Combined retrograde pedal access and antegrade femoral access for endovascular management of patients with critical limb ischemia

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Abstract: Objective: We aimed to analyze the outcomes combined retrograde pedal access and antegrade femoral access in patients with critical limb ischemia with an unsuccessful attempt at revascularization through an antegrade access. **Methods**: Limbs with unsuccessful crossing of the tibial occlusion through antegrade access were included in the study. Limb salvage rate were assessed by Kaplan-Meier analysis. **Results**: 50 limbs were included in the study. Technical success rate was achieved in 96%. The reported limb salvage rates were 70%, 59%, and 53% at 6, 12, and 24 months, respectively. **Conclusion:** Combined retrograde and antegrade access for complex popliteo-tibial occlusions after failed recanalization via antegrade access is safe, effective, and technically feasible to reestablish flow to the foot.

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1. Introduction

Antegrade endovascular interventions via ipsilateral or contralateral femoral puncture are safely used for revascularization of critical limb ischemia (CLI) patients, however, about 20% of patients especially those with complex popliteo-tibial occlusive lesions cannot be revascularized in an antegrade fashion, despite the skills of an experienced interventionalist. For these patients, crural or pedal bypass surgery is an alternative.[1-3] Unfortunately, patients suffering from CLI due to infrapopliteal obstructions are usually high-risk surgical patients because of their many comorbidities.[4] Therefore, the development of materials and endovascular techniques to increase the success rate for total tibioperoneal occlusions is desirable. We report our experience using combined antegrade and retrograde approaches for the treatment of complex popliteo-tibial occlusive disease.

2. Methods

The study was performed at King Salman Hospital, and Al Hada Military Hospital, Saudi Arabia. The study protocol was approved by our institutional review board and written informed consent was obtained from all patients.

Study design

From December 2011 to November 2016, limbs with unsuccessful crossing of the popliteal and/or tibial occlusion through antegrade femoral artery approach were prospectively included in the study for recanalization via combined retrograde pedal access and antegrade femoral approach. All procedures were done by vascular surgeons. All patients were poor surgical candidates because of either presence of medical comorbidities, poor quality runoffs, or lack of suitable conduits. Moreover, all patients had perfusion of either the anterior or posterior tibial artery at the level of the ankle. Patients without visible pedal vessels below the ankle were not eligible for this technique.

Technique

1- Antegrade femoral artery access (fig 1)

Femoral artery access (ipsilateral or contralateral) done in all patients to perform endovascular treatment in the usual antegrade fashion (antegrade approach). However, Antegrade approach was unsuccessful in crossing the popliteal and/or tibial occlusion. Pedal or tibial retrograde access was attempted to perform endovascular treatment using both accesses simultaneously (combined approach).

2- Retrograde Pedal/Tibial Vessel (fig 2-4)

Patients prepped in a way to allow antegrade femoral artery approach (retrograde or antegrade) and the foot prepped for the pedal access. Minimal local anesthesia (plus minimal sedation) used at the pedal access site to avoid compression of the target pedal vessel. Percutaneous approach under ultrasound guidance using echogenic micropuncture needle (sometimes aided by roadmapping from the femoral access site) routine and liberal use of vasodilators through the femoral access site to maximize the caliber of the target vessel.

Position the foot in plantar flexion during dorsalis pedis and anterior tibial artery access, dorsiflex and evert the foot during posterior tibial artery access, and invert the foot during distal peroneal

artery access, Choosing a patent as healthy as possible arterial segment for access site.

Once arterial access gained, (0.018 in) is passed into the vessel under fluoroscopy. We utilize the dilator of the sheath only to secure access in most cases and micropuncture 4-Fr sheath is passed over the wire only when needed. Then the patient is fully heparinized. We perform an angiogram through the dilator to confirm true lumen.

Figure 1. Angiography shows occluded anterior tibial artery.

Figure 2. Dorsalis pedis artery access.

Figure 3. Passage of the wire through the anterior tibial artery.

Figure 4. Angiography through the dilator confirm intraluminal position.

3- Crossing the Occlusion (fig 5,6)

After gaining access to the tibial vessel Crossing the occlusion using 0.018 (300cm) Guidewire (V-18™ Control WireR. Boston Scientific, Natick, Massachusetts), passing the wire till it passes into the patent lumen proximal to the occlusion. If difficulties in passing the guidewire encountered 4 fr micro sheath is inserted and supporting glide catheter is used. After crossing the occlusion, we used to maneuver the guidewire into the tip of a 4- to 5-F catheter inserted through antegrade sheath until the guidewire tip appeared through of the antegrade sheath.

If occasional subintimal passage of the retrograde wire occur we use balloon inflation over each wire just above the proximal end of the occlusion with ends of the balloons are touching each other to disrupt the septum separating the two spaces to create a single lumen, then snaring of the retrograde wire is done. then, intervention done in the standard fashion, from the femoral access. we usually leave the tip of the retrograde wire coming out from the pedal introducer till the end of intervention to improve pushability. At the end of intervention, the retrograde wire is removed from the femoral access. Final angiography to confirm any distal access site complications (fig. 7-9). The retrograde introducer or sheath is then withdrawn after infusion of intra-arterial nitroglycerin solution (nitroglycerin, 200 mg, and heparin, 1000 U in 100 mL 0.9% normal saline) then hemostasis is achieved by compression for 5 to 10 minutes.

