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TECHNICAL NOTE

Transfemoral Venous Access Facilitates Upper Extremity Dialysis Interventions: Procedural Success and Clinical Outcomes

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Abstract

Purpose To report technical success and clinical outcomes of transfemoral venous access for upper extremity dialysis interventions.

Materials and Methods A total of 15 patients underwent a transfemoral venous approach for fistulography ($n = 4$; 27%) or thrombectomy ($n = 11$; 73%) over a 14-month period. Access characteristics, sheath size, thrombectomy method, angioplasty site, fluoroscopy time, radiation dose, technical and clinical success, complications, and post-intervention primary and secondary patency rates were recorded.

Results Access type included arteriovenous fistulas ($n = 10$; 67%) and grafts ($n = 5$; 33%). The most common configuration was brachio-brachial ($n = 6$; 38%). Mean age of access was 37 months. Mean prior interventions were 4. Right CFV access was used in all patients using 6–8-French (most common: 7-French [$n = 10$; 67%]) sheaths. Most thrombectomies ($n = 11$; 73%) required both pharmacologic and mechanical maceration ($n = 9$; 82%). All accesses required angioplasty to treat underlying stenosis at the outflow vein ($n = 12$; 80%) or arteriovenous anastomosis ($n = 9$; 90%). Mean fluoroscopy time was 26.43 min. Air kerma and dose area product were 178.06 ± 225.77 mGy and 57,768.83 ± 87,553.29 μGym^2, respectively. Procedural and clinical success rates were 93% and 80%, respectively. Technical failure was due to persistent stenosis in one patient. Clinical failure was due to unsuccessful dialysis immediately following intervention in three patients. Mean post-intervention primary patency and secondary patency durations were 2.8 and 4.8 months, respectively. Primary patency rates at 1 and 3 months were 50% and 35%, respectively. Secondary patency rates at 1 and 3 months were 58% and 30%, respectively.

Conclusion A transfemoral venous approach for intervention of upper extremity dialysis accesses may be a valuable adjunct to traditional approaches.

Keywords Transfemoral · Dialysis intervention · Declot · Thrombectomy · Fistulogram · Fistulography

Abbreviations

AVF	Arteriovenous fistula
AVG	Arteriovenous graft
AV	Arteriovenous
TDC	Tunneled dialysis catheter

Introduction

Endovascular intervention is the preferred method for restoring dysfunctional upper extremity arteriovenous fistulas (AVF) and grafts (AVG) [1–5]. Traditional access for

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dialysis intervention is direct percutaneous puncture of the access site, often requiring a cross-catheter technique [6].

There are, however, several challenges with this approach. Operators may face suboptimal ergonomics and increased radiation exposure while manipulating the catheter system [7]. Technical challenges include direct vessel spasm and injuries. When sheaths cross one another, it is difficult to completely clear thrombus in the access sites. Furthermore, achieving hemostasis in high flow systems may require placement of "purse-string" sutures over the puncture sites. Sutures must be removed several hours later when intra-procedural anticoagulation is no longer effective or may remain in place, leaving potential tissue deformity.

Previous studies have explored modified approaches for transvenous access for dialysis intervention including a transjugular venous approach [8–10]. Transfemoral venous access, however, has not been investigated. The purpose of this study is to report outcomes of transfemoral venous access for upper extremity dialysis interventions.

Materials and Methods

Study Design

Institutional review board approval was obtained with waiver of informed consent for this retrospective study. A total of 15 patients [7 male (47%) and 8 females (53%); mean age 60 ± 21.37 years, range 20–96] underwent a transfemoral approach for dialysis interventions [fistulography (n = 4) or thrombectomy (n = 11)] between June 2017 and August 2018 (Table 1). All patients had undergone at least one prior access intervention via the conventional approach so that the appropriate outflow vein could be identified during transfemoral access. Access was in the arm only, not in the forearm (i.e., radiocephalic fistula), due to concerns about catheter length. Dialysis intervention at this institution typically consists of a mix of transfemoral, transjugular, and direct percutaneous due to operator preference. Patient selection for transfemoral intervention was determined based on the following parameters: (1) Patient must have had a prior conventional intervention in order to delineate the vascular anatomy, (2) grafts and fistulas in the forearm were excluded, and (3) patient was willing to consent for femoral access intervention.

