Symptomatic mechanical heart valve thrombosis: high morbidity and mortality despite successful treatment options

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Summary

Background: Recommendations for treatment of mechanical prosthetic heart valve thrombosis (PVT) include systemic thrombolysis and/or re-operation. Data on complications and outcome are limited.

Methods: Clinical and echocardiographic findings of 17 patients with mechanical PVT were reviewed. Complications and outcome of surgery and/or thrombolysis were analysed. Prospective follow-up was obtained.

Results: Symptomatic PVT occurred 8.4 ± 7.2 years after mechanical valve replacement at mean age 55 ± 15 years. Thrombosis involved the mitral valve in 12 patients (71%), the aortic valve in 4 (24%) and the tricuspid valve in one (6%). The reason for PVT was inadequate anticoagulation in 11 patients (65%), endomyocardial fibrosis in 2 (12%) and unknown in 4 (24%). Prior to diagnosis, systemic emboli occurred in 6 patients (35%). Thirteen patients (76%) presented in functional class NYHA IV. Haemodynamic valve obstruction was documented by echocardiography in 15 patients (88%). Treatment included primary reoperation in 12 patients (71%), thrombolysis with urokinase in 3 (18%) (with reoperation in 1), reinstitution of adequate anticoagulation in one (6%); death occurred before treatment in one (6%). Intraoperatively, both pannus and thrombus were found in 5 of 13 patients (38%). Treatment-related emboli occurred in 5 patients (29%), to the brain in 3, to the legs in one and to a coronary artery in one. Five patients died (mortality 29%) within 30 days due to multiorgan failure/septicaemia (3 patients), congestive heart failure (1), or cerebral emboli (1). Follow-up after 28 ± 28 months in the 12 surviving patients was unremarkable.

Conclusions: The most common aetiology for obstructive PVT is thrombus formation due to inadequate anticoagulation. PVT remains a serious complication with high morbidity and mortality despite aggressive treatment by thrombolysis and/or surgery. Surgery is often needed due to the frequent presence of pannus and/or large thrombi. However, long-term prognosis after successful treatment of PVT is excellent.

Keywords: prosthetic valve thrombosis; thrombolysis; surgery; complications; treatment; outcome; emboli; pannus

Introduction

Although the overall performance of prosthetic heart valves is excellent, prosthesis-related problems occur within 10 years of surgery in 30–35% of patients with a mechanical prosthesis [1]. Mechanical prosthetic heart valve thrombosis (PVT) is a rare but life-threatening complication with an incidence of 0.03–4.3% per year [2]. Thrombus formation generally occurs either from the sewing ring to the annulus or on the leading edge of tissue ingrowth, and extends along the struts and hinge points in disc and bileaflet-type valves. An increased risk of thrombosis has been described for valves in the mitral or tricuspid position, "first-generation" ball-cage or tilting-disc mitral prostheses (e.g. Starr-Edwards, Björk-Shiley, Omniscience valves), and in the presence of double-position prosthetic valves [3]. The classical treatment for PVT includes surgery with thrombectomy or valve replacement, with mortality ranging from 4.7 to 20% [4]. In 1971 the first successful thrombolysis of a thrombosed Starr-Edwards prosthesis in tricuspid position was reported, and thrombolysis of a left-sided thrombosed prosthetic valve in 1974 [5, 6]. Since then,

fibrinolytic therapy has emerged as a promising alternative to surgery, particularly in critically ill patients. Success rates ranging from 75 to 88% have been described [2, 7]. Thrombolysis is successful and safe for clinically stable patients with thrombi measuring ≤5 mm [8, 9].

As PVT is rare and the individual centres have only limited experience of both diagnosis and management, we analysed our own medically and/or surgically managed PVT patients with reference to aetiology, diagnostic clues, incidence of pannus formation, treatment, complications and long-term outcome.

Methods

Patients

The echocardiographic database between January 1990 and October 2000 was retrospectively screened to identify all patients with PVT. Patient charts, surgical reports, and data on histology or autopsy were reviewed. Patients fulfilling the diagnosis of prosthetic valve endocarditis according to the Duke criteria were excluded [10].

Inadequate anticoagulation was defined as interruption of anticoagulation or an international normalised ratio (INR) of <2.5 at the time of diagnosis of PVT or repeatedly within the year prior to occurrence of PVT.

