | 0.2-0.4  | 0.29  | ±0.07              |         |

**Table 2: Thickness of nodule(mm)**

| Type of cusp | sex    | range     | mean | Standard deviation | P Value |
|--------------|--------|-----------|------|--------------------|---------|
| Non coronary | Male   | 0.45-0.95 | 0.71 | ± 0.15             | 0.399   |
|              | female | 0.4-0.95  | 0.65 | ± 0.20             |         |
| Right        | Male   | 0.45-1    | 0.76 | ± 0.23             | 0.574   |
|              | female | 0.35-0.9  | 0.71 | ± 0.19             |         |
| Left         | Male   | 0.4-1.1   | 0.68 | ± 0.21             | 0.4     |
|              | female | 0.3-1     | 0.62 | ± 0.16             |         |

**Table 3: Thickness of lunules**

| Dimensions        | Type of cusp | Sex    | range     | mean | Standard deviation | P value |
|-------------------|--------------|--------|-----------|------|--------------------|---------|
| Thickness (in mm) | Non coronary | Male   | 0.12-0.25 | 0.18 | ± 0.07             | 0.49    |
|                   |              | Female | 0.1-0.25  | 0.16 | ± 0.06             |         |
|                   | Right        | Male   | 0.15-0.35 | 0.21 | ± 0.06             | 0.294   |
|                   |              | Female | 0.1-0.25  | 0.18 | ± 0.08             |         |
|                   | Left         | Male   | 0.1-0.25  | 0.17 | ± 0.06             | 0.667   |
|                   |              | Female | 0.1-0.25  | 0.16 | ± 0.05             |         |



