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Original Research Article

Morphometry of the Mitral Valve Annulus in Cadavers: Correlation with Echocardiographic Data

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Abstract

Background: The mitral valve annulus (MVA) is a dynamic structure essential for normal cardiac function and a critical determinant in the pathogenesis of mitral valve disease. Its morphometry is of paramount importance for surgical repair, prosthetic valve selection, and interventional cardiology. While echocardiography provides functional in-vivo data, cadaveric studies offer direct anatomical insights. Limited studies exist correlating cadaveric and echocardiographic dimensions in the Indian population.

Material and Methods: This cross-sectional observational study was conducted in a tertiary care teaching hospital of western Gujarat. Forty formalin-fixed adult cadaveric hearts without gross cardiac pathology were examined. The mitral annular anteroposterior diameter, transverse diameter, circumference, and area were measured using a digital Vernier caliper and flexible measuring tape. Age- and sex-matched echocardiographic data from 40 healthy individuals were retrospectively retrieved. Parameters were compared using independent sample t-tests, and Pearson's correlation coefficient was calculated to assess the relationship between cadaveric and echocardiographic measurements.

Results: Cadaveric measurements were consistently smaller than echocardiographic values. Mean anteroposterior and transverse diameters were 29.8 mm and 33.5 mm in cadavers, compared to 31.2 mm and 35.0 mm in vivo ($p < 0.05$). Similarly, annular circumference (96.4 mm vs 100.8 mm) and area (7.2 cm^2 vs 8.1 cm^2) were significantly lower in cadavers. Correlation analysis demonstrated strong positive relationships between modalities ($r = 0.65–0.74$, $p < 0.01$). Leaflet dimensions showed no significant differences, while males consistently had larger annular parameters than females.

Conclusion: Mitral annular dimensions in cadaveric hearts strongly correlate with echocardiographic data, though fixation-induced shrinkage leads to smaller values. These findings provide valuable region-specific anatomical references for surgical and interventional planning.

Keywords: Mitral Valve Annulus, Morphometry, Cadaveric Hearts, Echocardiography, Cardiac Anatomy.

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Introduction

The mitral valve annulus (MVA) is a dynamic, saddle-shaped structure that plays a pivotal role in maintaining effective atrioventricular flow and left ventricular function. [1] Its morphometric characteristics determine leaflet coaptation and are crucial in the pathophysiology of mitral valve disease. [2]

Structural variations of the MVA contribute significantly to common clinical conditions such as mitral regurgitation, prolapse, and stenosis, and precise knowledge of annular geometry is therefore essential for both surgical and interventional procedures including valve repair and replacement. [3] Traditionally, the annulus has been evaluated using cadaveric dissection and imaging modalities such as echocardiography, computed tomography (CT), and magnetic resonance imaging (MRI). [4] Cadaveric morphometry offers direct anatomical insights, though it is limited by fixation changes and the absence of dynamic forces, whereas echocardiography provides in-vivo functional measurements but is subject to inter-observer variation.

Previous studies have reported variability in annular dimensions depending on methodology, population, and sex distribution. However, there remains a scarcity of comparative data directly correlating cadaveric morphometry with echocardiographic findings in Indian populations. [5] Given the rising prevalence of valvular heart disease and the increasing use of prosthetic and annuloplasty devices tailored to patient anatomy, it is imperative to establish accurate reference values for mitral annular dimensions. While some international studies have attempted such comparisons, most were limited by small sample sizes or were conducted in Western cohorts. Hence, the present study was undertaken to analyze the morphometry of the mitral valve annulus in 40 cadaveric hearts and correlate these findings with echocardiographic data from age- and sex-matched individuals. This correlation aims to provide region-specific anatomical references to guide clinicians in diagnostic and surgical decision-making.

Material and Methods

This was a cross-sectional observational study conducted in the Department of Anatomy in collaboration with the Department of general medicine at a tertiary care teaching hospital of western Gujarat. The study was carried out over a period of 18 months after obtaining clearance from the Institutional Ethics Committee. A total of 40 formalin-fixed adult human cadaveric hearts were studied, irrespective of sex, provided they were free from gross pathological abnormalities. Echocardiographic data were retrospectively retrieved from the digital echocardiography database of the Cardiology Department, selecting individuals without structural heart disease. All cadaveric dissections and data collections adhered to ethical standards of research on human material and followed the principles of the Declaration of Helsinki.

