

Pharmacomechanical Thrombolysis versus Surgical Thrombectomy for the Treatment of Thrombosed Haemodialysis Grafts

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Abstract

Introduction: The key to treatment of a thrombosed dialysis graft is restoration and maintenance of function as long as possible. The objective of this study was to compare the outcomes of pharmacomechanical thrombolysis and surgical thrombectomy in the treatment of thrombosed haemodialysis grafts. **Materials and Methods:** During a 3-year period, 108 patients with 114 thrombosed dialysis grafts were referred to our institute for treatment. Fifty thrombosed dialysis grafts underwent pulse-spray catheter thrombolysis using recombinant tissue plasminogen activator (rt-PA) with angioplasty, and 64 thrombosed dialysis grafts underwent surgical thrombectomy. The procedural success rates, complications and average patency times and patency rates were compared between the 2 procedures. *P* values less than 0.05 were considered to be statistically significant. **Results:** There were no statistically significant differences between the pharmacomechanical thrombolysis group and the thrombectomy group in the procedural success rates (94% and 93.8%, *P* = 0.15) or average patency times (6.24 months and 6.30 months, *P* = 0.17). The primary and secondary patency rates at 12 months were 28.0% ± 8.4% and 54.3% ± 7.8% for the thrombolysis with angioplasty group, and 30.0% ± 6.3% and 57.0% ± 4.8% for the thrombectomy group, respectively (*P* = 0.65 and *P* = 0.49, respectively). There were no procedural-related major complications. **Conclusion:** Our study found no differences in outcomes between patients treated with pharmacomechanical thrombolysis and surgical thrombectomy for thrombosed haemodialysis grafts. Pharmacomechanical thrombolysis can be considered as an alternative treatment for dialysis graft thrombosis.

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Key words: Angioplasty, Arteriovenous graft, Thrombosis

Introduction

Permanent dialysis vascular access is the primary route for haemodialysis in patients with chronic renal failure, usually through an arteriovenous fistula (AVF) or an arteriovenous graft (AVG). The AVF has many advantages over synthetic grafts, including better patency, lower rates of infection and a lower incidence of vascular steal syndrome; however, the major problems are immaturity or a prolonged time for maturity. Although the patency rate of the AVG is lower than the AVF, it is still more widely used because it is easier to create and can be used earlier than AVF for haemodialysis. A thrombosed haemodialysis vascular access occurs frequently in a prosthetic graft. Salvage of a thrombosed haemodialysis graft is essential to maintain haemodialysis and prolong the

quality of life. The traditional treatment of graft thrombosis is surgical thrombectomy with 1-year patency rates varying from 25% to 70%.¹⁻⁴ Currently, 2 percutaneous endovascular techniques are widely used for the treatment of thrombosed AVG, mechanical thrombectomy and pharmacomechanical thrombolysis. Mechanical thrombectomy is a procedure that uses a device for thrombus removal, which is faster than the pharmaceutical method. However, the thrombectomy device is expensive, and the procedure is not available in all institutions. Pharmacomechanical thrombolysis is a method to treat thrombosed haemodialysis grafts using a thrombolytic drug and balloon catheter. This method is easier to perform, and any experienced interventional radiologist can perform it. Several studies have reported

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1-year patency rates of 57% to 69% with this method.⁵⁻⁹

Pharmacomechanical thrombolysis for the treatment of thrombosed haemodialysis graft has been performed in our institute since 2009. The purpose of this study was to report our experience with pharmacomechanical thrombolysis compared with surgical thrombectomy in thrombosed haemodialysis grafts.

Materials and Methods

Patients

This was a retrospective study of all patients with thrombosed haemodialysis grafts who underwent treatment by pharmacomechanical thrombolysis or surgical thrombectomy in our hospital during the 3-year period from January 2009 to December 2011. The data was retrieved from the Radiology Department records and general hospital databases. The decision to select patients for thrombolysis or thrombectomy depended on the judgment of the vascular surgeon. Patients who had much comorbidity or who were at a high-risk for anaesthesia or surgery, and had no contraindications for thrombolysis (contrast allergy, allergy to thrombolytic drug, graft infection, history of significant gastrointestinal haemorrhage or major surgery within the prior 3 months) were selected for thrombolytic therapy. Patients with any contraindications for thrombolysis as noted above were scheduled for surgical correction. In some cases, a further consideration was the availability of an operating room, which is usually tightly scheduled. Written informed consent for the procedure was obtained from all patients after a discussion of the advantages and risks of the procedure. The present study was approved by the Ethics Committee of our institute.