Echocardiography

For the echocardiographic investigations different machines were used: Hewlett Packard 2500 or 5500, Acuson Sequoia, Vingmed CFM 800 and Toshiba Powervision 8000. All patients had at least one complete transthoracic echocardiographic examination before and after therapy, and ≥1 transoesophageal echocardiographic exam (TEE) was performed prior to treatment in 16 of the 17 patients (94%). All echocardiographic examinations were recorded on videotape. All recordings obtained before any therapy was instituted were reviewed. Both the location and size of thrombi were carefully assessed.

Thrombolytic therapy

In our hospital the following protocol for thrombolysis was used for PVT: infusion of 200 000 U (in some patients up to 500 000 U) urokinase within one hour, followed by infusion of 100 000 U/hour [11]. The duration of urokinase administration was individualised according to the thrombolytic effect obtained in repeat Doppler-echocardiographic monitoring. Thrombolysis was defined as haemodynamically effective if a normal or near-normal transvalvular gradient was achieved or disappearance of the thrombus was documented [11]. The maximum duration of thrombolytic treatment was 72 hours.

Surgery

Patients were referred immediately for surgery if the prosthetic obstruction was diagnosed by clinical examination, fluoroscopy and/or echocardiography and thrombolysis was either not performed due to the presence of mobile or large thrombi or pannus, or not successful. In all patients the surgical method employed was median sternotomy with standard cardiopulmonary bypass techniques using a disposable membrane oxygenator. In all patients with left-sided PVT, cold blood potassium cardioplegia and moderate hypothermia were used for the operation. The operative procedures were either valve replacement or declotting with or without pannus excision. In all patients surgery was performed on an emergency basis.

Follow-up

Prospective follow-up of all survivors was obtained by a clinical visit or a telephone call to the patient. Medical records of subsequent hospital admissions were reviewed and information was obtained from both the family physician and cardiologists.

Statistics

All data are expressed as means ± 1 standard deviation.

Results

Patient characteristics and preoperative findings

The characteristics of the 17 patients (9 women) are summarised in Table 1. The majority had rheumatic heart disease (9 patients; 53%). Chronic atrial fibrillation was present in 8 patients (47%). Mean age at the time of PVT was 55 ± 15 years (range 24–77 years). PVT occurred an average of 8.4 ± 7.2 years (range: 0.1–25) after the last mechanical valve replacement. The mitral valve was most frequently involved (12 patients; 71%), followed by the aortic (4 patients; 24%) and the tricuspid valve (one patient; 6%). There were 13 bileaflet valves (Carbo-Medics in 12 patients and St. Jude Medical in one patient; 76%) and 4 disc prostheses (Björk-Shiley; 24%). PVT always involved only one heart valve even in the 2 patients with prior double valve replacement.

PVT was associated with inadequate oral anticoagulation in 11 patients (65%) and possibly related to endomyocardial fibrosis in 2 patients (12%). One patient (#17) with an aortic Björk-Shiley prosthesis had had no oral anticoagulation for 19 years! In 5 patients oral anticoagulation had been interrupted for non-cardiac surgery or because of gastrointestinal bleeding. In one patient (#10) oral anticoagulation had been replaced by unfractionated heparin (2 × 12500 U s.c.) during pregnancy, symptomatic thrombosis of the mitral valve subsequently occurred in the 11th week of gestation. In 4 patients (24%) with mitral mechanical prostheses the reason for PVT was unknown since long-term oral anticoagulation was adequate as assessed by repeated INR determination. No patient with a prosthesis in the aortic position and adequate anticoagulation had PVT.
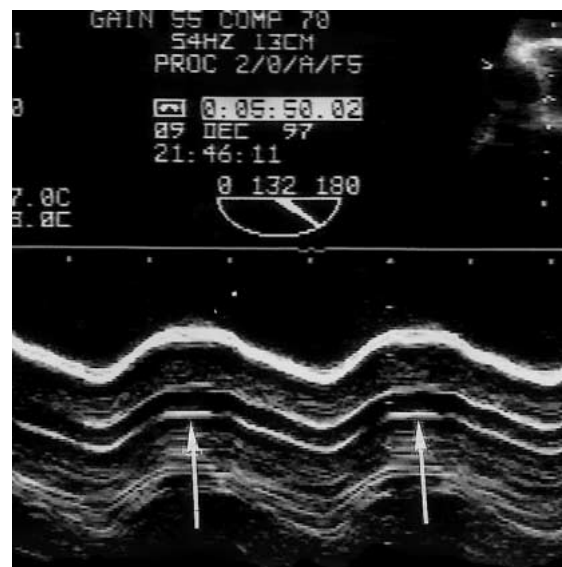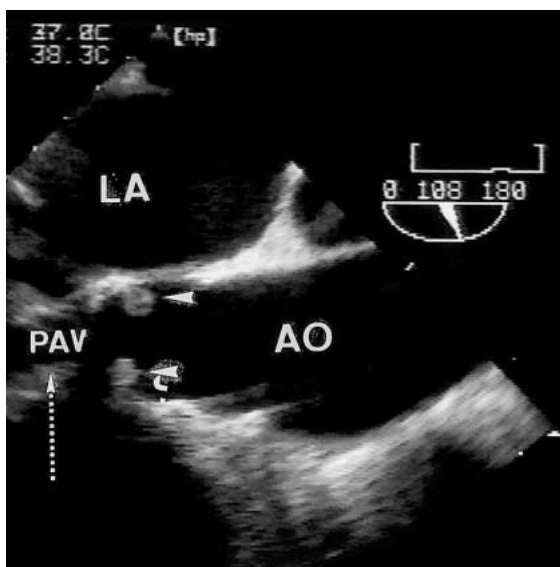
Table 1