Technique

All procedures were performed by an interventional radiologist. Dialysis interventions have been previously described [11, 12]. Figure 1 depicts the following procedural steps. Under ultrasound-guidance, the right common femoral vein was accessed and a 65–80 cm 6–8-French sheath was advanced into the left or right brachiocephalic vein. Central venography was performed through a 4-French, 120 cm length Glidecath (Terumo Medical; Tokyo, Japan) which was advanced peripherally. Types of wires used included 0.035 Bentson, Rosen, and/or angled Glidewires, which varied depending on operator's preferences. Patients were anticoagulated with 2000–5000 units of IV heparin. In cases of thrombosis, intermittent contrast injection was performed to identify areas of thrombosis. The catheter and wire were advanced through the anastomosis into the inflow brachial artery. Arteriography, from the brachial artery, was performed in order to evaluate the dialysis circuit. If thrombosis was identified, a combination of transcatheter pharmacologic therapy with pulse-spray tissue plasminogen activator (2–6 mg Alteplase) and mechanical thrombectomy (balloon maceration most commonly with Armada 6 mm × 2 or 4 cm) was

Table 1 Characteristics of patients and accesses

Characteristics	Mean ± SD or number (%)
Demographics	
Gender	
Female	8 (53)
Male	7 (47)
Age (years)	60 ± 21.37
Race	
Hispanic/Latino	5 (33)
White/Caucasian	4 (27)
Black	3 (20)
Mexican/Mexican American	2 (13)
Asian	1 (7)
Access	
Type	
Arteriovenous fistula	10 (67)
Arteriovenous graft	5 (33)
Side	
Left upper extremity	12 (80)
Right upper extremity	3 (20)
Configuration	
Brachio-brachial	6 (40)
Brachio-cephalic	5 (33)
Brachio-basilic	2 (13)
Brachio-axillary	2 (13)
Age (months)	
Mean ± SD	37 ± 37.67
Range	5–125
Number of prior interventions	4 ± 2.89

