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Malfunction of Björk-Shiley valve prosthesis in tricuspid position

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Eight months after triple valve replacement with Björk-Shiley tilting disc valves a patient developed symptoms and signs suggesting malfunction of the prosthesis in the tricuspid position. This was confirmed by echocardiography and angiocardiography, and at operation the disc of the prosthesis was found to be stuck half-open by fibrin and clot. A further 11 patients with the same type of prosthesis in the tricuspid position were then studied by phonocardiography and echocardiography. In one of these the prosthesis was found to be stuck and this was confirmed by angiocardiography and surgery. These 2 cases are reported in detail and the findings in the other 10 are discussed. The implications of this high incidence of malfunction of the Björk-Shiley prosthesis in the tricuspid position are considered. Echocardiography appears to be essential in the follow-up of such patients.

Obstruction of ball valve prostheses in the tricuspid position is well recognized (Samaan and Murali, 1970; Vander Veer *et al.*, 1971; Bache *et al.*, 1972; Suwansirikul *et al.*, 1974; Assad-Morell *et al.*, 1974). Assad-Morell *et al.* (1974) emphasized the value of phonocardiography and echocardiography in the diagnosis of this complication. Echocardiography has been used by a number of workers in the analysis of normal prosthetic valve function (Gimenez *et al.*, 1965; Winters, Gimenez, and Soloff, 1967; Johnson, Paton, and Holmes, 1970; Johnson, Holmes, and Paton, 1973; Douglas and Williams, 1974), and there have been reports of its use in the diagnosis of malfunction of prosthetic valves (Pfeifer *et al.*, 1972; Belenkie *et al.*, 1973; Oliva *et al.*, 1973; Miller, Gibson, and Stephens, 1973). We have, however, found no previous reports of malfunction of the Björk-Shiley tilting disc valve in the tricuspid position. The present study followed the discovery of a stuck prosthesis of this type in the tricuspid position in one patient (Case 1), and led to the discovery of another (Case 4).

Subjects and methods

After the diagnosis and successful treatment of Case 1 a further 11 patients with a Björk-Shiley disc valve prosthesis in the tricuspid position were studied. They were numbered (Table) in the order of their study. All patients were on anticoagulant therapy. Clinical examination and penetrated posteroanterior and lateral chest *x*-ray films were examined in every case. From these *x*-ray films the alignment of the disc of the prosthesis was determined and documented according to the direction of the small segment of the disc. Phonocardiograms and echocardiograms were recorded on a Cambridge strip-chart recorder. Echocardiography was performed using a Smith Klein Ekoline 20, and a 2·25 MHz transducer focused at 5 cm. The transducer was placed at the left sternal border in the fourth or fifth intercostal space and the patient was positioned so as to produce the clearest recording of the valve disc. The optimal position was usually supine or lying on the left side at an angle of about 45°. The excursion of the opening movement of the disc of the prosthesis in the tricuspid position was measured as shown in Fig. 1A.

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Results

The details are shown in the Table. In Cases 1 and 4 no movement of the disc of the prosthesis was recorded, but in all the others opening and closure were shown.

Case 1

A 66-year-old man had severe triple valve disease

TABLE *Details of patients with a Björk-Shiley valve prosthesis*

Case No.	*Age (y)*	*Sex*	*Valves replaced*	*Tricuspid size (mm)*	*Months from operation to study*	*Orientation of disc (small segment)*	*Disc excursion (cm)*	*No. of AV valve closing sounds*	*No. of AV valve opening sounds*
1	66	M	M, T, A	31	8	Inferior	Nil	1	1
2	35	F	M, T, A	29	7	Posterior	1·3	2	1
3	61	M	M, T, A	31	12	Inferior	1·3	1	2
4	48	F	M, T, A	31	15	Superior	Nil	1	1
5	50	F	M, T, A	31	22	Superior	1·0	2	1
6	49	F	M, T, A	31	12	Superior	1·6	2	2
7	45	F	M, T	31	7	Superior	1·35	2	1
8	69	F	M, T	29	10	Superior	0·85	2	1
9	37	F	M, T, A	31	22	Superior	0·9	2	2
10	48	F	M, T, A	31	14	Posterior	1·0	2	2
11	69	F	M, T, A	31	1	Superior	1·1	2	1
12	52	F	M, T, A	31	24	Posterior	1·0	2	2

M, mitral; T, tricuspid; A, aortic.

