

MORPHOLOGICAL AND MORPHOMETRICAL ANALYSIS OF MITRAL VALVE ANNULUS OF HEART IN HUMAN ADULT CADAVERS

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ABSTRACT

Background: Mitral / Left Atrio ventricular Orifice is almost vertical in diastole and 45° to the sagittal plane with slight forward tilt. Mitral annulus consists of a collagenous ring where the lamina fibrosa of the valve leaflets are attached. There is variation in the length of annular circumference in different studies due to racial difference. According to previous reports mitral valve mean circumference is 9.0 cm in males; 7.2cm in females. The present study is aimed at studying the Morphology and morphometry of mitral valve annulus by dissection method in South Indian adult population.

Materials and Methods: A total of 60 adult hearts procured from cadavers of dissection hall from Department of Anatomy, SRM Medical College, Sri Ramachandra Medical College, Chennai, were used for study irrespective of sex and age above 50 years. The hearts were meticulously dissected by conventional dissection method to expose the mitral leaflets with the annulus, chordae and papillary muscles. The shape of the mitral orifice was observed. The length of the annulus was measured with the help of a thread and millimeter scale in all hearts.

Results and Conclusion: The overall prevalence of mean annular circumference was found to be 8.86cm. The data presented gives the dimensions of mitral valve which may be of interest to Anatomists and Surgeons. Knowledge of normal measurements of the component parts of the valve will help the surgeon during operation to assess the exact mechanical reason for valve insufficiency.

KEY WORDS: Mitral valve, Annulus, Atrio ventricular Orifice, Lamina fibrosa.

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INTRODUCTION

The mitral orifice is a well – defined transitional zone between the atrial wall and the bases of the cusps. It lies postero – inferior and slightly to the left of aortic valve. The mitral orifice can admit the tips of two fingers. The orifice has two cusps, hence the name bicuspid valve. The mitral cusps resemble in shape the bishop's

miter (crown) [1].

Mitral valve insufficiency may result from the diseases of heart which affects the valves like stenosis, regurgitation of valves or prolapse of the leaflets. Advances in mitral valve surgery in the course of the last few years has prompted a thorough revision of our knowledge concerning the anatomy of the normal mitral valve. As a

result of such studies, current notions may be changed and extended so as to understand the morphology of the mitral valve better and to provide a scientific basis for its function.

The function of mitral valve depends on the anatomical and mechanical integrity of the atrio-ventricular ring, the valve leaflets, chordae tendinae and the papillary muscles.

Advances in echocardiography, invasive cardiology (including balloon mitral valvuloplasty) and surgical reconstruction of mitral valves necessitate an appreciation of many variations in the anatomy of the mitral valve.

The classical description of the mitral valve found in the textbooks of anatomy is inadequate for the need of the cardiac surgeons. Similarly the importance of the valvular structures and the myocardium in the mechanism of valve closure requires a new appraisal in view of recent observations. This study will be of much help for mitral valve procedures such as mitral commissurotomy, commissuroplasty, valvuloplasty and artificial chordae tendinae replacement and prosthetic valve replacements.

Developmentally, around the left atrioventricular canal, the mesenchyme proliferates to form collars of the endocardial cushions. The ventricular surface of these collars of cells is excavated to form the Atrio ventricular valves which are attached to the ventricular wall by the trabecular cords only. Later these cords give rise to chordae tendinae and papillary muscles [2].

Microscopically, the valves of the heart are composed of a core of collagenous fibrous tissue covered on each surface by vascular endothelium.

MATERIALS AND METHODS

Conventional dissection method:

Collection of specimens: The current study of mitral valve measurements were done with cadaveric hearts from various sources. Total of 60 hearts (irrespective of age and sex) were included in this study. Forty five hearts were taken from human cadavers from anatomy department, SRM Medical college and Research Institute, Chennai. Fifteen hearts were taken from Sri Ramachandra Medical college, Chennai. The hearts were preserved by Embalming

later on preserved in 10% formalin. The specimens were in good condition after removal from the body during dissection and retain their true features. The collected specimens were immersed in the following specific preservative solution - 10 litres of normal saline, 1 litre of 10% formalin, 50 ml of glycerine, 5 gms of powdered thymol.

Dissection of specimens: Position and orientation of the heart and its chambers were confirmed.

Left atrium was then opened by an incision through the right and left inferior pulmonary veins and the upper part of left atrial auricle was dissected. The heart thus opened was emptied of blood clots inside, washed thoroughly in running tap water. The mitral valve was inspected from above.

Out flow tract of the left ventricle was opened by an incision on the sternocostal surface of the heart extending from the apex, parallel and close to the interventricular septum upto the aortic orifice. The heart thus opened was emptied of blood clots inside, washed thoroughly in running tap water.