Preoperative patient characteristics of the 17 patients with mechanical valve thrombosis.
PVT = mechanical valve thrombosis;
VR = date of last valve replacement;
BL = bileaflet prosthesis;
TD = tilting disc prosthesis;
NYHA = New York Heart Association;
AC = anticoagulation;
EMF = endomyocardial fibroelastosis;
yrs = years;
NA = not available.

Gender, age	type of valve	valve disease	interval VR/PVT	NYHA class	emboli	aetiology PVT
#1, F, 27 yrs	tricuspid BL	Ebstein	1.5 months	II	no	insufficient AC
#2, F, 77 yrs	aortic TD	degenerative	5 yrs	IV	yes	insufficient AC (melaena)
#3, M, 49 yrs	mitral TD	rheumatic	24 yrs	IV	no	insufficient AC (dentist)
#4, F, 51 yrs	mitral TD	rheumatic	17 yrs	IV	no	unknown
#5, M, 56 yrs	mitral BL	rheumatic	5 yrs	IV	no	unknown
#6, F, 52 yrs	aortic BL	congenital	22 yrs	IV	yes	insufficient AC
#7, F, 48 yrs	mitral TD	EMF	25 yrs	IV	no	insufficient (EMF?)
#8, M, 71 yrs	mitral BL	ischaemic	2 yrs	IV	no	insufficient AC
#9, M, 57 yrs	mitral BL	rheumatic	7 yrs	IV	no	insufficient AC (surgery)
#10, F, 24 yrs	mitral BL	rheumatic	23 yrs	IV	yes	insufficient AC (pregnancy)
#11, F, 67 yrs	aortic BL	congenital	16 yrs	IV	yes	insufficient AC
#12, F, 55 yrs	mitral BL	rheumatic	8 yrs	IV	no	unknown
#13, F, 67 yrs	mitral BL	EMF	3 yrs	IV	no	unknown (EMF?)
#14, M, 53 yrs	mitral BL	rheumatic	9 yrs	II	yes	insufficient AC
#15, M, 28 yrs	mitral BL	rheumatic	2 yrs	III	no	unknown
#16, M, 77 yrs	mitral BL	CAD	1 month	NA	yes	insufficient AC (surgery)
#17, M, 48 yrs	aortic TD	rheumatic	22 yrs	IV	no	no oral AC for 19 yrs

Figure 1

a. Transoesophageal echocardiography (longitudinal view), patient #2 after bileaflet aortic valve replacement. 3 thrombi are visible: 2 above (arrow) und 1 beneath the prosthetic aortic valve (dashed arrow).
b. M-mode echocardiography through the aortic prosthesis shows no closure of the aortic valve (arrow) which is stuck due to the thrombi, resulting in severe aortic regurgitation.
LA = left atrium
PAV = prosthetic aortic valve
AO = aorta

Disappearance of prosthetic valve clicks and/or a change in heart murmurs was noticed in 5 patients (29%) and 10 patients (59%) respectively.