Note: All prosthetic valves were Björk-Shiley prostheses, except for Case 10 in whom the mitral and aortic prostheses were Starr-Edwards ball valve prostheses.

and a history of rheumatic fever. Cardiac catheterization had confirmed severe mitral stenosis and moderate mitral regurgitation, moderate aortic stenosis and mild aortic regurgitation, and moderate tricuspid regurgitation, with severe pulmonary hypertension. A triple valve replacement was performed using Björk-Shiley prostheses. He subsequently did well until eight months after the operation when he began to feel weak and tired, with ankle swelling and moderate exertional dyspnoea. He had required admission to another hospital for restabilization of his anticoagulants about a month earlier because he had had too high a dosage. Otherwise his anticoagulation had been satisfactory. On examination he had mild ankle oedema and 3 cm hepatomegaly, and the jugular

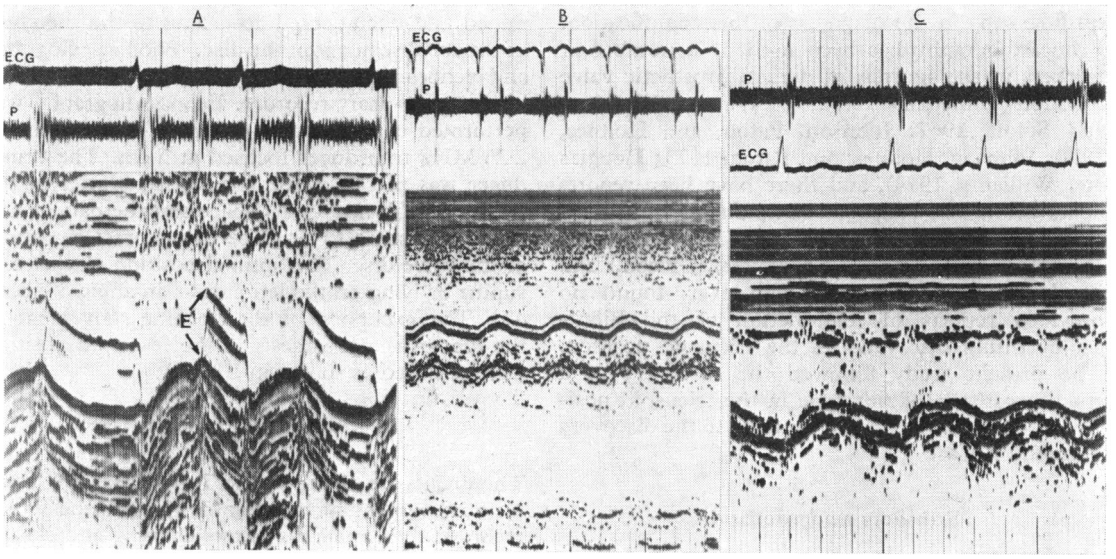

FIG. 1 *Echocardiograms of tricuspid valve prostheses. (A) Functioning prosthesis in Case 3; disc excursion (E) was measured between the two black arrows. (B) Stuck prosthesis in Case 1. (C) Stuck prosthesis in Case 4. P=phonocardiogram.*

venous pressure was raised to about 10 cm above the sternal angle. He was in controlled atrial fibrillation. On auscultation there was a grade 3/4 delayed diastolic murmur, heard maximally at the lower left sternal edge, and increasing in intensity with inspiration. There was also a soft pansystolic murmur at the left sternal edge and a soft aortic systolic murmur. The prosthetic valve sounds were considered clinically to be normal. The diagnosis was thought to be malfunction of the tricuspid valve prosthesis, with resulting stenosis and regurgitation.

Phonocardiography confirmed the clinical description of the murmurs and showed only single atrioventricular (AV) valve opening and closing sounds. Echocardiography of the tricuspid valve prosthesis showed two parallel lines with no evidence of an opening movement (Fig. 1B). The mitral and aortic valve prostheses were considered to be functioning normally. Right and left heart catheterization was performed. There was a high right atrial pressure with a mean of 14 mmHg and a *v* wave of 22 mmHg. An end-diastolic tricuspid gradient of 12 mmHg was recorded on withdrawal across the prosthesis. Angiocardiography with right atrial injection showed that the disc of the prosthesis was immobile in the half-open position. Mitral and aortic prosthetic valve function was normal. The diagnosis of thrombotic obstruction of the tricuspid valve prosthesis was made. At operation there was a fibrinous covering of the valve struts causing the disc to be held in the half-open position and to be completely immobile (Fig. 2). The valve was excised and a Starr-Edwards ball valve prosthesis was inserted. The patient has remained well since the operation and is now on dipyridamole as well as warfarin.

