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Original Article

Prosthesis Mismatch in Mitral Valve Replacement with TTK-CHITRA Valves: A Retrospective Study

G Josephraj[1], Vijay Anand[2], P Rani[2], V T Siddharth[3], B Karthikeyan[3], Heber Anandan[4]

[1]Professor and Chief, Department of Cardiothoracic Surgery, Madurai Medical College, Madurai, Tamil Nadu, India, [2]Senior Assistant Professor, Department of Cardiothoracic Surgery, Madurai Medical College, Madurai, Tamil Nadu, India, [3]Junior Resident, Department of Cardiothoracic Surgery, Madurai Medical College, Madurai, Tamil Nadu, India, [4]Senior Clinical Scientist, Department of Clinical Research, Dr. Agarwal's Healthcare Limited, Tirunelveli, Tamil Nadu, India

Abstract

Introduction: Rheumatic heart disease remains the most common etiological factors for the significant mitral valvular lesions. The treatment modalities include valve repair or replacement. Although repair techniques for mitral and tricuspid valvular lesions are well established, mitral valve replacement (MVR) remains the most common modality of treatment in many centers in our country with valve repairs are still in the emerging phase.

Aim: This is a retrospective study in evaluation of patient-prosthesis mismatch (PPM) in MVR with TTK-CHITRA valves.

Methods: Systolic pulmonary artery (PA) pressure measured by the Doppler echocardiography in our subset of patients after MVR. Mitral valve effective orifice area was determined by Doppler, by the continuity equation and indexed for body surface area. A study done by evaluating PPM for the valve implanted by the above criteria and post-operative regression or persistence of PA pressure, and other adverse surgical outcomes noted and inference was drawn. This study was done on 40 patients of MVR done in our institute from January 2016 to December 2016 retrospectively.

Results: In our study of PPM in MVR with TTK-CHITRA valves of 40 patients, 6 patients had moderate PPM as defined by Dummensil. Patients with 23 sized valve and 14% of patients with 25 sized valves had PPM. Implantation of bigger-sized valves >25 sizes with patients with body surface area (BSA) >1.4 resulted in avoiding PPM in mitral position.

Conclusion: Study shows that even small-sized valves (25) when implanted in patients with BSA of 1.3-1.4 does not produce PPM.

Key words: Mitral valve, Patient-prosthesis mismatch, TTK valves

INTRODUCTION

Rheumatic heart disease constitutes the most common etiology for valvular heart disease presenting in this part of country.[1-4] Rheumatic mitral stenosis presents with commissural fusion, leaflet thickening, annular calcification, and subvalvular involvement preventing any form of valvular repair procedures, leading to valve replacement with prosthetic device the most common outcome.[5-7]

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In our hospital, mitral valve replacement (MVR) is being done with TTK-CHITRA mono leaflet tilting disc valve. This valve is made in India product with hemodynamic performance and durability comparable with the any other tilting disc valve supplied by international manufacturers but at a fraction of cost compared to others.[8]

Prosthesis-patient mismatch (PPM) was first described in 1978 by Rahimtoola as follows: "Mismatch can be considered to be present when the effective prosthetic valve area, after insertion into the patient, is less than that of a normal human valve."[9] Inherent in this concept is that a smaller than expected effective orifice area (EOA) in relation to the patient's body surface area (BSA) will result in higher transvalvar gradients. This is best exemplified by the hydraulic equation transvalvar pressure gradient (TPG) = $Q^2/[k \times EOA^2]$, which shows that the TPG is

Corresponding Author: Vijay Anand, Senior Assistant Professor, Department of Cardiothoracic Surgery, Madurai Medical College, Madurai, Tamil Nadu, India. Phone: 09003156763. E-mail: karthikeyanctsmbbs@gmail.com

directly related to the square of transvalvar flow (Q) and inversely related to the square of the valve EOA; k is a constant. Hence, the EOA must be proportionate to flow requirement for gradients to remain low.

At rest, transvalvar flow is largely related to cardiac output, which in turn is determined by BSA. PPM thus occurs when the EOA of the prosthetic valve is too small in relation to a patient's body size.[9-12] The immediate consequence is the persistence of abnormally high TPGs. For instance, assuming a normal cardiac index of 3 l/min/m^2, the implantation of a prosthesis with an EOA of 1.3 cm^2 in a patient with a BSA of 1.5 m^2 will theoretically result in a mean TPG of about 13 mmHg. The mean TPG will theoretically be 35 mmHg if the same prosthesis is implanted in a patient with a BSA of 2.5 m^2. Moreover, the difference in TPGs between these two patients would be even more important during exercise, given that gradients are a square function of flow.

