The Transpedal Approach for Peripheral Intervention: Innovative or Alternative?

Is transpedal access the future of peripheral revascularization?

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Peripheral artery disease (PAD) has reached pandemic proportions, with an estimated 202 million individuals currently affected around the world. This estimate is a 23.5% increase since 2001, according to a meta-analysis conducted by Fowkes and colleagues.[1] The prevalence of patients with multiple chronic diseases and advanced age has increased, which has led to the need for advancement of endovascular revascularization for PAD.

The current trend in health care is to provide patients with safe, effective care while containing cost and minimizing risk. In coronary revascularization, transradial arterial access has been proven safer than the femoral arterial approach, and its use has been increasing.[2] Similarly, a transpedal approach may potentially exemplify similar superiority in lower extremity revascularization, both below the knee and above the knee. This article reviews the technique for complete lower extremity revascularization using the transpedal approach. Our experiences demonstrate that the transpedal approach can be successfully performed to intervene in the common iliac, superficial femoral (SFA), and popliteal arteries, in addition to the tibial and peroneal arteries.

CASE PRESENTATIONS

Case 1: SFA and Anterior Tibial Artery Revascularization

An 82-year-old woman presented to the office with severe recurrent claudication and rest pain. She had multiple comorbidities, including hypertension (HTN), diabetes mellitus (DM), coronary artery disease, heart failure with ejection fraction of 45%, and a stent in the left SFA. Ankle-brachial index (ABI) measurements were 0.45 on the right and 0.46 on the left, indicating severe bilateral PAD.[3] Arterial Doppler images revealed severe disease with occlusion of the left SFA and diffuse monophasic wave on all tibial and peroneal arteries. The transpedal approach was chosen over a femoral approach because of severe extensive infrapopliteal disease and the expected occlusion of the SFA origin.

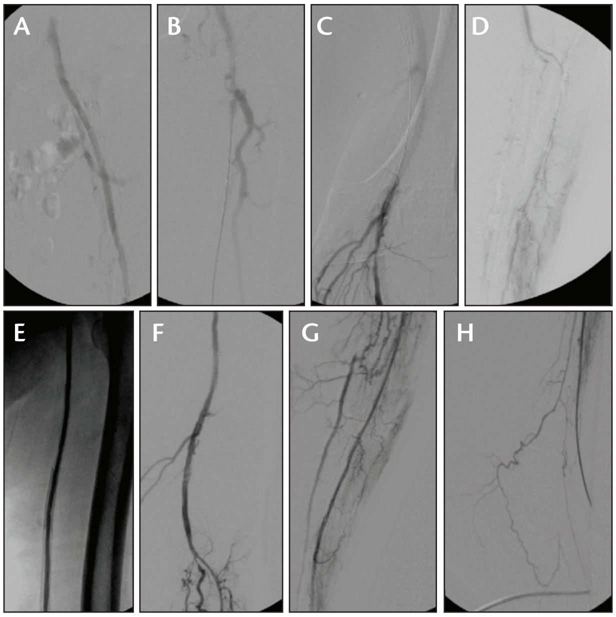

Figure 1. Patent left common iliac, external iliac, and common femoral arteries (A). Totally occluded left SFA with patent profunda artery (B). Patent distal SFA and diffuse disease of the popliteal artery (C). Extensive diffuse disease and occlusion of the infrapopliteal arteries (D). Postinterventional angiograms: patent left SFA (E), popliteal artery (F), and anterior tibial artery (G), with collaterals to the posterior tibial and plantar arteries (H).

Procedure Description

The left anterior tibial artery was accessed using a 21-gauge needle and ultrasound guidance. An 0.021-inch wire was placed in the anterior tibial artery, and the needle was exchanged for a 4-F X 11-cm introducer sheath. The wire was then removed, and the sheath was flushed. Placement was verified with retrograde angiography.

