Original Article

Preoperative mitral annulus size – Can we get it right?

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ABSTRACT

Objective: We looked for a correlation between the surgically measured mitral valve size and the cardiac dimensions (left ventricle internal diameter, left atrial size, aorta size, and body surface area) measured by preoperative and intraoperative echocardiography. We also assessed to see if we could predict the mitral prosthesis size based on the correlation data obtained.

Methods: The hospital records of 180 patients who underwent mitral valve replacement (MVR) with TTK Chitra valve between January 2008 and December 2012 at our hospital, were studied. The correlation between surgically measured mitral annulus size to left ventricular internal diameter systolic (LVIDS) and diastolic (LVIDD), left atrial size (linear measurement), and aorta size on echocardiography and body surface area was calculated using Pearson correlation coefficient. Mean LVIDS was calculated for each valve prosthesis size separately and the correlation was studied.

Results: The correlation between mitral valve prosthesis size and left ventricular internal diameter (systolic) showed a Pearson coefficient of 3.3 with significance at the level 0.01. Mitral valve size and left atrial size showed a correlation coefficient of 2.7 with significance at the level 0.01. The correlation coefficient for mitral valve size with left ventricular internal diameter diastolic, aorta and body surface area were 2.5, 1.9, and 1.8, respectively. There was a gradual increase in the mean LVIDS with increase in the prosthetic valve size. Box plot and scatter plot showed linear correlation between valve size and mean LVIDS.

Keywords: Body surface area, left ventricular internal diameter, mitral annulus size, valve prosthesis

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BACKGROUND

Preoperative assessment of mitral valve size and measurements is always a challenge for the cardiac surgical team. Aortic annulus can be accurately measured using transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) with great accuracy, to predict the size of the aortic prosthesis. But mitral annulus and leaflet measurements can be obtained accurately with 3D echocardiography reconstruction.[1] The idea of reverse analysis for identifying any correlation between a surgically chosen mitral valve size and the preoperative dimensions obtained from 2D echocardiography formed the basis for this study.

There are a number of studies which look into the aspect of left ventricular (LV) function and chordal preservation in mitral stenosis.[2,3] And there is enough literature available on the progression of mitral valve disease and the surgical treatment options. According to the authors surgical experience, mitral stenosis of rheumatic origin is a condition in which the annulus size is overestimated and this effects the prosthesis selection. The severity of the

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sub-valvar pathology in rheumatic mitral stenosis and the small size of the left ventricle (LV) might have a role to play. There are no studies comparing the aetiology of mitral valve disease with the LV dimensions and mitral annulus size. This study focuses on the relation of LV or left atrial (LA) dimension which in effect is a reflection of the aetiology of the disease, with the size of the valve chosen. Sometimes, an appropriately sized prosthesis cannot be placed in the annulus owing to the restraints placed by the patient's LV size. This knowledge aids the surgeon in choosing other options like open mitral valvotomy (OMV) or repair, thereby accepting suboptimal results.

INTRODUCTION

This study is a first–of-its-kind which compares the size of the surgically measured mitral annulus to LV, LA, aorta dimensions, and body surface area. Mitral valve replacement (MVR) requires the annulus to be sized before selecting an appropriately sized prosthesis. Replacing the native valve with a larger prosthesis can cause atrioventricular groove disruption and smaller prosthesis increases the risk of patient-prosthesis mismatch.[4-6] Unlike the aortic annulus measurements, echocardiography based annular measurements of the mitral valve correlate poorly with intraoperative measurements obtained with a valve sizer. Traditionally, mitral annular size is believed to be correlated to the person's age, sex, and body surface area. Echocardiography and computerized tomography (CT) based studies have shown positive correlation between mitral annulus size and body surface area.[7,8] But these studies are based on echocardiography and CT measurements of annulus of mitral valve and there are no studies in literature comparing actual valve size with body surface area and LV dimensions. We hypothesized that the mitral annulus size, measured with a sizer during mitral valve replacement correlates with the left ventricular internal diameter (LVID), which is an indicator of the left ventricular size.

MATERIALS AND METHODS

This is a retrospective study conducted at Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, India.

OBJECTIVE

We looked for a correlation between the surgically measured mitral valve size and the cardiac dimensions (left ventricle internal diameter, left atrial size, aorta size, and body surface area) measured by preoperative transthoracic and intraoperative transesophageal echocardiography. We also assessed to see if we could predict the mitral annulus based on the correlation data obtained.