Foot ulcers were documented and monitored for size and healing on a regular basis. Indications, comorbidities, periprocedure complications (bleeding, thrombosis, renal failure myocardial infarction) were recorded and limb salvage rate were assessed by Kaplan-Meier analysis. Procedural success was defined as successful pedal or tibial access guidewire passage through the occlusion with the help of the retrograde approach and consecutive balloon angioplasty leaving a residual stenosis less than 30%.

3. Results

From December 2011 to November 2016, 50 limbs with unsuccessful crossing of the popliteal and/or tibial occlusion through antegrade femoral artery approach were included in the study. Demographic and clinical characteristics of the study population are outlined in the Table I.

Table I. Demographic & clinical characteristics of the study population.

Characteristic	**no**	**%**
Age (Mean ± SD[a])	61.2 ± 10	
Female sex	23	46
Diabetes mellitus	42	84
Hypertension	34	68
Coronary artery disease	19	38
Congestive heart failure	1	2
Rutherford class IV	15	30
Rutherford class V	34	68
contralateral major amputation	9	18
Chronic kidney disease	19	38
ESRD on dialysis	6	12
Renal transplant	0	0
Current smoking	35	70
Exsmoker	15	30
[a]SD, Standard deviation.		

Figure 5: balloon inflation over each wire disrupt the septum separating the two spaces to create a single lumen

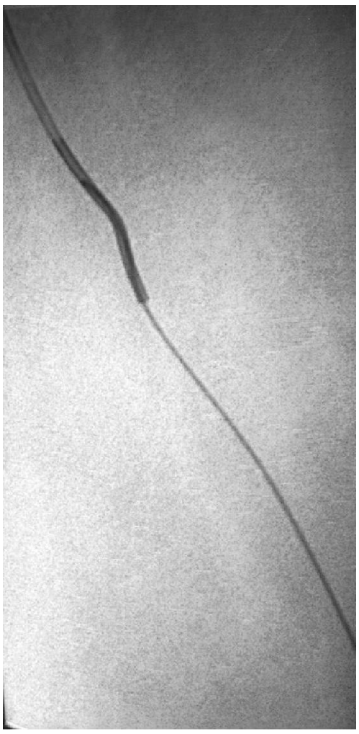

Figure 6. Retrograde wire retrieved from the antegrade access

Figure 7. Anterior tibial artery angioplasty.

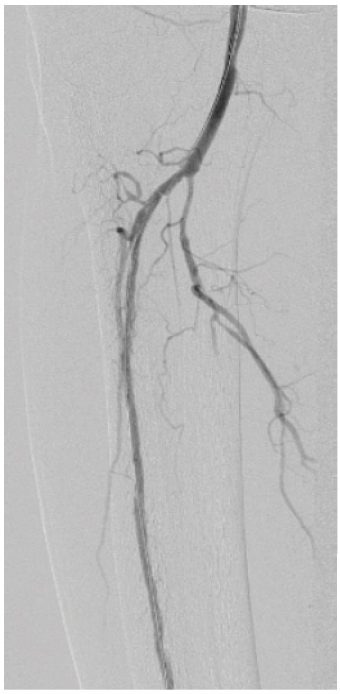

Figure 8. Successfully recanalized anterior tibial artery.

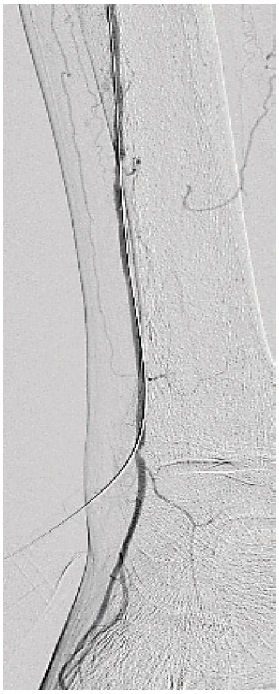

Figure 9. Patent access site after angioplasty.

30 % of patients had concomitant popliteal and/or Superficial femoral artery lesions and 10% had previous iliac intervention done in prior separate intervention. The mean occlusion length was 8 cm (range, 2-22 cm). Technical success rate was achieved in 96% of patients, technical failures were attributed to failure of guidewire to cross the occlusion. In 2% of patients drug-eluting stent used for suboptimal

angioplasty result. The mean procedural time was 2.4 hours (range 2.1–3.5), and mean contrast volume used was 240 mL (range 100–350). The mean fluoroscopy time was 36 minutes (range 25–75). We reported limb salvage rates of 70%, 59%, and 48% at 6, 12, and 24 months, respectively. mean follow-up of 19.1 ± 10.3 months.