All patients were symptomatic. Emboli occurred prior to treatment in 6 patients (35%). In patient #2 embolic occlusion of the right popliteal artery was present, requiring embolectomy prior to treatment for PVT. Three days after embolectomy thrombolysis with urokinase was begun, but the patient died within three hours due to heart failure in the presence of severe aortic regurgitation. Bleeding was ruled out by autopsy. In patient #6 the presenting symptoms were recurrent cerebral emboli followed by pulmonary oedema. Computer tomography of the brain showed multiple ischaemic lesions. In patient #10 an embolic occlusion of a small artery of the lower leg was found which did not require embolectomy. In patients #11, 14 and 16 cerebral emboli led to the diagnosis and in patient #16 ultimately proved fatal.

Echocardiographic findings

The echocardiographic findings are summarised in Table 2. The thrombi varied in size from a few millimetres up to 1.8×4.5 cm; in 4 patients the size of thrombi could not be measured. In 12 of 13 patients the thrombi were >0.5 cm. The largest thrombus was found in a patient with a thrombosed mechanical mitral valve and subsequent pulmonary oedema (#9, Figure 1). In 15 of the 17 patients the transvalvular prosthetic gradient was increased. The thrombi commonly caused stenosis of the mechanical prosthesis, significant regurgitation being found in only one patient (#2) with an aortic Carbomedics prosthesis which was stuck in the open position (see Figure 2). Typically the thrombotic material was attached to both the leaflets and the ring, causing diminished leaflet motion.

Table 2

Echocardiographic findings. CM = CarboMedics; BS = Björk-Shiley; bpm = heart rate in beats per minute; TR = tricuspid regurgitation; AR = aortic regurgitation; MR = mitral regurgitation; PHT = pulmonary hypertension.

Patient	type of valve	mean gradient, mm Hg (heart rate in bpm)	thrombotic material (maximum size of thrombi)	other findings
#1	tricuspid CM 31	12 (92)	not measurable	diminished leaflet motion, trivial TR
#2	aortic CM 23	30 (100)	3 thrombi (0.8×0.6 cm)	diminished leaflet motion, severe AR, severe MR, PHT
#3	mitral BS 23	21 (80)	1 thrombus (3×1.9 cm)	normal aortic BS 23, PHT, no MR
#4	mitral BS 29	12 (60)	1 thrombus (1.5×1.5 cm)	normal aortic BS 25, mild MR
#5	mitral CM 31	25 (75)	1 thrombus (3×2.6 cm)	severe PHT, no MR, diminished leaflet motion
#6	aortic CM 23	51 (76)	not measurable	diminished leaflet opening, mild AR
#7	mitral BS 31	20 (97)	>3 thrombi (2.2×0.8 cm)	severe PHT, mild MR
#8	mitral CM 27	28 (60)	1 thrombus (2.5×1.8 cm)	severe PHT, diminished leaflet motion
#9	mitral CM 31	15 (100)	>3 thrombi (4.5×1.8 cm)	PHT, trivial MR
#10	mitral CM 27	20 (130)	>3 thrombi (2.1×1.1 cm)	PHT, mild MR
#11	aortic SJ 23	29 (76)	1 thrombus (1×1 cm)	mild AR, mild MR
#12	mitral CM 29	9 (64)	not measurable	diminished leaflet motion, PHT, no MR
#13	mitral CM 29	30 (98)	not measurable	diminished leaflet motion, PHT, severe MR
#14	mitral CM 31	14 (67)	2.0×2.5 cm	severe PHT, mild MR, normal bileaflet aortic valve
#15	mitral CM 31	11 (76)	1 thrombus (2.0×2.0 cm)	mild MR, diminished leaflet motion, normal bileaflet aortic valve
#16	mitral CM 29	NA	2 thrombi (1×0.5 cm)	trivial MR
#17	aortic BS 29	6 (92)	>3 small thrombi	PHT, mild MR

Left atrial size was increased in 15 patients (88%), with a giant left atrium (end-systolic diameter ≥6.0 cm) in 8 (47%). Left ventricular function was reduced in 4 patients (24%).

Treatment

Treatment-related data are summarised in Table 3. Thrombolysis was chosen as the initial therapy in 3 patients. In patient #1, with Ebstein anomaly and prior tricuspid valve replacement, the risk of redo surgery was considered higher than that of thrombolysis of this thrombosed right-sided valve. Thrombolysis (urokinase for 40 hours) and follow-up were uneventful.

