Intravascular hemolysis in patients with normally functioning mechanical heart valves in mitral position

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Abstract

Objective: **Traumatic intravascular hemolysis has been recognized as a potentially serious problem after heart valve replacement. Chronic subclinical hemolysis in these patients with normally functioning valvular mechanical or biologic prostheses rarely develop decompensated anemia. This prospective study evaluates the presence and severity of hemolysis in patients with normally functioning mitral prosthetic valves.**

Methods: **In this prospective study 78 patients with normally functioning mitral prosthetic valves were evaluated for hemolysis postoperatively on 7^{th},30^{th} and 180^{th} days by clinical evaluation, transthoracic echocardiography, hemoglobin, serum lactic dehydrogenase (LDH), and reticulocyte count. Data was statistically analysed with paired t test and variance test.**

Results: **LDH was elevated in almost all the patients with mechanical valve replacement. None had significant anemia. All the evidence of hemolysis was not observed in any of the recipients. There was no statistically significant difference in the degree of hemolysis among the recipients of various tilting disc valves. There was no significant correlation between the severity of hemolysis and cardiac rhythm or the size of valve. The recipients of bileaflet valve had significantly more severe hemolysis than those of tilting disc valves.**

Conclusions: **Almost all the recipients of mechanical mitral valves had increased LDH values at the follow up. However none had decompensated anemia during 180 days follow up. Bileaflet valves cause more hemolysis than tilting ones. Recipients of Chitra TTK valve prosthesis showed least hemolysis.** ***(Ind J Thorac Cardiovasc Surg, 2006; 22: 215-218)***

Keywords: Mechanical heart valve, Echocardiography, Valve replacement

Introduction

Traumatic intravascular hemolysis after heart valve replacement can be a serious problem[1,2]. It is reported to occur in 5% to 15% of patients with a ball-caged valve prosthesis[1]. Even though chronic subclinical hemolysis may be present in patients with mechanical or biologic valve prostheses, significant anemia is rare with normally functioning valvular prosthesis[3]. Such hemolysis is probably due to the turbulence of flow with high shear-stress forces and abnormal flow jets through the prosthetic valve[4,5].

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Patients and Methods

A prospective study was carried out in the Department of Cardiovascular and Thoracic Surgery, KEM Hospital, Mumbai to evaluate the presence and severity of hemolysis in 78 patients who underwent mitral valve replacement with the mechanical heart valves viz Chitra TTK, (TTK Healthcare Ltd, India), Sorin Carbocast, (Sorin Biomedica, Italy), Medtronic Hall, (Medtronic Inc, USA), and Mira Edwards, (Edwards Lifesciences Inc, USA) during one year period from January 2004 to December 2004 and were subsequently discharged with normally functioning prosthetic valves. They were 17 to 54 years old, 43 being

females. Those with significant coronary artery, renal, hepatic, or pulmonary disease, valve dysfunction and hematologic disorder were excluded from the study.

All these patients were evaluated for hemolysis postoperatively on 7th,30th and 180th days. Every follow-up examination consisted of (1) clinical evaluation with investigations for other possible causes of hemolytic anemia, (2) assessment of prosthetic valve function by means of transthoracic echocardiography in all and transesophageal echocardiography if there was any evidence of hemolysis causing significant anemia or if the transthoracic window was poor and (3) hematological evaluation of hemolysis, as measured by total blood hemoglobin(Hb) level, serum lactic dehydrogenase (LDH) level, and reticulocyte count.

Intravascular hemolysis was considered to be present if

1. Serum LDH levels were greater than 190 U/L (normal, 100-190 U/L).
2. Blood hemoglobin level of less than 13.0 g/dl for male patients (normal, 13.0-1509 g/dl) and less than 12.0 g/dl for female patients (normal, 12.0-14.0 g/dl);
3. Reticulocyte count of greater than 2% (normal, <2%)

The measured values are expressed as mean ± SD. Data among two groups was compared by paired t test. Data comparison among three or more groups was based on analysis of variance test (ANOVA). Results were considered to be significant at $p<0.05$.