Table II. Results of the current published data on retrograde pedal/tibial access.

Series	year	Number	Indication			Vessel Accessed			stenting	Tech. Success
			[a]CLI	Claudication	Acute Ischemia	[b]ATA/ [c]DPA	[d]PTA	[e]Per A		
Botti et al.	2003	6	6			2	4		3	100%
Downer & Uberoi	2007	1			1	1				100%
Fusaro et al.	2007	1	1			1				100%
Montero-Baker et al.	2008	51	45	6		22	29		21	86%
Walker C.	2010	273	273			128	123	2		93%
Rogers et al.	2011	13	8	3	2	2	11	0		85%
Hernan A.et al.	2014	13	13			5	8	-	3	69%
Sridhar V. et al.	2014	9	9			5	3	1		73%

Complications

No procedure related mortality reported in our series. Pedal access complications including pedal access site thrombosis in one patients and small pseudoaneurysm in another patients and small hematoma in one patients. There were one tibial vessel perforations managed successfully by inflating a balloon in place for 2 minutes. worsening renal function occur in two patients and improved by conservative measures.

4. Discussion

Endovascular treatment of CLI in conjunction with medical therapy is a will established treatment strategy. Significant proportion of patients with CLI can be treated successfully with the conventional antegrade endovascular interventions, however in patients with complex popliteo-tibial occlusive disease failure of revascularization via antegrade approach occur in about 20-40% of patients despite advances in catheters and personal skills, antegrade approaches do not allow crossing of the complex popliteo-tibial occlusive lesion.[5,6]

Iyer and colleagues In 1990 described the use of a retrograde pedal/tibial approach to treat cases in whom the conventional way of crossing the tibial lesion had failed.[7] Early access into the pedal vessels was done via cut down and later percutaneous puncture used[8-10] retrograde pedal approach for the treatment of tibial arterial occlusive disease has been reported in many case reports and small case studies.[8,9,11-15] Table 2 summarizes the results of the current published data on retrograde pedal/tibial access. Fusaro described a sheathless retrograde pedal approach, using a 0.018 guidewire for crossing the lesion[10]. Gandini used a 4-Fr sheath, Spinosa used 3-Fr sheath and a 3-Fr catheter to help the passage of the wire[16] and Botti used only the 4-Fr introducer, which allowed angiography and passage of the 0.018 guidewire only but did not allow use of catheters or balloons.[15] We selectively utilize all such strategies we use sheathless approach in occlusions very close to the retrograde puncture site, otherwise we always start by the 4-Fr introducer to allow angiography for confirmation of intraluminal cannulation and we use the 4-Fr introducer sheath (Cook Medical Micropuncture® Pedal Access Set) when needed to add supporting catheter to aid guidewire crossing the occlusion.

There advantages to the retrograde pedal access include; small diameter of tibial vessels in addition to proximity to the occlusion (in comparison with antegrade approach) will increase pushability through the infrapopliteal occlusion, less chance of entering side branches as they arise in a caudal direction, the distal portion of the arterial occlusion often softer (in our opinion because once occlusion occur it propagates proximally rather than distally as it start as a thrombosis which then organize then calcify), and access through it is easier, and retrograde pedal access is more simple than antegrade approach in obese patients or those with hostile groin. However, the disadvantages of retrograde pedal approach include small diameter of the pedal/tibial vessels, especially in women, prone to vasospasm and possible thrombus formation this could result in spasm, thrombosis, and risk of obliteration of the runoff to the foot.

We used to pass the guidewire into the tip of a 4- to 5-F catheter inserted through antegrade sheath until the guidewire tip appeared through of the antegrade sheath similar technique used by Spinosa et al while others use snare for extraction of the retrograde guidewire from the antegrade sheath.[8,16]

In contrary to our protocol we dilate the occlusion by balloon advanced through the antegrade approach Fusaro[17] dilated the lesion by balloon advanced from the retrograde access in our opinion removal of winged balloon through delicate pedal artery might increase the risk of vessel injury. Montero-Baker reported dorsalis pedis access site

occlusion managed by pedal bypass[13]. We reported one case of pedal access thrombosis manged by popliteo-distal bypass. Retrograde access site complications may be avoided with the use of the transcollateral retrograde access described by Fusaro et al.[18] We do not use collateral puncture site in our series. Some authors added glycoprotein blockers[9] for fear of thrombotic pedal access site occlusion. We used 60-80 unit/kg ho heparin to maintain an activated clotting time of 250 to 300 seconds throughout the procedure in addition to frequent access site flushing with nitroglycerine solution. Fusaro[17] used the balloon introduced through antegrade approach for blocking the puncture site which in our opinion, increase trauma to the pedal artery; we found manual compression of the artery effective and sufficient.

Conclusion

The use of combined retrograde and antegrade access for complex popliteo-tibial occlusions after failed recanalization via antegrade access is safe, effective, and technically feasible to reestablish flow to the foot, it extends the technical success rate and improve limb salvage rates in treatment of CLI patients.

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