

# TRA for Hemodialysis Access Interventions

Transradial access options in dysfunctional hemodialysis fistula management.

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**L**ong-term maintenance of native arteriovenous fistulas (AVFs) in hemodialysis patients remains a technical challenge to all interventionists. Various endovascular techniques for the diagnosis and treatment of dysfunctional and nonmaturing fistulas have been described.<sup>1-7</sup> One of the many challenges faced by the interventionist when evaluating hemodialysis access is the ability to obtain the best access point to the fistula to both diagnose and adequately treat the AVF in a safe, effective, and time-efficient manner.

Currently, there is no consensus regarding the best approach for AVF interventions. The most common puncture sites are directly into the vein; for declotting procedures or simultaneous interventions at the anastomosis and within the venous outflow, two transvenous punctures are used, providing antegrade and retrograde access. Direct brachial artery puncture with small-gauge needles has also been reported, with the purpose of facilitating angiographic identification of the AV anastomosis.<sup>2</sup> Intervention from a brachial approach is less frequent due to the larger sheath sizes that are required and the concomitant risk of arterial injury and upper extremity ischemia. Rarely, access to the AVF may be obtained via the ipsilateral jugular vein.<sup>3</sup> Although not commonly employed, there has been recent interest in using a transradial artery approach to gain access to the AVF. This approach affords excellent identification of the arterial anastomosis, as well as allowing easy intervention for anastomotic and venous outflow lesions.<sup>4-7</sup>

## CHOOSING AN AVF ACCESS SITE

The optimal access point for the diagnosis and management of any hemodialysis fistula varies due to operator preferences, suspected type and sites of abnormality, and the anatomic pattern of the fistula. Decisions regarding the puncture site(s) are predicated on physical examination, knowledge of the surgical construction of the fistula, and review of previous imaging studies. Notably, because AVFs often fail to mature, are dysfunctional, or thrombose due to

stenotic lesions at or near the arterial anastomosis, the puncture site must often allow direct-line catheter and wire manipulation to this region. Additional problems, including vein stenosis, competing collaterals, and areas of aneurysm dilation requiring endovascular therapy, often also simultaneously occur in the venous outflow tract or central veins. Ideally, the goal for the interventionist is to choose an access point that is well suited to identify and treat all of these lesions to reduce needle punctures, lessen procedure time and variation, and allow rapid restoration of access function so that the patient can quickly return to hemodialysis (see *Access Advantages and Disadvantages* sidebar).

## Transvenous Access

Generally considered the standard approach, transvenous access is usually relatively simple because the access vein is dilated in mature fistulas and only rarely spasm. The dilated vein is also well suited to accommodate large sheaths that may be needed for larger-diameter angioplasty balloons and stents. Drawbacks of the antegrade transvenous approach include difficulty identifying the AV anastomosis and afferent artery during reflux angiography (ie, during cuff inflation or balloon occlusion of the venous outflow), possible puncture site occlusion during compression after the procedure, and a potential risk for distal embolization into the hand when crossing anastomotic occlusive lesions containing thrombus in a retrograde fashion. Even in cases in which transvenous retrograde access allows for satisfactory evaluation of the anastomosis and afferent artery, it generally leads to awkward positioning and increased operator radiation exposure during the procedure.

## Transbrachial Access

The antegrade transbrachial approach allows for excellent visualization of the arterial and venous vasculature, including collateral vessels of the arm; however, its routine use is not generally recommended. The potential for brachial artery complications when using sheaths up to 7 F in size is by and large not worth the risk.<sup>8</sup>

