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Case Report

Angiographic Pedal-Plantar Loop Technique in Treating Critical Limb Ischemia: Experience from a Single Center

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A 54-year-old woman was referred to our department for critical limb ischemia. Lower limb angiography showed stumpless total occlusion of the posterior tibial artery. To achieve complete revascularization, we used a retrograde approach with the pedal plantar loop technique that successfully preserved the circulation of her leg without recourse to amputation up to 1 year of follow-up. In this report, we also retrospectively reviewed the clinical course of patients who underwent the pedal-plantar loop technique between March 2012 and November 2014 at our center. A total of 20 patients were enrolled, and the acute success rate was 100%. After 1 year of follow-up, the mortality rate was 0%, limb salvage rate was 73%, and re-intervention rate was 0%. Therefore, the results suggest that the pedal-plantar loop technique is feasible and safe with a high success rate and good clinical outcomes when performed by experienced peripheral interventionists.

Key words: angioplasty, blow-the-ankle, critical limb ischemia, peal-plantar loop, limb salvage

Case Report

A 54-year-old woman with diabetes mellitus, hypertension, and chronic kidney disease, was admitted to our plastic surgery ward due to a chronic unhealing wound (Fig. 1a) on her right leg. However, not much improvement was noted after wound debridement. Her right ankle-brachial index (ABI) was 0.38. After evaluation, the plastic surgeon sought advice from intervention cardiologists who performed right lower leg angiography the following day.

Because of the lack of information with regards to the presence of lesions over her right superficial femoral artery or above her common femoral artery, a contralateral punc-

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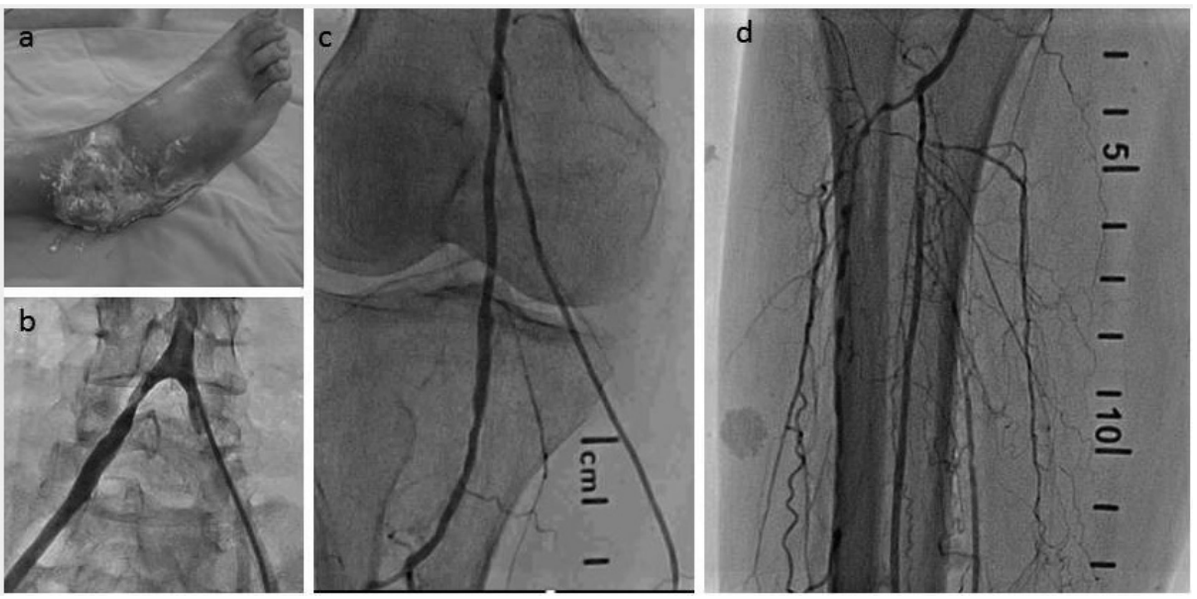

Fig. 1 Chronic unhealing wound (a) on right lower extremity and diagnostic angiograms of her right lower limb (b, c, d).