Patient #2 was in low cardiac output due to severe aortic regurgitation. The surgical risk was considered too high and she died in heart failure only 3 hours after urokinase was started. Autopsy disclosed that thrombolysis had already been successful since only small thrombi were left on the valve. Patient #3 had pulmonary oedema at the initial presentation and with urokinase the haemodynamics improved dramatically within 2 days. In view of major embolism to the leg and residual thrombi on the prosthetic valve, the patient then underwent mitral valve replacement. Postoperative follow-up was uneventful.

In 12 patients surgery was chosen as the initial procedure: thrombectomy alone was performed in 2 patients and in combination with prosthesis replacement in 10.

Both patients (#9 and #10) undergoing thrombectomy had a "cauliflower-like" extension of thrombotic material on both sides of the prosthetic Carbo-Medics valve. Thrombectomy was chosen in patient #10 who was in the 11th week of pregnancy. The foetus died on day one postoperatively, otherwise the patient's postoperative course was uneventful. Thrombectomy was also feasible in patient #9.

Patient #7 (underlying endomyocardial fibrosis) was operated on (redo mitral valve replacement) at age 48 years due to PVT on a mitral Björk-Shiley 31 mm prosthesis. Postoperatively she developed an embolic anterior myocardial infarction despite a normal preoperative coronary angiogram. Recovery was uneventful.

Death occurred in 3 of 13 patients within 30 days of surgery (Table 3). Patient #5 died of pulmonary emboli and mediastinitis on postoperative day 13. He had pre-existent hemiplegia due to prior cerebrovascular accidents. In patient #8 central nervous system embolisation occurred the day after mitral valve replacement and he died on the fifth postoperative day. Patient #13 (underlying endomyocardial fibrosis) died of septicaemia on postoperative day 21.

Two patients underwent neither surgery nor thrombolysis. One patient (#16) died from massive embolic cerebrovascular accidents prior to any intervention. In one patient (#17) with nonobstructive PVT, reinstitution of oral anticoagulation was sufficient to resolve the thrombi.

Follow-up

Postoperative long-term follow-up was obtained in all 12 surviving patients after 28 ± 28 months postoperatively. No patient developed recurrent PVT or recurrent embolic events. Only one patient (#14) developed severe paravalvular regurgitation after redo mitral valve surgery and will eventually need reoperation.

Table 3

Treatment and outcome in patients with prosthetic valve thrombosis.
CM = CarboMedics;
mU = million units;
UK = urokinase;
MVR = repeat mitral valve replacement;
AVR = repeat aortic valve replacement.

Patient	treatment	other findings, complications and follow-up
#1	thrombolysis (4.1 mU UK)	no complications, follow-up: good
#2	thrombolysis (1 mU UK)	sudden cardiac death after 3 hours UK due to heart failure.
#3	thrombolysis (4.5 mU UK) + surgery	emboli in leg arteries with UK. Embolectomy, MVR (thrombus), follow-up: good
#4	surgery (MVR)	thrombus, uneventful recovery, follow-up: good
#5	surgery (MVR)	thrombus, death after 13 days, embolic cerebral infarction and pulmonary emboli
#6	surgery (AVR)	thrombus, uneventful recovery, follow-up: good
#7	surgery (MVR)	thrombus, embolic anterior myocardial infarction, later uneventful recovery, follow-up: good
#8	surgery (MVR)	thrombus + pannus, embolic cerebral infarction day 1 and death postoperative day 5
#9	surgery (thrombectomy)	thrombus, uneventful recovery, follow-up: good
#10	surgery (thrombectomy)	thrombus, 1 day after surgery death of foetus, otherwise uneventful recovery, follow-up: good
#11	surgery (AVR)	thrombus, prolonged recovery due to hemiplegia (preoperative cerebrovascular accident)
#12	surgery (MVR)	thrombus + pannus, uneventful recovery, follow-up: good
#13	surgery (MVR)	thrombus + pannus, death due to septicaemia postoperative day 21
#14	surgery (MVR)	thrombus + pannus, uneventful recovery, follow-up: severe paravalvular regurgitation
#15	surgery (MVR)	thrombus + pannus, uneventful recovery, follow-up: good
#16	no therapy possible	death due to embolic cerebral infarctions, embolic infarction kidney
#17	reinstitution anticoagulation	uneventful recovery, follow-up: good

Discussion

Prosthetic valve thrombosis has been defined as "any obstruction of a prosthesis by non-infective thrombotic material" [12]. Despite innovations in valve design and use of pyrolytic carbon or other material to coat valve surfaces, the reported incidence of thrombosis of prosthetic heart valves still ranges from 0.03 to 4.3% per year [2].