An intra-arterial (IA) cocktail of 100 µg of nitroglycerin, 2,500 units of heparin, and 250 µg of nicardipine was given to prevent spasm and distal thrombosis. A 0.035-inch X 260-cm hydrophilic wire was advanced in a retrograde fashion along with a 0.035-inch support catheter into the right common iliac artery. Angiography via a support catheter was used to verify placement. The 0.035-inch wire was removed, and angiography with distal runoff was performed through the support catheter. The runoff displayed heavily calcified vessels with 100% occlusion of the left SFA and a total occlusion of the left anterior tibial, posterior tibial, and peroneal arteries (Figure 1A through 1D).

Initially, 70 units/kg of heparin, with varied subsequent dosing, was given intravenously to maintain an activated clotting time (ACT) of 250 seconds throughout the procedure. The 0.035-inch wire was exchanged for a 0.014-inch Viperwire (Cardiovascular Systems, Inc.). The Viperwire was placed in the distal aorta, and a 1.25-mm Diamondback 360° orbital atherectomy device (Cardiovascular Systems, Inc.) was used. Orbital atherectomy was performed in the left SFA and left anterior tibial artery. Angiography after atherectomy confirmed vessel patency.

A 4- X 220-mm balloon and a 2.5- X 250-mm balloon catheter were used to dilate the left SFA and left anterior tibial artery, respectively. Angiography confirmed vessel patency and TIMI III flow (Figure 1E through 1H). The Viperwire and catheter were then removed. Another IA cocktail of 100 µg of nitroglycerin, 2,500 units of heparin, and 250 µg of nicardipine was given before sheath removal. The sheath was removed, and the patient was discharged within the hour.

Case 2: External Iliac and Common Femoral Revascularization

A 65-year-old woman presented to the office with rest pain and a nonhealing ulcer on the left great toe. She had multiple comorbidities, including DM, HTN, chronic obstructive pulmonary disease, and a history of smoking.

Initially, the traditional femoral arterial approach was used, and the right femoral artery was cannulated with a 5-F X 11-cm sheath. Angiography of the abdominal aorta with distal runoff showed extensive diffuse disease in the right common iliac artery as well as mild disease in the left common and internal iliac arteries. The left external iliac artery was completely occluded from the origin to the proximal left common femoral artery (CFA) and reconstituted at the proximal left SFA (Figure 2A and 2B). There was no stump at the left external iliac artery, which made intervention from the contralateral approach difficult. The tibial peroneal trunk remained intact with mild disease, which made the transpedal approach optimal for this patient.

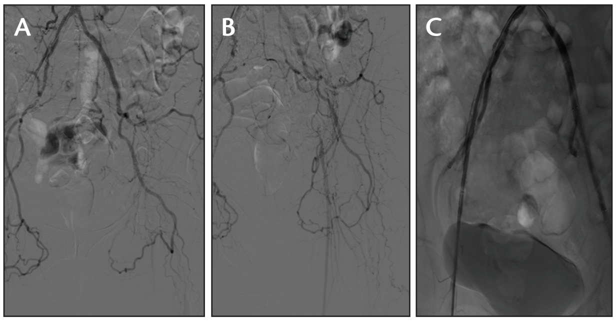

Figure 2. Mild stenosis of the left common iliac artery and total occlusion of the left external iliac artery (A). Total occlusion of the external iliac artery with reconstitution at the left SFA (B). Postinterventional angiogram of the left external iliac artery (C).

Procedure Description

Left posterior tibial access was achieved using ultrasound guidance with a 21-gauge needle and an 0.021-inch wire. The needle was exchanged for a 4-F X 11-cm sheath, and the 0.021-inch wire was removed. An IA cocktail of 250 µg of nicardipine, 2,500 units of heparin, and 100 µg of nitroglycerin was given.

An 0.035-inch hydrophilic wire was advanced to the left common iliac artery in a retrograde fashion. An 0.035-inch support catheter was advanced over the hydrophilic wire, and the wire was exchanged for the 0.014-inch Viperwire. Angiography of the left common iliac artery was performed via the support catheter, and wire placement was verified. The support catheter was removed, and a 1.5-mm Diamondback 360° orbital atherectomy device was placed in the left external iliac. Orbital atherectomy was performed to the left external iliac and to the left CFA.

