

## A Cadaveric Study on Adult Human Heart Valve Annular Circumference and Its Clinical Significance

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### Abstract:

**Aim:** Human heart valve is a vital structure and knowledge about the normal anatomy of heart valve circumference is important for assessing the valve pathologies and also in valve replacement surgery for a deceased valve. Thus the present study was done to assess the exact dimension of the annular circumference of all the valves in formalin fixed human hearts.

**Materials and Methods:** The study was carried out in 50 formalin fixed hearts procured from human cadavers. Circumferences of all the valves were measured in all the specimens.

**Results:** The Average annular circumference of the tricuspid valve was found to be 10.372 cm, mitral valve was 8.285 cm, aortic valve was found to be 7.542 cm and the pulmonary valve was 6.823 cm.

**Conclusion:** The present study provides the necessary data on the dimensions of circumference of all the valves of the heart, which will be helpful for surgeons to carry out valve repair and to manufacture prosthetic valves of appropriate dimension.

**Keywords:** Tricuspid, Mitral, Aortic, Pulmonary, Valve, Prostheses.

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### I. Introduction

Human heart includes four chambers which are provided with openings meant for inflow and outflow of blood. These openings are guarded by valves for the purpose of scheduled and controlled flow of blood. The periphery to which the valves are attached is termed as the annulus. Atrioventricular valves are two in number namely tricuspid and mitral (bicuspid), named based on the number of cusps and are situated between the atrium and ventricles on both the sides. The other valve namely pulmonary valve regulates the flow of blood through pulmonary trunk and aortic valve regulates the flow through the aorta. The valves in general acts as shutters for the chambers, thereby regulates the inflow and outflow mechanism. Increase in incidence of sedentary life style leads to heart disease which accounts to rise in mortality and morbidity among humans [12]. In addition cardiac valves are also affected by various disease and disorders like stenosis, regurgitation, valve prolapse, infective endocarditis & rheumatic fever and fibro-calcific degeneration or dilatation of the valve annulus [1]. Cardiac disease may also involve more than one valve. Severe damage to heart valves can be corrected with prosthetic valves [2].

To evaluate valvular stenosis, cardiac dilation, cardiac hypertrophy, measurements of valve circumference is important. Guided by these dimensions, the surgeon can aim to insert prosthesis of appropriate size. Hence detailed knowledge about the normal anatomy of heart valve is required for assessing the valve pathologies by imaging modalities, manufacturing prosthetic valves of appropriate dimensions and in surgical correction of damaged heart valves and hence the study is undertaken to find out the precise dimension of all the valves in every heart specimen. Improvised prosthetic design of accurate dimension when utilized for valve repair helps to overcome the cardiac disease and reduce the failure rate post operatively.

### II. Materials and methods

A total of 50 adult cadaveric human hearts were taken up for the study from the Department of Anatomy, Aarupadai Veedu Medical College and Hospital, Puducherry. The present work includes only the specimens which retains its morphological features and in good condition after removal from the cadavers and the reason for undertaking is to explore the accurate dimension of the annular circumference of all the valves of the heart. Specimens with gross morphological changes and having calcified valves were excluded.

#### Material

Digital vernier calipers, magnifying glass, foot ruler, thread, scissors, gloves.

### III. Method of dissection

A vertical incision was made along the right border of the heart starting from the level of the entry of the superior vena cava in to the right atrium till the level of entry of inferior vena cava into the right atrium. From the lower end of this incision a horizontal incision severing the inferior vena cava was made up to the entry point of the coronary sinus into the right atrium. The muscular flap was raised and blood clots were removed. Thorough saline wash was given. The interior of the right atrium was observed and circumference of the right atrioventricular valve (Tricuspid valve) was measured.

An incision was made on the left margin of the heart and extended up to the apex of the heart. The left ventricle was opened and blood clots were removed from the left atrium. Thorough saline wash was given and bicuspid (Mitral valve) was observed and measured.

“L” shaped incision was made on the anterior aspect of the arch of aorta and care was taken not to damage the cusps. Incision is stopped once when all the cusps and their attachment was reached. The circumference of the aortic valve orifice was measured.

“L” shaped incision was made on the anterior aspect of the pulmonary trunk and care was taken not to damage the cusps. Incision is stopped once when all the cusps and their attachment was reached. The circumference of the pulmonary valve orifice was measured.

