# Valve thrombectomy in Patients with Acute Prosthetic Valve Thrombosis; Long-term results

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## Abstract

**Background:** Prosthetic valve thrombosis (PVT) is one of the major causes of primary valve failure and is defined as any thrombus formation, near or attached to an implanted prosthetic valve, obstructing part of the blood flow or interfering with valvular leaflet motion. This report aims to present our clinical experience with the surgical prosthetic valve thrombectomy to address the morbidity and mortality of the procedure and late follow up. **Method & Materials:** Between February 2015 to February 2018, 32 consecutive patients with mechanical prosthesis thrombosis requiring surgical management and not suitable for thrombolysis or after failed thrombolysis, underwent surgical valve thrombectomy. Preoperative two-dimensional trans-thoracic and trans-esophageal echocardiography were performed in all patients to assess hemodynamic severity, thrombus size, and valve motion. Furthermore, fluoroscopy was performed to document abnormality in valve motion. Postoperatively, our primary endpoints were all-cause mortality and morbidity. **Results:** During three years 32 consecutive patients with a mean age of $55.07 \pm 12.81$ years (range, 35 to 82 years) underwent valve thrombectomy. The majority of patients were male (65.6%) and time to previous surgery was $7.9 \pm 5.4$ years. Valve thrombectomy was performed on mitral (23 pts), aortic (7 pts), tricuspid (1 pt), and both mitral/aortic valves (1 pt). Mean INR at hospital admission was $1.5 \pm 0.6$. The mean CPB and cross-clamp time were $76.0 \pm 34.4$ and $49.3 \pm 25.4$ minutes respectively. Mean ICU stay of patients was $2.4 \pm 0.9$ (range 2–6) and mean hospital stay of patients was $10.0 \pm 4.6$ (range 5–23). Early or late mortality and recurrence of valve thrombosis was nil. **Conclusion:** Although prosthetic valve thrombosis is a serious complication with high morbidity and mortality, prosthetic valve thrombectomy seems to be a safe, rapid, and simple procedure in the majority of patients with low morbidity and mortality.

**Keywords:** Prosthetic valve thrombosis, valve thrombectomy, redo valve surgery

## INTRODUCTION

Prosthetic valve thrombosis (PVT) is one of the major causes of primary valve failure and is defined as any thrombus formation, near or attached to an implanted prosthetic valve, obstructing part of the blood flow or interfering with valvular leaflet motion [1]. Prosthetic valve dysfunction leads to either valvular stenosis or insufficiency due to impaired leaflet motion and coaptation [2-4].

Although PVT is less frequently observed in new-generation prosthetic valves due to improvements in valve design and materials, the physical and hemodynamic properties of

mechanical valves remain thrombogenic [5, 6]. Thrombus formation can occur alone but it is often observed in association with fibrotic pannus ingrowth [2].

The incidence of PVT is reported to be 0.03% in biologic valves, 0.5%–8% in mechanical prosthetic valves in the aortic and mitral positions, and as high as 20% in mechanical valves in a tricuspid position [5, 7]. Moreover, the risk is higher in the

early perioperative period and association with subtherapeutic anticoagulation [8].

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There are various therapeutic strategies for PVT, including an increase in anticoagulation level, thrombolytic therapy [5, 9], and surgery [10], which are selected based on the presence of

valvular dysfunction, valve location, and patient's clinical condition. Hemodynamically stable patients can be treated with anticoagulation and thrombolytic therapy, while others may require surgical prosthesis thrombectomy or valve replacement [11]. Surgical intervention including valve thrombectomy or replacement has been the conventional option to manage prosthetic valve thrombosis, especially left-sided cardiac prostheses, but it is associated with reported mortality rates as high as 69%, depending on the patient's condition and cardiac functional class [12, 13].

Although it is believed that mechanical prosthesis replacement is the standard approach in the surgical management of valve thrombosis, thrombectomy could be an excellent approach when all parts of the thrombus are removed. With this strategy, thrombectomy seems to be easier, faster, with the advantages of shorter pump time and cross-clamping time.

This report aims to present our clinical experience with the surgical prosthetic valve thrombectomy to address the morbidity and mortality of the procedure and late follow up.

## PATIENTS AND METHODS

Between February 2015 to February 2018, 32 consecutive patients with mechanical prosthesis thrombosis requiring surgical management and not suitable for thrombolysis or after failed thrombolysis, underwent surgical valve thrombectomy.

The primary inclusion criteria for the patient selection were the diagnosis of symptomatic patients with a thrombosed prosthetic heart valve with NYHA class III to IV symptoms or presence of a mobile or large thrombus ($>0.8$ cm$^2$) on the left-sided valve. Failure of fibrinolytic therapy was another reasonable indication for surgical management.

