Dimensions Of Mitral Valve Of Normal Human Hearts In Pakistani Subjects

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Summary

Mitral valve has been extensively studied in the west but no data is available about its dimensions in Pakistan population. We have studied 29 human hearts of healthy subjects which included 23 males and 6 females. Various dimensions were noted in great details.

The annulus was found to be "D" shaped with a mean circumference of 10.7 cm in males and 9.167 cm in females. The anterior leaflet had a basal length of 3.952 cm in males and 3.137 cm in females. The height of cusp was 2.517 cm in males and 2.133 in female. The posterior mitral leaflet was uniscalloped in 16 hearts, biscalloped in six and triscalloped in seven hearts. The mean basal length of uniscalloped posterior leaflet was 6.654 cm in males and 5.927 cm in females. The basal length of bicuspid end triscalloped posterior leaflets is different and so is their height. Nevertheless the main scallope in these leaflets had dimensions which were comparable with those of uniscalloped posterior leaflet.

All these dimensions have been compared with data from similar studies wherever available.

Introduction

The structure of the mitral valve has been studied in great details by a large number of workers. They include pure anatomists as well as the cardiac surgeons. The data available in various texts provides us the dimensions of various parts of the mitral valve. There is no doubt that the knowledge of such figures is of prime importance during surgical interventions like valvotomy, valve repair and prosthetic valve replacement. Unfortunately the data about the Asian population is not available. In this article we have evaluated the normal dimensions of the human mitral valve apparatus in 29 hearts of Pakistani subjects. Our limited study could not find any significant difference between our observations and the figures quoted by the western authors.

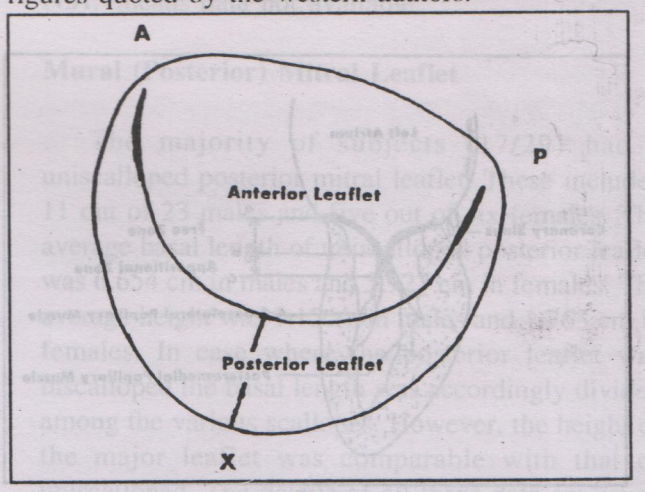

Fig. 1.
Mitral Valve (superior view)

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Materials and Methods

Twentynine hearts were studied for the structural evaluation of the mitral valve. These hearts were obtained from the Department of Forensic Medicine, King Edward Medical College, Lahore. The cause of death in these cases was head injury resulting either from fire arm or automobile accident. None of these had any disease which could deform the anatomy of the mitral valve. The average age of these subjects was 30.2 (±10.51) years. They included 23 male and six female subjects.

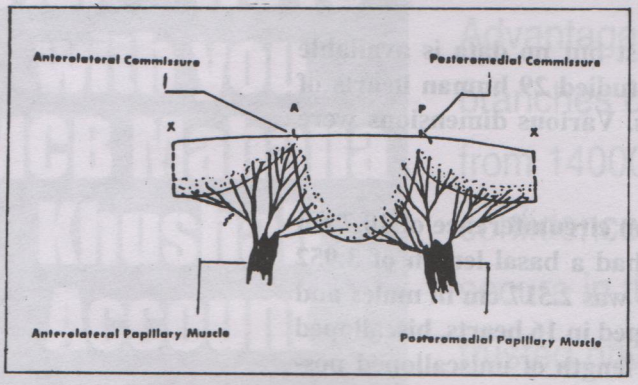

Fig. 2.
Mitral Valve (sectioned at the middle of posterior leaflet)

The mitral valve was studied systematically after the removal of left atrium. The gross appearance of the cusps and the annulus was noted and then the annulus was cut of the middle of the posterior cusp with a pair of scissors. The anterolateral and the posteromedial papillary muscles were saved as the incision passed through the lateral wall of the left ventrich.