The Diamondback 360° device was removed, a 4- X 150-mm balloon was placed in the left external iliac, and angioplasty was performed to the external iliac as well as the left CFA. The balloon catheter was removed and exchanged for a self-expanding stent. The left external iliac stent was deployed. The 0.035-inch support catheter was placed in the left common iliac artery. Left leg angiography was performed and TIMI III flow established (Figure 2C). The support catheter was removed, and an IA cocktail of 100 µg of nitroglycerin, 250 µg of nicardipine, and 2,500 units of heparin was given. The sheath was removed, and the patient was discharged home in 1 hour.

Case 3: Anterior and Posterior Tibial Revascularization

A 78-year-old woman presented to the clinic with a nonhealing ulcer on the left second toe. She had multiple comorbidities, including HTN, DM, coronary artery disease status postcoronary artery bypass, and PAD with a nonhealing ulcer. She also had right femoropopliteal bypass surgery. A previous angiogram showed severe infrapopliteal disease with very poor distal runoff (Figure 3A). She was referred for limb salvage intervention. She was found to have total occlusion of the left anterior tibial artery, total occlusion of the peroneal artery, and a subtotal occlusion of the left posterior tibial artery (Figure 3A). We decided to proceed with a transpedal approach because of the patient's previous right femoral popliteal bypass surgery and extensive scarring of the right groin.

Procedure Description

The left anterior tibial artery was accessed using ultrasound guidance with a 21-gauge needle. An 0.021-inch wire was advanced into the anterior tibial artery, and the needle was exchanged for a 4-F X 11-cm sheath. The sheath was flushed, and an IA cocktail of 100 µg of nitroglycerin, 250 µg of nicardipine, and 2,500 units of heparin was given. Next, 70 units/kg of heparin with varied subsequent dosing was given intravenously to maintain an ACT of 250 seconds.

An 0.035-inch hydrophilic wire and 0.035-inch support catheter were advanced from the left anterior tibial artery and placed in the distal segment of the femoral popliteal artery. The 0.035-inch wire was exchanged for the 0.014-inch Viperwire, a 1.25-mm Diamondback 360° orbital atherectomy device was used to perform atherectomy to the left anterior tibial artery, and the atherectomy device was removed.

A 3- X 220-mm balloon was advanced over the 0.014-inch wire, and angioplasty was performed to the left anterior tibial artery. Angiography was performed to verify vessel patency. A RIM catheter was used to engage the left posterior tibial artery. An 0.014-inch guidewire was advanced to cross the left posterior tibial artery (Figure 3B). The 0.014-inch guidewire was then removed and exchanged for the 0.014-inch Viperwire, a 1.25-mm Diamondback 360° orbital atherectomy device was used (Figure 3C) in the left posterior tibial artery, and the atherectomy device was removed. A 2.5- X 220-mm balloon was advanced, and angioplasty was performed in the left posterior tibial artery. Final angiography verified vessel patency and TIMI III flow (Figure 3D). The wire and balloon were removed. Another IA cocktail of 100 µg of nitroglycerin, 250 µg of nicardipine, and 2,500 units of heparin was given before sheath removal. The sheath was removed, and the patient was discharged within an hour.

Case 4: SFA, Popliteal, and Posterior Tibial Revascularization

A 55-year-old man presented to the clinic with severe right leg claudication that limited his ability to ambulate more than 10 feet at a time. He had multiple comorbidities, including HTN, DM, hypercholesterolemia, aortic valve replacement, and PAD status after percutaneous transluminal angioplasty to the right SFA. ABIs were performed in the office with the results of right, 0.45 and left, 0.6. The claudication and ABI results prompted further evaluation with angiography.