The circumference of all the heart valve orifices were observed and measured with the help of a thread. The thread was placed along the boundary of the annulus conforming to its shape and is cut where the ends of the thread meet and then measured with a ruler after it is straightened<sup>[3]</sup> (Figure.5) (Figure.6).

### IV. Observation

#### Circumference of tricuspid valve

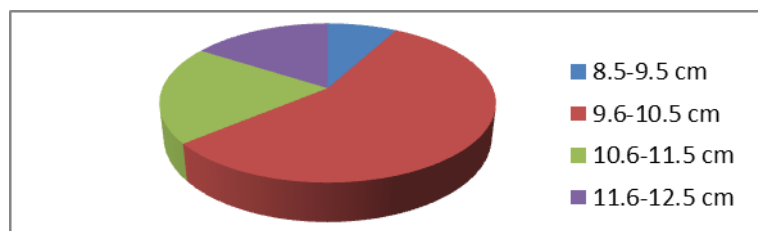
The circumference of the tricuspid valve ranged from 8.5-9.5 cm in 4 specimens and 9.6-10.5 cm in 28 specimens and 10.6-11.5 cm in 10 specimens and 11.6-12.5 cm in 8 specimens. The circumference of the tricuspid valve orifice ranged from 8.5-12.5 cm indicated in (Table.1)

The average circumference of the Tricuspid valve orifice is 10.372 cm. Annular circumference is maximum in range of 9.6-10.5 cm (56%) followed by 10.6-11.5 cm (20%), 11.6-12.5 cm (16%) and lowest in range of 8.5-9.5 cm (8%) (Figure.1)

**CIRCUMFERENCE OF TRICUSPID VALVE**

Total Number of Specimens	Range in cm	Percentage
4	8.5-9.5	8
28	9.6-10.5	56
10	10.6-11.5	20
8	11.6-12.5	16
<b>50</b>	<b>Total</b>	<b>100</b>

**Table 1(ANNULAR CIRCUMFERENCE)**



**Figure 1**

#### Circumference of the mitral valve

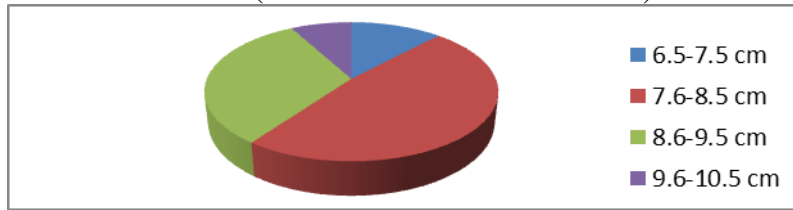
The circumference of the mitral valve ranged from 6.5-7.5 cm in 6 specimens and 7.6-8.5 cm in 24 specimens and 8.6-9.5 cm in 16 specimens and 9.6-10.5 cm in 4 specimens. The circumference of the mitral valve orifice ranged from 6.5-10.5 cm indicated in (Table.2)

The average circumference of the Mitral valve orifice is 8.285 cm. Annular circumference is maximum in range of 7.6-8.5 cm (48%) followed by 8.6-9.5 cm (32%), 6.5-7.5 cm (12%), and lowest in range of 9.6-10.5 cm (8%) (Figure.2)

**CIRCUMFERENCE OF THE MITRAL VALVE**

Total Number of Specimens	Range in cm	Percentage
6	6.5-7.5	12
24	7.6-8.5	48
16	8.6-9.5	32
4	9.6-10.5	8
<b>50</b>	<b>Total</b>	<b>100</b>

**Table 2 (ANNULAR CIRCUMFERENCE)**



**Figure.2**

**Circumference of the aortic valve**

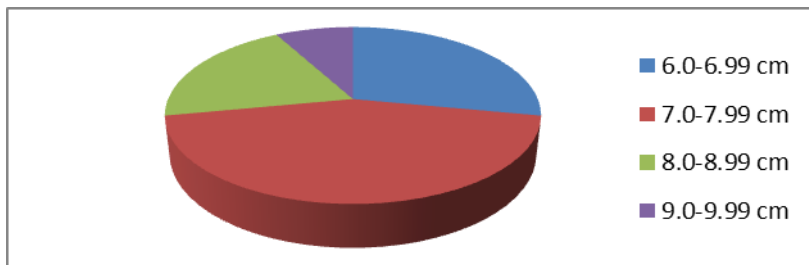
The circumference of the aortic valve ranged from 6.0-6.99 cm in 14 specimens and 7.0-7.99 cm in 22 specimens and 8.0-8.99 cm in 10 specimens and 9.0-9.99 cm in 4 specimens. The circumference of the aortic valve orifice ranged from 6.0-9.99 cm indicated in (Table 3).