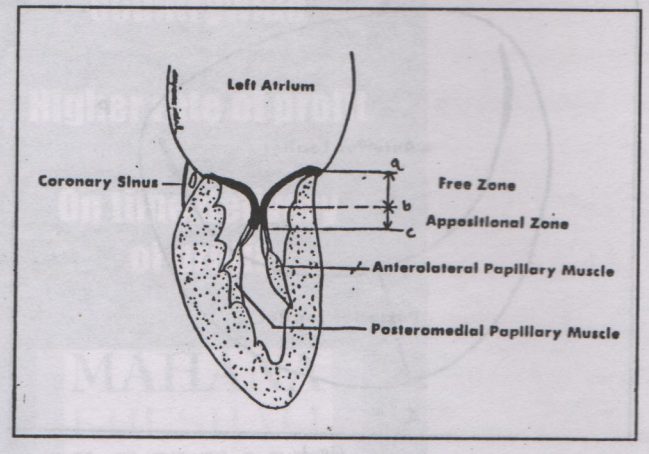

Fig. 3.
Left Ventricle (inflow tract)

The size of annulus was measured with a metric ruler. The basal length of the aortic (anterior) leaflet was taken from the anterolateral to the posteromedial commissures, i.e, A-P (fig. 1&2). Similarly, the basal length of the mural (posterior) leaflet was calculated by adding the measurements taken from these commissural points (i.e, 'A' and 'P') to the respective cut ends, i.e, A-X + P-X (fig. 1&2).

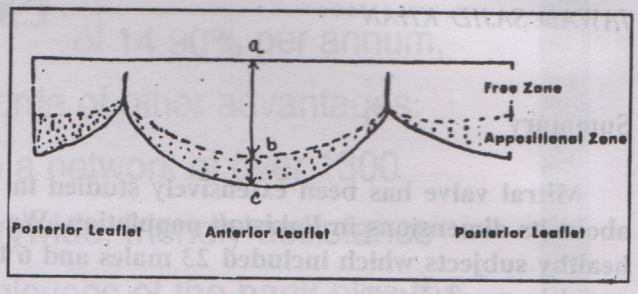

Fig. 4.
Mitral Valve
(sectioned at the middle of posterior leaflet)

Total height of the aortic leaflet was taken at its center from annulus to its apex a-c (fig. 3&4). The free zone was from the annulus to the line of closure, i.e, a-b (fig. 3&4) and the appositional zone thus extended from line of closure to the free margin i.e, b-c.

TABLE 1

CIRCUMFERENCE OF THE MITRAL VALVE ANNULUS AND COMPARISON WITH STUDY BY CHIECHI & LEES (1956)

Measurements	Present Study (1995)		Chiechi & Lees (1956)	
	Male	Female	Male	Female
No. of Hearts	23	6	60	45
Mean Circumference (cm)	10.7	9.167	10	9
Standard Deviation (±)	0.898	0.983	Not Available	
Range (cm)	8.9-12	8-11	8.5-11.5	8-10.5

According to the same scheme, the measurements

of the posterior leaflet were noted down. In cases where the mural leaflet was bi- or tri- scalloped these measurements were taken for individual scallopes.

Results

The mean weight of hearts differed significantly in male and female subjects. However, other dimensions regarding the annulus and the cusps did not have similar difference. The mean weight of heart in males was 317.6 (±44.02) grams and in females was 267.5 (±26.22) grams. Other dimensions were noted as under.

TABLE 2

DIMENSIONS OF ANTERIOR MITRAL LEAFLET IN 23 MALE AND SIX (6) FEMALE HEARTS

Measurements (CM)	Male Hearts Mean (±S.D.) Range			Female Hearts Mean (±S.D.) Range		
Basal Length	3.952	(0.602)	2.8-5.0	3.137	(0.402)	3.0-4.0
Height						
Free Zone	1.952	(0.294)	1.0-2.2	1.650	(0.378)	1.0-2.0
Appositional	0.565	(0.161)	0.3-1.0	0.483	(0.041)	0.4-0.5
Total	2;517	(0.267)	1.7-2.9	2.133	(0.383)	1.5-2.5

S.D. = standard deviation.