Aetiology of PVT

The aetiology of PVT may be no, or insufficient, oral anticoagulation (INR <2.5) or extreme fluctuations of the INR values within the therapeutic range [11, 13]. In 65% of our patients insufficient anticoagulation was the main cause of PVT, due in particular to surgical procedures, pregnancy, or non-compliance with therapy. This underscores the high risk of PVT if oral anticoagulation is intermittently omitted despite heparin substitution.

Occasionally, however, PVT may occur despite adequate oral anticoagulation [13]. It has been reported that concomitant aspirin therapy (81 mg daily) in patients with prosthetic valves significantly reduces mortality and major systemic embolism [14]. In Switzerland the combination of aspirin and oral anticoagulation is not commonly used, and thus none of our patients had concomitant aspirin therapy. This may have slightly increased the risk of PVT.

A high percentage of our patients had atrial fibrillation or giant left atria. However, left atrial size, left ventricular function or the presence of atrial fibrillation have not so far been identified as risk factors for mechanical valve thrombosis [15, 16].
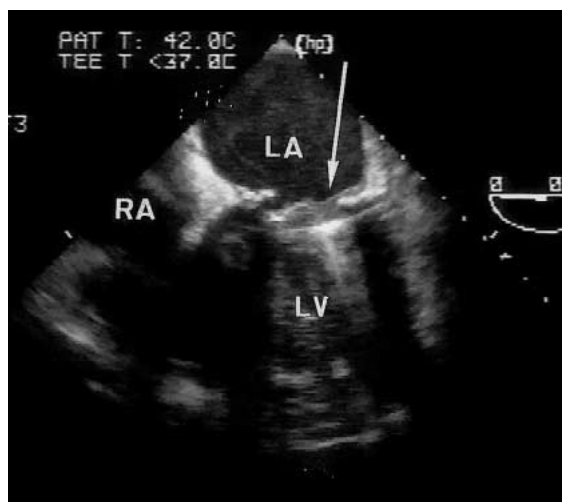
Two of these patients had endomyocardial fibrosis, which may have been conducive to thrombus formation due to recurrent tissue growth. So far increased thrombogeneity of prosthetic valves in endomyocardial fibrosis has not been described in the literature.

Symptoms and diagnosis

As PVT is relatively rare, the clinical diagnosis may be missed. Early diagnosis of PVT is essential, since in the past – prior to widespread use of high-tech echocardiography – almost 50% of obstructed valves were diagnosed only at autopsy [15]. Although small, non-obstructive thrombi are found postoperatively in 20% of patients after mitral valve replacement, late PVT rarely occurs and is an incidental finding in only 4.1% of patients with prosthetic valves [16]. Any new or worsening symptom or an embolic event in a patient with a prosthetic valve should prompt thorough investigation to rule out valve obstruction [17, 18].
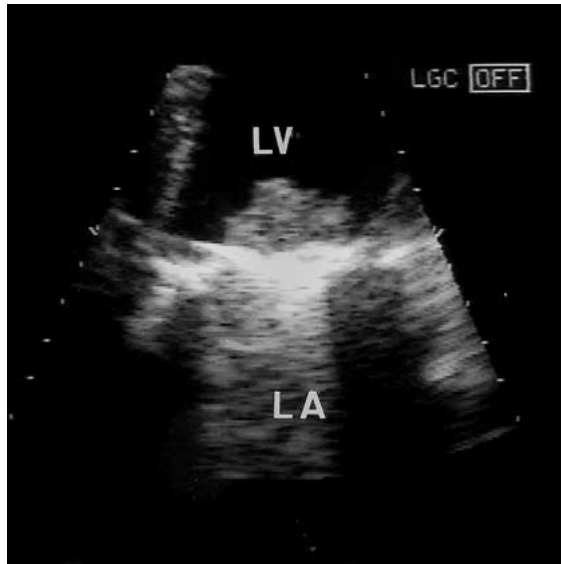
Figure 2