The average circumference of the aortic valve orifice is 7.542 cm. Annular circumference is maximum in range of 7.0-7.99 cm (44%) followed by 6.0-6.99 cm (28%), 8.0-8.99 cm (20%) and lowest in range of 9.0-9.99 cm (8%) (Figure.3)

**CIRCUMFERENCE OF THE AORTIC VALVE**

Total Number of Specimens	Range in cm	Percentage
14	6.0-6.99	28
22	7.0-7.99	44
10	8.0-8.99	20
4	9.0-9.99	8
<b>50</b>	<b>Total</b>	<b>100</b>

**Table 3 (ANNULAR CIRCUMFERENCE)**



**Figure 3**

**Circumference of the pulmonary valve**

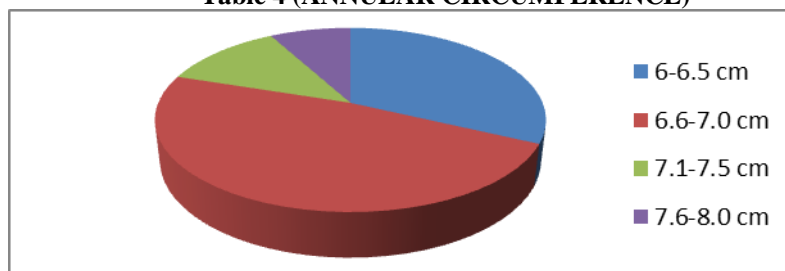
The circumference of the pulmonary valve ranged from 6.0-6.5 cm in 16 specimens and 6.6-7.0 cm in 24 specimens and 7.1-7.5 cm in 6 specimens and 7.6-8.0 cm in 4 specimens. The circumference of the pulmonary valve orifice ranged from 6.0-8.0 cm indicated in (Table 4).

The average circumference of the pulmonary valve orifice is 6.823 cm. Annular circumference is maximum in range of 6.6-7.0 cm (48%) followed by 6.0-6.5 cm (32%), 7.1-7.5 cm (12%) and lowest in range of 7.6-8.0 cm (8%) (Figure.4)

**CIRCUMFERENCE OF THE PULMONARY VALVE**

Total Number of Specimens	Range in cm	Percentage
16	6.0-6.5	32
24	6.6-7.0	48
6	7.1-7.5	12
4	7.6-8.0	8
<b>50</b>	<b>Total</b>	<b>100</b>

**Table 4 (ANNULAR CIRCUMFERENCE)**



**Figure 4**

## V. Discussion

The frequency of the annular circumference of the heart valves were compared with the other available literatures in (Table.5).

The present observation of average annular circumference of the tricuspid valve (10.372 cm) which ranged from 8.5-12.5 cm is slightly higher than that of Kouji Chida et al who have reported a range of (9.9 ± 1.0 cm) but lower than that of reported by Westaby S (11.9 ± 2.72 cm) and Tei C (13.5 ± 0.8 cm) and coincides with that of reported by M. Skwarek (10.28 ± 1.66 cm).

Similarly the average annular circumference of the mitral valve (8.285 cm) ranged from 6.5-10.5 cm agrees with that of Kouji Chida et al who have reported (8.3 ± 1.0 cm) and Deopujari, R (8.27 cm) but lower than that of reported by Gupta C (9.11 ± 0.44 cm) and Westaby S (8.70 ± 2.08 cm).

Again the annular circumference of the aortic valve (7.542 cm) which ranged from 6.0-9.99 cm agrees with that of Kouji Chida et al who have reported (7.3 ± 0.7 cm) but higher than that of reported by Westaby S (4.81± 1.30 cm) and Kazman et al. (4.11 cm), but slightly lower than that of reported by Krishnaiah M (7.98 cm).

