Description and outcomes of a simple surgical technique to treat thrombosed autogenous accesses

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Objective: **Owing to the difficulty of removing acute and chronic thrombus from autogenous accesses (AA) by standard surgical and endovascular techniques, many surgeons consider efforts to salvage a thrombosed AA as being futile. We describe a simple technique to extract acute and chronic thrombus from a failed AA. This technique involves making an incision adjacent to the anastomosis, directly extracting the arterial plug, and manually milking thrombus from the access. This report details the outcomes of a series of thrombosed AAs treated by surgical thrombectomy/intervention using this technique for manual clot extraction.**

Methods: **A total of 146 surgical thrombectomies/interventions were performed in 102 patients to salvage a thrombosed AA. Mean follow-up was 15.6 months. Office, hospital, and dialysis unit records were reviewed to identify patient demographics, define procedure type, and determine functional patency rates. Kaplan-Meier survival analysis was used to estimate primary and secondary functional patency rates.**

Results: **Complete extraction of thrombus from the AA was achieved in 140 of 146 cases (95%). The studied procedure itself was technically successful in 127 cases (87%). Reasons for failure were the inability to completely extract thrombus from the AA in six, failed angioplasty due to long segment vein stenosis or sclerosis in seven or vein rupture in two, and central vein occlusion in one. Three failures occurred for unknown causes ≤3 days of successful thrombectomy. No single factor analyzed (age, sex, race, diabetes status, access type or location) was associated with technical failure. The estimated primary and secondary functional patency rates were 27% ± 5% and 61% ± 6% at 12 months.**

Conclusions: **The manual clot extraction technique described in this report effectively removed acute and chronic thrombus from failed AAs. Its use, combined with an intervention to treat the underlying cause for AA failure, significantly extended access durability. (J Vasc Surg 2012;56:861-5.)**

Since the publication in 1997 of the Dialysis Outcome Quality Initiative (DOQI) Clinical Practice Guidelines for Vascular Access and launch of the Fistula First Breakthrough Initiative (FFBI), there has been a major emphasis on increasing autogenous access (AA) use in the United States. The FFBI has been able to change dramatically the practice pattern of access surgeons during the past decade by establishing a national target for AA prevalence that specifically has become the de facto marker for the quality of a dialysis access program.[1] Unfortunately, the current AA prevalence rate in the United States seems to have stalled at 55%, a rate that is well short of the 66% target set by FFBI.[2] Newer or more refined procedures to salvage thrombosed AAs could potentially play a major role at increasing the prevalence rate. Still, some surgeons consider thrombectomy of the AA difficult—if not futile—and thus suggest that new access placement may be preferable to procedures for salvage of a thrombosed AA.[3]

We previously reported outcomes for a small series of patients who underwent surgical thrombectomy and revision for thrombosed AAs. That report described a simple procedure that completely extracts acute and chronic thrombus from AA, even from those AAs with large aneurysms and clot burdens.[4] Since then, we have performed this procedure in a much larger series of patients, and in this report we describe our technique for thrombus extraction and review our experience using this technique to salvage a series of thrombosed AAs.

METHODS

Study approval was obtained from the Institutional Review Board of the Greenville Hospital System/University Medical Center (GHS/UMC). The GHS/UMC Department of Surgery vascular access database and GHS/UMC inpatient database were reviewed to identify all patients who underwent an initial AA creation and subsequent surgical thrombectomy of that same AA between January 2001 and January 2011. The vascular access database, hospital and office medical records, dialysis unit records, and operative reports were reviewed to verify patient eligibility and obtain patient demographics, access proce-

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Fig 1. Thrombosed brachiocephalic autogenous access with two pseudoaneurysms is prepared for thrombus removal. The *transverse blue line* marking the planned skin incision is positioned near the anastomosis of the access.

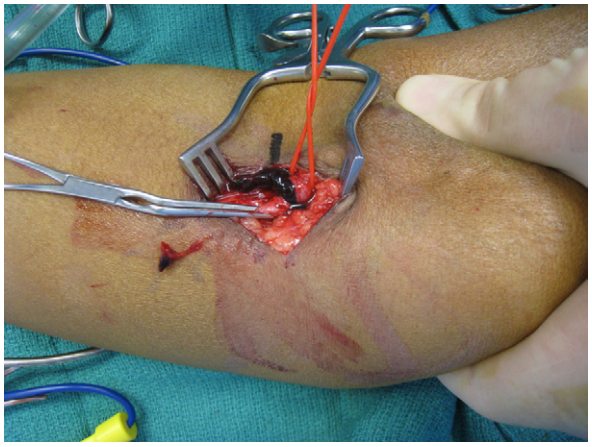


Fig 2. After arterial inflow is re-established by removing the arterial plug, thrombus is extracted from the venous outflow by applying firm pressure over the access and by milking thrombus out the fistulotomy.

dure type, and information related to access outcome such as complications and access functional patency.