Transoesophageal echocardiography in patient #8 shows tissue covering the bileaflet mitral valve, with one leaflet completely immobilised and one partially. Intraoperatively, pannus and thrombus completely covering the prosthetic mitral valve and extending far into the left ventricle were found.
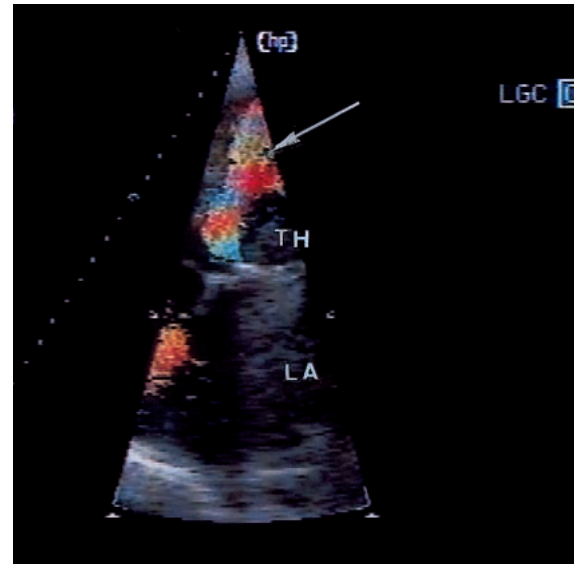LA = left atrium;
LV = left ventricle;
RA = right atrium.

a

b

Auscultatory findings may be abnormal in up to 21.4% of patients with PVT [4]. A prosthetic opening sound is not consistently detected in normal aortic valve prostheses (in only 15%), but a closing sound should uniformly be present and was absent in 29% of our patients [19, 20].

Cinefluoroscopy remains a useful procedure for initial rapid screening for reduced disc/leaflet motion, but is limited to radio-opaque disc or bileaflet valves [21]. However, cinefluoroscopy does not provide a means of assessing the underlying aetiology of valve obstruction.

Echocardiography is currently the non-invasive method of choice for evaluation of prosthetic valve function. However, due to attenuation and acoustic shadowing by the mechanical prosthesis, the sensitivity of transthoracic echocardiography may be as low as 0% for detection of nonobstructive thrombosis [18]. Transoesophageal echocardiography is therefore often needed to confirm PVT and abnormal prosthetic leaflet or disc motion [15, 16]. Signs of thrombosis are an increase in the transprosthetic pressure gradient to $>2\times$ normal values, due to obstruction, or an increase in transvalvular regurgitation [13]. In our patients valve obstruction without severe regurgitation was the leading haemodynamic finding in Doppler echocardiography. Only one patient had severe regurgitation due to PVT.

Distinguishing thrombus from pannus on obstructed prosthetic valves is essential, since pannus formation is an indication for immediate surgery without prior thrombolytic therapy. Pannus formation is the result of an inflammatory reaction to a foreign body, as is confirmed by the histological features of pannus, involving giant cells, fibroblastic proliferation, and neoformed vessels [20]. In a large series analysing surgery for PVT, pannus formation coexisted in 23/106 procedures (22%) [2]. Five (29%) of our patients who were operated on had thrombi combined with pannus formation. According to the literature, the best discriminators between thrombus and pannus are duration of symptoms (shorter duration typical of thrombi), anticoagulation status and ultrasound intensity of the mass [16]. Extension of the thrombus into the left atrium has been considered specific for thrombus formation [16]. However, in one patient (#14) pannus extended into the left atrium just above the mitral valve (Figure 2). In echocardiography sensitivity for pannus formation in our series was 80% and specificity 92%.

Surgery

The recommended treatment options include redo surgery, thrombolysis or continuation of anticoagulation therapy. Mortality rates after surgery depend on the clinical and functional class of the patient [4, 24]. Patients in functional classes I to III have operative mortality of 4.7%, a rate similar to that of primary valve replacement [4]. Early surgical mortality for prosthesis declotting and excision of pannus is reported to be comparable with that for normal valve prosthesis replacement [4]. In patients who are critically ill the mortality for emergency operation is 35–55% [4, 24]. We usually choose surgery in PVT involving large mobile thrombi or underlying pannus on the prosthetic valve, if the patient is operable [21]. Therefore, most of the patients (13 of 17 patients, 76%) underwent emergency surgery. They constituted a high risk group with 10 of 13 patients (77%) in NYHA class IV preoperatively. Perioperative mortality was 23%, which is comparable to the literature [4, 24]. Causes of death in our patients were cerebral emboli, pulmonary emboli or septicaemia (one patient each). Intra- or early postoperative embolic events occurred in 3 of 13 patients (23%). Among all 10 surviving patients there was no death in the long-term follow-up after 28 ± 28 months.