Similarly the average annular circumference of the pulmonary valve (6.823 cm) which ranged from 6.0-8.0 cm agrees with that of Kouji Chida et al who have reported (6.8 ± 0.8 cm) but higher than that of reported by Garg S (6.5 ± 0.59 cm) and Westaby S (4.88±1.25 cm) .

**Table .5 (ANNULAR CIRCUMFERENCE - frequency)**

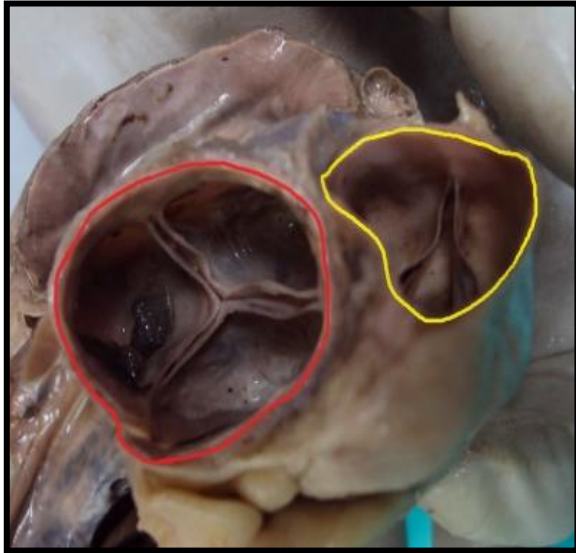
STUDY	TRICUSPID (cm)	MITRAL (cm)	AORTIC (cm)	PULMONARY (cm)
Kouji Chida et al <sup>[4]</sup>	9.9 ± 1.0	8.3 ± 1.0	7.3 ± 0.7	6.8 ± 0.8
Westaby S <sup>[5]</sup>	11.9 ± 2.72	8.70 ± 2.08	4.81 ± 1.30	4.88 ± 1.25
Krishnaiah M <sup>[6]</sup>	-	-	7.98	-
Kazman et al. <sup>[7]</sup>	-	-	4.11	-
Garg S <sup>[8]</sup>	-	-	-	6.5 ± 0.59
Tei C <sup>[9]</sup>	13.5 ± 0.8	-	-	-
M. Skwarek <sup>[10]</sup>	10.28 ± 1.66	-	-	-
Gupta C <sup>[3]</sup>	-	9.11 ± 0.44	-	-
Deopujari, R <sup>[11]</sup>	-	8.27	-	-
<b>Present study</b>	<b>10.372</b>	<b>8.285</b>	<b>7.542</b>	<b>6.823</b>

## VI. Conclusion

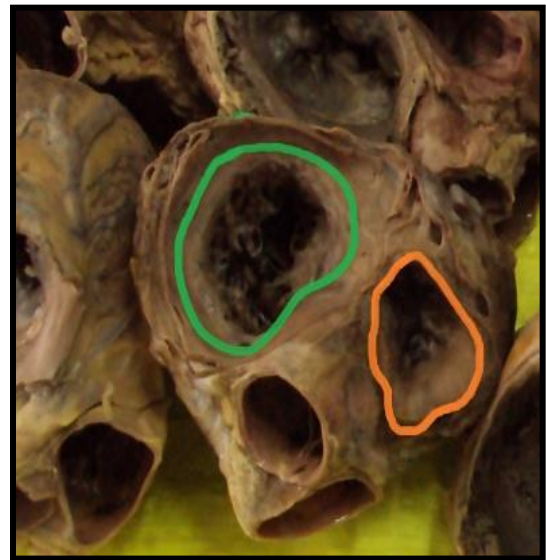
To conclude, The Average annular Circumference of the tricuspid valve was 10.372 cm, mitral valve was 8.285 cm, aortic valve was 7.542 cm and the pulmonary valve was 6.823 cm. Accurate knowledge about the dimensions of all the heart valves is essential for assessing the valve pathology and in designing the prosthesis for valve replacement. Hope that the present study provides the necessary data on the dimensions of valve circumference, which will be helpful for surgeons as well as in manufacturing prosthetic valves.

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**Figure.5**  
RED – Aortic valve  
YELLOW – Pulmonary valve



**Figure.6**  
GREEN – Tricuspid valve  
ORANGE – Mitral valve