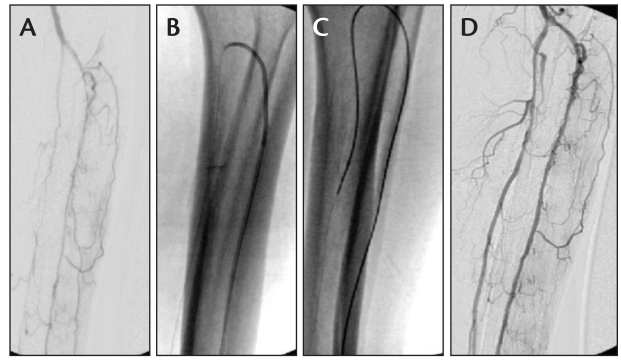

Figure 3. Extensive diffuse infrapopliteal arteries (A). A rim catheter was used to engage the posterior tibial artery (B). Atherectomy was performed to the posterior tibial artery (C). Postinterventional angiogram of patent anterior and posterior tibial arteries (D).

Procedure Description

The conventional femoral approach was initially performed using the left femoral artery. Contralateral runoff evaluation was performed to the right leg. Angiography revealed a total occlusion of the right SFA, which reconstituted at the distal segment just above the knee (Figure 4A through 4C). There was total occlusion of the popliteal artery, a 99% blockage of the right posterior tibial artery, total diffuse disease of the peroneal artery, and total occlusion of the right anterior tibial artery (Figure 4D). Endovascular therapy was recommended because of extensive peripheral vascular disease with poor distal runoff. The 5-F X 11-cm sheath in the right femoral artery was exchanged for a 6-F X 45-cm sheath. The tip of the 6-F sheath was placed in the right SFA. An 0.035-inch wire was used to cross the right SFA lesion. The wire was placed subintimally, and despite multiple attempts, we could not get into the true lumen of the SFA.

It was decided to attempt revascularization from the retrograde transpedal approach. Arterial access was achieved with ultrasound guidance using a 22-gauge needle. An 0.021-inch wire was placed in the right posterior tibial artery and was exchanged for a 5-F X 11-cm sheath. An IA cocktail of 100 µg of nitroglycerin, 250 µg of nicardipine, and 2,500 units of heparin was given to decrease vasospasm and distal thrombosis.

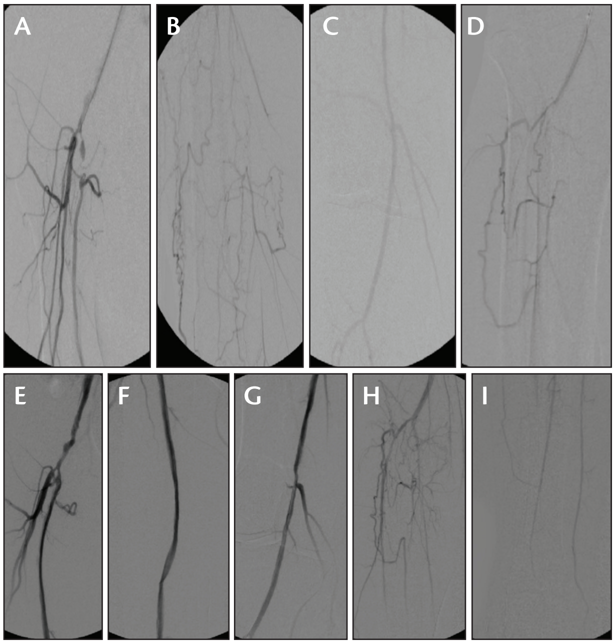

Figure 4. Total occlusion of the right SFA, which reconstitutes at the distal SFA (A–C). Diffuse disease of the anterior and posterior tibial arteries and total occlusion of the peroneal artery (D). Postinterventional angiograms showing the patent right SFA (E, F), popliteal artery (G), anterior tibial artery, and posterior tibial artery (H, I).