SD standard deviation

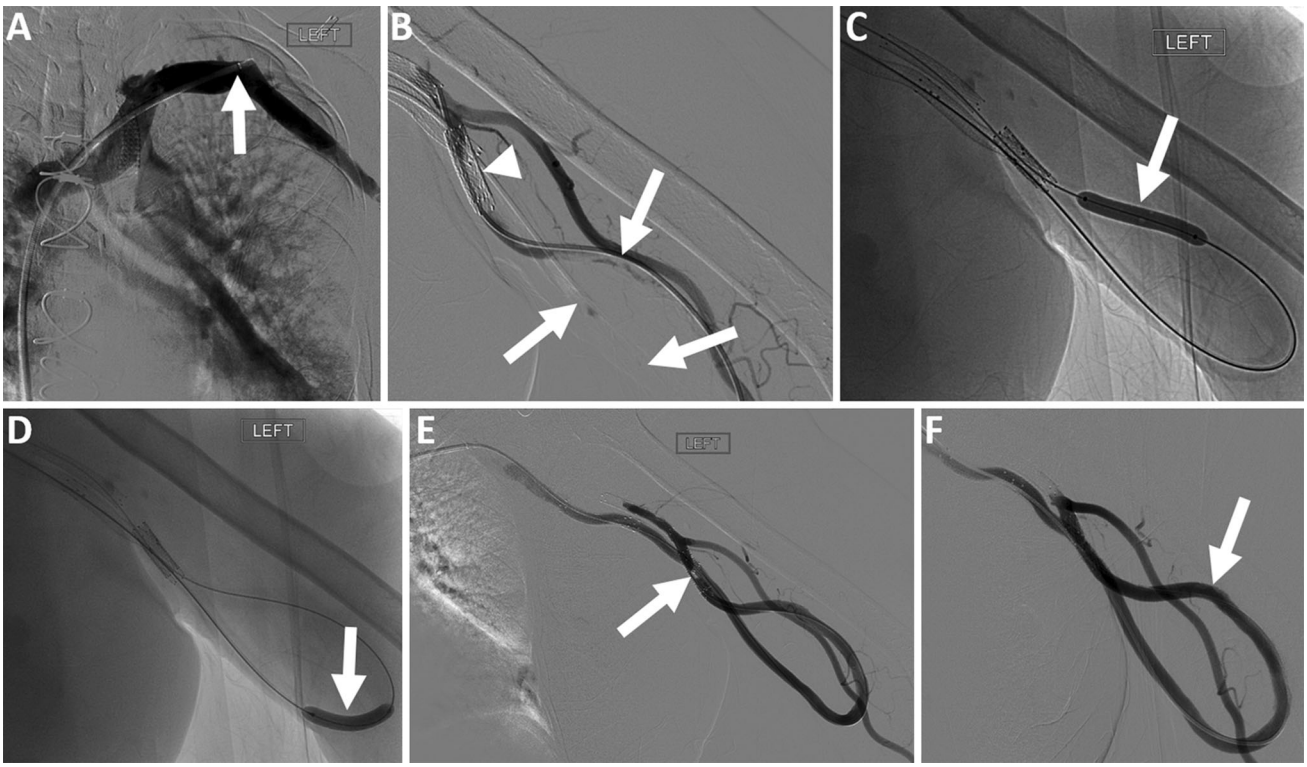

Fig. 1 A 68-year-old woman with end-stage renal disease and a thrombosed left upper extremity AV graft. **A** Right common femoral vein access was obtained and a 6-French, 65 cm sheath was placed. Contrast injection through a 120-cm Glidecath (Terumo Medical) positioned in the subclavian vein (white arrow) demonstrates free flow to the right atrium. **B** The catheter was further advanced across the arterial anastomosis with contrast injection demonstrating static flow within the outflow vein (white arrows) as well as an occluded stent (white arrowhead) near the arterial anastomosis. **C**, **D** After intravenous heparin was given, pulse-spray thrombolysis of the outflow vein was performed with 6 mg tPA. The clot was then balloon-macerated and swept with a 6 mm × 4 cm Armada balloon (white arrows). **E** Repeat digital subtraction contrast injection revealed a small amount of residual clot (white arrow) in the outflow vein near the arterial anastomosis. Additional balloon maceration and sweep were performed. **F** Completion injection demonstrates patency throughout the graft with no residual clot (white arrow). The access was functional at the time of dialysis

performed. Over a stiff wire, angioplasty of identified stenotic lesions including the central veins, outflow veins, venous anastomosis, intra-graft, arterial anastomosis, arteriovenous anastomosis, and inflow artery was performed. Types of angioplasty balloons used included Armada (Abbott Vascular; Chicago, IL), Charger (Boston Scientific; Marlborough, MA), and Evercross (Medtronic; Minneapolis, MN) of various sizes depending on lesion characteristics. Following re-establishment of flow, the sheath was removed and hemostasis achieved with manual compression.

Variables, Definitions, and Outcomes

Variables are as follows: access type, age, configuration, prior interventions, presenting indication, sheath size, thrombectomy method, angioplasty site, fluoroscopy time, radiation dose, technical and clinical success, minor and major complications, post-intervention primary and secondary patency. Procedural success was defined as anatomic success plus at least one indicator of clinical success. Anatomic success is defined as $< 30\%$ residual diameter stenosis of the treated vascular segment for stenoses without thrombosis and defined as restoration of flow combined with a $< 30\%$ residual diameter stenosis for any significant underlying stenosis for thrombosed accesses. Clinical success was defined as re-establishment of normal dialysis for at least one session. Primary patency was defined as interval following intervention until repeated thrombosis or intervention. Secondary patency was defined as interval following intervention until circuit was abandoned or surgically managed. Fluoroscopy time was recorded in minutes. Dose area product was recorded in μGym^2 and reference air kerma in mGy. Complications were classified based upon the *Society of Interventional Radiology Quality* Improvement Guidelines [13].

