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RESEARCH ARTICLE

HEMODYNAMIC EVALUATION OF TTK CHITRA HEART VALVE BY DOPPLER ECHOCARDIOGRAPHY-AT MITRAL AND AORTIC POSITION

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Abstract

Artificial heart valves are engineered devices used for replacing diseased or damaged natural valves of the heart. Most commonly used for replacement are mechanical heart valves and biological valves. Rheumatic disease continues to be a major indication for valvular heart surgery in India. TTK Chitra heart valve prosthesis (CHVP) is a tilting disc artificial heart valve designed and developed by Sree ChitraTirunal Institute for Medical Sciences and Technology (SCTIMST). It has an ultra-high-molecular-weight polyethylene disc, Haynes-25 alloy (Haynes International Inc., USA)cage, and polyester suture ring.[1-4]Distinguished features of TTK Chitra valve which highlight it amongst prosthetic heart valves are Complete Structural Integrity, Absence of cavitations related damage, silent operation, Rotatable within the sewing ring to assure its freedom to rotate if repositioning is required, Low profile. Because of its low cost and proven efficacy, it has a high potential for more widespread use in developed countries.

In the present work 60 cases have been studied. The study population consist of 60 consecutive patients who had undergone T.T.K Chitra valve replacement either in mitral and aortic position or both and will undergo routine follow up in Cardiothoracic surgery OPD and have been subjected to a routine follow-up echocardiographic examination.

So far, various clinical studies have been reported but homodynamic studies especially with Doppler Echocardiography are far and few. This paper presents experimental observation and analysis with the TTK Chitra valve in mitral and aortic positions and also an in-vivo hemodynamic assessment of the valve with focus on echocardiographic characteristics. We have studied the Doppler echocardiographic parameters of the normally functioning CHVP in the mitral position & aortic position to make reference for these parameters and to assess whether derivation of MVA using the CE and more commonly used PHT method is comparable in the functional assessment of this tilting disc prosthesis.

The statistical analysis of data and inferences drawn revealed that the average mean gradient of T.T.K. Chitra valve in Mitral position was 5.14±2.19.There was significant correlation between size of the valve used and mean gradient across the valve in Mitral position of T.T.K. Chitra prosthesis (P valve 0.001). Mean gradient was inversely proportional to the size of the valve. Average mean gradient of T.T.K. Chitra valve in aortic position is 15.78±6.41.The correlation between size of the valve used and

Mean gradient in Aortic position was statistically signification, P valve 0.004.

The average peak velocity of T.T.K. Chitra valve in Mitral position was 2.03±1.45mmHg.There was significant correlation between size of the Valve used and Peak Velocity across the valve in Mitral position of T.T.K. Chitra prosthesis. (P valve 0.001). Peak velocity was inversely proportional to size of the valve. The average peak velocity of T.T.K. Chitra valve in Aortic position was 3.05±1.51mmHg.There correlation between size of the valve used and Peak Velocity across the valve in Aortic position of T.T.K. Chitra prosthesis was statistically insignificant. In aortic position the peak gradient, mean gradient and peak velocity of T.T.K. Chitra valve were 26.5±10.33mmHg. 15.77±6.41mmHg and 3.05±1.51m/s respectively. Peak gradient and peak velocity did not correlate well with the size of the valve in Aortic position. (P>0.224, P>0.101) but mean gradient decreases significantly with increase in the size of the valve, P<0.004.

In the present study 60 cases that had undergone valve replacement by T.T.K. Chitra prosthesis either in mitral position or at aortic position and attendance the cardiothoracic OPD for routine follow-up and having ejection fraction more than 50% were included. Those who had undergone valve replacement other than T.T.K. Chitra valve and those who had left ventricular dysfunction were excluded from the study.

The age group of patients ranged from 9 – 50 years with mean age 27.7±10.1. The maximum distribution of cases was in the 3rd to 4th decade (61.6%). These findings were comparable to Pawan et al[5] (mean age 26±5year) and Namboodiri et al[6]. Where the mean age was 38.8±10.5 year and Joshi et al was 30.98±9.3year.

Rheumatic heart disease was the commonest etiological factor for valve replacement in this study; none of the patient had degenerative valve disease. The finding was comparable to Namboodiri et al[6]. Where 95% of the patient had RHD as the etiology for valve replacement.