ture and crossover approach was adopted. Angiography (Fig. 1b, c, d) revealed a discrete lesion over her right proximal common iliac artery without obvious lesions over her common femoral artery or superficial femoral artery. Besides, diffuse narrowing of her popliteal artery was noted. Balloons of size 8.0 mm and 4.0 mm were used to dilate to the common iliac and popliteal arteries, respectively. After fixing the inflow problem, further angiographic examination distal to the knee level demonstrated proximal focal stenosis of the peroneal artery (PeA) and diffuse lesions of the anterior tibial artery (ATA) with nearly total occlusion. The most problematic lesion was in the posterior tibial artery (PTA), of which the proximal part was totally occluded. Moreover, we were unable to locate the ostium.

After recanalization of the ATA and PeA with a 2.5-mm balloon, PTA was the next target. Antegrade approach was considered unsuitable become of failure to locate the PTA ostium under digital subtraction angiography. Although a retrograde approach via the distal PTA was feasible, the most suitable puncture site was near the wound. Therefore, a retrograde approach was adopted via a pedal-plantar loop.

The PTA ends at the plantar artery which is divided into the medial and lateral plantar arteries, while the ATA ends at the dorsalis pedis artery before dividing into the first dorsal metatarsal artery and deep perforating artery. The "Pedal-Plantar Loop" connects the lateral plantar artery to the dorsalis pedis via the deep perforating artery (Fig. 2). Therefore, we used a retrograde approach through the pedal-plantar loop for this procedure (Fig. 3).

For the procedure, we used a 0.014-inch workhorse guidewire and a 2.0-mm balloon. The first step was to locate the pedal-plantar

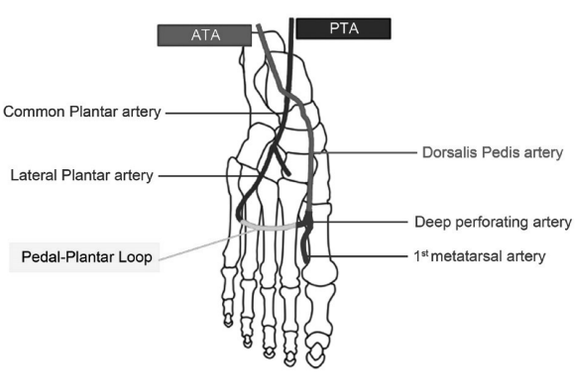

Fig. 2 Anatomy of pedal-plantar loop

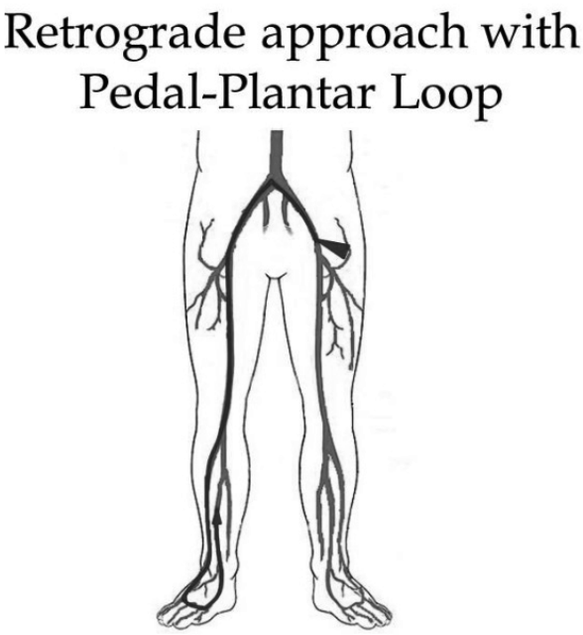

Fig. 3 Anatomy of pedal-plantar loop

loop. After using the 2.0-mm balloon to dilate the dorsalis pedis at 8 atm, the pedal-plantar loop was clearly visible after balloon tip injection (Fig. 4a). Under fluoroscopic guidance, we inserted the 0.014-inch guidewire through the pedal-plantar loop before introducing the 2.0-mm balloon catheter. The pedal artery and plantar artery were then dilated at 8 atm (Fig. 4b). Despite the increase in vessel diameter and decrease in resistance after balloon dilatation, the balloon catheter could only be advanced to the distal tibial artery because of the marked tortuosity of foot vessels (Fig. 4c). The Regalia wire (Asahi, Japan) was then introduced to the proximal PTA (Fig. 4d).