Annulus

The mean circumference (length) of the annulus was 10.7 cm in males and 9.167 cm in females. The difference in these figures was statistically non significant. The details of the measurements are given in Table 1 and the data is compared with similar study done by Cheichi & Lees et al[1].

Aortic (Anterior) Mitral Leaflet

The aortic mitral leaflet had a mean basal length of 3.952 cm in males and 3.137 cm in females. The average height was 2.517 cm in males and 2.133 cm in females. The 3/4 of this height was contributed by the free zone of the cusp and 1/4 consisted of the appositional zone. This ratio was similar in both sexes (Table 2).

TABLE 3

DIMENSIONS OF ANTERIOR MITRAL LEAFLET COMPARISON OF DATA FROM VARIOUS STUDIES

Dimensions (CM)	Rusted (1952)	Chiechi (1956)	Ranganathan (1970)	Present Study (1995)
HEIGHT:				
Male	2.3 (1.6-2.9)	2.1 1.9-3.2)	2.4 (1.5-2.5)	2.5 (1.7-2.9)
Female	2.1 (1.6-2.5)	2.2 (1.8-2.7)	2.2 (1.8-3.5)	2.1 (1.5-2.5)
BASAL LENGTH:				
Male	N.A.	3.7 (2.5-4.5)	3.6 (2.4-4.8)	3.9 (2.8-5.0)
Female	N.A.	3.3 (2.4-4.2)	2.9 (1.8-4.2)	3.1 (3.0-4.0)

Values are Mean (Range)
N.A. 'means data not available'.

Mural (Posterior) Mitral Leaflet

The majority of subjects (17/29) had a uniscalloped posterior mitral leaflet. These included 11 out of 23 males and five out of six females. The average basal length of uniscalloped posterior leaflet was 6.654 cm in males and 5.927 cm in females. The average height was 1.15cm in males and 1.763 cm in females. In case where the posterior leaflet was biscalloped the basal length was accordingly divided among the various scallopes. However, the height of the major leaflet was comparable with that of uniscalloped. The details of all these data are given in Table 4 to 7.

Discussion

In the past few decades, there existed considerable controversy regarding the shape and structure of the mitral valve annulus and the arrangement of leaflets. Brock[2] described the annulus as a ring. Later the annulus was discovered to be incompletely developed anteriorly along the attachment of anterior mitral leaflet. Chiechi[1], Walmsley[3] and Loop[4] stated that it was completely absent anteriorly. Davila[5] divided the annulus into an anterior deficient 1/3 and a complete posterior 2/3. He described it as horse shoe shaped. In our view, horse shoe shape becomes too large for the posterior 2/3.

TABLE 4

DIMENSIONS OF UNISCALLOPED POSTERIOR MITRAL LEAFLET IN 11 MALE AND FIVE 5 FEMALE HEARTS

Measurements (CM)	Male Hearts Mean (±S.D.) Range	Female Hearts Mean (±S.D.) Range
Basal Length	6.654 (0.808) 5.3-8.0	5.927 (0.729) 5.0-7.0
Height		
Free Zone	0.973 (0.300) 0.7-1.8	1.340 (0.150) 1.0-1.5
Appositional	0.536 (0.246) 0.4-1.0	0.420 (0.110) 0.3-0.5
Total	1.510 (0.468) 1.1-2.5	1.763 (0.251) 1.5-2.0

S.D. = Standard deviation.

We consider that the annulus is roughly 'D' shaped. The straight part of letter D represents the anterior deficient 1/3 of the annulus and the semicircular part represents the posterior 2/3 of the annulus. The angles of the D represent the commissures of the valve.