Excluded patients from this series were; patients with evidence of prosthetic valve endocarditis diagnosed during operation or severe prosthetic ring dehiscence and paravalvular leakage needing valve replacement.

Patients presenting with symptoms of malfunctioning prosthetic valves were immediately treated with intravenous heparin, diuretic, inotropic support, and intra-aortic balloon pump depending on the patient's hemodynamic stability. Preoperative two-dimensional trans-thoracic and trans-esophageal echocardiography were performed in all patients to assess hemodynamic severity, thrombus size, and valve motion. Furthermore, fluoroscopy was performed to document abnormality in valve motion. Retrospective data were collected using standard data forms. Elicited information covered patients' demographics, risk factors, imaging, and operation data.

Postoperatively, our primary endpoint was all-cause mortality. Other outcome variables included low cardiac output state, reoperation for bleeding or tamponade, arrhythmia, blood transfusion, respiratory failure, TIA or stroke, intra-aortic balloon pump (IABP), post-op echocardiographic data, ICU and hospital length of stay, in-hospital death, early ($\leq$30 days) and late mortality and fallow up echocardiographic data.

All the data were collected retrospectively and the statistical software SPSS version 21 for Windows (SPSS Inc., Chicago, IL) was used for statistical analyses. All the data were expressed as mean ± standard deviation.

### Technique
A standardized anesthetic technique was used in all patients. After median redo sternotomy using an oscillatory saw and releasing adhesions in working space, cardiopulmonary bypass was initiated after administration of heparin at a dose of 300-400 IU/kg sufficient to rise the activated clotting time (ACT) to above 480 seconds before initiation of CPB. All patients were centrally cannulated in the standard protocol and CPB was established when the activated clotting time was appropriate with controlled blood flow at 30-50 ml/kg/min.

On the full cardiopulmonary bypass (CPB) and cardioplegic arrest, aorta or left atrium were opened from the previous incision. Gross thrombotic materials were removed using suction or grasper. A soft tip suction, right-angle hook, big sized surgical needle, and CO2 blower were used for cleaning the mechanical prosthesis from micro-thrombi and pannus material attached to the valve disks, subvalvular apparatus and in the rotation axe or hinge of the valve. Great care was taken not to damage the valve disks and struts. Gentle clockwise leaflet rotation within the sewing ring (in the rotatable prostheses) was done with the appropriate valve holder to cleanse all the valve quadrants and to facilitate complete visualization of the subvalvular aspect.

After complete cleansing of the prosthesis from thrombosis and pannus materials and confirming the free valve movement by the appropriate valve tester, aorta or left atrium were closed. Once re-warming to 37 C and de-airing were completed and CPB discontinued, protamine sulphate was administered to reverse systemic heparinization.

### RESULTS
The mean age of the patients was 55.07 ± 12.81 years (range, 35 to 82 years), and 21 patients (65.6%) were male. The mean interval between the previous valve replacement and the occurrence of prosthetic valve replacement was 7.9 ± 5.4 years (range, 1.2-10 years).

The median time between the presentation of symptoms and surgery was 20 hours (range, 10-96 hours). Preoperative patients' characteristics and risk factors are described in table

1. The mean INR level recorded at presentation was 1.5 ± 0.6 (range, 1-2.9) which was less than 2 in 25 patients (78%).

All patients with prosthetic valve thrombosis were in NYHA functional class III or IV at the time of presentation. Symptoms at presentation were dyspnea in 28 patients (87.5 %), thromboembolism (stroke, limb or organ ischemia) in 6 patients (18.8%), and chest pain in two patients (6.3%).

The re-operation for valve thrombosis was performed on mitral valve in 23 cases (71.9%), aortic valve in 7 patients (21.9%), concomitant aortic and mitral valve in one patient (3.1%) and tricuspid valve in one patient (3.1%). All of the mechanical valves were the third generation bileaflet prostheses. Preoperative and postoperative echocardiography data are summarized in tables 2,3.

Intra-aortic balloon pump (IABP) was used preoperatively in two patients for a low cardiac output state. Mean cardiopulmonary bypass time and cross-clamp time were 76.0 ± 34.4 and 49.3 ± 25.4 respectively. The mean number of packed cell transfusions during hospitalization was 2.2 ±0.8 units (range, 1 to 3 units).

The mean time to extubation was 6.9 ± 1.4 hours (range, 5–10 hours). New onset or exacerbation of cerebrovascular accidents did not occur in any patient. The average amount of mediastinal drainage in the first 24 hours of operation was 410.7±149.6 and reoperation due to mediastinal bleeding was performed in two patients.