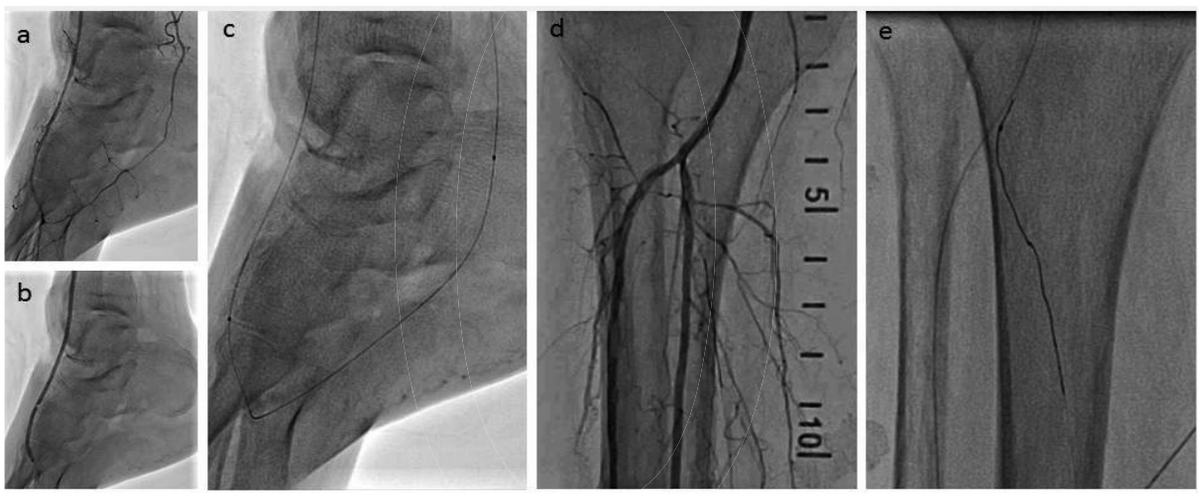

Fig. 4 The steps of the procedure: First. the pedal-plantar loop was located (a). After successful wiring, a 2.0-mm balloon was used to dilate the dorsalis pedis (b) to facilitate advancing the balloon (c). Under balloon support, the wire was advanced to the proximal PTA (d) as a marker. Finally, another wire was used to cross the whole occlusion using the kissing wire technique (e).

Fig. 5 Final angiogram

The downsides of this approach are the long course and difficulty in wire control. This also necessitates our leaving the retrograde wire in place as a marker.

We then used an antegrade approach for the PTA with another 0.014-inch wire and a 2.5-mm balloon using the kissing wire technique (Fig. 4e).

After successfully crossing the entire occlusion of the PTA, we performed balloon tip injection to confirm that the catheter was in the true lumen. We then used the 2.5-mm balloon to dilate the PTA for 3 minutes. The final angiogram (Fig. 5) showed complete revascularization. After the procedure, the patient received successful skin grafting and was discharged 1 month later. After one year follow-up, the wound had healed and amputation of her leg was not required.

Discussion

This is a representative case of our success in using the pedal-plantar loop technique for revascularization.[1,2,4] In practice, we use the pedal-plantar loop technique to establish retrograde collaterals in order to provide indirect flow. In case 2, we failed to open the PTA (Fig. 6a). After opening the ATA (Fig. 6b, c), we located the pedal-plantar loop (Fig. 6d)

Fig. 6 Case 2: We used a pedal-plantar loop to improve indirect revascularization when sufficient collateral was achieved.