Methodology

The hospital records of 180 patients who satisfied the inclusion and exclusion criteria were studied.

Inclusion criteria- All patients who underwent mitral valve replacement using TTK Chitra heart valve prosthesis (TTK CHVP, TTK Healthcare Limited Chennai, Tamil Nadu) between January 2008 and December 2012 at our institute were included in the study.

Exclusion criteria - Patients who underwent concomitant aortic valve replacement (double valve replacement - DVR) and coronary artery bypass grafting along with mitral valve replacement were excluded.

We have included only patients who underwent MVR with TTK Chitra valve[9,10] to have uniformity of valve sizing. The operating surgeon measured the annulus intraoperatively with a standard valve sizer specific for a prosthetic valve type after suture placement at the mitral annulus which are normally from atrial side to ventricular side. Left ventricular internal diameter- systolic and diastolic, left atrial size (linear measurement), and aorta size were collected from preoperative echocardiogram from parasternal long axis view. Demographic parameters, body surface area, and mitral prosthetic valve sizes were collected from patient records.

Statistical analysis

Descriptive analysis was carried out by computing mean and standard error for quantitative variables, frequency, and proportion for categorical variables [Table 1]. Correlation was studied by calculating using Pearson correlation coefficient. Mean LVIDS was calculated for each valve size separately, and correlation was studied using box plot and scatter diagram. IBM SPSS version 22 was used for statistical analysis. Institutional technical advisory committee and institutional ethics committee clearances were obtained before commencing the study.

RESULTS

Correlation between mitral valve size and left ventricular internal diameter (systolic) showed a Pearson correlation coefficient of 3.3 with significance at the level 0.01. Mitral valve size and left atrial size showed a correlation coefficient of 2.7 with significance at the level 0.01. The Pearson correlation coefficient for mitral valve size with left ventricular internal diameter diastolic, aorta and

body surface area were 2.5, 1.9, and 1.8, respectively [Table 2].

Mean LVIDS was calculated for each valve size separately [Table 3]. Twenty-three size valve had a mean LVIDS of 26.400 (SE- 1.5861), 25 size valve had a mean LVIDS of 27.951 (SE-0.9975), 27 size valve had a mean LVIDS of 29.416 (SE- 0.5470), 29 size valve had a mean LVIDS of 30.895 (SE- 0.7864) and 31 size valve had a mean LVIDS of 34.786 (SE-1.5800). There was a gradual increase in the mean LVIDS with increase in the valve size. In other words bigger valves were placed for patients with larger mean LVIDS. Box plot [Figure 1] and scatter plot [Figure 2] showed linear correlation between valve size and mean LVIDS.

Table 1: Baseline characteristics

Baseline Characteristics	Value
Mean age at the time of MVR (years)	45.115 (SE- 1.057)
Mean height (cm)	156.175 (SE- 0.990)
Mean weight (kg)	54.105 (SE- 1.04)
Mean Body surface area (Kg/m^2)	1.52 (SE- 0.02)
Number of females	107 (59.4%)
Number of males	73 (40.6%)

Table 2: Correlation between mitral valve size, left atrial (LA) and aorta sizes left ventricular internal diameter- systolic and diastolic and body surface area

MITRAL valve size vs	LA size	AORTA	LVIDS	LVIDD	BSA
Pearson Correlation	0.275	0.198	0.332	0.252	0.184
Sig. (2-tailed)	<0.01	0.008	<0.01	<0.01	0.013

Table 3: Mean LVIDS for each valve size

Valve size	Mean LVIDS (SE) (95% confidence interval for mean)
23	26.400 (1.5861) (22.812-29.988)
25	27.951 (0.9975) (25.935-29.967)
27	29.416 (0.5470) (28.326-30.505)
29	30.895 (0.7864) (29.301-32.488)
31	34.786 (1.5800) (31.372-38.199)