Results

One-third of the patients were in atrial fibrillation. Three fourths of these patients had presented in NYHA Class III. Nearly half the patients received Chitra TTK* prosthesis. (Table 1)All patients had significantly improved clinically at the follow up.

LDH was consistently elevated in most of the recipients of the mechanical valves at postoperative follow up. (Table 2) None of the patients had significant anemia. All the evidence of hemolysis was not observed in any of the recipients of any of the prosthesis studied (Table 3) Thus none of the valve prosthesis in this study was causing any significant clinically manifested hemolysis. The severity of hemolysis did not show any significant correlation with the postoperative cardiac rhythm.(Table 4)

Table 1. Patient characteristics

Variables	No of Patients
Sinus Rhythm	52
Atrial Fibrillation	26
NYHA II	13
NYHA III	62
NYHA IV	3
Chitra-TTK	34
Sorin Carbocast	19
Medtronic Hall	16
Mira Edwards	9

NYHA: New York Heart Association

Table 2. No of patients with normal and elevated LDH values at follow up

Postop Day	Normal No of patients	Per Cent	Elevated No of patients	Per Cent
7	9	11.5%	69	88.55%
30	4	5%	74	95%
180	2	2.5%	76	97.5%

Table 3. Mean LDH,Reticulocyte,Hb at follow up

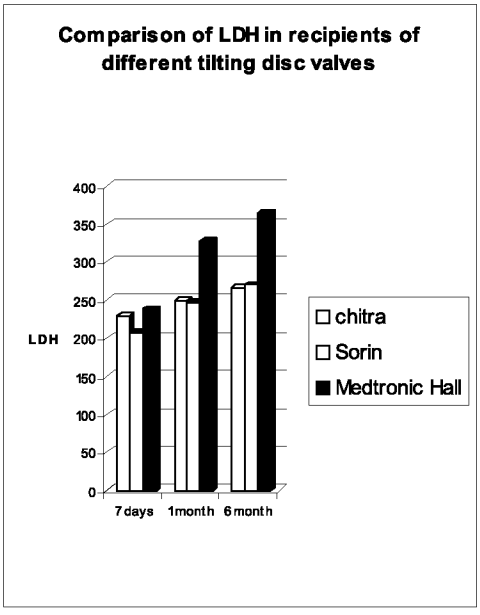
Post op day	LDH u/l	Retic count	Hb gm/dl
7	233±61	1.61±0.32	12.7±0.69
30	266±62.8	1.48±0.44	12.8±0.78
180	291±64.3	1.33±0.57	12.8±0.91

Table 4. LDH in patients with sinus rhythm and atrial fibrillation

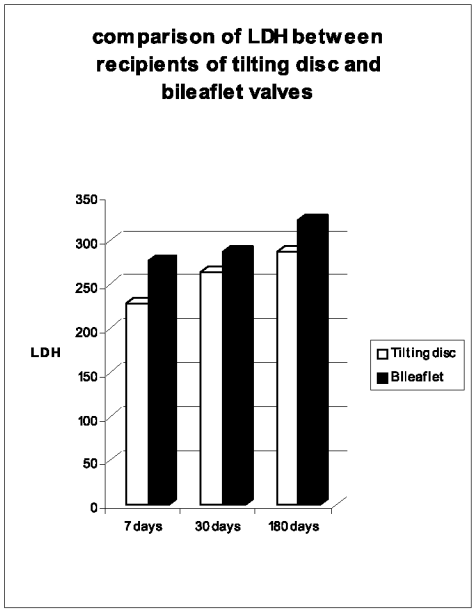
LDH U/L	AF (n-27)	SR (n-51)	P value
7 days	236±59	231±62.6	0.76
30 days	265±54.5	267±67.3	0.91
180 days	294±57.7	289±68	0.75

The severity of hemolysis among the recipients of various tilting disc valves at 7th postoperative day was not significantly different. However the severity of hemolysis in the recipients of Medtronic Hall valves was more than those of the others at 30th and 180th day and the difference was statistically significant(Fig 1a). Similarly the hemolysis was statistically more significant at 180 days follow up in the recipients of bileaflet prosthesis. (Fig 1b). There was no significant correlation between the severity of hemolysis and the size of the prosthesis. (Fig 2).