### Transradial Access

The use of transradial access (TRA) is a widely accepted and well-described technique for coronary artery interventions and for the diagnosis and treatment of aortic and mesenteric disease.<sup>9</sup> Since 2006, several reports from Asian investigators have shown that the use of TRA for the dysfunctional AVF is safe and feasible.<sup>4-7</sup> Kawarada et al initially described the use of TRA in 11 patients with predominantly nonthrombosed Brescia-Cimino fistulas. There were no occurrences of hand ischemia or puncture-site complications observed out to 6 months after intervention.<sup>3</sup> Heparin and isosorbide dinitrate were administered through the radial sheath to prevent spasm and thrombosis.<sup>4</sup> Lin et al subsequently reported on transradial interventions in 165 upper arm fistulas, more than half of which were performed for thrombosed accesses. Heparin was used, but no vasodilator was administered. Two episodes of radial artery spasm preventing thrombosis and two asymptomatic radial dissections occurred, although no patient developed hand ischemia.<sup>7</sup> Most recently, Chen and associates described their experience with 154 transradial Brescia-Cimino fistula treatments (including 99 thrombosed accesses). There was a differen-

tial technical success for nonoccluded fistulas compared to fistulas having a “fibrous” occlusion, with success noted in 99% and 46%, respectively. Overall 30-day primary patency was 75%.<sup>5</sup> Taken together, the anatomic or clinical success rates from these reports are comparable to those reported in previous studies using the more traditional transvenous approach.<sup>4-7</sup>

The TRA approach offers unique potential advantages for the evaluation and treatment of dysfunctional AVFs. The radial artery is easily accessible by manual palpation or duplex sonography, and operator fluoroscopic exposure is substantially reduced with this approach. Most fundamentally, the radial approach permits evaluation and treatment of the entire fistula from the afferent artery through to the central veins with only a single puncture; to accomplish this, the puncture site must be distal to the AV anastomosis site (below the radiocephalic anastomosis for Brescia-Cimino fistulas). In occluded or nonmaturing fistulas, the radial artery distal to the anastomosis is often not compromised and usually provides easy identification and catheterization of the AV anastomosis, which is often difficult to achieve with the typical approach using retrograde cannulation of the venous

#### ACCESS ADVANTAGES AND DISADVANTAGES

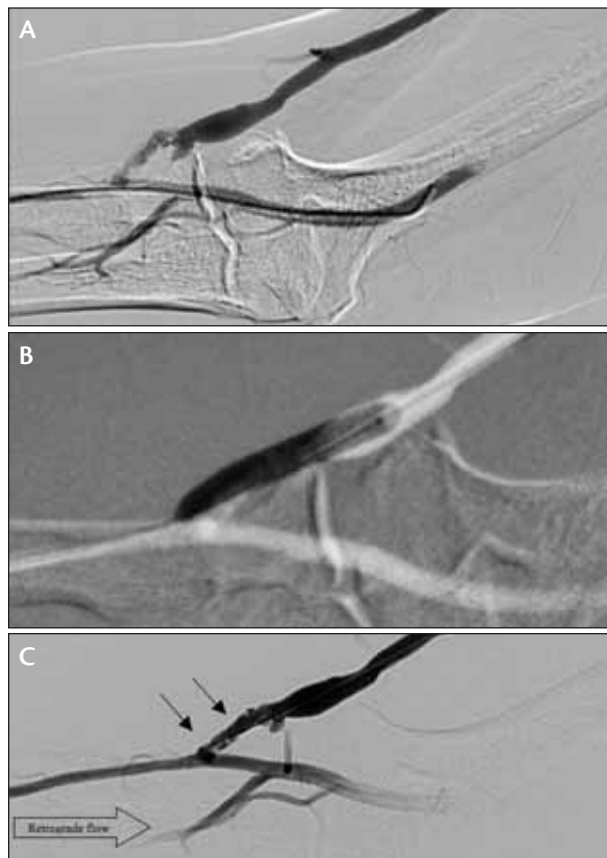
Approach	Advantages	Disadvantages
Antegrade Brachial Artery Approach	Excellent depiction of anatomy	Puncture site complications (pseudoaneurysm, hematoma, spasm)
	Facilitates crossing of anastomosis	Long route with “U” turn at anastomosis
	All lesions treated via one puncture	increases difficulty
	Consider when transvenous approach fails	
Distal Radial Artery Approach	Direct approach across radiocephalic anastomosis	Radial artery must be palpable
	Sheath distal to anastomosis does not interrupt flow to fistula	Location of anastomosis generally should be > 2 cm proximal to radial styloid process
	Relatively easy-to-stop bleeding at puncture site	End-to-end anastomosis not feasible
	No fistula compression to achieve hemostasis	Small radial artery more prone to trauma
	Visualize arteries and veins	Small sheath size may limit balloon size
	An occlusion at the puncture site is usually well tolerated because of ulnar supply to the hand	Difficult to treat upper arm access and central veins
Transvenous Approach	Easily accessible for puncture	Depiction of the anastomosis and afferent artery may be difficult to evaluate during reflux angiography
	Well suited for larger sheath sizes	May require two access sites for complete intervention
		Risk for distal embolization into the hand when crossing the anastomosis
		Risk of puncture site occlusion during compression after procedure