The striking features of these patients profile were young age (27.7±10.1) and late presentation.

There were 68.3% males and 31.6% female patients. There was a male preponderance with a male to female ratio is 2.1:1. These finding are comparable to study conducted by N.Namboodri et al(6) which had male 57.5% and female 42.5%.

Out of 60 patients 38 out of 60 (55%) had mitral valve pathology alone and had MVR and 36.6% had DVR (MVR+AVR) and only 2% had AVR alone. This findings was comparable to N.Namboodri et al (70) where 78 (58.7%) had mitral valve replacement (MVR).

The T.T.K. Chitra valve on the merits of efficiency performance and low cost and proven efficacy, it has a high potential for more widespread use in India and developing countries

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INTRODUCTION

Replacement of damaged heart valves is necessary in certain conditions. Artificial heart valves are engineered devices used for replacing diseased or damaged natural valves of the heart. Most commonly used for replacement are mechanical heart valves and biological valves. Rheumatic disease continues to be a major indication for valvular heart surgery in India. As in most developing nations, during late 70‟s and 80‟s, India was also plagued with a high incidence of rheumatic heart disease. Rheumatic heart disease is a major indication for replacement of damaged heart valves.

TTK Chitra heart valve prosthesis (CHVP) is a tilting disc artificial heart valve designed and developed by Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST). It has an ultra-high-molecular-weight polyethylene disc, Haynes-25 alloy (Haynes International Inc., USA)cage, and polyester suture ring.[1-4] **Distinguished features of TTK Chitra valve which highlight it amongst prosthetic heart valves are** Complete Structural Integrity, Absence of cavitation related damage,Silent operation, Rotatable within the sewing ring to assure its freedom to rotate if repositioning is required, Low profile. **Because of its low cost and proven efficacy, it has a high potential for more widespread use in developed countries.**

So far, various clinical studies have been reported but hemodynamic studies especially with Doppler Echocardiography are far and few. We will present our experience with the TTK Chitra valve in mitral and aortic positions and also an in-vivo hemodynamic assessment of the valve with focus on echocardiographic characteristics.We will study the Doppler echocardiographic parameters of the normally functioning CHVP in the mitral position & aortic position to make reference for these parameters and to assess whether derivation of MVA using the CE and more commonly used PHT method is comparable in the functional assessment of this tilting disc prosthesis.

AIMS & OBJECTIVES

1. To Study the hemodynamics with respect to peak Pressure gradient, mean pressure gradient and Peak Velocity of T.T.K Chitra valve in mitral and aortic position by Doppler echocardiography.

2. To study the correlation of pressure gradients and peak velocity with the size of the T.T.K Chitra prosthesis.

3. To compare the hemodynamics of T.T.K Chitra heart valve prosthesis with other available mechanical valves.

MATERIALS AND METHODS

In the present work a total of 60 cases have been studied. The study population consist of 60 consecutive patients who had undergone T.T.K Chitra valve replacement either in mitral and aortic position or both and will undergo routine follow up in Cardiothoracic surgery OPD and have been subjected to a routine follow-up echocardiographic examination.

INCLUSION CRITERIA.

Eligible patients include all patients who had undergone T.T.K. Chitra valve replacement either in mitral and aortic position or both with CHVP and having normal LV function (EF.50%), irrespective of etiology of valvular heart disease.

EXCLUSION CRITERIA

1. Short term follow-up < 3 months of valve replacement
2. Patients having left ventricular dysfunction (EF<50%)
3. Patient who had received valve replacement other than T.T.K. Chitra valve.

All Patients who were included in the study had **rheumatic heart disease** as the etiological factor of valvular heart disease.

All patients who will be included in the study will undergo complete physical examination to watch for sign and symptoms of LVD and of endocardits. Cardiovascular examination will be done to see functioning of the prosthesis by ausclultating normal click of the valve, complete neurological examination will be done to find out any focal neurological deficit.

Following investigations have been done in each patient.