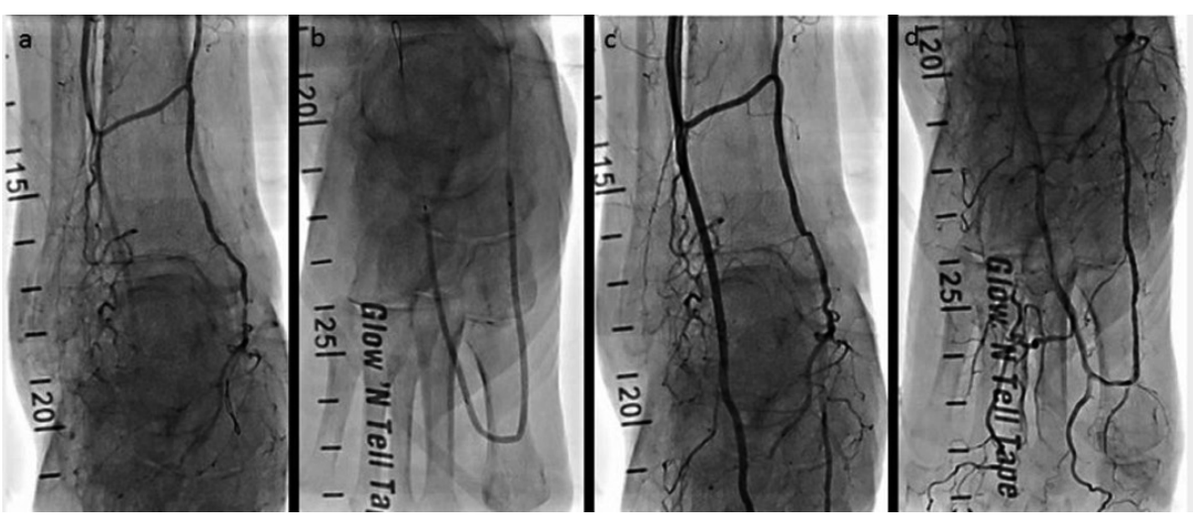

Fig. 7 Case 3: We used pedal-plantar loop dilatation to improve distal run-off of the tibial artery.

and performed balloon angioplasty (Fig. 6e). Finally, with pedal-plantar loop and blood flow through ATA, we restored both the dorsal and plantar circulation of the foot (Fig. 6f).

In some situations we use the pedal-plantar loop technique as a bail-out solution. In case 3, there was still slow flow due to poor distal runoff after angioplasty to the PTA (Fig. 7a). After pedal-plantar loop angioplasty (Fig. 7b), the final angiogram showed satisfactory flow with good distal runoff (Fig. 7 c, d).

The limitation of this technique is total occlusion of the pedal-plantar loop or, in rare cases, the absence of this natural connection. In addition, the pedal-plantar loop technique may be associated with complications such as vessel dissection, perforation and thrombosis.[3,6] However, thanks to the currently available low-profile devices and aggressive antithrombotic medication, such complications can be managed successfully by repeating prolonged balloon inflation. The most difficult part of this technique is tracking the pedal loop. Therefore, familiarity with the anatomy, locating the pedal-plantar loop after fixing the inflow lesions, such as those over the dorsalis pedis or plantar artery, and dexterity with techniques especially tip injection via over-the-wire balloon are essential before wire tracking.[5,7,8] Practice is also important for this technique.

From March 2012 to November 2014, there were 20 patients with critical limb ischemia managed with the pedal-plantar loop technique at our hospital. Among these patients, the majority (90%, n = 18) belonged to Rutherford Class 6. On the other hand, there was one patient belonging to Class 5 and another patient belonged to Class 4. The pedal-plantar loop technique was performed in four patients to establish retrograde collaterals for stumpless total occlusion of the tibial artery, eight for restoring indirect flow, and eight as a bail-out solution to improve distal run-off. The acute success rate was 100%. After one year of follow-up, the mortality rate was 0%, limb salvage rate was 73%, and re-intervention rate was 0%.

In conclusion, the pedal-plantar loop technique is feasible and safe with a high technique success rate and good clinical results when performed by experienced peripheral interventionists.

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