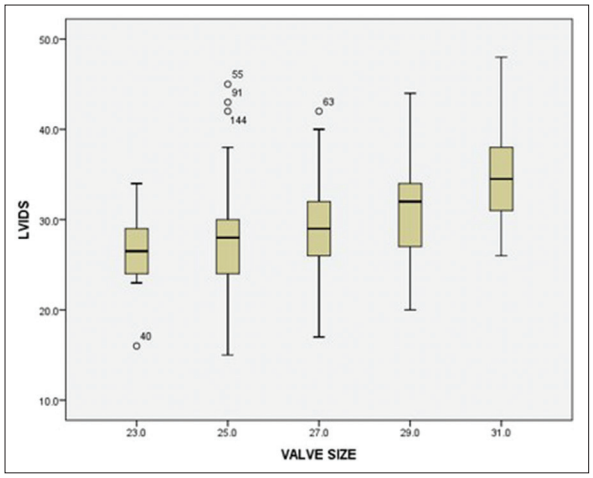

Figure 1: Box plot showing relationship between valve size and LVIDS

DISCUSSION

This study is a first-of-its-kind which compares the size of the surgically measured mitral annulus to LV, LA, aorta dimensions, and body surface area. Even after extensive literature search, we did not find any published data which tried to correlate the size of the mitral annulus with LV chamber size represented by LVID or left atrial size or aortic size. The mitral valve has six components which encompass the so-called mitral apparatus: left atrial wall, annulus, leaflets, chordae, papillary muscles, and/or left ventricular free wall.[11] Different pathologies involve different components.

Pathologies affecting the mitral valve affect the structure and function of the mitral apparatus directly or indirectly. Chronic mitral regurgitation causes dilatation of the left ventricle due to volume overload. Similarly, the volume underloaded ventricle in mitral stenosis, may be small.[7] In this study we looked into the relationship between the size of the mitral annulus size with the various components of mitral valve apparatus – LA, LV, and the correlation between them.

The correlation between mitral valve annulus size and body surface area has been studied before. Rajendran *et al.* in their study including 406 patients found out that the mitral valve diameter rose steadily with rise in BSA of the patients.[7] Their study was based on the echocardiographic measurement of mitral annulus. Naoum *et al.* in their CT based study on 147 patients also established positive correlation between mitral annular dimension with BSA.[8] Contrary to the findings in these studies, we could not determine any strong correlation between the mitral annulus size and body surface area. The Pearson correlation coefficient between BSA and valve size was only 1.8 in our study.

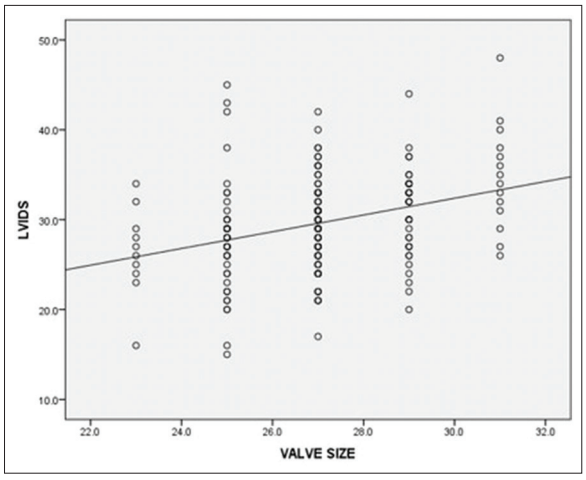

Figure 2: Scatter plot showing Linear correlation between valve size and mean LVIDS

In the present study, the Pearson correlation coefficient for mitral valve size with left atrial size, left ventricular internal diameter- diastolic (LVIDD), aorta was 2.7, 2.5, 1.9. Correlation between mitral valve size and left ventricular internal diameter- systolic (LVIDS) showed a Pearson correlation coefficient of 3.3 with significance at the level 0.01. LVIDS showed the strongest correlation with the valve size. We found only a weak association between the LVIDD, aortic size, left atrial size and mitral annular dimension. Naoum *et al.* established an association between mitral annular area indexed and left ventricular end systolic volume indexed, in their CT based study. Although patients with mitral valve prolapse demonstrated a positive correlation between annular size and both LA and LV systolic volumes, those with functional mitral regurgitation annular size appeared to have a correlation with increasing LA size only.[8]

We tried to ascertain the relation between surgically sized annulus and the LVIDS measured by echocardiography in this study. Mean LVIDS was calculated for each valve size separately [Table 3]. There was a gradual increase in the mean LVIDS with increase in the prosthetic valve size. In other words, larger prostheses were placed for patients with higher mean LVIDS. Box plot [Figure 1] and scatter plot [Figure 2] showed linear correlation between valve prosthesis size and mean LVIDS.