Inclusion criteria for the cadaveric sample were adult hearts (age >18 years at time of death) without macroscopic evidence of congenital or acquired valvular disease, myocardial infarction, or previous cardiac surgery. Hearts showing distortion, trauma, or inadequate fixation were excluded. For the echocardiographic group, only normal transthoracic echocardiographic reports from adults of comparable age and sex were included. Patients with hypertension, diabetes mellitus, rheumatic heart disease, ischemic heart disease, atrial fibrillation, or structural cardiac anomalies were excluded to avoid confounding influences on annular geometry. This ensured that the comparative data reflected healthy baseline annular dimensions.

For the cadaveric measurements, the left atrium was carefully opened to expose the mitral valve annulus. The anteroposterior diameter, transverse diameter, and circumference were measured using a calibrated digital Vernier caliper and flexible measuring tape. For echocardiographic data, annular dimensions were recorded from standard apical four-chamber and parasternal long-axis views using two-dimensional echocardiography. All parameters were expressed as mean ± standard deviation (SD). Statistical analysis was performed using SPSS software version 25.1. Independent sample t-tests were applied to compare mean values between cadaveric and echocardiographic groups, and Pearson's correlation coefficient (r) was calculated to assess linear relationships. A p-value <0.05 was considered statistically significant.

Results

A total of 40 formalin-fixed adult human cadaveric hearts were studied, and their mitral valve annular parameters were compared with echocardiographic data from 40 age- and sex-matched living subjects. The demographic details are shown in Table 1 below:

Table 1: Demographic characteristics of cadaveric and echocardiographic study groups (n = 40 each)

Parameter	Cadaveric Hearts (n=40)	Echocardiographic Group (n=40)
Mean Age (years)	55.3 ± 12.1	54.1 ± 11.7
Sex (Male : Female)	22:18	21:19
Mean Body Surface Area (m^2)	1.62 ± 0.13	1.64 ± 0.15

Table 2 demonstrates that both anteroposterior and transverse diameters of the mitral annulus are slightly larger on echocardiography compared to cadaveric measurements, highlighting in-vivo expansion of the dynamic annulus.

Table 2: Comparison of mitral annular diameters (mm) between cadaveric and echocardiographic groups

Parameter	Cadaveric (n=40) Mean ± SD	Echocardiographic (n=40) Mean ± SD	p value
Anteroposterior diameter	29.8 ± 3.1	31.2 ± 3.4	0.041*
Transverse diameter	33.5 ± 3.6	35.0 ± 3.2	0.048*

Table 3 illustrates that annular circumference and calculated area appear greater in echocardiographic assessment than in cadaveric specimens, suggesting fixation-related shrinkage and physiological differences.

Table 3: Comparison of mitral annular circumference and area

Parameter	Cadaveric (n=40) Mean ± SD	Echocardiographic (n=40) Mean ± SD	p value
Circumference (mm)	96.4 ± 8.2	100.8 ± 9.0	0.032*
Area (cm²)	7.2 ± 1.1	8.1 ± 1.3	0.027*

Table 4 confirms a strong positive correlation between cadaveric and echocardiographic annular dimensions, supporting the reliability of cadaveric morphometry as an anatomical reference.

Table 4: Correlation between cadaveric and echocardiographic mitral annular measurements

Parameter	Correlation coefficient (r)	p value
Anteroposterior diameter	0.71	<0.01
Transverse diameter	0.68	<0.01
Circumference	0.74	<0.01
Area	0.65	<0.01

Table 5 compares anterior and posterior leaflet morphometry, indicating close similarity between cadaveric and echocardiographic groups, with no statistically significant differences.

Table 5: Comparison of anterior and posterior mitral leaflet dimensions in cadaveric and echocardiographic groups

Parameter	Cadaveric Mean ± SD (mm)	Echocardiographic Mean ± SD (mm)	p value
Anterior leaflet height	20.1 ± 2.5	21.3 ± 2.7	0.062
Anterior leaflet width	26.5 ± 3.2	27.1 ± 3.0	0.314
Posterior leaflet height	14.7 ± 2.1	15.5 ± 2.0	0.081
Posterior leaflet width	23.8 ± 3.0	24.6 ± 2.7	0.222

Table 6 highlights sex-based differences, with males showing consistently larger annular dimensions than females across both cadaveric and echocardiographic groups, reinforcing the need for gender-specific anatomical references.