1. EGG
2. Complete blood count with DLC
3. Blood urea and s.creatinine
4. Routine X- ray Chest PA view
5. Prothrombin time

Their INR will be kept between 2.5 to 3

A complete transthoracic echocardiographic examination has been performed with Vivid 7 echocardiographic system (GE Vingmed Ultrasound A/S, GE Healthcare, and Horten, Norway) in these patients to assess the prosthetic valve function and left ventricular function initially. Two-dimensional and Doppler echocardiographic studies were performed later and parameters will be derived.Colour flow Doppler imaging will also be done to assess the degree of regurgitation. Mitral valve prosthesis will be evaluated in the apical four-chamber view and the aortic valve prosthesis in apical five chamber view. The peak gradient, mean gradient and peak velocity of the prosthetic value will be evaluated in both mitral and aortic positions. A total of 56 patients will be subjected to echocardiographic examination at follow-up during the study. Flow velocity across the mitral prosthesis will be recorded with continuous-wave Doppler guided by colour flow. Measurements will be made from the view with the least angulation with flow, most commonly from the apical window. Colour flow Doppler will be used in evaluating the direction of flow into the left ventricle and optimizing Doppler recordings of jet velocity. From the tracing of prosthetic inflow velocity, maximal velocity, peak gradient and mean gradient will be measured.

STATISTICAL ANALYSIS

All continuous data will be reported as mean+standard deviation. Subgroup analysis will be done for each size of the valve implanted. One-way analysis of variance (ANOVA) will be used to compare continuous variables between multiple groups. P value <0.005 will be considered significant. Analysis will be performed using SPSS version 14.0 for Windows.

OBSERVATIONS

We analyzed 60 patients during one year of study, who had undergone T.T.K. Chitra Prosthetic valve replacement in mitral position, in aortic position or both (MVR and AVR) in Department of Cardiothoracic Surgery and came for follow-up in CTVS OPD. Hemodynamic evaluation was done of each prosthesis either in Mitral position or Aortic position by measuring their Peak Gradient. Mean Gradient and Peak velocity Doppler Echocardiography Observations were as follows Mean age of the patients = 27.7±10.1 years.

DISCUSSION

Our aim was to provide Doppler Echocardiographic Evaluation of this valve so as to provide the data of this valve. These data are particularly relevant in developing countries. We measured peak gradient, mean gradient and peak velocity of different sizes of T.T.K. Prosthesis in mitral and aortic position.

Rheumatic Heart disease is more prevalent in India than other countries. It is the major indication of valve replacement in developing countries like India. The valve imported from other countries are expensive and beyond the reach of needy peoples, as RHD is more common in low socioeconomic group, T.T.K. Chitra valve is the only valve which is manufactured in India. It is costing approximately 18000 rupees. Which is about one third of the cost of available other valves. Because of its low cost and proven efficacy its used more frequently for valve replacement in India.[1]

In this study 60 cases who had undergone valve replacement by **T.T.K. Chitra prosthesis** either in mitral position or at aortic position and attendance the cardiothoracic OPD for routine follow-up and having ejection fraction more than 50% were included. Those who had undergone valve replacement other than T.T.K. Chitra valve and those who had left ventricular dysfunction were excluded from the study.

The age group of patients ranged from 9 – 50 years with mean age 27.7±10.1. The maximum distributions of cases were in the 3rd to 4th decade (61.6%). These findings were comparable to Pawan et al[5] (mean age 26±5year) and Namboodiri et al[6]. Where the mean age was 38.8±10.5 year and Joshi et al was 30.98±9.3year.

Rheumatic heart disease was the commonest etiological factor for valve replacement in this study; none of the patient had degenerative valve disease. The finding was comparable to Namboodiri et al[6]. Where 95% of the patient had RHD as the etiology for valve replacement.

The striking features of these patients profile were young age (27.7±10.1) and late presentation.

There were 68.3% males and 31.6% female patients. There was a male preponderance with a male to female ratio is 2.1:1. These finding are comparable to study conducted by N.Namboodri et al (6) which had male 57.5% and female 42.5%.

Out of 60 patients 38 out of 60 (55%) had mitral valve pathology alone and had MVR and 36.6% had DVR (MVR+AVR) and only 2% had AVR alone. This findings was comparable to N.Namboodri et al (70) where 78 (58.7%) had mitral valve replacement (MVR).

