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Original Research Article

Measurements of the tricuspid annulus of formalin fixed cadaveric heart

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Abstract

Background: The right atrioventricular valve, also called the tricuspid valve, its blood flow in one direction from the right atrium to the left ventricle. Cardiac surgeons use the tricuspid valve's shape and size data to do heart surgery on people who have a tricuspid valve. In a valve replacement surgery, a prosthetic valve takes the place of the old valve. Prosthesis of the synthetic valve for understanding the Tricuspid valve annulus.

Materials and Methods: We conducted our study by dissecting 100 formalin-fixed human cadaveric hearts. The sex of the human was not specified. The heart was taken out of the pericardial cavity and put on display. The specimens collected were sequentially numbered from 1 to 100 and preserved in a 10% formalin solution. We cut open the tricuspid orifice and measured these dimensions. 1. Circumference of annulus of tricuspid valve. 2. Diameter of tricuspid valve. Measurements were taken using a scale, thread, and vernier calliper.

Results: annular circumference of tricuspid annulus was range from 9.8 cm. to 14.8 cm, average was 11.94±1.05 cm. Diameter of tricuspid annulus was range from 1.8 cm. to 4 cm, average was 3.12±0.47 cm.

Conclusion: These data may assist cardiac surgeons, invasive cardiologists, and the fabrication of synthetic (prosthetic) valves.

Keywords: Tricuspid valve annulus, Right ventricle, Circumference, Diameters

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1. Introduction

The scientific study of the structure of living things is called anatomy. The heart is a muscular organ that pumps blood through two systems: the systemic circulation (the "left" heart) and the pulmonary circulation (the "right" heart). The tricuspid annulus is an elliptical saddle-shaped structure with two high points (pointing up towards the right atrium) and two low points (pointing down towards the right ventricle). From the atrial side, clearly see the opening of the tricuspid valve. It is about 11.4 cm around in men and 10.8 cm around in women. The edges of the tricuspid valve orifice are not all in the same plane; instead, they are almost vertical, making a 45-degree angle with the sagittal plane and leaning slightly towards the vertical.[1] It is roughly triangular, and its edges are called antero-superior, inferior, and septal because they are where the valvular leaflets attach. Autopsy data from a normal tricuspid valve can assist in establishing the standard dimensions of the tricuspid valves, serving as baseline data for cardiac surgeons. In both ventricles, the atrioventricular valvular complex is made up of the orifice and its anulus, the leaflets, the supporting chordae tendineae of different types, and the papillary muscles.

Motabagani et al. (2006), in their study of 40 human tricuspid valves, found that the circumference of the tricuspid valve ranged from 11.8 to 13.9 cm in men and from 11.3 to 12.4 cm in women. The tricuspid valve is a heterogeneous structure of great clinical importance, particularly due to advancements in operative techniques and invasive cardiac surgery, including the partial transfer of the posterior leaflet of the tricuspid valve for mitral valve repair, tricuspid replacement, and complications following heart transplantation, invasive cardiology, and valvuloplasty.[2]. When a patient has heart valve disease, they have to have surgery to replace the prosthetic valve. At this time, the repair is done with valves made of different synthetic materials or biological tissue, as shown below.

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1. Homograft (Allograft): This is when a human cadaveric valve is transplanted into a person with a diseased heart valve.
2. Autograft: Transplanting fascia lata or pericardium from the patient's own body.
3. Heterograft (Xenograft) – Bovine pericardial tissue is harvested and transplanted into the affected individual. Stenosis, incompetence, and prolapse of the leaflets are some of the congenital conditions and diseases that can change the size of these valves and openings.[3]

2. Materials and Methods

The current study specimens of heart were collected from the Department of Anatomy, S.M.S. Medical College, Jaipur and RUHS- CMS Jaipur. Dissection is done by 100 formalin fixed human cadaveric hearts. The gender of human was not included.

2.1. Instruments used

Instruments used during the study for dissection & data collection procedures are Forceps (Plain), Forceps (tooth), Scalpel, Knife, Scissors(straight & curved) ,digital Vernier Calliper, Scale, Pencil, Non elastic cotton thread, hand gloves.

Morphometric Parameters Measured Were:

1. Circumference of tricuspid valve annulus.
2. Diameter of tricuspid annulus.

2.2. Collection of specimens

The specimen thus collected were serially numbered from 1 to 100 & preserved in 10% formalin solution. Specimens were taken cleaned by water and any clots within the chambers.

2.3. Steps of dissection dissection

After getting final approval from the DRC, the Screening Committee for Projects, and the Ethics Committee, the study began as an anatomical dissection method to cut the heart along its edge. Dissection of heart was done following Cunningham's

2.4. Manual of practical anatomy volume-2.

A vertical cut was made along the right edge of the heart, starting at the level where the superior vena cava enters the right atrium and ending at the level where the inferior vena cava enters the right atrium. Then, the right atrium was cut open about 1 cm above the tricuspid valve annulus. The muscular flap was pulled back, and blood clots were taken out. A thorough saline wash was performed. Circumference and diameter of the valve annulus was measured: We looked at and measured the circumference of the heart valve's orifice using a thread. The thread was cut at the ends where they met and then measured with a measuring scale. It was placed along the edge of the annulus to fit its shape. **Figure 1** The values were recorded and organized into a table. The diameter of the tricuspid valve annulus was measured in a single orientated plane at the points of maximum separation. We used a digital vernier calliper to measure the valves' diameters. **Figure 2**. The values were recorded and put into a table.

Figure 1: Method to measure annular circumference of Tricuspid valve

Figure 2: Method to measure diameter of tricuspid valve

3. Objectives

To study of morphometric details including circumference, diameter of tricuspid valve annulus.