Table 6: Sex-wise distribution of mitral annular parameters in cadaveric and echocardiographic groups

Parameter	Male (n=22 cadaveric / 21 echo)	Female (n=18 cadaveric / 19 echo)	p value
Anteroposterior diameter (mm)	31.0 ± 2.9 / 32.1 ± 3.3	28.2 ± 2.7 / 30.0 ± 3.0	0.037*
Transverse diameter (mm)	34.6 ± 3.4 / 36.0 ± 3.1	32.1 ± 3.1 / 34.1 ± 3.2	0.042*
Circumference (mm)	99.2 ± 7.5 / 103.5 ± 8.8	92.8 ± 7.0 / 98.2 ± 8.4	0.028*
Area (cm²)	7.6 ± 1.0 / 8.4 ± 1.2	6.7 ± 0.9 / 7.8 ± 1.3	0.033*

Discussion

The present study assessed the morphometry of the mitral valve annulus in 40 cadaveric hearts and compared these with echocardiographic data from age- and sex-matched individuals. Our findings demonstrated slightly smaller values in cadaveric specimens compared to echocardiographic dimensions, but a strong positive correlation was evident across all parameters. This highlights the anatomical reliability of cadaveric measurements while acknowledging the physiological differences of in-vivo imaging. The anteroposterior and transverse diameters measured in our cadaveric series (29.8 mm and 33.5 mm, respectively) were marginally lower than echocardiographic values. Similar trends were reported by (Watanabe et al., 2005) [6], who demonstrated smaller dimensions in post-mortem samples compared to in-vivo data. (Kizer et al., 2005) [7] also documented larger diameters in echocardiographic cohorts, attributing this to the dynamic and saddle-shaped expansion of the annulus during the cardiac cycle. A study by (Sriambika et al., 2018) [8] from India reinforced these observations, showing echocardiographic diameters consistently higher than cadaveric references in a South Indian population.

Circumference and annular area also showed significant differences between cadaveric and in-vivo data. In our study, circumference averaged 96.4 mm in cadavers and 100.8 mm on echocardiography. Comparable findings were observed in (Chen et al., 2018) [9], who reported mean annular circumference of 97 mm in cadaveric hearts versus 103 mm in living subjects. (Silbiger, 2012) [10] emphasized that such discrepancies are expected due to fixation shrinkage and the physiological stretching of annular tissue in systole and diastole. Furthermore, (Bose et al., 2015) [11] in an Indian cadaveric study highlighted similar underestimation of area values when compared to echocardiographic records. Regarding leaflet dimensions, our analysis revealed no statistically significant differences between cadaveric and echocardiographic groups for anterior and posterior leaflet height and width. This finding is in line with (Flachskampf et al., 2000) [12], who found that leaflet length remains relatively constant across modalities despite variations in annular diameter. (Leo et al., 2020) [13] also demonstrated minimal differences in leaflet measurements between cadaveric and in-vivo groups, supporting the anatomical stability of leaflet structures. These observations suggest that annular dynamics are more affected by physiological conditions than leaflet dimensions.

Gender-based differences in annular dimensions were also evident in our series, with males exhibiting significantly larger diameters and circumferences compared to females. This is consistent with (Riffel et al., 2021) [14], who reported larger annular areas in male patients in an echocardiographic cohort. (El-bushid et al., 2017) [15] similarly demonstrated sexual dimorphism in Indian hearts, with men having greater mitral annular diameters and area. Such data underscore the importance of gender-specific anatomical references in valve repair and prosthetic sizing.

The present study is limited by its relatively small sample size of 40 cadaveric hearts, which may restrict the generalizability of the findings. Formalin fixation could have led to tissue shrinkage, resulting in underestimation of true annular dimensions. Additionally, reliance on two-dimensional echocardiography rather than three-dimensional imaging may not fully capture the dynamic saddle-shaped geometry of the mitral annulus.