**Figure 1: showing nodule, lunule, commissure**



**Figure 2: circumference of aortic orifice**

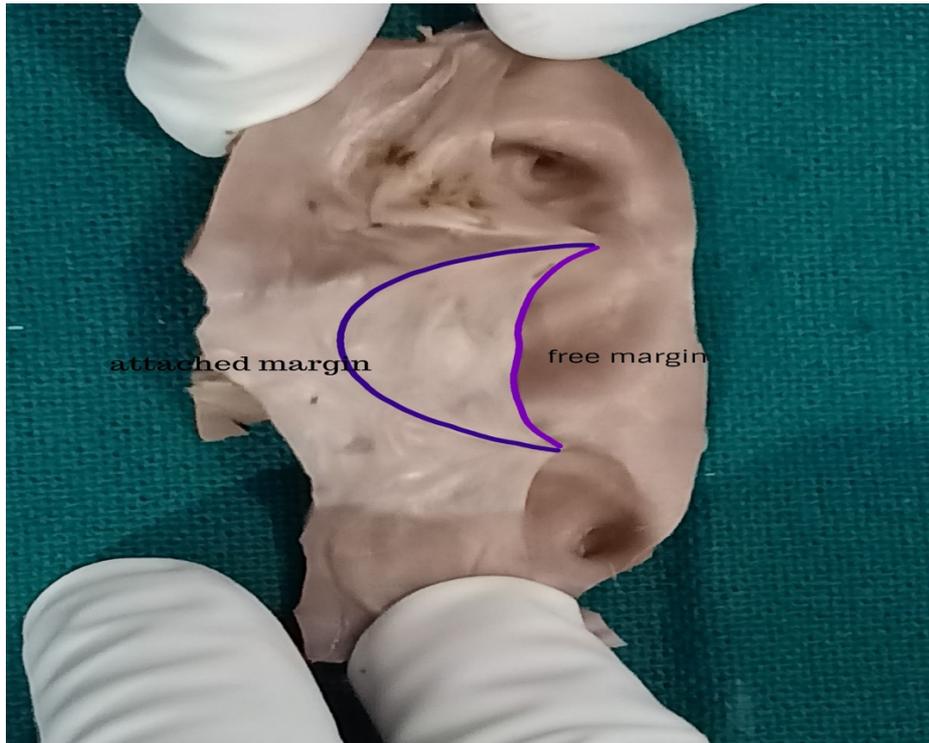


Figure 3: showing free margin and attached margin

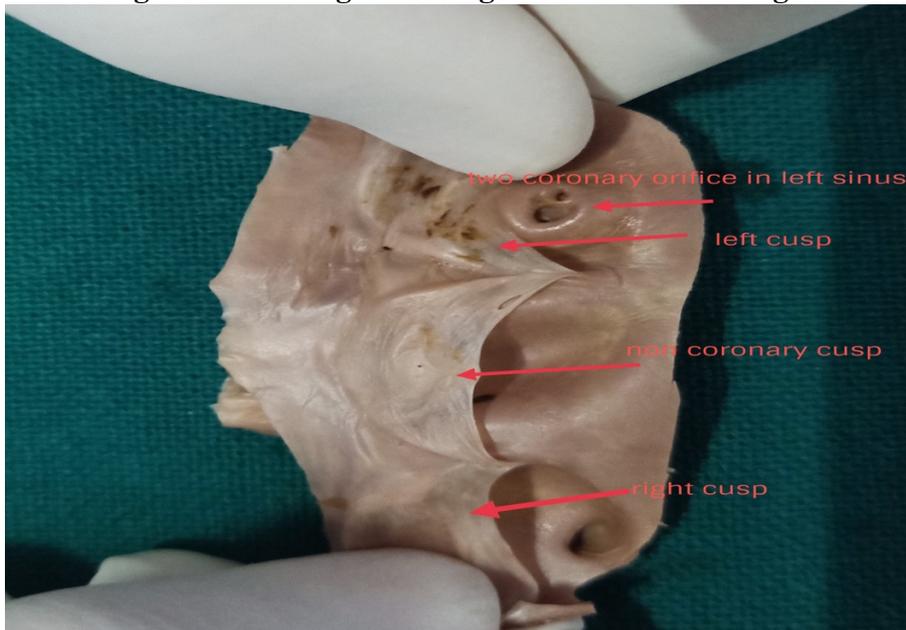


Figure 4: showing all cusps and two coronary orifice in left sinus

### Discussion

Circumference:- the mean value of circumference of the aortic orifice was found as  $71 \pm 4.24$ mm in male which is less than the figure reported by Boyd(75mm)<sup>[6]</sup>and Major Gupta Natin et al(88mm)<sup>[7]</sup> and almost accord with finding of Krishna M et al 7.09cm<sup>[8]</sup>.

In present study the mean value of circumference of the aortic orifice was found as  $71 \pm 4.24$ mm in male which females  $68 \pm 3.42$ mm

Cusps :-Three cusps of almost equal dimensions were noted. The mean value of length of free margin in female  $24.37 \pm 2.5$  mm were considerably less than male  $27.9 \pm 3.6$ mm (table 1). The mean free margin length was  $27.9 \pm 3.6$ mm was less than Laurent De Kerchove et al  $34.3 \pm 3.1$  mm. [9]

The nodule, which was seen as round thickening in the middle (82%) of the free margin of cusps and in 18% specimen it was slightly shifted to one side of the center. The thickness of nodules was almost same in both sexes(table2), was found to be slightly less(0.76mm) than the finding of Y Sahasakul et al (0.87mm). [10]

Lunules are thin free margin of the cusps on either side of nodules are very thin and translucent. lunules are very thin and in some cups its thickness reduced to 0.1mm.

Two coronary orifice were always placed 1-2 mm above the free margin of cusps. These finding suggest that the coronary orifice are not closed by their respective cusps during systole. Therefore blood will flow through the coronary arteries both during systole and diastole. In 10% specimen it shifted to one side of center of sinus. In one specimen two coronary orifice was present.

### Conclusion

We describe the normal dimension of aortic valves in people of north bihar. We found circumference of valve orifice(71mm) is less than previous studies Boyd(75mm) and major gupta natin et al(88mm) and almost accord with finding of Krishna M et al(7.09cm). all other dimensions are lee than previous studies. In present study all dimensions in female are less than males. The morphometric measurement of this study might help the prosthetic valve manufacturing companies to make the valves of the exact size.

**Acknowledgements:** The authors would like to thank and pay respect to all those kind hearts who have donated their body for research and education purposes without whom this work would not have been accomplished

**Source(s) of support:** this research did not receive any grant from funding agencies in public, commercial, or non profit sectors.

**Conflicting Interest :** There is no conflict of intrest.

**Contribution Details:** All authors equally contributed in preparing this article

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