Salvage Procedure

Pharmacomechanical Thrombolysis

The procedure was performed under local anaesthesia. Salvage of the thrombosed graft was performed by the pulse-spray technique by injection of recombinant tissue plasminogen activator (rt-PA) via the multi-sidehole infusion

catheter. A total dose of 10 mg of rt-PA was administered using 4 mg of loading dose via infusion catheter and forceful injections of 0.5 mg of rt-PA via infusion catheter every 30 seconds. Balloon angioplasty was performed to macerate the residual clots and treat all underlying stenoses. A final angiogram was done to assess the patency graft, arterial and venous anastomoses, venous outflow and central vein (Fig. 1).

Surgical Thrombectomy

The procedure was performed under general or regional (brachial blocking) anaesthesia. An incision was done at the venous limb of the graft and thrombectomy was performed by advancing a Fogarty thrombectomy catheter through the graft into the native venous outflow as far centrally as possible. Rigid dilators were used to dilate the venous anastomosis. A similar thrombectomy technique was directly performed on the arterial limb for the removal of the intragraft thrombus. Graft revision with patchplasty or graft interposition was performed in some patients.

Follow-up

All patients had regular haemodialysis after either the thrombolysis or thrombectomy procedures, and all were followed up at the haemodialysis centre and vascular surgery clinic. Cases of apparent graft dysfunction or failure were confirmed by a nephrologist or vascular surgeon before reoperation.

Definitions

Following the standard practice guideline published by the Society of Interventional Radiology (SIR),¹⁰ procedural success in the study was defined as restoration of flow in the dialysis graft and a palpable thrill. Additionally, less than a 30% residual diameter stenosis was a criterion included for technical success in the thrombolysis group. Primary patency was defined as the time interval after the procedure until the next access thrombosis or first subsequent intervention. Secondary patency was defined as the time

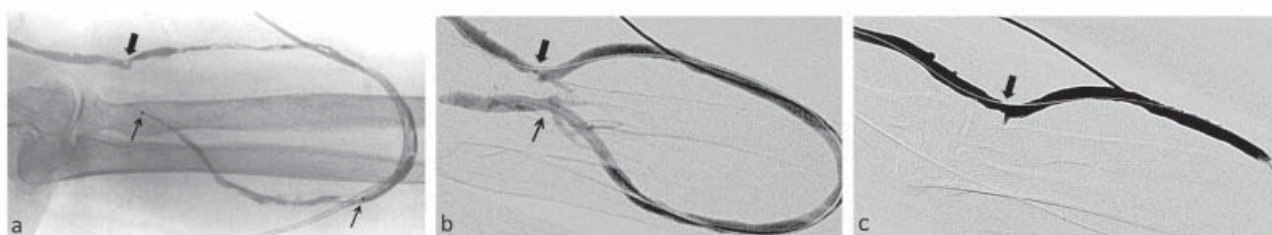


Fig 1. A 45-year-old male with a thrombosed forearm U-shaped arteriovenous graft; (a) angiogram showing intraluminal thrombus filled in entirely with intragraft and venous anastomotic stenosis (thickened arrow). Note proximal and distal markers (thin arrows) of a multi-sidehole catheter that was placed from the venous limb of the graft; (b) angiogram after thrombolysis with angioplasty showing patent arterial anastomosis (thin arrow) and intragraft with residual stenosis at the venous anastomosis (thickened arrow); (c) final angiogram after re-angioplasty showing less than 30% of residual stenosis (thickened arrow).

interval after intervention until the access was surgically declotted, revised, or abandoned. Major complications were defined as complications that required additional treatment, or resulted in permanent sequelae or death. Minor complications were defined as problems requiring no or nominal therapy with no sequelae.

Statistical Analysis

We compared patient data, graft characteristics and outcomes of the procedures between the 2 groups. All continuous data were presented as mean $\pm$ standard deviation using Student's *t*-test. Categorical data were evaluated by chi-square test. Patency rates between the 2 groups were analysed by the Kaplan-Meier test. *P* values less than 0.05 were considered to be statistically significant.