**Figure 1.** Patient open preparation for TRA. After preparation, a sterile glove is placed over the patient's hand to allow manipulation of the hand and preserve a sterile procedure field.

outflow. Further, because the anastomosis is crossed from the arterial side into the venous outflow with a radial artery puncture, the potential risk of arterial embolization when treating thrombosed fistulas is minimized (ie, thrombus would more likely be mobilized into the venous tract). Finally, postprocedure hemostasis of a radial puncture is easily achieved despite the intraprocedural use of heparin or thrombolytic agents because of its favorable anatomic location and easy compressibility.

There are also several potential drawbacks to the use of TRA. Technically, the TRA puncture can be difficult for those who are not comfortable with this technique; however, there is only a minimal learning curve in developing proficiency. Puncture of the radial artery may be difficult if the pulse is weak. This can be overcome with the use of ultrasonography for an image-guided puncture. Infiltration of the subcutaneous periradial tissues with lidocaine containing 500 µg of nitroglycerin can also cause radial artery vasodilation and facilitate puncture.<sup>10</sup> Temporary radial artery occlusion can occur during puncture and is seen in < 5% of patients undergoing TRA for coronary interventions.<sup>11</sup> Repeated puncture of the radial artery for access may lead to eventual occlusion or stenosis and prevent this approach for access; however, Chen et al found that 98.7% (152/154) of patients had a good palpable pulse at follow-up.<sup>5</sup> Due to the relatively small size of the radial artery, sheath size may be limited to a 5- or 6-F sheath. This potentially prevents the use of larger balloon catheters for central venous angioplasty, necessitating an additional transvenous puncture if such devices are necessary. The availability of newer low-profile monorail balloons (eg, Sterling balloon catheter, Boston Scientific Corporation, Natick, MA) provide the ability to perform 8-mm percutaneous transluminal

