Percutaneous Trans-Radial Intervention for Acute Thrombosis of Upper Arm Grafts: An Outpatient-Based, Effective, and Feasible Option

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**Purpose:** To evaluate the efficacy, safety, and feasibility of an outpatient-based trans-radial intervention for acute thrombosis of upper arm graft.

**Materials and methods:** A total of 101 trans-radial balloon angioplasty was performed in 63 patients with acute thrombosis of upper arm graft (29 males, 34 females; age: 69 ± 10 years). Thrombus was macerated and pushed into the central circulation with a balloon catheter. Low-dose urokinase injection was given as an adjunctive therapy in 17 interventions. Procedure time, anatomical and clinical success, and complications were analyzed.

**Results:** The procedural time was 56±29 minutes. Anatomical success (< 30% residual stenosis) was obtained in 87.2% of cases and clinical success in 79.2%. There was no major bleeding or symptomatic pulmonary embolism. Other complications were distal arterial embolism with or without clinical symptoms in 2% and 5.9% of cases, respectively. The complication rate of axillary extravasations was 3%.

**Conclusion:** Trans-radial intervention for acute thrombosis of upper arm graft as an outpatient procedure had comparable success and complications compared to the results reported earlier. Therefore, outpatient-based trans-radial intervention should be considered a feasible therapy for acute thrombosis of upper arm graft.

**Key Words:** Trans-radial approach • Angioplasty • Hemodialysis access

**INTRODUCTION**

Maintaining adequate patency of arterio-venous (AV) access is very important for patients on hemodialysis. AV access often gets occluded and contributes significantly to morbidity and hospitalization for such patients.1 Acute occlusion of an AV access in patients on hemodialysis necessitates immediate restoration of patency. The treatment of an AV graft thrombosis has traditionally been surgical, i.e. incision of the graft with Fogarty balloon, thrombectomy and revision as necessary. However, percutaneous methods are also an effective alternative to surgical thrombectomy.1-3 Transvenous4-7 or trans-brachial8 approaches are common techniques in endovascular intervention for thrombosed access. Both trans-brachial and trans-venous approaches (crossed catheter technique) are commonly used to increase success rate.5,9-12

The trans-radial approach is widely used for percutaneous coronary intervention because of fewer complications related to the puncture site, and early ambulation.13 Recently, it has also been applied for non-coronary interventions such as renal artery stenting, mesenteric artery stenting or cerebral artery stenting.14-17 How-
ever, there are very few studies on trans-radial intervention for managing thrombosis of AV access in hemodialysis patients; only two studies related to radio-cephalic fistula have been reported.

This study was an analysis of a single center’s experience with endovascular intervention using trans-radial approach for acute thrombosis of upper arm grafts over a three-year period. We sought to examine the feasibility, efficacy and complications of this outpatient-based approach.

METHOD

Patient population

This study was conducted in Chang Gung Memorial Hospital, Chia Yi, Taiwan. All patients from January 2004 to July 2007 with acute occlusion of upper arm graft due to thrombosis and normal Allen’s test that were referred to the interventional cardiology department were included in this study. They underwent treatment within 72 hours of no palpable thrill. Grafts with evidence of infection were excluded. All grafts were made with polytetrafluoroethylene (Gore-Tex; W.L. Core, Elkton, MD). Patients underwent treatment on an outpatient basis and were hospitalized only if necessary for other reasons. Written informed consent was obtained from all patients prior to the procedure.

Interventional procedure

The radial artery was punctured with a 30-mm 20-G sheathed needle, under local anesthesia (2% lidocaine). After successful access and free flow of blood, the needle was removed from the sheath and a 150-cm 0.025-in angled hydrophilic guidewire (Terumo) was inserted through the soft sheath. The wire was advanced until secured, then the 20-G soft sheath was removed, leaving the guidewire in place. A 6-Fr 10-cm sheath (Terumo) was then introduced into the radial artery. Heparin (3000 IU) was given in all cases in order to prevent intraprocedural thrombus formation. Midazolam (5 mg) was administered intravenously for anxiolysis and amnesia as needed. Nitroglycerin (0.2 mg) was administered intr arterially if brachial artery spasm occurred.