Aim

To study the prevalence of patient-prosthesis mismatch (PPM) among MVR patients with TTK-CHITRA tilting disc valves.

MATERIALS AND METHODS

This study was conducted in the Department of Cardiothoracic Surgery at Government Rajaji Hospital. Patients having rheumatic mitral stenosis, rheumatic mitral stenosis with mitral regurgitation, rheumatic mitral stenosis with mitral regurgitation with atrial fibrillation, restenosis of mitral valve were included in this study. The patients who had significant other valvular lesions were excluded from the study. Informed written consent was obtained from patient and patient attender.

Systolic PA pressure measured by the Doppler echocardiography in our subset of patients after MVR. Mitral valve EOA was determined by Doppler, by the continuity equation and indexed for BSA. A study done by evaluating PPM for the valve implanted by the above criteria and post-operative regression or persistence of PA pressure, and other adverse surgical outcomes noted and inference was drawn. Inclusion criteria included patients >18 years with a clinical condition of mitral valve prosthesis. Exclusion criteria included evidence of prosthesis valve dysfunction (dehiscence, endocarditis, or thrombus of prosthetic mitral valve), concomitant aortic valve prosthesis, and tricuspid valve prosthesis; presence of >+2 aortic valve regurgitation and/or mild aortic stenosis, left ventricular ejection fraction <50%, chronic obstructive pulmonary disease, concomitant hypertrophic cardiomyopathy, atrial septal defect; patients with poor ECG window. The mitral valve annulus sizing is done pre-operatively with echo as well intraoperatively with derlin sizes provided by manufacturers. The valve that fits the annulus without disparity is chosen. All the patients were implanted TTK-CHITRA valve varying from size 23 to 29 cm. The pre- and post-operative echo evaluation was done in the cardiology department in Government Rajaji Hospital. The post-operative follow-up echo was done at 10th post-operative day followed by echo evaluation at the end of 30 days on discharge. Pre- and post-operative NYHA class and echo evaluation were compared and analyzed.

RESULTS

A total of 40 patients underwent MVR, all patients had MVR with posterior mitral leaflet preservation with TTK-CHITRA valves. The youngest is the 13 and the oldest 54 years, with 33 being the mean age of the population (Table 1).

Combined mitral stenosis and regurgitation contributes majority of cases in our study followed by isolated regurgitation (Table 2).

The study group of 40 cases comprised 13 males and 27 females. The male:female ratio in our study group is 1:2. Females have higher incidence of mitral valvular disease in our study group (Table 3).

Table 1: Distribution of study patient in age and gender

Age in years	Male	Female	Total
<20	2	6	11
21-30	4	7	9
31-40	6	9	11
41-60	2	4	9
Total	14	26	40

Table 2: Mitral valve etiology distribution

Pathology	Number
Mitral stenosis	10
Mitral regurgitation	14
MS+MR	16
Total	40

Table 3: Sex distribution

Sex	Mitral stenosis	Mitral regurgitation	MS+MR	Total
Male	4	4	5	13
Female	6	10	11	27
Total	10	14	16	40

Of the valve implanted 25TTK valve comprised 21 valves which comprised 52% of our valves implanted. This corresponds well with the small BSA of the patients in our study group (Table 4).

Effective orifice area is least in 23 sized valve compared to other sizes may lead to prosthesis mismatch (Table 5).

All the three patients implanted with 23 valves are stenotic which shows impact of least EOA. 25 sized valves can be implanted in persons with BSA of 1.3-1.4 (which comprises 50% of our study group). Persons with BSA >1.4 require bigger-sized valves 27 and above. Our subset of population includes most people with small BSA (1.3-1.4). We implant small-sized valves (25 and 27) in a majority of patients. Study shows that even small-sized valves (25) when implanted in patients with BSA of 1.3-1.4 does not produce PPM. BSA above 1.4 require valves >25 size to avoid PPM.