Statistical Analysis

Statistical analysis was performed using SPSS version 25 (IBM; Armonk, NY).

Results

Patient characteristics and dialysis access configurations are shown in Table 1. Presenting indication was poor dialysis secondary to thrombosed (n = 11; 73%) or stenosed (n = 4; 27%) access.

Right common femoral vein access was used in all patients using sheath size of 6–8-French (most common: 7-French sheath [n = 10; 67%]). Most thrombectomies (n = 11) required both pharmacologic (2–6 mg tPA—Activase; Genetech; San Francisco, CA) and clot maceration (most commonly Armada 6 × 20 or 6 × 40 mm) (n = 9; 82%). All accesses required balloon angioplasty to treat underlying stenosis commonly at the outflow vein (12/15; 80%) or arteriovenous anastomosis (9/10; 90%) (Table 2). Mean fluoroscopy time was 26.43 ± 9.69 min (range 7.3–45.8 min). Air kerma and dose area product were 178.06 ± 225.77 mGy (range 30–875 mGy) and 57,768.83 ± 87,553.29 μGym^2 (range 8531–318,257 μGym^2), respectively. All patients were able to ambulate in 2 hours without suture-assisted closure. Procedural and clinical success rates were 93% (14/15) and 80% (12/15), respectively. The procedural failure was due to persistent stenotic lesions despite intervention which led to subsequent abandonment of the access. Clinical failure was due to failed dialysis immediately following intervention in three patients. There were no complications.

Mean post-intervention primary patency and secondary patency durations were 2.83 ± 3.41 (0.03–8.5) and 4.75 ± 6.79 (0.1–16.07) months, respectively. Based on individual operator preference at the time of procedure, the most common re-intervention access approach was direct percutaneous access (n = 5; 33%) followed by right internal jugular vein (n = 3; 20%) and transfemoral vein (n = 1; 7%) access. Mean patency duration for direct access and transjugular re-intervention was 4.6 and 3.34 months, respectively. There were seven abandoned accesses. Indications for abandonment included inability to treat original lesion (4/7; 57%) and surgeon preference (3/7; 43%). Abandoned accesses were replaced with a tunneled dialysis catheter (TDC) (n = 5; 33%) or a newly constructed graft or fistula (n = 2; 13%). Primary patency rates at 1 and 3 months were 50% and 35%, respectively. Secondary patency rates at 1 and 3 months were 58% and 30%, respectively. Number at risk in the secondary patency group was greater than the primary patency group at greater than 6 months (2, 2, and 1 at risk at 9, 12, and 15 months, respectively) (Kaplan–Meier, Fig. 2).

Discussion

Results of this study indicate that transfemoral-mediated upper extremity dialysis interventions are safe, feasible, and technically effective. Through a single access, the operator may treat multiple lesions along the arteriovenous circuit. Since crossing sheaths are not within the outflow vein, thrombus tends to be much easier to clear. Further, the operators' hands are never within the fluoroscopic field. Potential complications such as direct puncture site hematoma secondary to access into a high flow system or failure of purse-string stitches are also avoided. With the potential for reduced bleeding complications and hospital stays, a transfemoral approach may offer not only medical but also economic benefits.

Many benefits offered by a transfemoral approach are shared with the transjugular approach [8–10]. Ferral et al.; however, notes one disadvantage of this approach,

Table 2 Characteristics of procedure

Characteristics	Mean ± SD or number (%)
Type of intervention	
Angioplasty	4 (27)
Percutaneous thrombolysis/thrombectomy + angioplasty	11 (73)
Location of stenosis	
Outflow veins	12 (80)
Anastomosis/proximal 2 cm	13 (87)
All other sites	8 (53)
Number of lesions	
1	5 (33)
> 1	10 (67)
Fluoroscopy time (min)	26.43 ± 9.69
Radiation dose air kerma (mGy)	178.06 ± 225.77
Kerma air product (mGy*cm^2)	57,768.83 ± 87,553.29