TABLE -1
SHOWING AGE WISE DISTRIBUTION OF PATIENTS

Age of the Patients	No. of Patients	Percentage
1-9	1	1.6%
10-19	9	14.9%
20-29	20	33.3%
30-39	17	28.3%
40-49	13	21.6%
Total	60	100%

Majority of patients were between 3rd to 4th decade (37), out of these majority were of 3rd decade (20 out of 37). Only patients was operated in his first decade (1.6%)

TABLE-2
SHOWING DISTRIBUTUON OF PATIENTS ACCORDING TO SEX

Sex	No of patients	Percentage
Male	41	68.3%
Female	19	31.6%
Total	60	100%

41 out of 60 were male (68.3%) and 19 were female (31.6%)

TABLE-3
SHOWING DISTRIBUTION OF PATIENTS ACCORDING TO OPERATIONS

Name of Operation	No. of Patients	Percentage
Mitral valve replacement (MVR)	38	63.3%
Aortic valve replacement (AVR)	01	1.6%
Dual valve replacement (DVR)	22	36.6%
Total	60	100%

60 out of 60 (100%) had Rheumatic heart disease as the etiology of Valvular heart disease. Out of these 60 patients 38 had mitral valve replacement alone, 22 patients underwent both mitral valve replacement wile only one underwent isolated aortic valve replacement. None had triple Valve replacement and none had associated Tricuspid valve repair.

TABLE-4
SHOWING NUMBER OF PATIENTS ACCORDING TO SIZE OF THE VALVE IN MVR

Valve Size	No. of Patients	Percentage
25	11	18.6%
27	21	35.5%
29	18	30.5%
31	9	15.2%
Total	59	100%

Four sizes of T.T.K. Chitra valves were used in Mitral position (25, 27, 29,31mm). Out of these 4 valves maximum patients were received 27mm valve (35.5%). 11,18 and 9 valves were of size 25mm, 29mm and 31mm respectively. None had received 33mm valve.
There was significant correlation between size of the valve used and peak gradient in mitral position P valve 0.0001. As the size of the valve increases peak gradient tends to decrease.

TABLE-5
SHOWING SIZE OF THE VALVE USED IN AORTIC POSITION

Valve size (mm)	No. of Patients	Percentage
19	09	39.1%
21	12	52.1%
23	02	8.69%
Total	23	100%

In aortic position 3 sizes of T.T.K. Chitra valves were used Majorly (12 out of 23 valves, 52.1%) had received 21mm size valve, while 09 and 2 Patients had received 19mm and 23mm sizes of the prosthetic valves respectively.

TABLE-6
SHOWING PEAK GRADIENT ACCORDING TO THE SIZE OF THE VALVES IN MVR PATIENTS

Valve Size (mm)	25	27	29	31	Total
Peak Gradient [mmHg]	18.6±6.1	13.7±6.1	9.3±3.1	6.1±1.7	12.05±4.62

The average peak (Diastolic). Gradient in 25mm valve was 18.6±6.1mmHg, 13.7±6.1mmHg in 27mm valve 9.3±3.1mmHg in 29mm valve and 6.1±1.7 in 31mm valve. Overall peak gradient of T.T.K. Chitra valve in mitral position was 12.05±4.62 mmHg.

There was signification correlation between size of the valve used and peak gradient in mitral position. P value 0.000. As the size of the valve increases peak gradient tends to decrease.

TABLE-7
SHOWING PEAK GRADIENT ACCORDING TO SIZE OF THE VALVE IN AVR PROSTHETIC VALVE REPLACEMENT

Valve Size (mm)	19	21	23	Total
Peak Gradient (mmHg)	33.7±19.3	27.1±10.3	19.3±0.91	26.4±10.31

Statistical interference, The average peak gradient of T.T.K. Chitra valve in Aortic position was 26.4±10.31mmHg . The peak systolic gradient in 19mm valve was 33.7±19.3, in 21mm valve is 27.1±10.3mmHg in 23mm, 19.3±0.91mmHg.

The correlation between size of the valve used and peak gradient in aortic position was statistically insignificant P valve 0.224.