PPM was taken to be present when the IEOA was <1.2 sqcm/m^2. Among the study group of 40 patients, 6 patients had moderate PPM. None had severe PPM (Table 6).

DISCUSSION

The prosthetic MVR is commonly performed in our center. Of this TTK-CHITRA valves constitute the bulk load of the prosthetic devices.[3] MVR is done by preservation of posterior leaflet in all our patients. A total of 40 patients were taken up for the study. The study was done in a retrospective manner, with patients chosen and excluded by criteria.

All the patients in the study group underwent MVR using TTK-CHITRA valve, using chordal preserving surgery.

Table 4: Size of valve

Size of valve (mm)	Male	Female	Total
TTK 23	1	2	3
TTK 25	4	17	21
TTK 27	5	3	8
TTK 29	3	4	7
Total	13	27	40

The suturing technique employed was everting continuous suturing with pledgeted 2-0 ethibond. Standard operative procedures were followed with cold blood cardioplegia administered through aortic root for myocardial protection.

The study group of 40 cases comprised 13 males and 27 females. The male:female ratio in our study group is 1:2. Females have higher incidence of mitral valvular disease in our study group due to the prevalence of more number of rheumatic fever cases in females.[4]

Combined mitral stenosis and regurgitation contributes majority of cases in our study followed by isolated regurgitation. The youngest age is the 13 and the oldest 54 years, with 33 being the mean age of the population.[6]

Our study group comprised patients of poor socioeconomic status combined with the morbidity of mitral valvular disease with low cardiac output, with low BSA.

Of the valve implanted 25TTK valve comprised 21 valves which comprised 52% of our valves implanted. This corresponds well with the small BSA of the patients in our study group. The EOA was calculated on the follow-up of the patients by our cardiologist using velocity time integral method. The EOA was indexed with BSA to arrive at the indexed effective orifice area (IEOA). PPM was taken to be present when the IEOA was <1.2 sqcm/m^2.[9]

Among the study group of 40 patients, six patients had moderate PPM. None had severe PPM. Patients with PPM - three had 23 size valve implanted, due to severe subvalvular fusion and small annulus. Three patients had 25 size valve implanted.

In the patient with PPM post-operative pulmonary pressure did not subside. Eventually, patients with PPM presented varying degrees of congestive cardiac failure. Three patients had chronic atrial fibrillation and required anticoagulation. We lost the other three patients with PPM in the follow-up.[13]

The result shows that majority of our valves implanted in our study group are all small-sized valves (23,25, and 27), PPM in our population is limited to only three patients with

Table 5: Transvalvular gradients, peak velocity, and EOA of TTK-CHITRA valve in mitral position

Valve size (mm)	Number of patients	Mean gradient (mmHg)	Peak velocity (m/s)	Actual orifice area	Effective orifice area (cm^2)
23	6	6±4	2.0±0.3	2.5	1.3±0.4
25	15	5±3	1.8±0.3	3.14	1.8±0.4
27	14	4±2	1.7±0.2	3.8	2.1±0.3
29	5	4±2	1.7±0.2	4.52	2.3±0.4

EOA: Effective orifice area

Table 6: Patients with patient-prosthesis mismatch

Valve size	BSA	EOA	IEOA	Pre-operative PA pressure	Post-operative PA pressure
23	1.4	1.3	0.8	70	60
23	1.2	1.4	1.1	70	50
23	1.2	1.4	1.15	70	50
25	1.6	1.9	1.18	70	50
25	1.5	1.8	1.19	60	40
25	1.5	1.8	1.17	60	40

BSA: Body surface area, EOA: Effective orifice area, IEOA: Indexed effective orifice area

23 sized valves and 3 out of 21 of 25 valves implanted. Considering the small BSA in our subset of population, 23 sized TTK valve is stenotic in our subset. 25 sized valves can be implanted in persons with BSA of 1.3-1.4 (which comprises 50% of our study group). Persons with BSA >1.4 require bigger-sized valves 27 and above. The indigenously manufactured TTK-CHITRA valves hemodynamic performance in our subset of population is as good as mechanical valves made by international companies.[14-17]

CONCLUSION

Our subset of population includes most people with small BSA (1.3-1.4). We implant small-sized valves (25 and 27) in a majority of patients. Study shows that even small-sized valves (25) when implanted in patients with BSA of 1.3-1.4 does not produce PPM. BSA above 1.4 require valves >25 sizes to avoid PPM. The study also demonstrates that TTK valves are hemodynamically as good as comparable valves in the market.

