# Surgical treatment of acutely thrombosed mechanical mitral valve prostheses

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**Abstract: Background:** Acute thrombosis of mitral valve prosthesis is a life threatening complication. Data on complications and outcome are limited. **Objective:** to evaluate surgical treatment of acute prosthetic mitral valve thrombosis regarding indications, contraindications, complications and outcome. **Patients and methods:** Between March 2011 and December 2013, thirty patients with acute thrombotic mitral valve prostheses were admitted to Al-Hussein University Hospital. All patients were subjected to complete history, examination and investigations. Exposure of the mitral valve was done via the standard left atriotomy in 12 patients (40%) and right atrial trans-septal approach in 18 patients (60%). **Results:** Thrombus was found in 5 patients (16.67%), pannus alone in 10 patients (33.34%), thrombus and pannus together were found in 15 patients (50%). A biological valve was implanted in 5 patients (17%) while in 25 patients a mechanical valve was implanted (83%). Tricuspid valve repair was done in 18 patients using De-Veg technique. **Conclusion:** Prosthetic valve thrombosis (PVT) is a potentially fatal complication of heart valve replacement. These acceptable results suggest that early surgical intervention might be a safe and effective treatment of choice in patients with PVT. Patients with mechanical valve prostheses should be informed adequately about the need for, and the importance of, an effective anticoagulation regimen.
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## 1. Introduction

Prosthetic valve thrombosis (PVT) is a rare, but one of the life-threatening, complication associated with high morbidity and mortality **(Bonou *et al.,* 2012)**. PVT has an estimated incidence of 0.1-5.7% a year in aortic and mitral position **(Lobo *et al.,* 2009; Casais and Rolandi, 2013)**.

PVT It is defined by any thrombus, in the absence of infection, attached to or near an operated valve, occluding part of the blood flow or interfering with valvular function. It is a dreaded complication of patients with mechanical heart valves, particularly those in the mitral position **(Ekim *et al.,* 2005)**.

The recent 2012 European Society of Cardiology and the European Association for Cardio-Thoracic Surgery guidelines gave a Class I recommendation for surgery in critically ill patients who have an obstructive thrombosed PHV; the level of Evidence was C **(Vahanian *et al.,* 2012)**.

There are 2 forms of therapy, thrombolytic therapy and surgical replacement of the thrombosed valve **(Huang *et al.,* 2013)**. The optimal treatment strategy in patients with PVT is controversial, with some authors advocating thrombolytic therapy, and others preferring surgical intervention **(Lafci *et al.,* 2006)**.

In this study we evaluate the results of surgical management of acutely thrombosed mitral valve prostheses.

## 2. Patients and methods

Between March 2011 and December 2013, thirty patients with acute thrombotic mitral valve prostheses were admitted to Al-Hussein University Hospital and treated surgically. They were 16 female and 14 male patients ranging in age from 22 to 52 years, with a mean age of 32.96±7.02 years. Any patients with large mobile thrombus i.e. >0.8 cm$^2$, or refusing thrombolytic therapy with no active peptic ulcer were included in this study. Patients with infective enodcarditis, those received thrombolytic therapy less than 24 hours, those not fit for surgery or refusing surgical re-intervention were excluded from this study.

### Preoperative

All patients were underwent history taking, general and local examination (muffled prosthetic valve sounds, new murmurs, signs of infective endocarditis) and investigated laboratory by (INR, aPTT, CBC, Blood culture, liver and kidney functions) Radiologically by (resting ECG, chest x ray, echocardiography, and Cinefluroscopy).

### Echocardiography:

Transthoracic echo: mean pressure gradient across the mitral valve prosthesis more than 15 mmHg was considered abnormally elevated. A thrombus area >0.8 cm by planimetry was considered as a contra-indication for thrombolytic therapy, mitral valve area, EF and chamber dimensions were measured.

**Transesophageal echocardiography (TEE):**

Particular attention was directed at defining prosthetic valve mobility, structure and presence of any mass on the valve and or adjacent cardiac chamber visualizing restriction of leaflet motion and to exclude mobile thrombi, whether thrombus is fresh or organized and to comment on the left atrial appendage.