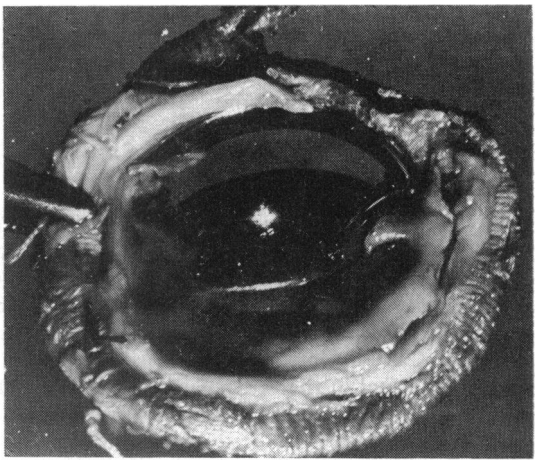

FIG. 2 *Excised prosthesis from Case 1 showing the disc of the valve stuck in the half-open position by fibrin covering the struts of the prosthesis. The excised prosthesis from Case 4 had a similar appearance though the fibrin covering the struts was less extensive. There was no evidence of infection on either valve prosthesis.*

Case 4

A 48-year-old woman had triple valve disease which was thought to be rheumatic in origin and had been complicated by infective endocarditis five years previously. Cardiac catheterization confirmed the presence of severe mitral regurgitation and stenosis, moderate aortic regurgitation with mild stenosis, and moderate tricuspid regurgitation and stenosis. A triple valve replacement was performed using Björk-Shiley valve prostheses. Subsequently she did well and was asymptomatic until one year after the operation when at a routine follow-up assessment she complained of a 'bloated' feeling and of having gained 12 kg in weight. Her exercise tolerance was however unchanged. The jugular venous pressure was noted to be moderately raised but the prosthetic valves were thought to be working normally. Four months later she was seen as part of the present study, initiated after the discovery of Case 1. She had by now developed ankle swelling in addition to her previous symptoms but exercise tolerance was still normal.

Clinical examination revealed a high jugular venous pressure with a *v* wave 12 cm above the sternal angle. There was bilateral ankle oedema and 4 cm hepatomegaly. On auscultation there was a grade 1 delayed diastolic murmur at the lower left sternal edge, increased in intensity by inspiration. The prosthetic valve sounds were considered to be clinically unremarkable and an aortic ejection murmur was present. The murmurs were confirmed by phonocardiography but no tricuspid valve sounds could be identified, there being only single AV valve opening and closing sounds. Echocardiography of the tricuspid valve prosthesis showed two parallel lines with no opening movement (Fig. 1C), an appearance very similar to that found in Case 1 (Fig. 1B). This was thought to indicate that the disc of the prosthesis was stuck. Right atrial angiocardiography showed a filling defect on the ventricular aspect of the prosthesis. The disc could be identified and was seen to be stuck in the half-open position. Fluoroscopy, with the valve in profile, confirmed that the disc could be visualized and that it was stuck half-open and virtually immobile. At operation the valve was found to be obstructed

by clot of varying ages and fibrin, with the disc stuck half-open. It was replaced by a Hancock mounted xenograft valve. The patient made a good recovery and is now asymptomatic, two months after the second operation.

Other cases

All the other 10 patients studied (Cases 2, 3, and 5 to 12) were either asymptomatic or had minimal effort dyspnoea apart from Case 6 who had mild effort dyspnoea and Case 12 who had severe effort dyspnoea. The jugular venous pressure was mildly raised in Case 6, considerably raised in Case 12 and was normal in the other patients. Cases 6, 11, and 12 had soft delayed diastolic murmurs, and these were thought to arise from the tricuspid valve prostheses. However, in all cases the echocardiogram of the tricuspid valve prosthesis showed clear opening and closing movements (Fig. 1A).