In each heart a detailed examination of the mitral valve annulus was made. The following morphological features of mitral valve annulus were studied namely Shape &

Circumference Measurements were taken with the help of a divider, thread and a millimeter scale. Circumference of Mitral Annulus was taken by keeping a thread in the sulcal margin and this distance in the thread is measured with millimeter scale. This is a simple method as no complicated instruments were used. The limitation of this method is that it may cause human error during measurements. Statistical Analysis was done using the data obtained.

RESULTS

The peripheral margin of the mitral annulus is represented by a sulcal margin. The shape of the mitral annulus is D shaped in all 60 specimens.

The superomedial part of the mitral annulus gave attachment to the anterior leaflet in all 60 specimens. Rest of the mitral annulus provides attachment to the posterior leaflet in all the 60

hearts.

Circumference of the mitral annulus was studied with the help of a thread and millimeter scale. The average value of the total length of the valve ring (valve circumference) in my study was found to be 8.86 ± 0.16 cm.

Fig. 1: Photograph showing the method of measuring the annular circumference.

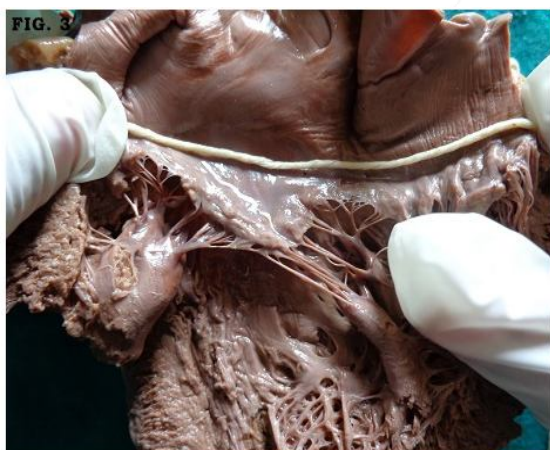
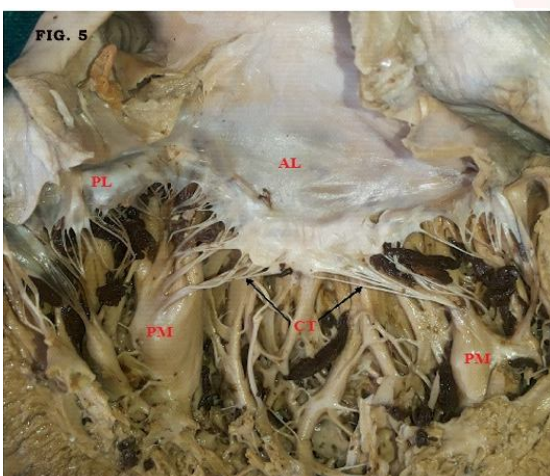


Fig. 2: Photograph showing the morphology of mitral valve – “d” shaped annulus. (AL – Anterior Leaflet, PL – Posterior Leaflet)



Fig. 3: Photograph showing the mitral valve complex (AL – Anterior Leaflet, PL – Posterior Leaflet, PM – Papillary Muscle, CT – Chordate Tendinae)



The range of mean annular circumference of 60 hearts studied was tabulated (Table 1). The percentile variation and the number of specimens in each range of mitral valve annular circumference is depicted using a pie chart and bar diagram (Fig. 1 & Fig. 2). It ranges from 5 - 11.99 cm. Out of 60 hearts, the annular circumference is maximum in the range 9-9.99cm seen in 17 hearts (28.3%) and the lowest is in the range of 5-5.99cm seen in 1 heart (1.67%).

Table 1: Shows the No. of specimens and their percentage in varied ranges of annular circumference of mitral valve (5 – 12 cm) and their statistical analysis.

RANGE (cm)	5-5.99	6-6.99	7-7.99	8-8.99	9-9.99	10-10.99	11-11.99
NO. OF SPECIMENS	1	2	12	16	17	9	3
PERCENTAGE	1.67	3.33	20	26.67	28.33	15	5
MEAN	5.8	6.4	7.5	8.5	9.4	10.4	11.3
S.D	-	2.5	2.7	2.9	3.1	3.2	3.4
SEM	-	0.4	0.1	0.1	0.1	0.1	0.3

Table 2: Comparison Of Circumference Of Mitral Valve With Other Studies.