Despite the absence of a definite annular tissue, the anterior 1/3 of the annulus is compensated by the presence of fibrous aortico-mitral continuity created by the attachment of anterior mitral Q leaflet to the subaortic valvular tissue extending between the fibrous trigones. Hence the ends of the anterior leaflet are secured by their attachment to the fibrous trigones. The anterior 1/3 of the annulus is not only devoid of the fibrous tissue but also lacks the atrioventricular myocardium. Posterior 2/3, on the contrary, is well developed in the fibrous element and lies between the atrioventricular myocardium. This atrioventricular myocardium plays a significant role in the dynamic behaviour of the annulus during ventricular systole when the posterior 2/3 shortens by 30% whereas the anterior 1/3 does not undergo any change. This plays an important role in the competence of the valve and a thorough understanding of these factors is mandatory for a surgeon who intends to do mitral valve repair.

TABLE 5

DIMENSIONS OF BISCALLOPED (I.E., MIDDLE + ANTEROLATERAL) POSTERIOR MITRAL LEAFLET IN 3 MALE HEARTS

Measurements (CM)	Middle Scallope Mean (±S.D.) Range	Anterolateral Scallope Mean (±S.D.) Range
Basal Length	4.50 (1.00) 3.5-5.5	2.37 (0.55) 2.0-3.0
Height		
Free Zone	1.06 (0.12) 1.0-1.2	1.10 (0.26) 0.9-1.4
Appositional	0.56 (0.06) 0.5-0.6	0.43 (0.11) 0.3-0.5
Total	1.60 (0.15) 1.5-1.8	1.56 (0.31) 1.3-1.9

S.D. = Standard deviation.

The size of the annulus and the various other dimensions of the anterior leaflet have been compared with the figures quoted by Ranganathan[6], Rusted[7] and Chiechi[1] in tables 1 & 3. A review of these tables reveals that these figures are quite comparable. Therefore one can have an idea that the racial difference has very little bearing upon the dimensions of the mitral valve.

Conclusions

1. The annulus of the mitral valve is D shaped, with a straight anterior 1/3 giving attachment to the

anterior mitral leaflet and a semicircular posterior 2/3 which gives attachment to the posterior mitral leaflet.

2. Approximately three quarter of the anterior leaflet consists of free zone and the distal one fourth consists of appositional zone.

TABLE 6

DIMENSIONS OF BISCALLOPED (I.E., MIDDLE + POSTEROMEDIAL) POSTERIOR MITRAL LEAFLET IN 3 MALE HEARTS

Measurements (CM)	Middle Scallope Mean (±S.D.)	Range	Posteromedial Scallope Mean (±S.D.)	Range
Basal Length	3.50 (0.50)	3.0-4.0	3.83 (1.04)	3.0-5.0
Height				
Free Zone	1.00 (0.00)	1.0-1.0	0.93 (0.12)	0.8-1.0
Appositional	0.50 (0.00)	0.5-0.5	0.50 (0.00)	0.5-0.5
Total	1.50 (0.00)	1.5-1.5	1.43 (0.12)	1.3-1.5

S.D. = Standard deviation.

3. The various dimensions are comparable with those noted by other workers. Therefore, there is no significant racial difference in the anatomy of the mitral valve.

TABLE 7

DIMENSIONS OF TRISCALLOPED POSTERIOR MITRAL LEAFLET IN SIX MALE AND ONE FEMALE HEARTS

Dimensions	Mean	(±S.D.)	Range
BASAL LENGTH:			
Middle Scallope	2.49	0.23	2.0-2.7
Anterolateral Scallope	1.81	0.52	1.3-2.5
Posteromedial Scallope	2.13	0.36	1.5-2.5
Total	6.43	0.48	5.7-7.0
HEIGHT:			
Middle Scallope			
Free Zone	1.10	(0.29)	0.7-1.5
Appositional	0.48	(0.04)	0.4-0.5
Total	1.58	(0.30)	1.2-2.0
Anterolateral Scallope			
Free Zone	0.91	(0.30)	0.5-1.5
Appositional	0.48	(0.04)	0.4-0.5
Total	1.40	(0.29)	1.0-1.9
Posteromedial Scallope			
Free Zone	0.75	(0.25)	0.5-1.0
Appositional	0.45	(0.08)	0.3-0.5
Total	1.21	(0.25)	0.9-1.5

S.D. = Standard deviation.

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