Results

A total of 108 patients with 114 thrombosed dialysis grafts were enrolled. Forty-eight patients with 50 thrombosed dialysis grafts underwent thrombolysis with balloon angioplasty and 60 patients with 64 thrombosed dialysis grafts underwent surgical thrombectomy. The mean ages of patients in the thrombolytic and thrombectomy groups were 55 ± 10 years (range, 40 to 70 years) and 57 ± 9.5 years (range, 42 to 72 years), respectively. Two patients in the thrombolytic group had 2 episodes of thrombosed graft. One and 2 patients in the thrombectomy group had 3 and 2 episodes of thrombosed graft, respectively. A forearm U-shaped graft was the most common thrombosed graft in both groups. The average time from graft thrombosis until treatment was 20 ± 15 hours in the thrombolysis group and 32 ± 12 hours in the thrombectomy group. Summaries of the patient data and graft characteristics in each group are shown in Table 1. There were no statistically significant differences between the thrombolysis and thrombectomy techniques in the procedural success rates (94% and 93.8 %,

$P = 0.15$). The mean procedural times of the thrombolysis and thrombectomy techniques were 2.0 ± 1.5 hours and 2.1 ± 1.3 hours ($P = 0.20$). The average patency times of the thrombolysis and thrombectomy groups were 6.24 months and 6.30 months ($P = 0.17$). The primary patency rates at 12 months were $28.0\% \pm 8.4\%$ for the thrombolysis group and $30.0\% \pm 6.3\%$ for the thrombectomy group ($P = 0.65$) (Fig. 2). The secondary patency rates at 12 months were $54.3\% \pm 7.8\%$ for the thrombolysis group and $57.0\% \pm 4.8\%$ for the thrombectomy group ($P = 0.49$) (Fig. 3). A small amount of perigraft haematoma was found in both groups, 30% for the thrombolysis group and 40% for the thrombectomy group ($P = 0.48$). There were no procedure-related major complications in either group.

Discussion

Since the first described use of thrombolytic drugs for the treatment of thrombosed prosthetic graft by Zeit and Cope¹¹ in 1985, this technique has been accepted worldwide with various modifications and instruments. Earlier studies have indicated that a surgical thrombectomy had overall better outcomes than the endovascular technique. Schuman et al¹² reported 67% procedural success rates with thrombolysis and 94% surgically. A prospective, randomised study by Marston et al⁴ showed a statistically significant difference in the 6-month primary patency rates, with their thrombolysis group at 11% at 6 months and the surgical thrombectomy group at 36%. However, more recent studies¹³⁻¹⁶ have showed an equivalent outcome between the 2 groups. A prospective, randomised study by Dougherty et al¹⁶ reported no statistically significant difference in the 12-month primary patency rates between the thrombolysis ($13.7\% \pm 6.6\%$) and the surgical thrombectomy groups ($26.0\% \pm 7.6\%$), nor in the mean time to graft rethrombosis between the groups (6 months vs 7 months, respectively). Our results were the same as the study by Dougherty et al¹⁶ that showed equivalent patency rate in both groups. Another recent

Table 1. Patient Data and Graft Characteristics

Parameter	Thrombolysis	Thrombectomy	<i>P</i> Value
Age (years)	55 ± 10	57 ± 9.5	0.45
Sex			0.55
Male	26	33	
Female	22	27	
Type of graft			0.39
Forearm U-shaped type	28	34	
Forearm straight type	16	22	
Arm U-shaped type	2	6	
Arm straight type	4	2	
Time interval before treatment (hours)	20 ± 15	32 ± 12	0.04

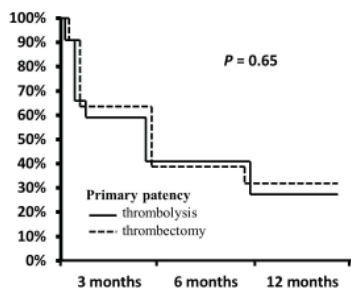


Fig 2. Kaplan-Meier curve for primary patency rate after restoration of thrombosed dialysis graft.