The patient was given intravenous heparin to maintain an ACT of 250 seconds. An 0.035-inch hydrophilic wire and an 0.035-inch support catheter were advanced from the right posterior tibial artery to the right SFA. The 0.035-inch wire was exchanged for an 0.014-inch Viperwire, and a 1.5-mm Diamondback 360° orbital atherectomy device was placed in the right posterior tibial artery. Orbital atherectomy was completed in the posterior tibial artery, the device was advanced, and atherectomy was performed in the right SFA. Angiography was performed to visualize vessel patency, and the Diamondback 360° device was removed.

A 4- X 220-mm balloon was advanced over the 0.014-inch wire into the right SFA, and angioplasty was performed. The first balloon was removed, and a 2.5- X 220-mm balloon was advanced into the right posterior tibial artery. Angioplasty was performed, and the balloon was removed. A self-expanding stent was advanced into the right SFA and deployed. The delivery system was removed, and a 4- X 220-mm balloon was advanced into the right popliteal artery, where angioplasty was performed, and the balloon catheter was removed.

Final angiography (Figure 4E through 4I) was performed, and the wire and support catheter were removed. TIMI III flow was verified. Another IA cocktail of 100 µg of nitroglycerin, 250 µg of nicardipine, and 2,500 units of heparin was given before sheath removal, and the patient was discharged home in 1 hour.

DISCUSSION

Our experiences have demonstrated that transpedal access can be used for diagnostic aortography with distal runoff, as well as iliac, CFA, SFA, popliteal, and tibial artery revascularization. All these procedures can be performed safely and cost-effectively in both the inpatient and outpatient settings.

There are several benefits associated with transpedal cannulation for lower extremity revascularization. When using the transpedal approach, a 4-F sheath is used for diagnostic imaging, and a 5-F sheath (with 6-F inner lumen) is used for stenting. The use of smaller catheters and equipment decreases the incidence of postprocedure complications usually associated with femoral puncture, such as hematoma, retroperitoneal bleeding, pseudoaneurysm, and arteriovenous fistula.

Other benefits to the transpedal approach include less contrast utilization, less radiation exposure, and its suitability for outpatients. This last benefit is twofold: it allows patients to go home 1 hour after the procedure, and, because the procedure is performed in an outpatient setting, the number of hospitalizations is reduced, which decreases health care costs.

It is also important to discuss the limitations of this approach. One limitation is that transpedal arterial access is often difficult to achieve. Most patients with PAD also have small-vessel disease. This limitation can be mitigated with ultrasound use for arterial access. We believe that this difficulty can be diminished with appropriate training.

Another limitation is the potential for distal embolization. Arterial spasm, distal occlusion, and embolization are difficulties encountered in the literature with regard to pedal access.[4-6] Tibial arteries are small-diameter vessels, and although 4-F sheaths are used, distal embolization remains a potential complication. During the procedure, we reduce that possibility by maintaining an ACT of 250 seconds and by giving an IA cocktail of 100 µg of nitroglycerin, 250 µg of nicardipine, and 2,500 units of heparin every 30 to 60 minutes.

The final limitation currently experienced with the transpedal approach involves equipment ease of use. Most equipment now used for lower extremity revascularization has been created for larger French-size sheaths, and there is a lack of dedicated distal tibial reentry devices.[4] In our experience, it is difficult to deploy stents in the SFA through a 4- or 5-F sheath. It will be important in the future to modify equipment and increase ease of use with the transpedal approach.

CONCLUSION

Because the current trend in health care is cost containment without sacrificing safe and effective care, it is imperative that we seek innovative methods for endovascular procedures. The shift away from the femoral approach to radial artery cannulation for coronary angiography and revascularization has been proven to decrease the risk of bleeding and groin complications, thus containing costs through decreased hospitalization.[2]

As the incidence of complex PAD grows every year—combined with the climbing number of patient comorbidities—the percutaneous approach continues to be the preferred method for revascularization.[1,6] We believe that the transpedal approach for lower extremity revascularization is the way of the future for a select group of patients. The techniques we use have proven to be safe and effective in above-the-knee and below-the-knee revascularization. We therefore project that the transpedal approach will ultimately become the preferred technique for peripheral intervention. ■

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