Locations of stenosis for anastomosis include arteriovenous fistula, venous graft, and arterial graft; all other sites include central veins, intra-graft, and inflow artery

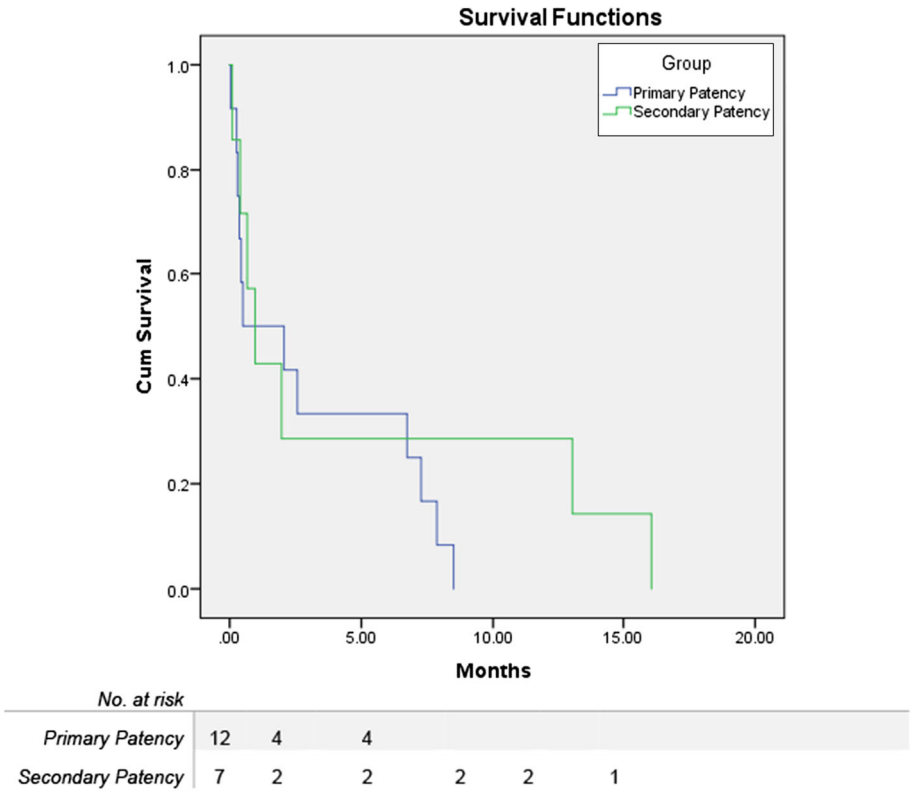

Fig. 2 Kaplan–Meier curves showing primary and secondary patency

specifically technical difficulty with angulation and cannulation of outflow veins from an ipsilateral transjugular access. This issue with retrograde catheterization may require puncture of the outflow vein in order to use snares to direct the catheter system into the outflow tract making for a cumbersome process. While it may still be difficult to cross the valve into a thrombosed fistula or graft from a femoral venous approach, the angulation issue is less of a concern from this approach given the smoother transition to the outflow vein.

Procedural and clinical success rates in this study were 93% and 80%, respectively. One failed access was due to persistent stenotic lesions following intervention. Several reasons contributed to treatment failure including access age (10.45 years) and multiple prior interventions. Future encounters of recalcitrant stenosis despite angioplasty intervention may warrant stent–graft placement. Three accesses were clinical failures due to unsuccessful hemodialysis following intervention. Low post-intervention primary patency duration for these failed accesses may be attributable to underlying comorbidities. When comparing mean patency durations, grafts and fistulas appear to function longer after re-intervention via direct access and transjugular approach though direct comparison was not possible due to the small data set.

Limitations of this study include its small sample size and retrospective nature. The small sample size also led to the mixing of patients undergoing fistulograms and declots as well as AVFs and AVGs which some may see as a methodologic flaw. Future studies may benefit from further stratification of the study population. Ideally, a direct comparison between the conventional access approach and transfemoral route would help determine the best method of intervention.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This study was conducted with institutional review board approval and complied with the Health Insurance Portability and Accountability Act.

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