Access salvage was attempted for nearly all functional AAs, including those with large aneurysms or pseudoaneurysms, with and without large clot burdens, and for those AAs with significant skin erythema or induration from thrombophlebitis. Salvage was generally not attempted for AAs that were small, sclerotic, or nonfunctional before thrombosis or for AAs thrombosed >30 days.

Multiple AA thrombectomy procedures were done in 29 patients. No consistent monitoring or surveillance program was used for patients in this series. After suture removal, the patient's nephrologist directed the follow-up evaluations and care of the AA. Primary and secondary functional patency estimates and technical success rates were based on the initial (index) thrombectomy procedure. Procedures that resulted in complete extraction of thrombus from the access and maintained access functionality for at least one dialysis session were deemed technically successful. Kaplan-Meier life-table analysis was used to assess primary and secondary functional patency for those index access procedures that were technically successful. The Fisher exact test and the Wilcoxon rank sum test were used to identify baseline patient characteristics (age, sex, race, diabetes, access location) associated with technical failure.

Surgical technique. Procedures were performed in the operative suite using intravenous sedation and local anesthetic. A transverse incision is made over the AA adjacent to the arterial anastomosis (Fig 1). A 2-cm length of the AA is dissected from the surrounding tissue and encircled with a vessel loop. Systemic heparin is administered. A transverse fistulotomy is made in the vein within 2 to 3 cm of the arterial anastomosis, and thrombus is then removed from the arterial anastomosis with a 4-mm thromboembolectomy catheter. Compliance of the vessel at the anastomosis will occasionally result in the thromboembolectomy catheter sliding across the anastomosis without dislodging the arterial plug. In such cases, forceps can be inserted into the AA to grasp the plug and extract it.

Once all thrombus is removed from the AA, a vascular clamp is placed across the proximal AA. Thrombus can then be removed from the venous outflow of the AA by manually "milking" the thrombus retrograde through the fistulotomy. This milking maneuver begins over the AA adjacent to the fistulotomy and proceeds stepwise up the extremity until no additional thrombus is expelled from the access (Fig 2). To completely extract thrombus from the access, it may be necessary to extend this milking maneuver to the deltopectoral groove for brachiocephalic AAs or to the axilla for brachiobasilic AAs. Acute thrombus and the chronic laminar thrombus often found in aneurysmal accesses are both removed with this technique. The thrombus extraction maneuver requires vigorous manipulation and firm pressure over the AA. This can be quite uncomfortable for the patient; therefore, additional sedation may be necessary during this portion of the procedure. Although we generally pass the thromboembolectomy catheter through the AA several times after the milking maneuver has been completed, in most cases the milking maneuver alone removes all thrombus from the access.

A fistulogram is routinely performed to identify the etiology of AA failure and to confirm complete extraction of the thrombus from the access. AA stenoses are generally treated with balloon angioplasty or surgical revision.

RESULTS

During the study period, 102 patients underwent surgical thrombectomy/revision procedures to salvage a thrombosed AA. Patient demographics are summarized in Table I. Mean patient follow-up was 15.6 months. Stenosis was identified as the cause for access failure in all of the index surgical thrombectomy/interventional procedures.

Table I. Patient demographics

Characteristic	*Mean ± SD or No. (%) (N = 102)*
Follow-up, months	15.6 ± 16.1
Age, years	54.6 ± 13.8
Sex	
Female	39 (38.2)
Male	63 (61.8)
Race	
Black	49 (48.0)
White	45 (44.1)
Other	8 (7.8)
Diabetes	54 (52.9)
Fistula location	
Forearm	22 (21.6)
Upper arm	80 (78.4)

SD, Standard deviation.

Table II. Procedures performed

Procedure	*No. (%)*
Thrombectomy	102 (100)
Fistulogram	94 (92)
Angioplasty	69 (68)
Stent	12 (12)
Revision	20 (20)

In addition to surgical thrombectomy, an adjunctive procedure was required to treat the underlying cause for access failure in all but one patient and included balloon angioplasty of a stenosis in 69 patients (68%), balloon angioplasty/stent placement in 12 (12%), and surgical revision of the access in 20 (20%; Table II).

