

## Initial Experience during Balloon Angioplasty Assisted Surgical Thrombectomy for Thrombosed Hemodialysis Grafts

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**Background:** Access failure in hemodialysis patients is commonly encountered by vascular surgeons. Researchers have reported various solutions for dealing with clotted grafts, including thrombectomy, thrombolysis, interposition grafting, angioplasty, or a combination of these methods. Surgical thrombectomy has been the standard procedure for dealing with thrombosed hemodialysis grafts in the cardiovascular department of Chang Gung Memorial Hospital. However, to correct associated stenotic lesions and improve the results of surgery, intraoperative balloon angioplasty has been applied in consecutive cases of dialysis graft failure since July 2001.

**Methods:** Initial experience with 13 consecutive intraoperative balloon angioplasties performed during a 2-month period was reviewed. Noncompliant high-pressure balloons were used for the procedures. Age, gender, graft age, and initial outcome were reviewed and analyzed.

**Results:** A success rate of 100% was achieved in the group that underwent thrombectomy plus intraoperative balloon angioplasty. Furthermore, the primary patency rates were 77% at 1 month, 62% at 3 months, and 38% at 6 months.

**Conclusions:** We recommend intraoperative balloon angioplasty plus surgical thrombectomy as an effective method of salvaging thrombosed hemodialysis grafts. However, since these are the initial results for this kind of hybrid procedure from a single hospital, large-scale studies with long-term follow up are required.

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**Key words:** dialysis graft, thrombosis, surgical thrombectomy, balloon angioplasty, endovascular therapy.

Access failure in hemodialysis patients is commonly encountered by vascular surgeons. Since the introduction of the polytetrafluoroethylene (PTFE) graft for access creation in hemodialysis patients, acute graft thrombosis has become an important complication.<sup>(1)</sup> Owing to the relatively poor prognosis of graft patency following thrombo-

sis, several different treatment modalities have been developed for dealing with acute thrombosis of dialysis grafts.

Several methods now exist for dealing with acute thrombosis of dialysis grafts. Surgical thrombectomy with or without graft revision is the most straightforward approach for keeping grafts

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patent.<sup>(2,3)</sup> However, surgery is more invasive than percutaneous methods such as thrombolytic therapy and mechanical thrombectomy.<sup>(4)</sup> Both methods have advantages and disadvantages.

At Chang Gung Memorial Hospital, surgical thrombectomy has long been the standard approach for treating acute dialysis graft thrombosis. To enhance the short-term and long-term results of graft thrombectomy, and also correct the underlying stenotic lesions of the vascular access, intraoperative fistulography and balloon dilatation techniques have recently begun to be incorporated into surgical thrombectomy of dialysis grafts.

## METHODS

We retrospectively reviewed our experience of 13 consecutive patients that underwent surgical thrombectomy followed by intraoperative balloon angioplasties of the discovered vascular stenosis that were conducted during a 2-month period last year.

For each patient that suffered from acute thrombosis of dialysis graft, surgical thrombectomy was performed on an urgent or emergent basis under local anesthesia with or without intravenous sedation. A transverse graftotomy was first performed on the venous side of the graft, at least 2 cm from the anastomosis. Additional arterial side graftotomy was performed only where necessary. The thrombus was removed directly using Fogarty balloon catheter. Following the thrombectomy, routine intraoperative fistulography was performed by injection of contrast media via the graftotomy to demonstrate the possible residual thrombus and the underlying vascular stenosis (Fig. 1). Balloon angioplasty was conducted when any significant stenosis was found. Appropriate non-compliant balloon dilatation catheter, typically 4 mm to 7 mm in diameter, was then used to correct the stenotic lesion with adequate pressure and inflation time. The graftotomy was then closed and the graft blood flow was restored. Finally, post-procedure angiography was performed immediately to document the results (Fig. 2).

Basic patient data was collected, along with the findings of angiography and the operative results. The patients were followed up for at least 6 months, and the primary patency of the grafts following salvage was calculated.



**Fig. 1** Intraoperative angiography after thrombectomy showed a significant stenotic lesion over the venous outlet of dialysis graft.



**Fig. 2** After adjuvant balloon angioplasty, the stenotic lesion was corrected.

## RESULTS

Among the consecutive 14 patients with dialysis grafts that underwent thrombectomy, 13 patients were found to have stenotic lesions over the vascular route. The patients in this sample were between 42 and 83 years old. The sample included eight women and five men. Most of the patients had other systemic diseases, such as DM or hypertension. All of the dialysis grafts were PTFE grafts, and duration of the grafts ranged from 3 to 20 months (average, 10 months) at the time of thrombectomy. The types of grafts included one forearm radial to cephalic graft,

six forearm looped grafts and six upper arm grafts. The intraoperative angiography indicated that seven of the 13 patients had single significant graft venous outlet lesions, while the others had multiple lesions. Eight patients achieved optimal angioplasty results after the procedure (defined as residual stricture less than 30%), and the remaining five patients achieved sub-optimal results. All of the patients with suboptimal angioplasty results suffered recurrent graft failure within 3 months of thrombectomy (1 after 1 month, 3 after 2 months, and 1 after 3 months).