Fig 1. LDH Values at Follow up in recipients of a) various Tilting and b) Bileaflet prosthesis

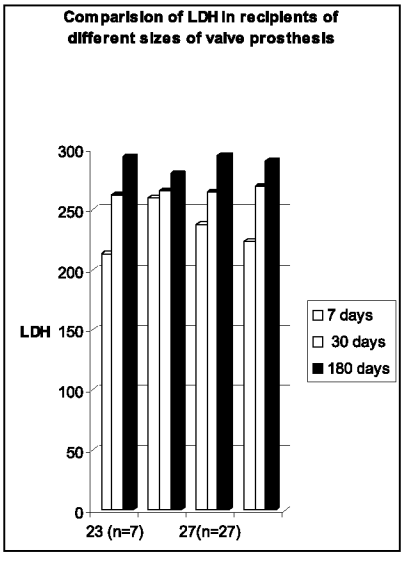


a: various tilting disc prosthesis



b: tilting versus bileaflet prosthesis

Fig 2. Comparison of LDH in recipients of different sizes of valve prosthesis at follow up.



Different sizes of the valve prosthesis and number of patients (in parenthesis)

Discussion

Though mild degrees of intravascular hemolysis are not uncommon among patients with normally functioning prostheses, it is often subclinical[1,5-7]. However, it may be severe enough in 2.5% to 15% to cause anemia[8]. Absence of clinically manifested severe hemolysis in the present series may be related to the use of newer generation valves and better methods of evaluating prosthetic valve function.

Assessment of prosthetic mitral regurgitation remains limited due to significant attenuation of the ultrasound beam by the prosthesis and the frequent underestimation of severity of regurgitation by transthoracic echocardiography[9,10]. Transesophageal echocardiography is increasingly used in the evaluation of prosthetic dysfunction being particularly useful in determining the site and mechanism of prosthetic regurgitation and further is superior to transthoracic echocardiography in identifying perivalvular pathology, differentiating paravalvular from valvular regurgitation and in defining the anatomic abnormality responsible for the prosthetic valve dysfunction[11]. It however offers no advantage over the transthoracic approach in the detection and quantification of prosthetic aortic regurgitation unless the transthoracic image quality is poor and is limited in detecting mechanical valve obstruction and in detecting aortic regurgitation in the presence of a mechanical prosthesis in the mitral valve position[12]. A complete anatomic and hemodynamic assessment of prosthetic valve function is possible with combined transthoracic and transesophageal examination[12].

More LDH elevation was observed in patients with bileaflet (Mira Edwards) valve prosthesis than those with tilting disc valve prosthesis (Sorin Carbocast and Chitra TTK) in mitral position. More hemolysis has been reported with bileaflet prosthesis[6,7,13,14]. More degree of hemolysis in bileaflet valve as compared to tilting disc valve may be due to a greater reflux volume and multiple peripherally regurgitant jets demonstrated in the former on transesophageal echo[6,15].

More LDH elevation in this study was found in recipient of Medtronic Hall valve prosthesis as compared to those of Chitra TTK and Sorin Carbocast valves. This may be due to more transvalvular regurgitation through central strut present in Medtronic Hall valve causing high shear stress and therefore hemolysis[15]. Least hemolysis was observed with Chitra TTK heart valve. This may be attributed to less cavitation in Chitra TTK heart valve due to use of ultra high molecular weight polyethylene[16].

No correlation has been observed between severity of hemolysis and valve size or the cardiac rhythm[3,6]. This study too found no corelation between the severity of hemolysis and the valve size or the cardiac rhythm.

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