This correlation will help us predict the prosthetic valve size preoperatively. Patients with mean LVIDS 26.400 (SE-1.5861) 95% confidence interval (22.812-29.988) received a valve prosthesis of size 23. Patients with mean LVIDS 27.951 (SE-0.9975), 95% confidence interval (25.935-29.967) received a prosthetic valve of size 25. Patients with mean LVIDS 29.416 (SE-0.5470), 95% confidence interval (28.326-30.505) got a valve with size 27. Patients with mean LVIDS 30.895 (SE- 0.7864), 95% confidence interval (29.301-32.488) got a valve with size 29. Patients with mean LVIDS 34.786 (SE-1.5800), 95% confidence interval (31.372-38.199) got a valve with size 31.

Larger studies will help us develop nomograms which might aid us in accurately predicting the mitral valve prosthesis size from the LVIDS obtained echocardiographically in the preoperative period. Such predictions will help the surgeon in planning the surgical options. When the valve prosthesis to be implanted is likely to produce patient prosthesis mismatch, alternative treatment options like open mitral valvotomy or repair will need to be considered, accepting probable suboptimal results. The nomograms or predictions will aid in prosthesis size to be used for transcatheter mitral valve replacement (TMVR), which otherwise uses the help of echocardiogram and computerised tomogram.[12]

CONCLUSION

There exists an association between left ventricular internal diameter systolic (LVIDS) calculated echocardiographically and surgically sized mitral annulus dimension which will help us in predicting the valve prosthesis size preoperatively.

Institution Ethical committee clearance obtained, (IEC no-SCT/IEC/1226/June2018). As it is a retrospective study based on hospital records, informed consent was waived off.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Foster GP, Dunn AK, Abraham S, Ahmadi N, Sarraf G. Accurate measurement of mitral annular dimensions by echocardiography: Importance of correctly aligned imaging planes and anatomic landmarks. J Am Soc Echocardiogr 2009;22:458-63.
2. Al Mosa AF, Omair A, Arifi AA, Najm HK. Mitral valve replacement for mitral stenosis: A 15-year single center experience. J Saudi Heart Assoc 2016;28:232-8.
3. Ghavidel AA, Mirmesdagh Y, Sharifi M, Sadeghpour A, Nakhaeizadeh R, Omrani G. The impact of sub-valvular apparatus preservation on prosthetic valve dysfunction during mitral valve replacement. Res Cardiovasc Med 2013;2:55-61.
4. Sersar SI, Jamjoom AA. Left ventricular rupture post mitral valve replacement. Clin Med Cardiol 2009;3:101-13.
5. Zacharias A. Repair of spontaneous rupture of the posterior wall of the left ventricle after mitral valve replacement. Op Tech Thorac Cardiovasc Surg 2003;8:36-41.
6. Rahimtoola SH, Murphy E. Valve prosthesis-patient mismatch. A long-term sequela. Heart 1981;45:331-5.
7. Rajendran HSR, Seshayyan S, Victor A, Murugesan N, Sundaramurthi I. The study of mitral valve annular dimension in relation to the body surface area in the Indian population. Eur J Cardio-Thorac Surg 2011;39:653-6.
8. Naoum C, Leipsic J, Cheung A, Ye J, Bibley N, Mak G, *et al.* Mitral annular dimensions and geometry in patients with functional mitral regurgitation and mitral valve prolapse: Implications for transcatheter mitral valve implantation. JACC Cardiovasc Imaging 2016;9:269-80.
9. Bhuvaneshwar GS, Muraleedharan CV, Vijayan GA, Kumar RS, Valiathan MS. Development of the Chitra tilting disc heart valve prosthesis. J Heart Valve Dis 1996;5:448-58.
10. Namboodiri N, Othayoth S, Jaganmohan A, Sankarkumar R, Titus T, Valaparambil A, *et al.* Doppler echocardiographic assessment of TTK Chitra prosthetic heart valve in the mitral position. Eur J Echocardiography 2008;9:599-604.
11. Fishbein GA, Fishbein MC. Mitral valve pathology. Curr Cardiol Rep 2019;21:61.
12. Regueiro A, Granada J, Dagenais F, Rodés-Cabau J. Transcatheter mitral valve replacement insights from early clinical experience and future challenges. J American Coll Cardiol 2017;69:2175-92.