TABLE-8
SHOWING MEAN GRADIENT ACCORDING TO THE SIZE OF THE VALVES IN MVR

Value size (mm)	25	27	29	31	Total
Mean gradient in (mmHg)	7.93±4.3	5.3±2.53	4.3±0.93	3.05±0.5	5.14±2.19

Statistical interference, The average mean gradient of T.T.K. Chitra valve in Mitral position was 5.14±2.19
There was significant correlation between size of the valve used and mean gradient across the valve in Mitral position of T.T.K. Chitra prosthesis (P valve 0.001). Mean gradient was inversely proportional to the size of the valve.

TABLE-9
SHOWING MEAN GRADIENT ACCORDING TO SIZE OF THE PROSTHETIC VALVE IN AVR PATIENTS

Size of the valve	19	21	23	Total
Mean gradient (mmHg)	21.91±11.25	16.53±7.15	8.91±0.90	15.78±6.41

Average mean gradient of T.T.K. Chitra valve in aortic position is 15.78±6.41

The correlation between size of the valve used and Mean gradient in Aortic position was statistically signification, P valve 0.004.

TABLE-10
SHOWING PEAK VELOCITY (M/S) ACCORDING TO THE SIZE OF THE PROSTHETIC VALVES IN MVR PATIENTS

Valve size (mm)	23	25	27	29	Total
Peak Velocity (m/s)	3.4±2.54	2.11±1.07	1.43±0.31	1.35±0.43	2.03±1.45

The average peak velocity of T.T.K. Chitra valve in Mitral position was 2.03±1.45mmHg.
There was significant correlation between size of the Valve used and Peak Velocity across the valve in Mitral position of T.T.K. Chitra prosthesis. (P valve 0.001). Peak velocity was inversely proportional to size of the valve.

TABLE-11
SHOWING PEAK VELOCITY ACCORDING TO SIZE OF THE PROSTHETIC VALVE IN AVR PATIENTS

Valve size (mm)	19	21	23	Total
Peak Velocity (m/s)	4.67±3.15	2.70±0.59	2.83±0.77	3.05±1.51

The average peak velocity of T.T.K. Chitra valve in Aortic position was 3.05±1.51mmHg.
There correlation between size of the valve used and Peak Velocity across the valve in Aortic position of T.T.K. Chitra prosthesis was statistically insignificant.

TABLE NO.-12
HEMODYNAMICS OF T.T.K. CHITRA VALVE IN AORTIC POSITION

Valve Size	No. of Patients	Peak Gradient (mmHg)	Mean gradient (mmHg)	Peak Velocity (m/s)
19	09	33.6±19.3	21.91±11.25	4.67±3.15
21	12	27.1±10.3	16.53±7.13	2.91±0.79
23	04	19.0±0.93	8.91±0.90	2.83±0.77
Total	25	26.5±10.33	15.77±6.41	3.05±1.51

In aortic position the peak gradient, mean gradient and peak velocity of T.T.K. Chitra valve were 26.5±10.33mmHg. 15.77±6.41mmHg and 3.05±1.51m/s respectively.

Peak gradient and peak velocity did not correlate well with the size of the valve in Aortic position. ($P>0.224$, $P>0.101$) but mean gradient decreases significantly with increase in the size of the valve, $P<0.004$.

Size of T.T.K. Chitra prosthesis.

There are 5 types of valves available to be used in Mitral position of T.T.K. Chitra Prosthesis, 25mm, 27mm, 29mm, 31mm and 33mm. In our study (21 out of 59) 35.5% patients were implanted with 27mm T.T.K. Chitra prosthesis. None of the pt had 33mm size valve. This findings were comparable to N.Namboodri et at [6] where 57% (23 out of 40) of patients had 27mm size of the valve in mitral position and Pawan et al[5] where 323 out of 455 patients (81%) had undergone MVR with 27mm size of the valve in mitral position. At aortic position (52.1%) of patient had 21mm size of the CVHP, which as comparable to Pawan et al[5] where 51% patient had undergone AVR with 21mm size CVHP.

The most important variables that measure prosthetic valve performance are mechanical integrity hemodynamic characteristics and thrombogenecity. Gradient across the prosthetic valve is a good tool to asses the hemodynamic and normal functioning of the prosthetic valve. Less is the gradient better is the valve.

However the gradient is affected by cardiac output, endothelisation around prosthetic valve. As the cardiac output increases gradient tends in increase so it is also depend on duration of follow-up after the implant.