Two patients were immediately lost to follow-up and thus excluded from outcomes analysis. This resulted in an analytic cohort of 100 patients undergoing 144 procedures for which outcome data were available. The index surgical thrombectomy/intervention procedure was technically successful in 84 patients (84%). Reasons for technical failure were inability to completely clear thrombus from the AA in five cases, failed balloon angioplasty due to long segment venous stenosis in six, failed balloon angioplasty due to vein rupture in two, and central venous occlusion in one. Among these index procedures, two failures occurred from an unknown cause ≤3 days of successful thrombectomy. Subsequent surgical thrombectomy/intervention procedures, comprising 44 procedures in 29 patients, were successful in 41 (93%). Reasons for technical failure in these secondary procedures were inability to completely clear thrombus from the AA in one patient and failed balloon angioplasty due to long segment venous stenosis in another. An additional failure arose for an unknown cause ≤3 days of successful thrombectomy. No factor analyzed (age, sex, race, diabetes, access type or location) was associated with technical failure ($P > .2$ for all cases).

One (0.7%) major procedure-related complication occurred from the total of 146 procedures. This patient was taken back to the operating room on postoperative day 1 for severe hand ischemia. Thrombus was found in the artery distal to the AA anastomosis. The thrombus was removed, and the patient recovered without sequelae.

The estimated functional primary patency for technically successful index procedures was 45% ± 6% at 6 months and 27 ± 5% at 12 months. The secondary functional patency was 74% ± 5% at 6 months and 61% ± 6% at 12 months (Fig 3).

DISCUSSION

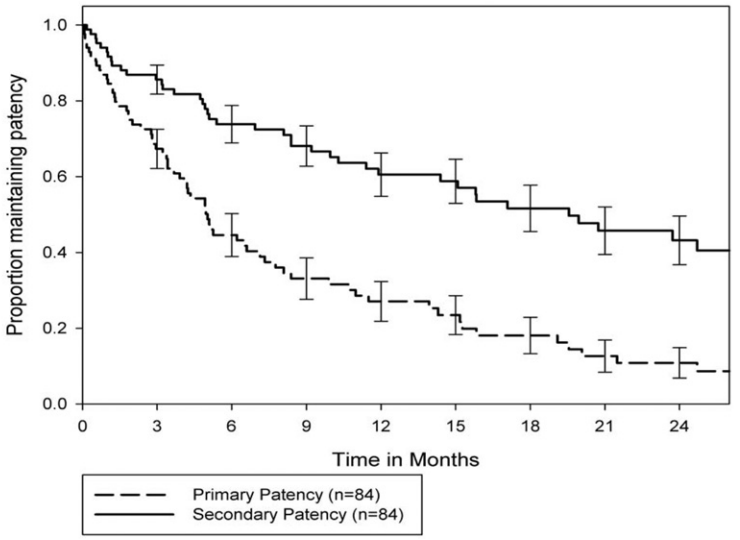
The latest edition of *Rutherford's Vascular Surgery*[3] states "autogenous access thrombectomy should be undertaken only in stable, relatively healthy patients in whom the procedure risk is acceptably low, because success is fleeting at best." This sentiment, shared by many vascular access interventionists, was born out of small, historical studies that reported the outcome of surgical thrombectomy for AA.[5] Unfortunately, most of these studies made no attempt to identify and treat the underlying cause for access failure. As expected, results from surgical thrombectomy in these reports were poor. The belief that attempts to salvage the failed AA are futile is also supported by the apparent insurmountable technical challenges of completely clearing thrombus from the access. AAs that are aneurysmal or with multiple pseudoaneurysms have large clot burdens of both acute and chronic nature that make it difficult to extract all of the thrombus using traditional thrombectomy techniques. It also can be difficult to re-establish arterial inflow through a thrombosed AA because compliance of the vein may allow the embolectomy catheter to slide past the thrombus plug without dislodging it.

A number of studies have detailed outcomes using various percutaneous mechanical and pharmacomechanical techniques to salvage thrombosed AA.[6-13] These studies are relatively small, and outcomes reported with their techniques are inconsistent. These studies generally exclude thrombosed AA with chronic thrombus, pseudoaneurysms, and large clot burdens. In addition, specific techniques used to extract thrombus are poorly described and technically challenging.

Liang et al[6] reported a series of 42 thrombosed AAs treated with urokinase and an angioplasty balloon. Technical success was obtained in 93%. Primary and secondary patencies at 12 months were 70% and 80%, respectively. This study was criticized for only including AAs with a minimal clot burden.[7]

Zaleski et al[8] used a percutaneous pharmacomechanical method to treat 17 patients with thrombosed AA and had technical success in 82%. For those successful procedures, primary and secondary patencies at 12 months were 64% and 100%; however, the average procedural time was 1.7 hours. The techniques used have been considered "tedious" by other interventionists.[6] Also of note was that the procedure was complicated by arterial embolism in four cases.

