Hemodynamic performance evaluation of TTK Chitra heart valve prosthesis in the aortic position using Doppler echocardiography

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1. Introduction

More than 15,000 patients have been implanted with TTK Chitra heart valve prosthesis (CHVP), a tilting disc prosthetic valve in various institutions in India. Though it has been in use for more than 15 years with a few follow up studies reporting excellent long term clinical results [1–3], there is scarcity of data on the normal echocardiographic parameters of this valve. This study was planned to establish a reference for the normal Doppler echocardiographic parameters for the CHVP in aortic position with the use of transthoracic echocardiography (TTE), in a large series of patients with normally functioning valves.

2. Material and methods

A total of 760 patients had undergone implantation of CHVP in our institute during the period December 1990 to December 2005. We prospectively enrolled 110 consecutive patients with CHVP, who were subjected to routine follow-up TTE during the period January–July 2006. Those patients with a short follow-up (<3 months after surgery), evidence of prosthetic valve dysfunction like significant obstruction, regurgitation or complications like endocarditis, significant left ventricular dysfunction (ejection fraction <40%), or unsatisfactory echocardiographic windows were excluded, and 97 patients were included in the final analysis.

The following parameters were assessed to evaluate the prosthetic valve in the aortic position as described earlier [4–6]; peak velocity, peak gradient, mean gradient, Doppler velocity index (DVI), effective orifice area (EOA) and valve resistance (VR).

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3. Statistical analysis

Continuous variables between groups were compared using one-way analysis of variance (ANOVA). Correlation between the variables and valve sizes was tested using bivariate correlation analysis. Discrete variables were compared using the Chi square test. Analysis was performed using SPSS version 14.0 for Windows.

4. Results

Out of 97 patients analyzed, 53 had undergone aortic valve replacement (AVR) alone, and 44 had double valve

Table 1
Baseline characteristics of the patients.

Total number of patients , *n*=		97
Age		39.0±11.5 years
Sex	Male	63 (64.9%)
	Female	34 (35.1%)
Diagnosis	Rheumatic	65(67%)
	Degenerative	13(13.4%)
	Bicuspid AV	8 (8.3%)
	others	11 (11.3%)
NYHA class	1	72 (74.2%)
	2	25 (25.8%)
Mean interval of evaluation from implant	30.9 (3–180) months	
Rhythm	Sinus rhythm	80 (82.5%)
	Atrial fibrillation	16 (16.5%)
	Paced (VVI)	1 (1%)
Echo parameters at evaluation	LVIDD, mm	47.9±6.7
	LVIDS, mm	32.8±6.1
	EF, %	66.7±8.2
	LA, mm	39.7±8.2
	Aorta, mm	31.0±3.8
Distribution of valve size	Valve size	No. of patients
	19	12
	21	34
	23	26
	25	19
	27	6

Table 2
Baseline and derived Doppler echocardiographic parameters of Chitra valve in aortic position.

Valve size, mm	No. of patients	Peak velocity, m/s	Peak gradient, mm Hg	Mean gradient, mm Hg	Doppler velocity index (DVI)	Effective orifice area, cm^2	Valve resistance, dynes s cm^{-5}
19	12	3.21±0.46 (2.60–4.06)	42.0±12.2 (27.0–66.0)	21.3±6.2 (15.6–37.0)	0.36±0.06 (0.28–0.49)	0.91±0.19 (0.75–1.46)	154.5±33.7 (68.4–204.6)
21	34	2.75±0.39 (2.10–3.63)	30.8±8.7 (17.7–52.9)	15.8±5.0 (8.1–28.7)	0.39±0.08 (0.28–0.61)	1.13±0.25 (0.76–1.87)	109.3±33.9 (50.5–206.4)
23	26	2.44±0.31 (1.94–3.25)	24.1±6.3 (15.0–42.2)	12.0±3.8 (7.0–24.5)	0.43±0.06 (0.31–0.55)	1.49±0.27 (1.05–1.85)	72.2±19.2 (45.0–124.1)
25	19	2.14±0.37 (1.55–3.09)	19.0±6.9 (9.6–38.3)	9.2±3.6 (5.3–19.1)	0.43±0.07 (0.32–0.60)	1.93±0.39 (1.21–2.94)	49.7±19.5 (25.2–108.5)
27	6	1.78±0.33 (1.40–2.29)	13.0±4.9 (7.7–21.0)	5.8±1.3 (3.6–7.0)	0.43±0.04 (0.37–0.47)	2.15±0.18 (1.83–2.30)	34.9±5.2 (30.1–44.1)
Total	97	2.54±.53 (1.40–4.1)	27.0±11.1 (7.7–66.0)	13.6±6.1 (3.6–37.0)	0.41±0.08 (0.28–0.61)	1.42±.48 (0.75–2.94)	88.6±44.4 (30.1–206.4)

All values expressed as mean±standard deviation with range in parentheses.

replacement (DVR, mitral and aortic). Of the 44 patients who had DVR, 17 had CHVP while others had Starr-Edwards prosthesis at mitral position. Baseline characteristics are shown in Table 1. The echocardiographic parameters derived are shown according to valve size in Table 2.