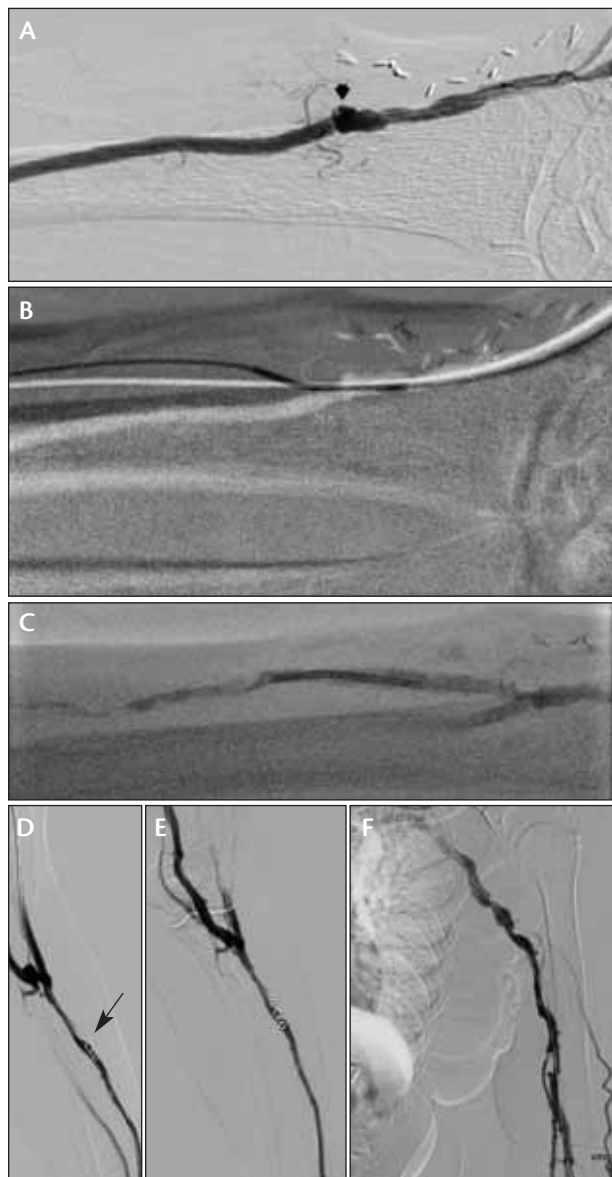


**Figure 2.** Stenotic brachiocephalic vein upper arm fistula. Contrast injection through a 4-F catheter positioned in the brachial artery shows severe stenosis just distal to the arterial anastomosis (A). After balloon dilation (B), there is resolution of the lesion (arrows) (C) and improved fistula flow. Note that completion arteriography performed through the radial sheath shows preferential retrograde flow into the fistula.

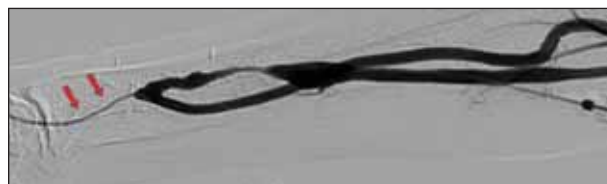
angioplasty (PTA) via a 4-F sheath and up to a 10-mm PTA via a 5-F sheath.

## PATIENT SELECTION AND PREPARATION

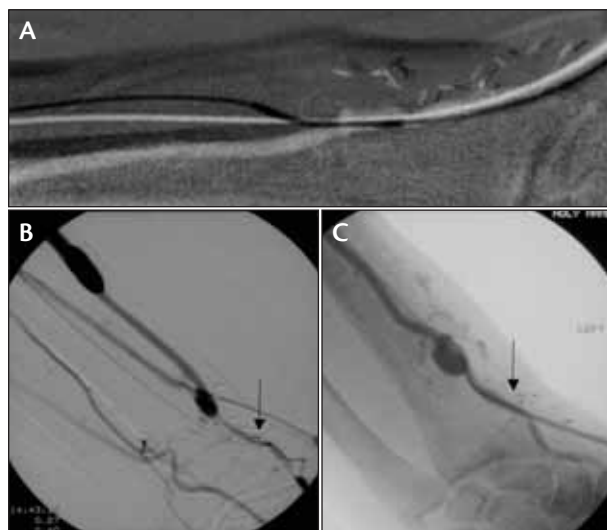
When considering a patient for TRA, the interventionist must evaluate the radial artery and assess the radial/ulnar artery circulation. This can be accomplished by performing the Allen's test. To perform the Allen's test, both the radial and ulnar arteries are compressed until blanching of the hand occurs. The examiner then releases pressure on the ulnar artery to determine if flow returns to the radial aspect of the hand, implying patency of the palmar arch. If hyperemia does not occur (usually within 5–7 seconds), radial access should be avoided, because the patient does not have dual circulation to the hand. TRA in cases of an abnormal Allen's test result may result in hand ischemia and a substantial risk of radial artery occlusion.<sup>12</sup>