The phonocardiogram was examined for two sounds of AV valve opening and two sounds of AV valve closure. Five patients had two AV valve opening sounds and 9 had two AV valve closing sounds (Table). None of these 10 patients had both a single AV valve opening sound and a single AV valve closing sound. It was concluded that the disc of the tricuspid valve prosthesis was not stuck in any of these 10 patients. The maximum disc excursion of the tricuspid valve prostheses which were not stuck varied from 1·6 cm to 0·85 cm (mean 1·1 cm). The excursion did not seem to be related to the orientation of the disc or to the size of the prosthesis.

Discussion

Twelve patients with a Björk-Shiley prosthesis in the tricuspid position are presented. In 2 of them the disc of the prosthesis was stuck in the half-open position. Both of these patients had a pronounced rise in the jugular venous pressure and a delayed diastolic murmur, though in one of them (Case 4) the murmur was soft and could easily have been overlooked if attention was not paid specifically to this point. These physical signs, therefore, suggest the diagnosis of a stuck tricuspid valve prosthesis but they may be found when the disc of the prosthesis is shown to be mobile on the echocardiogram, as in Cases 6, 11, and 12. It is not possible to say from this study whether or not there were minor degrees of tricuspid prosthetic valve malfunction in these patients.

The phonocardiogram was found to be of limited use in making the diagnosis of a stuck tricuspid valve prosthesis. These patients all had mitral as well as tricuspid prostheses and all but two had aortic prostheses as well. This makes analysis of heart sounds very difficult even with the aid of simultaneous echocardiography. Some patients with both functioning mitral and tricuspid valve prostheses had single AV valve opening or closing sounds. Only the two patients with stuck tricuspid prosthetic valves, however, had both a single opening sound and a single closing sound.

Although angiocardiography was performed to confirm the diagnosis in the two cases with stuck prostheses reported here, the appearance on the echocardiogram of two parallel lines with no disc movement appears to be diagnostic. We believe that the two lines arise from the valve ring and the stationary disc. In a prosthesis that is opening the disc is seen to move anteriorly in diastole. The cause of an apparent double disc echo in some cases (Fig. 1A) is uncertain. Douglas and Williams (1974) emphasized the importance of the alignment of the disc and transducer in the echocardiographic assessment of Björk-Shiley prosthetic valves but this does not seem to be important in the detection of an immobilized disc in a prosthesis of this type in the tricuspid position.

Fluoroscopy showed the stuck disc in Case 4. In a normally functioning Björk-Shiley prosthesis the disc is not visible on fluoroscopy but it appears that when it is stationary and can be viewed in profile the disc can be visualized. Recently a radio-opaque ring has been incorporated in the discs of Björk-Shiley prostheses and the diagnosis of a stuck prosthesis of this modern type should be obvious on simple fluoroscopy. It seems reasonable to suggest that only this type of Björk-Shiley prosthesis should, in future, be used.

The incidence of malfunction of 2 out of 12 cases in our study may be an underestimate of the overall incidence as a further 5 patients who have had this type of prosthesis in the tricuspid position in this centre could not be included in this study. Three of these patients are overseas and 2 have died. Necropsy information on the state of the tricuspid valve prosthesis in these 2 patients is unfortunately not available.

It is of interest that in Case 4 there was thrombus of different ages on the valve at the time of operation and that some was recent. It appears from this observation that the lesion is progressive once it has started. It may be inferred that if anticoagulation is allowed to become inadequate even for a short time the process may start by which eventually prosthetic valve function may be destroyed by immobilization of the disc.

In reporting a case of late thrombosis of a ball valve prosthesis in the tricuspid position, Suwan-

sirikul *et al.* (1974) thought that this was the result of entrapment of the cage of the valve in the wall of the right ventricle. This mechanism cannot be implicated with the low profile Björk-Shiley valve prosthesis. Other factors must, therefore, be of importance in the apparent predisposition of tricuspid valve prostheses to thrombotic obstruction, such as the dynamics of flow in the right side of the heart as compared with the left.

Conclusion

The Björk-Shiley valve prosthesis is not the ideal valve for the tricuspid position. In cases with this type of prosthesis in the tricuspid position regular follow-up should be undertaken, paying particular attention to the jugular venous pressure and the presence of a diastolic murmur. Echocardiography should be performed frequently and it may be that serial studies would enable lesser degrees of tricuspid valve prosthetic malfunction to be detected before complete sticking of the disc. We suggest that in future if Björk-Shiley prostheses are used, only those with a radio-opaque ring incorporated in the disc should be employed.

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