The peak Doppler gradient ranged from 7.7 to 66 mm Hg, and the mean gradient ranged from 3.6 to 37 mm Hg. Peak velocity as well as peak and mean valve gradients decreased with increasing valve size ($r=-0.71$, $r=-0.69$, and $r=-0.68$ respectively; $p<0.001$). When small-size (valve sizes of 19 and 21 mm) groups were compared with large-size (larger than 21 mm) groups, significant differences in peak and mean gradients were found (one-way ANOVA; $p<0.001$). DVI ranged from 0.28 to 0.61. Though it is considered to be relatively size-independent [4], there was a significant correlation between DVI and the valve size ($r=0.31$, $p=0.003$, Fig. 1). However, when smaller sizes of 19 and 21 were excluded from the analysis, DVI was found to be independent of valve size ($r=-0.05, p=0.73$). EOA calculated by the continuity equation ranged from 0.75 to 2.94 cm^2. A significant correlation was observed between EOA and the valve size ($r=0.81$, $p<0.001$, Fig. 2). VR calculated by echocardiography ranged from 25.2 to 206.4 dynes s cm^{-5}. A significant negative correlation was observed between VR and the valve size ($r=-0.78$, $p<0.001$, Fig. 3).

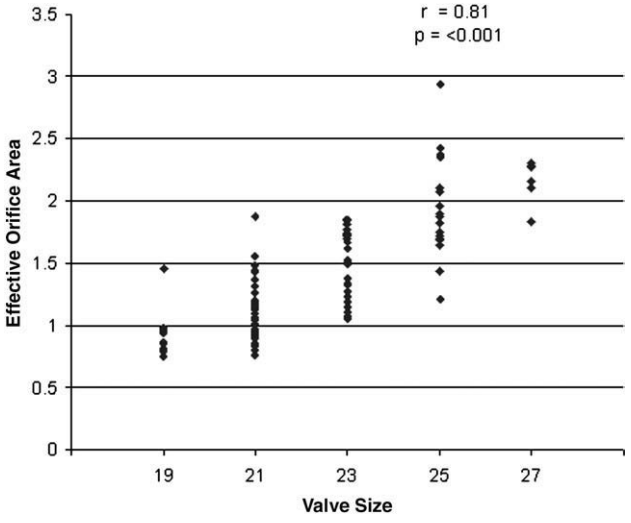

Fig. 2. Scatter diagram showing the correlation between different valve sizes and effective orifice area.

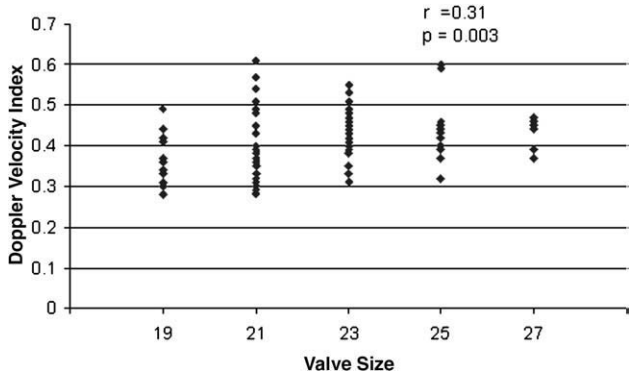

Fig. 1. Scatter diagram showing the correlation between different valve sizes and DVI.

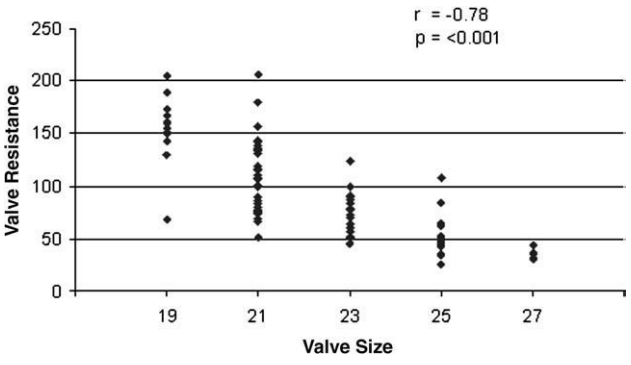

Fig. 3. Scatter diagram showing the correlation between different valve sizes and valve resistance.