A diagnostic fistulogram was conducted through the sheath. Upon fluoroscopy of a thrombosed upper arm graft, in most of the cases, only a small stump was visualized. A 6Fr right Judkins 4 (JR4) catheter (Boston Scientific, Maple Grove, MN) was used for better support to guide the hydrophilic guidewire. If the 0.025-in angled hydrophilic guidewire was unable to pass through the lesion, a 0.014-in coronary wire with a soft hydrophilic coating on the tip was employed. After the guidewire was passed through the lesion or the entire graft, the JR4 was withdrawn, and a 6-mm peripheral Wanda balloon (Boston Scientific Ireland, Galway, Ireland) was advanced over the wire. The balloon was inflated over the stump and then withdrawn with the guidewire left in place. The Wanda balloon was again advanced over the wire and inflated over the identified lesions under repeated imaging. The inflation pressure was increased gradually until no “waist” remained or the maximal rated balloon pressure was reached. The balloon catheter size was 6-7 mm × 20 or 40 mm. The balloon was usually inflated to 8-16 atmospheres (atm) for 30-40 seconds at a time. The balloon was inflated for up to 2 minutes as recoil was encountered. If the lesion revealed significant stenosis after initial ballooning, a non-compliant Conquest balloon (Bard, Crawley, UK) with a 1:1 balloon-vessel ratio was employed and inflated to 20-24 atm. When significant residual thrombus was demonstrated in the occluded segment, the same Wanda balloon was sequentially inflated downstream over the entire graft (6-8 atm) and for a shorter duration of inflation, usually 10-15 seconds a time. If thrombus was persistent, 60,000–120,000 U of urokinase was directly injected into the graft from the peripheral Wanda balloon catheter placed near the inflow anastomotic area. Contrast medium was injected 10-15 minutes thereafter to evaluate the effect of urokinase injection. Finally, the balloon was sequentially inflated downstream over the entire graft again at a low pressure of 6-8 atm and for a short duration of inflation to macerate residual clot or the inflated balloon maintained at 4-6 atm was used to push the residual clot into the central venous system. The declotting procedure was considered complete when fluoroscopy revealed restored blood flow and palpable thrill was detected (Figure 1).

At the end of the intervention, the sheath was removed and the puncture site was manually compressed for approximately 1-2 minutes before compression with gauze and pressure bandage. The bandage was removed two hours later. All procedures were performed on an outpatient basis unless the patient was already admitted to hospital.
Study definitions

Procedural time was measured from the start of percutaneous trans-radial puncture to completion of the endovascular procedure. In our laboratory, the procedure time also includes the time to achieve hemostasis of the puncture site. Anatomic success for thrombosed lesion was defined as restoration of flow with less than 30% maximal residual stenosis. Clinical success was defined as presence of palpable thrill and the ability to carry out hemodialysis for at least one week via treated AV graft. Major complications included symptomatic distal arterial embolization, remote site hematoma or bleeding, vascular perforation or rupture, death, symptomatic pulmonary embolism and puncture site complication. Minor complications included additional drug therapy or short hospital stay for observation.

RESULTS

From January 2004 to July 2007, 101 interventions of trans-radial balloon angioplasty were performed in 63 patients with normal Allen test (29 males, 34 females; age range: 20-90 years; average: 69 ± 10 years). The results of procedural time, anatomical and clinical success, and complications are shown in Table 1. Anatomic success was achieved in 88 of 101 interventions (87.2%). One intervention failed because of inaccessibility due to tortuosity of the radial artery. No trans-radial approach was hindered by unrelievable radial artery spasm. Twelve interventions failed due to residual stenosis exceeding 30%.

Table 1.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>N = 101</th>
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<tr>
<td>Procedural time (min)</td>
<td>56±29</td>
</tr>
<tr>
<td>Anatomic success rate</td>
<td>88/101  (87.2%)</td>
</tr>
<tr>
<td>Clinical success rate</td>
<td>80/101  (79.2%)</td>
</tr>
<tr>
<td>Major complications</td>
<td></td>
</tr>
<tr>
<td>Symptomatic distal arterial embolism</td>
<td>2/101   (2.0%)</td>
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<tr>
<td>Minor complications</td>
<td></td>
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<tr>
<td>Asymptomatic distal arterial embolism</td>
<td>6/101  (5.9%)</td>
</tr>
<tr>
<td>Axillary vein focal dissection or extravasation</td>
<td>3/101 (3.0%)</td>
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30% with excessive persistent thrombus. In 9 of the 12 failed interventions, PTA was done more than two days after onset. In 8 patients re-thrombosis occurred within 7 days of the intervention. All of them had lesions both at the venous and arterial junctions. Clinical success was achieved in 79.2% of interventions (80 of 101). Adjunctive therapy with urokinase (Abbokinase; Abbott Laboratories, North Chicago, IL) at doses ranging from 60,000 U to 120,000 U was used in 17 of 101 interventions at the discretion of the operating physician. The average procedure time was 56 ± 29 minutes.

Complications occurred in 10.5% of procedures. The major complications were two episodes of distal embolism in the ulnar artery with pain and coldness. Minor complication included six episodes of smaller distal arterial embolism without clinical symptoms, one episode of axillary vein focal dissection, two episodes of axillary vein extravasations, and no patient experienced bleeding complications or clinically detectable pulmonary embolism.