**Cinefluroscopy:**

Was used for assessment restriction of leaflet motion and opening and closing angles.

**Operative**

Six units of blood (fresh blood whenever possible) and 4 units of fresh frozen plasma were prepared. All patients were operated on under general anesthesia and endotracheal intubation. Inotropic support and mechanical ventilation was used in some patients with unstable hemodynamic states and referred to the operating theatre.

Exposure of the femoral vessels and preparation for emergency femoral-femoral cardiopulmonary bypass was considered prior to resternotomy. Sternal wires were removed and an oscillating saw was used to divide the sternum with caution to the underlying structures. The left pleural space was entered inferiorly followed by careful dissection of the other mediastinal structures. The pericardial dissection plane was developed by starting at the cardiophrenic angle and advancing slowly cephalad and laterally on the surface of the right side of the heart. Cephalad dissection was started with freeing the innominate vein prior to spreading the retractor to avoid its injury. Further dissection was carried down to the SVC, being careful to note the location of the right phrenic nerve. An area of consistently dense adhesions is the right atrial appendage. Dissection was done without heparin. The right atrium was injured in 3 patients and repair was done with prolene 4/0. The right upper pulmonary vein was injured in one patient and repaired with 5/0 prolene suture.

**Cannulation and cardiopulmonary bypass**

After complete dissection and heparin infusion, arterial cannulation was done via ascending aorta. Double venous cannulation was done and a tape was inserted around both SVC and IVC in cases requiring tricuspid valve repair. Insertion of cardioplegia cannula in the ascending aorta. Cardiopulmonary bypass (CPB) was established and the patient temperature lowered to $30^{o}C$ in cases of cold cardioplegia. In warm cardioplegia patients, temperature remained $35^{o}C$. Warm blood cardioplegia was injected in the aortic root from the CPB using double lumen cannula. Vent line was

connected to the other limb of the double lumen cannula. First dose was injected with flow 300 ml/min, over 3 minutes containing 18-20 mEq/L potassium, then each dose was injected with a flow 200 ml/min, over 2 minutes containing 10 mEq/L potassium. Cold blood cardioplegia was injected directly in the aortic root with a concentration 4:1 crystalloid: blood using Saint Thomas solution via the aortic root. The initial dose was 15 ml/kg then half this dose every 30 minutes if needed. Local cooling with cold saline and ice slash on the epicardial surface.

Several incisions were employed to view the underlying mitral valve:

1. The standard left atriotomy begins with blunt dissection of the interatrial groove (Waterston's groove). The right superior pulmonary vein at its junction with the left atrium then was exposed and the left atrium was opened at the mid point between the right superior pulmonary vein and the interatrial groove. The incision was extended longitudinally both superiorly and inferiorly to give enough exposure to the mitral valve. This approach was used in 12 patients (40%).

2. The right atrial transeptal approach. After opening the right atrium, the interatrial septum was incised starting at the fossa ovales and moving vertically upward for a few centimeters. This technique has the advantage that it minimizes the amount of dissection required and decreases the number of suture lines. So it was used in cases of cardiomegaly. This approach was used in 18 patients (60%).

**Removal of old mitral prosthesis:**

Old prosthetic valve was catched from one of the old sutures in order to avoid catching the prosthesis itself. When no apparent old suture, a small snip was made very close the old sewing ring, then the sewing ring was catched and removed using a scissor. Excessive annular resection may lead to atrioventricular disruption. Evertedethibond 2-0 sutures were used to seat the new prosthesis. Before placing sutures through the prosthesis sewing ring the valve orientated in its intended position. Once in place, the mechanical valves can be rotated to optimise orientation using the manufacturer's purpose-made device.

A biological valve was used in 5 patients, all were females and willing to have children, 4 were pregnant. In the other 25 patients mechanical valves were implanted. In some patients, a big thrombus was attached to the ventricular surface of the old prosthetic mitral valve.

**Closure of the atrium**

Clsoure of the left atrium done by using prolene 3-0 and the deairing was done by filling the heart and manual inflation of the lungs via vent line at the aortic root in cases of warm cardioplegia or at the right upper pulmonary vien in cases of cold cardioplegia. Closure of the right atrium: repair of tricuspid valve in some cases was done on a beating heart after removal of the aortic cross clamp and the right atrium was closed using prolene 4-0 sutures.