**Figure 3. Thrombosed radiocephalic fistula.** Radial artery angiography via the inner dilator of a 5-F micropuncture kit reveals a patent radial artery (A). The location of the anastomosis is seen as a focal contrast outpouching (arrowhead), which is the typical appearance. The fistula is then cannulated with a 4-F angled catheter and Glidewire (Terumo Interventional Systems, Somerset, NJ) under roadmap guidance (B). Contrast injection performed after catheterization of the fistula shows extensive thrombus (C). After the injection of recombinant tissue plasminogen activator, anastomotic angioplasty, and clot mobilization with a 5-mm balloon, there is restored flow in the fistula. Note the coils from previous collateral vein embolization (arrow) (D). A basilic venous stenosis (not shown) was subsequently treated with PTA and stenting, with resulting excellent venous outflow (E and F).



**Figure 4. Stenotic radial artery preventing TRA.** Fistulography performed via venous puncture shows a diminutive radial artery not suitable for transradial puncture (open arrows). This patient did not have a sufficient pulse to allow puncture during initial assessment.



**Figure 5. Initial images at the time of transradial declotting of a radiocephalic fistula (A). A fistulography performed via TRA at 1-month (B) and 11-month (C) follow-up shows preserved radial artery patency (arrows).**

Correct positioning of the wrist is important. The wrist should be hyperextended 60° and may be supported by placement of a towel underneath the wrist. To maintain sterility, the interventionist may place a sterile glove on the patient's hand and cover it with a sterile towel (Figure 1). Using physical examination or sonography, the radial artery should be punctured at least 1 to 2 cm distal to the venous anastomosis to allow sufficient distance for sheath insertion and anastomotic interventions. When evaluating upper arm fistulas using a TRA approach, the radial artery can be punctured at its most accessible location as determined by the pulse examination.

## CANNULATION AND INTERVENTION

We generally perform the transradial puncture with a 21-gauge, 7- or 4-cm-long needle either by direct palpation or under direct ultrasound guidance. The use of ultrasound guidance for TRA is not usually needed; however, when performing TRA for AVF interventions, ultrasound can be very

helpful to visualize the location and distance of the anastomosis from the intended puncture site to confirm puncture entry site distal to the anastomosis. Advancement of the 0.018-inch guidewire into the radial artery can be visualized with either ultrasound or fluoroscopic guidance.

The 3-F inner dilator of a coaxial micropuncture kit is then advanced in the radial artery proximal to the AV anastomosis. In most cases, complete angiographic assessment of the dysfunctional AVF can be performed through the 3-F catheter. Interestingly, due to preferential flow into a nonthrombosed fistula, the direction of flow in the radial artery is often retrograde, so that even upper arm AVFs can be visualized with injection of contrast near the wrist. However, if the anastomosis of an upper arm fistula is not seen, or in cases in which an upper arm AVF is thrombosed, then the 20-cm-long, 3-F inner portion of a Neff percutaneous access set (Cook Medical, Bloomington, IN) or equivalent can be inserted to allow direct angiography and identification of the AV anastomosis.

Using this approach, dilation and insertion of a larger sheath is only performed once it is deemed that intervention is required. We generally advance a 4- to 5-F sheath into the radial artery proximal to the anastomosis. A 0.035- or 0.018-inch wire is left in place, and the sheath is pulled back while gently injecting contrast. This is done so that the interventionist can easily visualize the location of the sheath in the artery distal to the anastomosis while maintaining wire access in case of inadvertent dislodgement. Once the anastomosis is seen, roadmap guidance is performed to guide catheterization of the fistula using a 4-F angled catheter. If it is necessary to maintain the wire position while injecting contrast, this can be achieved by injecting through the 4-F catheter over a 0.018- or 0.014-inch wire using an attached Check-Flo sidearm adapter (Cook Medical).