The average ICU stay of the patients was 2.4 ± 0.9 days (range, 2 to 6), and 72% of the study population stayed for only 2 days. The mean hospital stay of the patients was 10.0 ± 4.6 days

(range, 5 to 23), and the median length of stay was 7 days.

In-hospital and 30-day mortality was zero. Patients were followed for 13-37 months and all remain long-term survivors without valvular reintervention. Echocardiography data during follow up are presented in table 4.

## Discussion

Prosthetic valve thrombosis (PVT) is described as any thrombus formation, around or attached to an implanted prosthetic valve, obstructing part of the blood flow or interfering with valvular leaflet movement [1, 12].

Despite significant improvement in design, materials, manufacturing, operation techniques, and the long-term outcome of prosthetic valves, PVT is still a major complication of prosthetic valve replacement with a high rate of mortality and morbidity [14].

Thrombus formation can occur alone but it is often observed in concert with fibrotic pannus ingrowth [2]. Healthy endothelium is the only surface that actively prevents thrombosis. Artificial surfaces such as prosthetic valve material promote clot formation via a complex series of processes including protein adsorption, platelet adhesion, bonding of leukocytes, and red blood cells; activation of thrombin and complements [2]. Furthermore, primary and secondary causes of hypercoagulability state are a less frequent mechanism of PVT. Hemodynamics of blood flow through the prosthetic valve, inadequate anticoagulation, and loss of effective atrial contraction should also be considered as possible etiologies [15].

An exaggerated biological reaction to the implanted prosthesis material with a non-immune

inflammatory mechanism is thought to induce fibroblast proliferation and extracellular

matrix deposition resulting in fibrinous ingrowth around the annulus of the prosthetic valve which leads to restricted leaflet movement and presents clinically with prosthetic valve dysfunction [16].

A combination of both elements of pannus formation and thrombus is detected in many patients with mechanical valve obstructions and is reported by many investigators. The prevalence of this combination has been reported to be in 12%-75% of all PVT [17]. Pannus is an underlying etiology that may serve as a nidus for clot formation. In contrast to pannus formation, thrombus occurs earlier in the post-op period of valve replacement and is usually to inadequate anticoagulation and may be resolved with anticoagulation therapy or thrombolysis [17]. The occurrence of prosthetic valves thrombosis is approximately twice as likely for in the tricuspid or mitral position as compared to the aortic position due to a slower pattern of blood flow [5].

Patients with prosthetic valve thrombosis and dysfunction usually present with progressive dyspnea, pulmonary edema, symptoms of heart failure, or systemic embolization. Transthoracic echocardiography (TTE) with color Doppler is the first-line imaging study for the diagnosis of PVT, regardless of the anatomic position of the mechanical prosthesis. Although it is useful for determining hemodynamic severity and impact on valve motion, the study is limited for diagnosis of the etiology of PV dysfunction, due to acoustic shadowing of the prosthesis [18]. Recent increases in trans-valvular gradients in comparison to previous studies are indicative of PV dysfunction. Transesophageal echocardiography (TEE) is another imaging option and is often necessary to provide more accurate visualization and to distinguish between different etiologies of PV dysfunction such as pannus, vegetations, and thrombus. Cine-fluoroscopy which was historically the original imaging tool in the diagnosis of PVT, may also be useful and enables

visualization of the radiopaque valve disks and allows assessment of valve function with a comparison of the closing and opening angles of valve disks to normal angles [17].

The decision for treatment strategy of PVT is based on the patient's symptoms, the position of the valve, thrombus size, and degree of flow obstruction and may include thrombolytic therapy or surgical management [17]. Due to the extremely high mortality of repeat valve surgery, generally non-surgical management is favored as an initial treatment.

Fibrinolytic therapy is less likely to be successful in patients with chronic thrombosis or pannus due to its highly fibrotic makeup that does not respond to thrombolytic therapy. The complications related to fibrinolytic therapy are not uncommon. Mortality rates have been reported 2.8–11.8% and incidence of stroke were 4.4–6.7% [19]. This treatment should be individualized for patients with a critically ill condition, tricuspid or pulmonary thrombosis, for patients with left-sided PVT with low thrombus burden (<0.8 cm$^2$), and patients with contraindications to surgical treatment.