Surgical thrombectomy plus balloon angioplasty were performed successfully to restore access blood flow in all 13 patients. All patients were put on hemodialysis at least once immediately after the procedure, using the original vascular access. The primary patency rates of the dialysis grafts following these hybrid procedures at 1, 3, and 6 months were 77% (10 of 13), 62% (8 of 13), and 38% (5 of 13), respectively. No surgical complications, such as infection, bleeding or hematoma, were noted after the procedures.

## DISCUSSION

Vascular surgeons and interventional radiologists have developed various methods for dealing with dialysis graft occlusion. Among the available solutions, surgical methods and percutaneous techniques such as pharmacal or mechanical thrombolytic therapy all have advantages and disadvantages.<sup>(5)</sup>

Surgical thrombectomy alone is the technique traditionally used for declotting acute thrombosed grafts. Notably, surgical thrombectomy is known to be quick and effective in declotting dialysis access grafts. However, the results from pure surgical declotting are poor because of the underdiagnosis and incomplete treatment of possible residual lesions of the venous outflow tract. In most cases, surgical thrombectomy must be accompanied by procedures to correct the outflow stenosis.<sup>(6)</sup> Some surgeons perform surgical revisions, either using patch angioplasty or jump graft revision, following thrombectomy of the dialysis grafts to correct the underlying venous outlet lesions. However, surgical revisions combined with thrombectomy for thrombosed grafts may require significant dissection, creating potential for nerve injury, significant patient discomfort, and high rates of hematoma and infection, poor healing. In

addition, the graft may also be difficult to revise in the future.

Thrombolytic therapy using a percutaneous approach is less invasive than surgery for dissolving blood clots. However, mechanical thrombectomy or pharmacal thrombolytic therapy is more time consuming and expensive than surgery, may not dissolve the thrombus as completely as surgery, and may induce systemic complications such as bleeding.

To restore functionality to an acutely thrombosed dialysis graft, complete removal of the clot is required. Since over 80% of patients with thrombosed dialysis grafts have underlying lesions such as venous anastomosis area stenosis or venous outflow tract stenotic occlusion,<sup>(7)</sup> detection and correction of the specific vascular lesions is necessary to keep the graft in long-term patency. To remove the clot in the graft, surgical thrombectomy is more effective and straightforward and less expensive and time-consuming than the percutaneous mechanical or pharmacological methods. Moreover, arterial plugs are easier to remove surgically than using thrombolytic therapy. Furthermore, pure percutaneous methods have higher rates of technical failure and higher costs when dealing with thrombosed grafts.<sup>(8)</sup> To diagnose underlying venous outlet lesions in the vascular access during the procedure, intraoperative fistulography is required in addition to traditional thrombectomy. The vascular stenosis must be addressed and corrected to prevent recurrent thrombosis and maintain long-term access patency.

Balloon angioplasty is being used increasingly to treat vascular access stenotic lesions during percutaneous thrombolytic therapy. Compared with surgical patch angioplasty, balloon angioplasty has the advantages of being less invasive, time saving, and preserves vascular sites for future surgical revision. In addition, the endovascular approach appears to be a reasonable choice in cases where surgical exposure is difficult.<sup>(9)</sup> Thus, some surgeons have begun to use balloon angioplasty during surgery in adjunct to surgical thrombectomy. Performing balloon angioplasty in the operating room as opposed to the angiography room also has certain advantages. For example, in cases involving complications or difficulty in ballooning, surgical revision can be performed immediately to save the dialysis access.

To enhance the results of surgical thrombectomy in this investigation, intraoperative fistulography of

the vascular graft was performed to detect the possible underlying vascular stenosis and correct the lesions immediately by balloon angioplasty. Intraoperative angiography enables the examination of the entire vascular access route. In cases involving residual thrombus, Fogarty thrombectomy can be performed again to clear the vascular route. The underlying vascular lesion, usually located over the venous outlet, can also easily be addressed and additional corrective procedures can be conducted. The series presented here achieved a 100% clinical success rate for thrombectomy. That is, every patient was put on hemodialysis via the original vascular access at least once following the surgery. Accordingly, adjuvant intraoperative fistulography appears helpful in ensuring the completeness and initial success of the thrombectomy.