DISCUSSION

Trans-radial percutaneous transluminal angioplasty with or without urokinase restore the function of thrombosed upper arm graft, with acceptable anatomic (87.2%), clinical (79.2%) success rates. Previous studies related to salvaging thrombosed AV fistulae or grafts for hemodialysis access, including surgical thrombectomy and endovascular thrombectomy by various devices coupled with or without thrombolytic agents, have reported success ranging from 71–95%1,5,7,10,12,21-23 In our series of patients, the major anatomic failure was resulted from massive residual thrombus even after performance of several courses of angioplasty with higher pressure, larger balloon size, longer inflation time, non-compliant balloon or low-dose urokinase injection. The potential factors contributing to the persistence of thrombosis after PTA include venous limb stenosis,34 clotting disorder, compromised arterial inflow35 and the age of thrombus. In 9 of 13 cases with anatomical failure, PTA was done more than two days after onset. Organization of the relatively old thrombus might hamper effective fragmentation of the thrombus by PTA. Early intervention after onset may increase the success rate. In this study, only one patient had tortuous radial artery and resulted in a failed trans-radial intervention.

There were 8 episodes of early re-thrombosis. Hypercoaguloability, hypotension, and significant residual stenosis were the assumed causes of early thrombosis.36 Reviewing the fistulograms of these cases, all of them had lesions both at the venous and arterial junctions. Recoil after PTA at venous junction was noted in three patients. However, as early recoil occurs commonly in lesion at the graft junction, the anatomical locations of these lesions suggest that recoil after PTA with insufficient flow may have contributed to the early rethrombosis in these cases. None of them was treated with low-dose urokinase. However, it was beyond this study to answer whether routinely using low-dose urokinase could achieve lower re-thrombosis rate or not.

In some cases with large thrombus burden, inflated balloons were used at low-pressure status to push the residual clot to the central venous system after administering Urokinase injection for 10–15 minutes. We used lower dose of urokinase (60,000–120,000 U) instead of the full dose (250,000–500,000 U) as reported in some reports.11,26 Fifteen out of 17 times, urokinase injection helped the balloon angioplasty get optimal results. No bleeding complication occurred in this subgroup of patients. Low-dose urokinase injection could be an effective adjunctive therapy in patients with large thrombus burden. Further study is necessary to prove the benefit-risk ratio of routine usage of this pharmacological adjunctive therapy for all lesions.

The trans-radial approach overcomes several limitations of the traditional approach. First, the lesions can be clearly visualized by antegrade contrast medium injection. Second, operators can be protected from exposure to the X-ray generator throughout the procedure. Third, one sheath is sufficient to treat all lesions from brachial artery to the central vein, including thrombosed grafts. The average procedural time for endovascular management of thrombosed hemodialysis access reported previously was around 1 hour.5,7,21 In addition, more than 10 minutes were required to achieve hemostasis in the traditional approach, and often more if a thrombolytic agent was used. Thus, the average time was more than 1 hour in the traditional approach5,24 compared to this study, where it was 56 ± 29 minutes, which was inclusive of time required for hemostasis. In this study,
hemostasis was achieved in less than five minutes, which minimized the burden on nursing and medical staff.

The possible complications of the trans-radial approach include radial artery occlusion, radial artery dissection and extravasation. Stella PR reported persistent radial artery occlusion in less than 3% of patients, and none had clinical symptoms at the time of trans-radial artery coronary angioplasty with 6-Fr guiding sheath.25 In this study, 6-Fr guiding sheath was used in all patients, and no patient complained of cold sensations or numbness in the hand following the procedure, even those who underwent several interventions.

The overall complication rates in endovascular management for thrombosed lesions as reported earlier (4–15%)7,10,31,32 are comparable to our results (10.5% including 5.9% asymptomatic arterial embolism). The incidence of occurrence of a peripheral artery embolism was reported to be as high as 6%.31 In several studies,3,5,31,32 the reported incidence actually reflected the incidence of ‘symptomatic’ distal embolism. The suggested threshold (%) of symptomatic distal arterial embolization was 2%.31 Early in our experience, two episodes of symptomatic distal arterial embolism (2%) occurred during vigorous contrast injection after balloonizing the thrombosed stump. Subsequently, these two cases underwent successful surgical thrombectomy. There were six episodes of asymptomatic distal arterial embolism. All were related to smaller thrombus. Additionally, three complications of the axillary vein were treated with local compression successfully. Another concern with our technique (clot maceration without removal) was the possibility of pulmonary embolism. In this study, no patient had clinical symptoms of pulmonary embolism, which was consistent with previous studies.3,28,29

Thus, in all aspects, including success rate, complications and procedural time, the reported result of this study are not only equal but better in some ways to the traditional surgical techniques or those reported by previous authors.

Limitation of study

This was an observational study and did not compare head-to-head with traditional surgical methods. Peripheral duplex for radial artery before and after a trans-radial intervention would have shown a better additional index of success. This was not done in all patients. Primary and secondary patency rates or complications could not be evaluated in this study because not all patients were regularly followed up in this hospital.

CONCLUSION

This study showed that the success rate, procedural time and complication rate of trans-radial intervention for acute thrombosis of upper arm graft were comparable to those reported in previous studies. This study clearly demonstrated the overall safety, efficacy and feasibility of outpatient-based trans-radial intervention for acute thrombosis of upper arm graft.

REFERENCES