Doppler echocardiography allows accurate evaluation of trans-valvular flow patterns, thus facilitating recognition of turbulent, stenotic and regurgitant signals. Peak transvalvular velocities can be readily estimated. Failure to align the ultrasonic beam results in significant underestimation of Tran prosthetic velocity. To obtain exact velocity across the T.T.K Chitra valve the following technique was followed. The continuous wave cursor was arbitrarily placed parallel to the assumed direction of the flow. The transducer was then carefully maneuvered until well-defined velocity waveforms with the highest velocity were obtained and then a parallel orientation was assumed. Apical four-chamber view was used for parallel alignment of continuous wave cursor with the transmitral flow and apical, five-chamber view for attaining parallel orientation with the transaortic prosthetic flow signals. Soo CS[7], Panidis[8],

Reisner[9], Vongpatasin[10] have done echocardiographic evaluation to attaining parallel orientation with the transaortic prosthetic flow signals.

Doppler derived gradients of T.T.K. Chitra valve at Mitral position.

In our Study the average peak gradient, mean gradient and peak velocity were 12.05±4.62mmHg, 5.14±2.19mmHg and 2.03±1.45 (m/s) respectively. These observations were comparable to N.Namboodri et al[(6)] in this study average peak gradient mean gradient and peak velocity (across TTK Chitra valve) at mitral position were 11±3.7mmHg 4.1±1.50mmHg and 1.64±52m/s respectively.
Peak gradient (mmHg) mean gradient (mmHg) and peak velocity (m/s) were 18.6±6.1, 7.93±4.3, 3.4±2.54 in 25mm size 13.7±6.1, 5.3±2.53 and 2.11±1.07. In 27mm size 6.1±1.7, 3.05±0.5, 1.35±0.43 in 29mm size.
Our study shows that there is inverse correlation between size of the prosthetic valves used and Gradients (peak and mean) and velocity across that prosthetic valve at mitral position. Which is statistically significant (P<0.0001, P<0.001, P<0.001 respectively).

Our observations are comparable to various studies done on T.T.K Chitra valve.

The gradients (peak and mean) and peak velocity and effective orifice area (across TTK Chitra valve) in mitral position studied by **N.Namboodri** et al[(6)] is comparable to other valve available in the market as given in Table 13

TABLE- 13.
The Gradients (Peak and Mean) And Peak Velocity And Effective Orifice Area (Across TTK Chitra Valve) In Mitral Position

TTK Chitra (Tilting disc)	Peak Gradient (mmHg)	Mean Gradient (mmHg)	Peak Velocity (m/s)	Effective orifice area (cm2)
25	12.6±4.5	5.09±1.93	1.74±0.33	1.42±0.35
27	10.3±2.73	3.72±1.01	1.60±0.21	1.56±0.29
29	10.0±4.9	3.26±0.62	1.54±0.38	1.81±0.5

Dr. Pawan et al[(5)] Reported mean diastolic gradient 4±2 mm of Hg across the across the TTK Chitra valve in size was which was comparable to other mechanical valves

Nagarajan et al [(11)] reported average mean gradients of 5.09±2.14 mm of Hg in the mitral position.
Our Observations are also comparable to normal valves of other Mechanical Prosthetic Heart valves, given by

Rosnhek et al[12]. (The valves are given in Table 14) in Mitral position.

TABLE-14
SHOWING NORMAL HEMODYNAMICS OF OTHER AVAILABLE MECHANICAL VALVE IN MITRAL POSITION [(12)]

Valve size Peak gradient (mm)	Peak Gradient (mmHg)	Mean Gradient (mmHg)	Peak Velocity (m/s)	Effective orifice area (cm2)
Starr-Edwards				
26		10		1.4
28	7.0			1.9±0.57
30	12.2	6.99±2.5	1.7±0.38	1.65±0.4
32	11.5±4.225	5.08±2.5	1.7	1.98±0.4
34		5.0		2.6
Bjork-Shiley (tilting disc)				