Haage et al[9] reported results for 54 patients who underwent 81 percutaneous procedures for treatment of a



	Baseline	1 mo.	3 mo.	6 mo.	9 mo.	12 mo.	18 mo.	24 mo.
Primary Patency		86 ±	67 ±	45 ±	33 ±	27 ±	18 ±	11 ±
	100%	4%	5%	6%	5%	5%	5%	4%
# Failures	0	12	27	44	52	56	61	65
# At Risk	84	72	52	32	23	18	10	5
Secondary Patency		93 ±	86 ±	74 ±	68 ±	61 ±	52 ±	43 ±
	100%	3%	4%	5%	5%	6%	6%	6%
# Failures	0	6	12	21	25	30	35	39
# At Risk	84	78	67	55	47	39	28	17

Fig 3. Primary (*dashed line*) and secondary patencies (*solid line*) of technically successful index thrombectomy procedures are shown with the standard deviation (*range bars*).

thrombosed AA. A variety of techniques and mechanical thrombectomy devices were used to extract thrombus from the access. Although initial technical success was achieved in 72 procedures (89%), eight (11%) met early failure. The primary patency was 52% and 27% at 6 and 12 months, respectively, and secondary patency was 65% and 51%. This study did not include any AAs thrombosed >48 hours. The authors did note a decreased procedural success in those AAs thrombosed >24 hours. They also had less success in those AAs with large clot burdens.

In another study, Shatsky et al[7] also had difficulty in removing chronic thrombus from AAs with the Trerotola device (Arrow International, Reading, Pa). In his series, 15% (9 of 62) of the thrombectomy procedures left residual thrombus in the access after completion of the procedure. Only two of the AAs were aneurysmal.

In contrast to complex percutaneous methods for salvaging a thrombosed AA, the open surgical procedure we describe is simple to perform and effectively removes acute and chronic thrombus from aneurysmal AAs and from AAs with multiple pseudoaneurysms as well as with large clot burdens. Our reported procedure successfully extracted all thrombus from the access in 140 of 146 procedures (95%). Most technical failures in our series were not due to an inability to thoroughly clear thrombus from the access but rather were created by some problem with treatment of the underlying cause for access failure, such as rupture of the vein during balloon angioplasty of a long-segment stenosis.

Traditional methods of re-establishing arterial inflow by extracting the thrombus plug from the AA anastomosis with an embolectomy catheter can be frustrating because vein compliance permits the balloon catheter to slide past the plug without dislodging it. The technique we describe averts this problem. By mobilizing the AA adjacent to the anastomosis, the plug can easily be removed with forceps.

Early in our experience, we first extracted thrombus from the venous outflow of the AA before re-establishing arterial inflow. This practice resulted in our only complication, for in using the "milking" maneuver to extract thrombus from the AA, we pushed thrombus into the brachial artery, thereby causing significant hand ischemia. To prevent that complication, we now re-establish arterial inflow first and then place a clamp across the proximal AA before compressing the distal access. No further complication has occurred since that procedural modification was implemented.

On the basis of our experiences with this procedure, we do not advocate its use to salvage a thrombosed AA that is sclerotic or with long-segment stenoses not amenable to surgical or percutaneous intervention. Although we have salvaged AAs that have been thrombosed for several weeks, success with these chronically occluded AAs has been spo-

radic, and accordingly, we would not attempt the procedure for an access occluded >2 weeks. We have noted that thrombophlebitis, as manifested by significant erythema and tenderness, often develops in thrombosed AAs. Such findings nevertheless do not preclude salvage using this open surgical technique and do not require any changes in surgical technique. Once the thrombus has been cleared and patency restored, the thrombophlebitis quickly resolves.

CONCLUSIONS

We have shown that contrary to surgical dictum, open surgical thrombectomy of a thrombosed AA is often successful and increases AA utilization. The technique we have described is a simple, low-risk procedure. Unlike percutaneous thrombectomy procedures that can require a number of advanced maneuvers to remove all thrombus from the access, our technique is easily taught and can be performed by any access surgeon. The method is particularly helpful in situations where percutaneous intervention often fails, such as when there is a large clot burden or chronic thrombus in the access or when there are multiple or even giant pseudoaneurysms. The addition of this procedure to the access surgeon's armamentarium should help us get closer to achieving the goals of the FFBI of maximizing AA use in the United States.

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