Surgery is the first-line treatment in symptomatic patients with obstructive mechanical valve thrombosis, but the mortality rate of surgery may be as high as 69%, based on the patient's clinical condition [11]. For a patient candidate for surgery, controversy exists regarding the optimal strategy. Some surgeons replace the valve routinely but some believe it is enough to perform thrombectomy instead of mechanical valve replacement in patients with fresh thrombi due to the relatively shorter duration of surgery and lower risk of morbidity and mortality than valve replacement [14].

Some surgeons advise redo prosthetic valve replacement only in patients with extensive, circumferential pannus as the operative mortality of valve replacement was 10.8–15% and 20–40% in emergency surgeries and as high as 62.5% in early reports [14]. Valve thrombectomy may be sometimes difficult to perform owing to the adhesive character of the pannus or thrombus, which can involve any part of the mechanical prosthesis and the surrounding native tissues [20].

To our experience valve, thrombectomy is a fast, easy, and safe procedure with minimal morbidity and mortality. With gentle manipulation of the prosthesis during thrombectomy, the risk of prosthesis damage by surface trauma will be negligible and the risk of re-thrombosis is not increased.

Although the recurrence rate of re-thrombosis following valve thrombectomy and debridement due to damage of the disc surface has been reported to be higher than after prosthetic valve replacement, the difference in re-thrombosis between two groups was not statistically significant [21, 22].

In our reported series, the early and late mortality of patients undergone valve thrombectomy was nil. During late follow up the fate of valve thrombectomy was satisfactory which was documented by follow up echocardiography. Neither re-

thrombosis nor increasing in valve gradient occurred in any patients during follow up. We believe that valve thrombectomy would be possible in all cases not only in patients with fresh thrombi but also in patients with organized clots and extensive pannus formation. Reducing the pump and cross-clamp times using valve thrombectomy is associated with lower morbidity and mortality in comparison to valve replacement. Strict anticoagulant therapy after valve thrombectomy and maintaining a higher level of INR is another important point to diminish the risk of re-thrombosis.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

All authors have made a substantial contribution to the concept of this paper.

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**Table 1:** Pre-operative data and early outcomes variable

|  | Value (percentage) |
|---|---|
| Smoking | 2(6.2) |
| Addiction | 4(12.5) |
| Diabetes | 3(9.4) |
| Hypertension | 9(28.1) |
| Hyperlipidemia | 5(15.6) |
| Cerebrovascular accident | 4(12.5) |
| Ischemic heart disease | 0 |
| Mortality | 0 |
| Morbidity | 6 (18.8) |
| Re-exploration for bleeding | 2 (6.2) |
| Pneumonia | 2 (6.2) |
| Wound infection | 1(3.1) |
| Endocarditis | 0 |
| Renal failure | 1 (3.1) |

**Table 2:** Echocardiography data before and after prosthetic mitral valve thrombectomy

|  | Timing | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| EF(%) | Pre-op | 45.3 | 12.7 | 10 | 60 |
|  | Post-op | 46.3 | 9.7 | 25 | 65 |
| PAP(mmHg) | Pre-op | 59.2 | 17.2 | 30 | 82 |
|  | Post-op | 34.6 | 11.6 | 17 | 52 |
| Mitral- MPG(mmHg) | Pre-op | 13.6 | 7.9 | 5 | 30 |
|  | Post-op | 4.2 | 3.7 | 1 | 7 |

EF: ejection fraction; PAP: pulmonary artery pressure; MPG: mean pressure gradient

**Table 3:** Echocardiography data before and after prosthetic aortic valve thrombectomy

|  | Timing | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| EF(%) | Pre-op | 52.9 | 8.1 | 35 | 60 |
|  | Post-op | 57.1 | 2.7 | 55 | 60 |
| PAP(mmHg) | Pre-op | 30.8 | 8.6 | 20 | 45 |
|  | Post-op | 26 | 2.6 | 23 | 30 |
| Aortic- MPG(mmHg) | Pre-op | 34.4 | 13.9 | 26 | 66 |
|  | Post-op | 16.1 | 8.0 | 6 | 27 |

EF: ejection fraction; PAP: pulmonary artery pressure; MPG: mean pressure gradient

**Table 4:** Last follow up echocardiography data

|  | Valve | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| EF(%) | Aortic | 55.3 | 7.1 | 50 | 60 |
|  | Mitral | 47.5 | 9.5 | 30 | 65 |
| PAP(mmHg) | Aortic | 25.8 | 4.6 | 20 | 30 |
|  | Mitral | 36.5 | 12.3 | 20 | 55 |
| Mean Pressure Gradient(mmHg) | Aortic | 17.2 | 12.4 | 9 | 30 |
|  | Mitral | 3.9 | 3.1 | 2 | 6 |

EF: ejection fraction; PAP: pulmonary artery pressure