4. Results

100 cadaveric hearts were taken for the study. The annular circumference and diameter of tricuspid valve have been noted in the **Table 1**.

Parameters were done under following –

1. Circumference of the tricuspid valve annulus
2. Diameter of tricuspid annulus

4.1. Circumference of the tricuspid valve annulus

The circumference of tricuspid annulus minimum value was 9.8 cm and maximum diameter was 14.5 cm. The mean Circumference of annulus of tricuspid valve 11.94±1.05 cm.

4.2. Diameter of tricuspid valve annulus

The Diameter of tricuspid annulus minimum value was 1.8 cm and maximum diameter was 4 cm. The mean diameter of tricuspid valve annulus 3.12±0.47 cm.

Table 1: Tricuspid valve Annular circumference and diameter of tricuspid valve

No. of specimens (n = 100)	**Mean annular circumference of tricuspid valve (cm)** (Mean ± SD)	**Mean diameter of annulus of tricuspid valve (cm)** **5. (Mean ± SD)**
100	11.94±1.05	7. 3.12±0.47

8. Discussion

The circumference and diameter of the annulus of the tricuspid valve in 100 cadavers were examined at the Department of Anatomy, S.M.S. Medical College, Jaipur, within the Indian population. Although numerous studies have documented these dimensions in various populations, there is a paucity of literature addressing these measurements specifically in the Indian context. The data from this study can serve as a valuable reference in practice. The anatomical variations of a normal tricuspid valve complex can be utilized to distinguish it from a pathological malformation. A cadaveric study of the tricuspid valve across various regions will elucidate regional variations and serve as baseline data for cardiac surgeons.

8.1. Circumference

Silver M.D. et al. (1971)[13] and Paulo A. et al. (2000) reported that the annular circumference of the valve in 27 male hearts was 11.4 ± 1.1 cm, and in 23 female hearts, it was 10.8 ± 1.3 cm. Nagarathanamma et al. (2018) reported that the average circumference was 95.25 ± 11.48. Greys Anatomy 2008 said that the annular circumference of the tricuspid valve is 11.4 cm for men and 10.8 cm for women. R. Kalyani et al. (2012)[5] reported that the annular circumference of the tricuspid valve ranged from 89.34 ± 7 mm to 107.5 ± 10.6 mm in men and from 85.95 ± 6.75 mm to 104 ± 5.65 mm in women, indicating the size of the tricuspid valve among Indians. Motabagani et al. (2006) conducted a study on 40 human tricuspid valves, revealing that the tricuspid valve circumference varied from 11.8 to 13.9 cm in men and from 11.3 to 12.4 cm in women. Skwarek M et al.[7,11] In men, the tricuspid valve's circumference ranged from 107.28 ± 16.76 mm to 120.9 ± 20.95 mm. In women, it ranged from 104.04 ± 16.76 mm to 110.75 ± 14.38 mm. Babita Kujur et al. (2016) reported that the circumference of the tricuspid valve annulus in the current study ranged from 7.9 cm to 12 cm, with a maximum circumference of 12 cm, a minimum circumference of 7.9 cm, and an average circumference of 9.7 cm.

In our study the average annular circumference of the tricuspid valve was found to be 11.94±1.05 cm. The annular circumference of this study almost similar to the gray's anatomy, Lama cp, Motabagani et al. 2006.[3]

Table 2: Differentiation of the annular circumference of tricuspid valve with other studies.

S. No.	**Studies**	**Circumference of the tricuspid annulus**
1	Grays Anatomy 2008	11.4 male 10.8 female
2	Kalyani et al.2012[5]	10.7
3	Motabagani et al. 2006,[10]	12.3
4	Silver et al. 1971[13]	11.3 in male 10.7 in female
5	Present study	11.94

8.2. Diameter

Lama CP et al. (2018)[3] reported that the average diameter of the tricuspid valve was 2.33 ± 0.04 cm. The Department of Anatomy at Nepal Medical College and Teaching Hospital conducted a morphometric study involving a total of 50 cadaveric hearts. R. Kalyani et al. (2012)[5] reported that the study involved 100 formalin-fixed hearts devoid of pathology from patients who had succumbed to non-vascular causes, with ages ranging from 8 to 85 years. The frontal dimension augmented from 27.34 ± 3.97 mm to 32.5 ± 2.12 mm in males and from 24.72 ± 2.69 mm to 31 ± 4.24 mm in females between groups I and III. Supriya Premkumar et al. (2019) reported that the mean diameter of the tricuspid valve in males was 26.06 ± 2.49 mm and in females was 24.33 ± 1.75 mm.

In the present study diameter of tricuspid annulus was found to be 3.12±0.47 cm. The diameter of tricuspid annulus varies in each heart do not coincide with any of the authors.

Table 3: Differentiation of diameter of tricuspid valve annulus with other studies.

S. No.	**Name of study**	**Diameter of tricuspid valve Annulus (in cm)**
1	Gray's Anatomy	3.43 to3.63
2	Singh B and Mohan JC(1994)	2.26
3	John F. Secombe et al(2004)	2.13±0.03
4	Present study	3.12±0.47

9. Conclusion

The cadaveric examination of the tricuspid valve across various regions will assist in identifying regional variations and serve as baseline data for cardiac surgeons. These data may assist in the design of prosthetic valves for the replacement of severely damaged tricuspid valves. The current study analysed the morphometric parameters of the

tricuspid valve and the correlations among various parameters, facilitating a deeper understanding of the anatomy of the tricuspid valve complex and the optimal design of the valvular complex for transplantation.

10. Ethical No

849/MC/EC/2024.

11. Source of Funding

None.

12. Conflict of Interest

None.

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