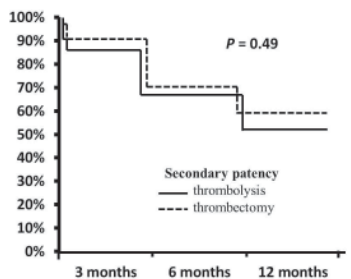


Fig 3. Kaplan-Meier curve for secondary patency rate after restoration of thrombosed dialysis graft.

study by Sofocleous et al¹⁷ using a similar endovascular technique and thrombolytic agent as ours for treatment of thrombosed dialysis graft had similar outcomes with a procedural success rate of 94% and primary and secondary patency rates of 44% and 72% at 6 months.

We think that an improvement of any instrument and technique such as using a multi-sidehole infusion catheter placed along the thrombus with a pulse-spray technique and using a rt-PA that is a potent thrombolytic drug will increase the effectiveness of clot lysis due to increased interactive surface area of the thrombus resulting in an improved outcome with the endovascular thrombolytic technique. In addition, balloon angioplasty can be used to treat any underlying stenosis in the thrombolysis group. Our study showed high procedural success rates in both groups with statistically non-significant differences (94% vs 93.8%, $P = 0.15$). However, a procedural failure involving both groups in our study was the failure to pass a guide wire or Fogarty thrombectomy catheter through the severe or occluded venous anastomosis. The time interval of graft thrombosis until treatment is another factor that affects the success of the thrombolysis technique. In our study, there was statistically significant difference in this time between the thrombolytic and thrombectomy groups (20 ± 15 hours vs 32 ± 12 hours; $P = 0.04$). We believe that an early thrombolysis of a fresh thrombus has a higher chance of procedural success.

Although these 2 procedures were not different in the outcomes of treatment, there were differences in the cost of the different procedures. Dougherty et al¹⁶ found significant differences in the mean costs for thrombolysis compared with surgical thrombectomy (US\$ 2925 vs \$1512; $P < 0.01$). In this study, we have not included the different costs of the

2 procedures in the results section; however, the total cost per patient in our institute was estimated at US\$ 1667 for thrombolysis vs only US\$ 667 for surgery thrombectomy. The main reason for these high costs in both the Dougherty et al¹⁶ and our study was the cost of the supplies, mainly the multi-sidehole catheter, the balloon catheter, and the thrombolytic drugs necessary for the procedure. The length of hospital stay in our institute was not a cost factor, as both groups were similar, with an average of 24 hours for the thrombolysis group and 24 to 48 hours for the thrombectomy group.

The most common complication of the procedures to salvage a thrombosed graft in our study was perigraft haematoma. Sands et al⁹ also reported this complication in their study with similar rates in both groups: 16% of the thrombolysis group and 11% of the thrombectomy group. Vein rupture, graft extravasation and pseudoaneurysm formation are other less common complications after a thrombolysis procedure that can be treated by an endovascular technique. One earlier study has reported an incidence of arterial embolisation of 0% to 7% with the thrombolytic technique,¹² but this complication was not reported with their surgical thrombectomy patients, possibly due to the fact that an immediate angiogram is not usually performed after a standard thrombectomy. However, clinically significant arterial embolisms can be treated by thrombo-aspiration or embolectomy. Pulmonary embolism after thrombosed graft correction is another concern. Usually, these pulmonary emboli are clinically silent and asymptomatic clots can be dissolved by autolysis. However, clinically significant pulmonary embolism has been reported.¹⁸ Other uncommon major complications have also been reported in surgical thrombectomy, including pulmonary edema and septicemia.⁹

There were some limitations in this study. Firstly, the study was a retrospective study. Secondly, the decision for doing either endovascular thrombolysis or surgical thrombectomy was dependent on the judgment of a vascular surgeon, which might have caused selection bias. Lastly, some included thrombosed AVGs had a history of multiple episodes of previous thrombosis, which could have had an impact on the patency results.

Conclusion

Our study found no differences in outcomes between patients treated with pharmacomechanical thrombolysis and surgical thrombectomy for thrombosed haemodialysis grafts. Additionally, there were no procedure-related major complications in the patients treated with pharmacomechanical thrombolysis, indicating that pharmacomechanical thrombolysis is a safe and effective procedure and can be set as an alternative option for treatment of dialysis graft thrombosis.

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