Discontinuation of cardiopulmonary bypass, haemostasis and chest wall closure were done.

**Post-operative**

After the surgery the patient is taken to a post-operative intensive care unit for monitoring and assisted respiration for the first few hours or days after surgery. After a day, the patient should be able to sit up in bed. After two days, the patient may be taken out of the intensive care unit. Patients are usually discharged after about seven to ten days. If the mitral valve replacement is successful, patients can expect to return to their regular condition or even better. Patients who have biological valve are prescribed thrombolytic therapy for 6 weeks to 3 months postoperative, while patients with mechanical valves are prescribed thrombolytic therapy for the rest of their lives. Once the patient's wounds are healed they should have few restrictions from daily activities.

**3. Results**

Thirty patients underwent mitral valve re-replacement because of acute thrombotic mitral valve prostheses. Their age ranged from 22-52 years with a mean 32.96±7.02 years, 14 patients were males (46.67%), 16 were females (53.34%). Four of the females were pregnant. NYHA classification: 3 patients were in class I (10%), 12 patients in class II (40%), 10 patients in class III (33.34%) and 5 patients in class IV (16-67%). Metallic click was auscultated in 11 patients (36-57%), harsh diastolic murmur was heard in 4 patients (13-34%). Twenty five patients were in AF (83-34%) while 5 patients were in sinus rhythm (16.67%). By fluoroscopy, one leaflet was fined in 16 patients (53.34%) and both leaflets were fixed in 14 patients (46.67%). Tricuspid valve incompetence was found in 18 patients (60%). Mitral valve area ranged from 0.90-1.40 $cm^2$ with a mean 1.18±0.16 $cm^2$. Pulmonary artery pressure ranged from 28-50 mmHg with a mean 38.00±5.37 mmHg. Pressure gradient across mitral valve prostheses was ranged from 19.00-50.00 with a mean 29.96±4.65 mmHg (Table 1).

**Table 1: Preoperative characteristics of patients with prosthetic valve thrombosis.**

| Characteristics | Results no (%) |
|---|---|
| Number of patients | 30 |
| Age (years) (Mean±SD) | 32.96±7.02 |
| Gender (female/male) | 16/14 |
| Pregnancy | 4 |
| INR (Mean±SD) | 1.70±0.14 |
| Local examination | |
| • Metallic click | 11(36.67%) |
| • Harsh diastolic murmur | 4(13.34%) |
| • Atrial fibrillation | 25(83.0%) |
| • Sinus rhythm | 5(16.67%) |
| Average systolic pulmonary arterial pressure (mmHg) (Mean±SD) | 38.0±5.37 |
| Pressure gradient across mitral valve prosthesis (mmHg) (Mean±SD) | 29.96±4.65 |
| Tricuspid valve incompetence | 14 (46.67%) |
| Thrombosed prosthetic valves (Bileaflet/monoleaflet) | 14/16 |
| NYHA functional class | |
| • I | 3 (10.0%) |
| • II | 12 (40.0%) |
| • III | 10 (33.3%) |
| • IV | 5 (16.67%) |

Values in parentheses are percentages.

Range of duration of previous mitral replacement was 12-120 months with a mean 49-82   26 months. Bypass time ranged from 45-85 minutes with a mean 66.25±12.23 minutes. Clamp time ranged from 24-50 minutes, with mean 35.30   6.37 minutes. Intra operatively, thrombus alone was found in 5 patients (16.67%), pannus alone was found in 10 patients (33.34%) while thrombus and pannus together were found in 15 patients (50%).   Explanted valve type showed that in 10 patients sorine valve was explanted (33.34%), 11 Saint Jude (ST-J) valve (36.67) and 9 carbomedics valve (30%). A biological valve was implanted in 5 patients (17%) while in 25 patients a mechanical valve was implanted (83%), sorine valve in 13 patients (43-34%) ST-J in 10 patients (33-34%) and carbomedics in 7 patients (23-34%) (Table 2).