25	12±4	6±2	1.75±0.38	1.72±0.6
27	10±4	5±2	1.6±4.9	1.72±0.6
29	7.83±2.93	2.83±1.27	1.37±0.25	2.1±0.43
31	6±3	2±1.9	1.41±0.26	2.2±0.43
Omnicarbon (tilting disc)				
25		6.05±1.81	1.77±0.24	
27		4.89±2.05	1.69±0.36	
29		4.93±2.16	1.56±0.27	
31		4.18±1.4	1.3±0.234	
ST. Jude Medical (bileaflet)				
25		2.5±1.1	1.34±1.12	1.35±0.37
27	11±4	5±1.82	1.61±0.29	1.67±0.17
29	10±3	4.15±1.8	1.57±0.29	1.75±0.17
31	12±6	4.46±2.22	1.59±0.33	2.03±0.32

The peak gradient mean gradient and peak velocity is slightly higher in T.T.K Chitra Prosthesis as compare to other available mechanical prosthesis in mitral position in our study. But overall it has good hemodynamics.

Doppler derived gradients of T.T.K. Chitra Valve at Aortic position
The average peak gradient mean gradient and peak velocity at aortic position were 26.5±10.33mmHg, 15.77±6.41 mmHg, 3.05±1.51 m/s respectively.

Peak gradient (mmHg), mean gradient (mmHg) and peak velocity (m/s) in aortic position were 33.6±19.3, 21.91±11.25, 4.67±3.15 in 19mm valve 27.1±10.3, 16.53±7.13, 2.91±0.79 in 21mm valve and 19.0±0.93, 8.91±0.90, 2.83±0.77 in 23mm size of T.T.K. Chitra valve. No study has shown peak gradient of this valve in aortic position but mean gradient and peak velocity what we got in our study was higher than other studies. In one study conducted in Sion Mumbai by Pawan et al[5], got the mean gradient 10±5mmHg and peak velocity 2.09±0.6m/s with 21mm size of the CHVP at aortic position.

Nagarajan et al [(11)] reported mean gradients and peak velocity 14.37±5.08mmHg and 2.01±0.52 m/s in 21 mm size of the CHVP at aortic position.

The gradient and velocity in our study was also higher in T.T.K. Chitra Prosthesis than other available mechanical valve. (Table 15)

TABLE 15
SHOWING NORMAL FREMODYNAMICS OF OTHER AVAILABLE
Mechanical valve at aortic Position[6]

Devices and size	Left ventricular to aortic pressure gradient (mmHg)	Effective orifice area
19-mm Devices		
Starr Edwards 1260		
Medtronic-Hall		
Bjork-Shiley monostrut		1.07
St. Jude	16-22	1.21
CarboMedics	17-19	1.12
21-mm Devices		
Starr Edwards 1260	12	1.23
Medtronic-Hall	12-13	1.74
Bjork-Shiley monostrut	1/00	1.45
St.Jude	13-15	1.81
CarboMedics	12	1.66

23-mm Devices		
Starr Edwards 1260		
Medtronic-Hall	9	2.26
Bjork-Shiley monostrut	9/7	2
St.Jude	12/8	2.24
CarboMedics	10/9	2.28
25-mm Devices		
Starr Edwards 1260		
Medtronic-Hall	1/4	1.75
Bjork-Shiley monostrut	7	3.64
St.Jude	12/11	3.34
CarboMedics	9/8	4.09

There was poor correlation between peak gradient and peak velocity across the valve and size of the valve (P valve>0.224 and P>0.101), but mean gradient was significantly reduced with the big size of the valve p valve <0.005).

In our study none of the patient who came for the follow up had thromboembolism, endocarditis or valve related complication like paravalvular leak or prosthetic valve thrombosis.

CONCLUSION.

Our Doppler echocardiographic study provides the valves for pressure gradients and peak velocity of all commonly used sizes of T.T.K. Chitra in mitral and aortic position.

The Doppler parameters obtained with CHVP in Mitral and Aortic position are slightly higher than those obtained with the different prosthetic valves in common use, however they are comparable. Overall the valve is cost effective and suitable for the patients.

Our Doppler Echocardiographic study and the Parameters studied will help to identify prosthetic valve dysfunction in clinical follow up of operated patients .Our study proves TTK Chitra valve a hemodynamically comparable and cheaper alternative to other prosthetic valves and a better suited design for Developing Country Like India where Rheumatic Heart Disease is more prevalent in low Socioeconomic Group.

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