Once TRA is established, it is relatively simple to complete any intervention, including declotting, balloon angioplasty, and collateral embolization. For declotting, the occluded fistula is cannulated, and a 4-F catheter is advanced into the proximal portion of the occluded AVF. Through a Check-Flo adapter, recombinant tissue plasminogen activator is then injected while gently advancing the catheter over the wire to promote distribution within the clotted access. Dilation and mobilization of thrombus from the arterial anastomosis through the venous outflow is then performed using a 4- to 5-mm PTA balloon with low-pressure hand inflation. Once thrombus is cleared and flow is restored, angioplasty and other interventions can then be performed in the usual fashion. Examples of transradial interventions and limitations are shown in Figures 2 through 4.

Two important technical considerations are notable in our experience. First, after the procedure, we have not used the radial artery compression bands that are typical-

ly described for hemostasis after transradial puncture for cardiac catheterization. Instead, we achieve hemostasis using nonocclusive manual compression and TipStop compression dressings (Gambro, Lakewood, CO). Second, we have not routinely anticoagulated our patients for transradial dialysis interventions. Despite these technical factors, we have had no occurrence of hand ischemia and only rare instances in which there is subsequent occlusion of the radial artery preventing future access (Figure 5).

## CONCLUSION

TRA is easy to learn and is accompanied with very few complications. Its use in dysfunctional dialysis access is safe, efficient, and effective. Notably, TRA allows most interventions for nonmaturing, thrombosed, or dysfunctional fistula to be performed via a single puncture site, greatly reducing operator fluoroscopy exposure and providing a more ergonomic approach for the interventionist. Although our experience suggests that many, if not most, AVF interventions can be performed using this approach, a preprocedure assessment including performance of an Allen's test and examination to determine the adequacy of radial puncture is critical for success. ■

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1. Turmel-Rodrigues L, Raynaud A, Louail B, et al. Manual catheter-directed aspiration and other thrombectomy techniques for declotting native fistulas for hemodialysis. *J Vasc Interv Radiol* 2001;12:1365-1371.
2. Manninen HI, Kaukanen ET, Ikäheimo R, et al. Brachial artery access: endovascular treatment of failing Brescia-Cimino hemodialysis fistulas—initial success and long-term results. *Radiology*. 2001;218:711-718.
3. Basile A, Medina JG, Lupattelli T, et al. Internal jugular vein access for the interventional management of nonfunctioning arterio-venous haemodialysis fistulas. *Eur J Radiol*. 2004;52:288-292.
4. Kwarada O, Yokoi Y, Nakata S, et al. Transradial intervention for native fistula failure. *Catheter Cardiovasc Interv*. 2006;68:513-520.
5. Chen SM, Hang CL, Yip HK, et al. Outcomes of interventions via a transradial approach for dysfunctional Brescia-Cimino fistulas. *Cardiovasc Interv Radiol*. 2009;32:952-959.
6. Wu CC, Wen SC, Chen MK, et al. Radial artery approach for endovascular salvage of occluded autogenous radial-cephalic fistulae. *Nephrol Dial Transplant*. 2009;24:2497-2502.
7. Lin YS, Lin PC, Hsu JT, et al. Feasibility of trans-radial approach in percutaneous intervention for upper arm dialysis access. *Semin Dial*. 2008;21:567-574.
8. Trerotola SO, Turmel-Rodrigues LA. Off the beaten path: transbrachial approach for native fistula interventions. *Radiology*. 2001;218:617-619.
9. Campeau L. Percutaneous radial artery approach for coronary angiography. *Cathet Cardiovasc Diagn*. 1989;16:3-7.
10. Candemir B, Kumbasar D, Turhan S, et al. Facilitation of radial artery cannulation by periradial subcutaneous administration of nitroglycerin. *J Vasc Interv Radiol*. 2009;20:1151-1156.
11. Stella PR, Kiemeneij F, Laarman GJ, et al. Incidence and outcome of radial artery occlusion following transradial artery coronary angioplasty. *Cathet Cardiovasc Diagn*. 1997;40:156-158.
12. Greenwood MJ, Della-Siega AJ, Fretz EB, et al. Vascular communications of the hand in patients being considered for transradial coronary angiography: is the Allen's test accurate? *J Am Coll Cardiol*. 2005;46:2013-2017.