S.NO.	STUDY PERFORMED	ANNULAR CIRCUMFERENCE OF MITRAL VALVE (cm)	NO. OF SPECIMENS USED
DISSECTION METHOD (CADAVERIC HEARTS)			
1	Present study	8.86 ± 0.16	60
2	Henry Gray [1]	9 in males, 7.2 in female	
3	Rusted I.E. [13]	9.9	
4	Ranganathan et al. [2]	9 in male, 7.2 in female	50
5	Gupta et al [5]	8-Oct	18
6	Gunai et al. [6]	9.12	116
7	Cheichi et al [15]	10 in male, 9 in females	
8	Gerdal Van Rijk – Zwikker [11]	10 in male, 9 in females	
9	Shahim Akthar Cheema [12]	10.7 in male, 9.16 in female	
10	Tetsura Sakai [14]	9.33 ± 1.1 cm	
11	Patil, Mehta, Prajapati [7]	8.248 cm	50
DISSECTION METHOD (CADAVERIC HEARTS)			
12	R C Brock [9]	9 cm	Surgical and pathological anatomy
13	Louis A Du Plessis [16]	10.2 cm	10
14	Bernadine H Bulkeley [10]	9 cm (7 – 11 cm)	24
15	A.K.Datta [17]	10.3 cm in male, 9.7cm in female	30
16	Andrade Tinois Vieira [20]	7.92 cm	
17	M. Kavimani [8]	8.9 cm in male, 8.3 cm in female	45
2 – D ECHO CARDIOGRAPHIC METHOD			
18	Omriston et al. [18]	9.3 ± 0.9 cm	

DISCUSSION

Morphologically, many reports state that the mitral annulus marking the hinge line of the valvular leaflets is more D shaped than circular shape [3]. The present study correlates with the above report as in all the 60 hearts the mitral annulus is represented by the sulcal margin and the shape of mitral annulus is D shaped.

Morphometric analysis of mitral valve showed variable findings depending upon the method used. The various studies were analysed with

fresh hearts and cadaveric hearts and also 2D echocardiography performed during the cardiac cycle. The present study was done with the cadaveric hearts by conventional dissection method. The annular circumference of the mitral valve in this study (8.86 ± 0.16 cm) corresponds with values (Table 2) reported with cadaveric hearts by Henry Gray [1], Ranganathan et al [4], Gupta et al [5], Gunal et al [6], Patil, Mehta and Prajapati [7] by dissection method, with fresh hearts by Kavimani et al [8] and also with the studies performed in living patients like Brock [9] who considered the surgical and pathological anatomy of mitral valve, Bulkley & Roberts [10]. The mean average value are in wide array of comparison with the studies of Gerda et al [11], Shahim Akthar et al [12], Rusted et al [13], Tetsura Sakai et al [14], Cheichi et al [15] using cadaveric hearts, Du Plessis and Merchand, [16], A.K. Datta et al [17] using fresh hearts and Ormiston, et al. [18] (9.3 ± 0.9 cm) by 2D echocardiographic method who reported a higher range in both the sexes with fresh heart specimens, but significantly lesser than findings of McAlpine [19] using hearts in diastolic state perfusion method and higher with the findings of Andrade, Tinois, Vieira et al. [20]. However, the maximum percentage of annular circumference is in the range of 9 – 9.99 cm which can be deliberately said as the no. of specimens used for the current study is much higher than with the earlier reports.

More precisely, in the current study the length of the annular circumference of the mitral valve ranges from 5 cm – 11.99 cm. The percentile variation of the range like the most frequent is between 9 – 9.99 cm, which almost coincides with majority of the reports mentioned [6-8]. The least range of 5 – 5.99 cm is found in only one small – sized heart and maximum range is 11 – 11.99 cm which appeared in 3 large sized hearts. This percentile variation may be due to the fact that the annular circumference is proportional to the size of the heart which in turn is proportional to the body size. Also, inferred with the large mitral valve circumference is that it may be associated with myxomatous valvular disease and may lead to functional mitral regurgitation.

The study performed will help in the choice of

prosthetic valves for mitral valve replacement surgery. The unique range of values thus obtained in the current study should be kept in mind which will help in finding the correct size of prosthesis for a valve replacement surgery which will accurately fit in to accommodate the flexibility of the valve ring.

CONCLUSION

The present study gives the detailed knowledge of the anatomy of the mitral valve annulus and improves understanding of mitral valve function, which aids the surgeon in understanding valve pathophysiology and in designing reconstructive procedures. Replacement of mitral valve with mitral homograft has been tried and is reemerging as a surgical alternative.

The present study will be useful for cardiologists and cardiothoracic surgeons in echocardiography, invasive cardiology and surgical reconstructive procedures of mitral valve. The morphometric analysis is useful for determining the size of the prosthetic valves in valve replacement procedures like commissurotomy and commissuroplasty.

Conflicts of Interests: None

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