REFERENCES

1. Pibarot P, Dumesnil JG. Patient-prosthesis mismatch and the predictive use of indexed effective orifice area: Is it relevant? Card Surg Today 2003;1:43-51.
2. Li M, Dumesnil JG, Mathieu P, Pibarot P. Impact of valve prosthesis-patient mismatch on pulmonary arterial pressure after mitral valve replacement. J Am Coll Cardiol 2005;45:1034-40.
3. Bhuvaneshwar GS, Muraleedharan CV, Vijayan CA, Sankarkumar R, Valiathan MS. Development of the Chitra tilting disc heart valve prosthesis. J Heart Valve Dis 1996;5:44-58.
4. Pibarot P, Dumesnil JG, Lemieux M, Cartier P, Métras J, Durand LG. Impact of prosthesis-patient mismatch on hemodynamic and symptomatic status, morbidity, and mortality after valve replacement with a bioprosthetic heart valve. J Heart Valve Dis 1998;7:211-8.
5. Yun KL, Jamieson WR, Khonsari S, Burr LH, Munro AI, Sintek CF. Prosthesis-patient mismatch: Hemodynamic comparison of stented and stentless valves. Semin Thorac Cardiovasc Surg 1999;11:98-102.
6. Rao V, Jamieson WR, Ivanov J, Armstrong S, David TE. Prosthesis-patient mismatch affects survival following valve replacement. Circulation 2000;102:III5-9.
7. Milano AD, De Carlo M, Mecozzi G, D'Alfonso A, Scioti G, Nardi C, *et al*. Clinical outcome in patients with 19-mm and 21-mm St. Jude aortic prostheses: Comparison at long-term follow-up. Ann Thorac Surg 2002;73:37-43.
8. Mohty-Echahidi D, Malouf JF, Girard SE, Schaff HV, Grill DE, Enriquez-Sarano ME, *et al*. The impact of prosthesispatient mismatch on long-term survival in patients with small St Jude medical mechanical prostheses in the aortic position. Circulation 2006;113:420-6.
9. Rahimtoola SH. The problem of valve prosthesis-patient mismatch. Circulation 1978;58:20-4.
10. Dumesnil JG, Honos GN, Lemieux M, Beauchemin J. Validation and applications of indexed prosthetic valve areas calculated by Doppler echocardiography. J Am Coll Cardiol 1990;16:637-43.
11. Dumesnil JG, Yoganathan AP. Valve prosthesis hemodynamics and the problem of high transprosthetic pressure gradients. Eur J Cardiothorac Surg 1992;6:S34-8.
12. Dumesnil JG, Honos GN, Lemieux M, Beauchemin J. Validation and applications of mitral prosthetic valvular areas calculated by Doppler echocardiography. Am J Cardiol 1990;65:1443-8.
13. Tasca G, Brunelli F, Cirillo M, DallaTomba M, Mhagna Z, Troise G, *et al*. Impact of valve prosthesis-patient mismatch on left ventricular mass regression following valve replacement. Ann Thorac Surg 2005;79:505-10.
14. Botzenhardt F, Eichinger WB, Guenzinger R, Bleiziffer S, Wagner I, Bauernschmitt R, *et al*. Hemodynamic performance and incidence of patient-prosthesis mismatch of the complete supraannular perimount magna bioprosthesis in the aortic position. Thorac Cardiovasc Surg 2005;53:226-30.
15. Botzenhardt F, Eichinger WB, Bleiziffer S, Guenzinger R, Wagner IM, Bauernschmitt R, *et al*. Hemodynamic comparison of bioprostheses for complete supra-annular position in patients with small aortic annulus. J Am Coll Cardiol 2005;45:2054-60.
16. Muneretto C, Bisleri G, Negri A, Manfredi J. The concept of patient-prosthesis mismatch. J Heart Valve Dis 2004;13:S59-62.
17. Tasca G, Mhagna Z, Perotti S, Centurini PB, Sabatini T, Amaducci A, *et al*. Impact of prosthesis-patient mismatch on cardiac events and mortality after aortic valve replacement in patients with pure aortic stenosis. Circulation 2006;113:570-6.

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