**Table 2: Operative data of patients with prosthetic valve thrombosis.**

| Characteristics | Results No (%) |
|---|---|
| Time from initial valve replacement (months) (M±SD) | 49.82±26 |
| Time from diagnosis to operation (days) (M±SD) | 7.05±2.33 |
| Nature of thrombosis | |
| •        Thrombus | 5 (16.67%) |
| •        Pannus | 10 (33.3%) |
| •        Thrombus + pannus | 15 (50.0%) |
| Total bypass time (min) (M±SD) | 66.25±12.23 |
| Clamp time (min) (M±SD) | 35.30±6.37 |
| Type of exposure of mitral valve | |
| •        Standard left atriotomy | 12 (40%) |
| •        Right atrial trans-septal | 18 (60%) |
| Explanted valve type | |
| •        Sorin valve | 10 (33.3%) |
| •        Saint Jude | 11 (36.67%) |
| •        Carbomedics | 9 (30.0%) |
| Type of valve implanted | |
| •        Mechanical valve | 25 (83.0%) |
| •        Biological valve | 5 (17.0%) |

Failure of weaning from cardiopulmonary bypass occurred in 2 patients (6-67%) due to low CO. Both were in NYHA class IV on admission. Cold antegrade blood cardioplegia was used in 16 patients (53.34) while warm antegrade blood cardioplegia was used in 14 patients (46.67%). Tricuspid valve repair was done in 18 patients (60%) using De-Vega technique. In warm cardioplegia patients versus cold: ICU stay was 53.53±13.74 vs 63.60±4.48 hours; hours ventilated: 8.85   0.89 vs 10.94±1.49, hospital stay was 9.46±3.20 vs 11.34±1.23 (Table 3).

**Table 3: Antegrade blood cardioplegia used in our patients**

| | Cold antegrade cardioplegia no=16 Mean±SD | Warm antegrade cardioplegia no=14 Mean±SD |
|---|---|---|
| ICU stay (hours) | 63.60±4.48 | 53.53±13.74 |
| Duration of ventilation (hours) | 10.94±1.49 | 8.85±0.89 |
| Hospital stay (days) | 11.34±1.23 | 9.46±3.20 |

**Complications:**

As regarding complications; 2 patients were re-opened because of bleeding (6.67%), 1 patient had acute renal failure and underwent renal hemodialysis (3.34%). From the 4 pregnant females, 2 had intrauterine fetal death, both of them were in the first trimester and underwent dilation and curettage (50%) while the other 2 patients had been discharged from hospital with a living fetus (Table 4).

**Table 4: Post-Operative complication.**

| Postoperative complication | no (%) |
|---|---|
| Reoperation for bleeding | 2 (6.67 %) |
| Renal failure (hemodialysis) | 1 (3.33 %) |
| Intrauterine fetal death (in 4 pregnant females) | 2 (6.67 %) |

## 4. Discussion

Thrombosis of a mechanical prosthesis in the mitral position is an emergency condition, which can be diagnosed by transthoracic echocardiography in combination with clinical information (mainly recent-onset symptoms and low INR). Transmitral flow can provide clear diagnostic data; in the form of an elevated mean pressure gradient combined with a high pressure half time **(Beldekos *et al.*, 2009).**

Reasons for the increased thrombogenicity of mechanical valves are the interaction of blood constituents such as platelet and blood cells first with injured endocardium immediately after the surgery, secondly with the surface of the mechanical valve that has thrombogenic properties leading to both platelet deposition and activation of factor XII, and thirdly with structural and metabolic changes due to irregular flow patterns arising around the prosthetic devices **(Bonou *et al.*, 2012)**

Pannus formation, defined as an excessive tissue fibrosis around a prosthetic valve, could be found in 25% of patients as early as the first postoperative month. The presence of pannus is correlated with a better prognosis and is a definite indication for prosthetic valve replacement. Mechanical valves, tilting disc valves, caged ball valves, mitral position and poor compliance with the anticoagulation treatment are the most frequently related risk factors for PVT **(Durrleman *et al.*, 2004).**

Optimal management of patients with prosthetic valve thrombosis remains controversial; even so, surgery is usually favored. Surgery is usually the favored treatment; however, reported a mortality rates are classically high depending on the clinical status. Nevertheless, recent advances in surgical techniques and intensive care unit management have improved the results of surgery **(Roudaut *et al.*, 2003).**

Our study contained 30 patients diagnosed as acute prosthetic mitral valve thrombosis who presented to the cardiothoracic surgery department at Al-Hussein University Hospital. The aim of the study was to report indications, success, complications and mortality of surgical treatment.