Neither of the 2 patients who underwent thrombectomy had a recurrent embolic event. While some authors have suggested that the rate of rethrombosis after declotting is higher than

after valve replacement, a large series of 100 patients undergoing surgery for PVT showed no difference in recurrent thrombosis between valve replacement and mechanical debridement [4]. Accordingly, the decision to replace or debride should be left to the surgeon.

Thrombolysis

Thrombolysis has been described as an alternative treatment modality. However, it harbours not only the risk of embolism but also the probability of incomplete success (pannus formation, vegetations). Heparin, streptokinase, urokinase and recombinant tissue plasminogen activator rtPA have been used [7, 25].

Heparin for nonobstructive PVT is successful only in some 50% of patients with small thrombi in functional class I or II [26]. It was used successfully in one patient in our series (#17) who had non-obstructive PVT with tiny thrombi.

Thrombolysis is usually superior to heparin. Success rates of thrombolytic therapy for PVT have been estimated at 62–82% [21, 25]. Complications occur in 30–35% [13] and include systemic embolisation (in 12–25%), bleeding and allergic reactions [21, 27]. Although major risk of permanent neurological or circulatory deficits is rare, some authors have reported an incidence as high as 6% for major cerebral embolism [20, 28]. One (#3) of our three patients (33%) undergoing urokinase thrombolysis had a major embolic event. The decision to proceed with thrombolytic therapy has therefore to be taken with care.

Most cases described in the literature involve the use of streptokinase [29]. In patients with a history of rheumatic heart disease the risk of an allergic reaction to streptokinase must be taken into account. For this reason we usually use urokinase. There is no statistically significant difference in outcome between urokinase and streptokinase. The usual urokinase doses are 4500 U UK/kg/h for 12–48 hours [21, 29].

Rt-PA may be an alternative [7]. Marked haemodynamic improvement can be seen within one hour after administration of rt-PA [30], which appears to make it ideal for haemodynamically unstable patients – if only as preparation for surgery. However, rt-PA is costly and may actually increase the risk of embolism and bleeding [21]. On the other hand, most centres nowadays are so familiar with the use of rt-PA that it may still be safer.

The length of thrombolytic therapy must be individualised and guided by assessment of valve gradients by repeat Doppler echocardiography. Lysis is usually stopped after 72 hours or as little as 24 hours if there is no haemodynamic improvement [21]. Thrombolysis lasting >48–72 hours does not appear to increase the success rate [27] and may delay emergency surgery.

Absolute contraindications to thrombolysis include active internal bleeding, history of haemorrhagic stroke, recent cranial trauma or neoplasm, blood pressure >200/120 mm Hg and diabetic haemorrhagic retinopathy [21].

Thrombolytic therapy should be reserved for patients with PVT and NYHA class IV, a low-output state or any patient in whom the operation carries an unacceptable risk, or for small thrombi of <5 mm size [8, 9]. In 12 of 13 of our patients with measurable thrombus size it was considerably larger than 5 mm. Thus, in our experience obstructive PVT is most commonly associated with large thrombi where surgery may be preferable to thrombolysis.

After successful thrombolytic treatment, anticoagulation should be targeted to an INR of 2.5–3.5 and 100 mg additional aspirin is recommended [14, 21].

Long-term follow-up showed that PVT recurred in 22% of a series [27] but in none of our patients.

Conclusions

The most common aetiology of obstructive PVT is inadequate anticoagulation. PVT remains a serious complication with high morbidity and mortality, despite aggressive treatment with thrombolysis and/or surgery. Surgery is often required, in particular due to large thrombi and the frequent coexistence of pannus. After successful treatment of PVT, however, the long-term prognosis is excellent. Because of the high risk of thromboembolism during thrombolysis for left-sided PVT, its use is reserved for high risk surgical candidates.

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