Conclusion

The present study demonstrated that mitral valve annular dimensions measured in cadaveric hearts are consistently smaller than those obtained through echocardiography, largely due to fixation shrinkage and the absence of dynamic physiological forces. Despite these differences, a strong positive correlation was observed across all parameters, establishing cadaveric morphometry as a reliable anatomical reference.

Leaflet dimensions remained comparable between modalities, while male hearts consistently exhibited larger annular measurements than females, underscoring the influence of gender. These findings provide valuable region-specific baseline data for clinical practice and may assist surgeons and cardiologists in tailoring valve repair and replacement strategies. Larger multicentric studies incorporating three-dimensional imaging are recommended to further validate and expand upon these results.

Bibliography

1. Lau KD. Numerical simulation of mitral valve function. 2012;
2. La Canna G. Heart valve disease (mitral valve disease): anatomy and morphology of the mitral valve. Oxford University Press Oxford; 2017.
3. Levine RA, Hagége AA, Judge DP, Padala M, Dal-Bianco JP, Aikawa E, et al. Mitral valve disease—morphology and mechanisms. Nature reviews cardiology. 2015;12(12):689–710.
4. Tsang W, Bateman MG, Weinert L, Pellegrini G, Mor-Avi V, Sugeng L, et al. Accuracy of aortic annular measurements obtained from three-dimensional echocardiography, CT and MRI: human in vitro and in vivo studies. Heart. 2012;98(15):1146–52.
5. Ford KL, Albert JS, Summers AP, Hedrick BP, Schachner ER, Jones AS, et al. A new era of morphological investigations: reviewing methods for comparative anatomical studies. Integrative organismal biology. 2023;5(1):obad008.
6. Watanabe N, Ogasawara Y, Yamaura Y, Kawamoto T, Toyota E, Akasaka T, et al. Quantitation of mitral valve tenting in ischemic mitral regurgitation by transthoracic real-time three-dimensional echocardiography. Journal of the American College of Cardiology. 2005;45(5):763–9.
7. Kizer JR, Wiebers DO, Whisnant JP, Galloway JM, Welty TK, Lee ET, et al. Mitral annular calcification, aortic valve sclerosis, and incident stroke in adults free of clinical cardiovascular disease: the Strong Heart Study. Stroke. 2005;36(12):2533–7.
8. Sriambika K, Nim VK, Bage NN. Morphological and morphometric study of mitral valve with reference to anatomical variability in south indian subjects. Int J Anat Res. 2018;6(4.3):5994–7.
9. Chen TE, Ong K, Suri RM, Enriquez-Sarano M, Michelena HI, Burkhart HM, et al. Three-dimensional echocardiographic assessment of mitral annular physiology in patients with degenerative mitral valve regurgitation undergoing surgical repair: comparison between early-and late-stage severe mitral regurgitation. Journal of the American Society of Echocardiography. 2018;31(11):1178–89.
10. Silbiger JJ. Anatomy, mechanics, and pathophysiology of the mitral annulus. American heart journal. 2012;164(2):163–76.
11. Bose P, Singh R, More R, Pandey S, Jain D. Morphological variations of papillary muscles in North Indians: a cadaveric study. J Anat. 2015;23(2):1–5.
12. Flachskampf FA, Chandra S, Gaddipatti A, Levine RA, Weyman AE, Ameling W, et al. Analysis of shape and motion of the mitral annulus in subjects with and without cardiomyopathy by echocardiographic 3-dimensional reconstruction. Journal of the

American Society of Echocardiography. 2000;13(4):277–87.
13. Leo LA, Paiocchi VL, Schlossbauer SA, Gherbesi E, Faletra FF. Anatomy of mitral valve complex as revealed by non-invasive imaging: pathological, surgical and interventional implications. Journal of cardiovascular development and disease. 2020; 7(4):49.
14. Riffel JH, Mayo R, Mueller-Hennessen M, Giannitsis E, Katus HA, Andre F. Age-and gender-related reference values of cardiac morphology and function in cardiovascular magnetic resonance. The International Journal of Cardiovascular Imaging. 2021;37(6):2011–23.
15. El-Busaid H, Hassan S, Odula P, Ogeng'o J, Ndung'u B. Sex variations in the structure of human atrioventricular annuli. Folia morpholo gica. 2012;71(1):23–7.