In our study, 30 patients were operated upon with success rate 93.33%, rate of re-opening 6.66%, 1 patient had acute renal failure (3.33%), over all complication rate was 9.74% and the mortality rate 6.67. The 2 mortality cases were in NYHA class IV.

Thrombus alone was found in 5 patients (16.67%), pannus alone was found in 10 patients (33.34%) while thrombus and pannus together were found in 15 patients (50%). These results were similar to findings of **Vitale and his colleagues (1997),** they evaluated whether patients had pannus and/or thrombus at echocardiography in 87 patients; 24% had thrombus only, 31% had pannus alone and 45% had both thrombus and pannus. Other ten studies were done regarding findings of thrombus and/or pannus at the time of surgery for a total of 518 patients **(Aoyagi *et al.*, 1996, Rizzoli *et al.*, 1999, Bollag *et al.*, 2001, Lengyel and Vandor, 2001, Durrleman *et al.*, 2004, Renzulli *et al.*, 2004, Ozkokeli *et al.*, 2005, Lafci *et al.*, 2006, Toker *et al.*, 2006, Keuleers *et al.*, 2011)**; 41% had thrombus only, 38% had pannus only, and 21% had both thrombus and pannus.

In a study done in **Switzerland in 2001,** 12 patients with prosthetic valve obstructions were treated surgically, 10 were in NYHA class IV, thrombus was found in 7 patients (58.33%) and thrombus and pannus were found in 5 patients (41.67%), complete recovery was obtained in 7 patients (58.33%), 3 patients died (25%), one from septicemia and two from cerebral infarction. In five patients (41.67%) oral anticoagulation had been interrupted for non cardiac surgery or because of gastrointestinal bleeding **(Bollag *et al.*, 2001).**

In a study done among 3 million populations in the southwestern part of France, 17.250 mechanical heart valves were inserted between 1978 and 2001, 136 prosthetic heart valve thrombosis episodes were treated with surgery. Surgery succeeded in 89% of patients. The earlymortality rate was 10.3%. Overall incidence of complications (hemorrhage, embolism, death) was 11.1% (*P*<0.01). It is recommended that surgery is the favored treatment of left sided prosthetic valves, particularly in cases of chronic obstruction or in cases of early postoperative obstruction **(Roudant *et al.*, 2003).**

In a study done by **Zeinab Ashour** on Egyptian patients and her colleagues, 10 patients were treated with thrombolytic therapy, 3 patients cured (30%), 3 patients died (30%), 4 patients needed surgery (40%). They concluded that thrombolytic therapy can be used as salvage therapy only and cannot be considered as an alternative to surgery in Egyptian patients. It may be because all patients in their study had obstructed tilting disc, where the design of this type of valves had lower rate of success and higher rate of peripheral immobilization with thrombolytic therapy because such valve needs a relatively large thrombus to cause significant obstruction **(Zeinab *et al.*, 2000).**

In our study we obtained high success rate in the surgical treatment of acute prosthetic valve thrombosis (93%). This result was in concordance with **Roudaut and colleagues (2003)** study, they found surgery to be successful in 89% of patients with PVT, and that the overall incidence of complications was low. Higher success rate most probably due to a high percentage of patients were in NYHA class II and IV (40% were in class II and 33.4% were in class III. Also pannus and thrombus together were found in a high percentage of patients (50%) and pannus alone was found in 33%.

**Conclusion**

Inadequate anticoagulant therapy is an important factor in the pathogenesis of thrombosis. The advent of new and more accurate diagnostic procedures allowed us to better select therapeutic options. Surgical replacement is the favored treatment of acute thrombosis of prosthetic mitral valve although this regimen remains a high risk option particularly in patients in functional class IV. The other option which is the thrombolytic therapy is indicated in those who could not tolerate cardiopulmonary bypass and those with severe hemodynamic compromise.

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