Balloon angioplasty was used here instead of surgical revision to correct the lesions found during the operation due to the following reasons. First, surgical revision, either using jump graft or patch angioplasty, is more time consuming and painful than balloon angioplasty. Second, surgical revision involves more dissection, and thus can be associated with more surgical complications, such as hematoma, pseudoaneurysm,<sup>(10)</sup> infection, and nerve injury. Third, certain lesions, such as subclavian and superior vena cava stenosis, are difficult to approach surgically and under local anesthesia. Furthermore, balloon angioplasty can preserve more puncture and vascular sites for possible future vascular access cre-

ation or revision.<sup>(11,12)</sup>

The primary patencies of the graft after the procedure performed here at 1, 3, and 6 months were 77%, 62%, and 38%, respectively. The results were far better than the results of surgical thrombectomy alone<sup>(13)</sup> and were also better than the results for most of the pure percutaneous thrombolytic procedures.<sup>(10,14-16)</sup> The above mentioned results also compared well with the results of surgical thrombectomy plus surgical revision reported in the literature (Table 1).<sup>(13,17)</sup> Finally, the results presented here were also comparable with other published results for thrombectomy plus balloon angioplasty (Table 2).<sup>(18-20)</sup>

Thus, from our initial experience, the technique of combined surgical thrombectomy and balloon angioplasty as a hybrid procedure for dealing with acute thrombosed dialysis grafts was not only effective but also had numerous advantages compared with other methods, such as pure surgical or pure percutaneous methods. The routine use of intraoperative fistulography can ensure complete thrombectomy and can effectively detect underlying vascular lesions. Correcting the residual lesions using balloon angioplasty immediately following thrombus removal is believed to eliminate the risk of immediate recurrent graft failure and increase dialysis graft patency. This hybrid method also reduced time and money expenditures by eliminating the need for another clinic visit and balloon angioplasty for residual lesions.

**Table 1.** Patency Rates of Surgical Thrombectomy, With or Without Revision as Reported in the Literature<sup>(11,13,19)</sup>

Study	Patency at 1 month	Patency at 3 month	Patency at 4 month	Patency at 5 month	Patency at 6 month
Brotman et al. (Thrombectomy alone)	30%		10%		
Brotman et al., (with revision)	59%		25%		
Bitar et al. (with revision)	86%	45%			17%
Dapunt et al. (with revision)	64.1%			28.9%	

**Table 2.** Results of Combined Surgical Thrombectomy and Balloon Angioplasty for Thrombosed Dialysis Grafts<sup>(18-20)</sup>

Study	Case number	Patency at 1 month	Patency at 3 months	Patency at 5 months	Patency at 6 months
Smith et al.	19			58%	
Bitar et al.	22	77%	40%		28%
Anain et al.	48	45%	45%		33%
Current study	13	77%	62%		38%

According to the results of this work, we recommend intraoperative balloon angioplasty plus surgical thrombectomy as an effective method for salvaging thrombosed hemodialysis grafts. This hybrid procedure not only removed thrombus directly but also corrected the associated lesion in a less invasive manner than a pure surgical approach. Since this work merely presents the initial results for the application of this hybrid procedure in our hospital, studies with large patient populations and long follow up periods are required to evaluate the method properly.

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# 應用外科去血栓術輔以術中血管內氣球擴張術 對於洗腎用人工血管通路急性阻塞之處理之初始經驗

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**背景：** 洗腎用動靜脈人工血管通路急性栓塞是血管外科醫師常遇見的臨床問題。臨床上有許多不同的方式，包括外科去血栓術 (surgical thrombectomy)，經皮血栓溶解術 (percutaneous thrombolysis)，經皮機械性去血栓術 (percutaneous mechanical thrombectomy)，經皮血管內氣球擴張術 (percutaneous balloon angioplasty)，以及外科血管成形術 (surgical angioplasty)，用來解決人工血管阻塞問題。不論是外科手術，或是經皮血管內療法都各有其優劣。

**方法：** 本科爲了提高去血栓手術的成功率以及一併解決血管通路栓塞的潛在狹窄問題，在2001年7月開始將術中血管攝影及血管內氣球擴張術引進外科去血栓手術中使用。我們回顧了我們此種治療的初始兩個月之內的經驗並追蹤其成果，共13例。

**結果：** 用這樣的方法，人工血管通路去血栓的成功率是百分之百。而術後血管的在1個月、3個月，以及半年的暢通率則分別是77%、62%，以及38%。

**結論：** 我們認爲洗腎用人工血管的去血栓手術合併使用術中氣球擴張術是一種能有效清除血栓的方式，能夠同時發現並解決血管通路的潛在性狹窄問題。  
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**關鍵字：** 人工血管，栓塞，去血栓術，氣球擴張術，洗腎通路。

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