Treating Foot Injuries by Grafting Pedicled Distal Peroneal Artery Perforator Flaps

Changqing Hu, Yong Lian, Xiao Fan and Zhiping Sun

ABSTRACT

Treating mid- and forefoot wounds is challenging. We share our clinical experience and describe the treatment of fore- and midfoot wounds by grafting pedicled distal peroneal artery perforator (PNAP) flaps. The study enrolled 21 patients with fore- and midfoot injuries, who underwent grafting with a pedicled distal PNAP flap between August 2013 and May 2016. All of the flaps survived and were followed for 2 to 11 months. The appearance and texture of these flaps were good. The range of motion of the injured ankle was similar to the unaffected side. There were no complications, such as scar contracture, ulcer, or tenderness. The pedicled distal PNAP flaps can effectively extend the length of the flap pedicles and are better for repairing fore- and midfoot wounds than the traditional distally pedicled sural neuro-fasciocutaneous flaps.

Key Words: *Surgical flap, Grafting, Foot, Distal.*

Treating mid- and forefoot wounds is challenging.[1] Free flaps and cross-leg flaps are often used. However, free flaps are difficult to design and only skilled micro-surgeons can perform the operation. Cross-leg skin flaps may be very painful, which make them unacceptable. Therefore, surgeons have used grafted fasciocutaneous leg flaps, although they are usually disappointing due to the poor blood supply of the flaps. Because the distal vascular perforators are too slender and the pedicles are too short, the grafted flaps are over-stretched, which commonly result in early partial flap necrosis and require continuous dressings or a second skin graft. Moreover, the bone in distal wounds can be exposed, requiring removal of some bone to close the wound and a grafted-free flap to preserve the weight-bearing area of the plantar surface.[2]

Here, we report 21 patients treated with selective flap grafting. The grafted flaps ranged from 5x7 to 13x22 cm^2. The flaps were designed to be slightly larger than the defect, based on the size and shape of the defects. A marker (rotation point) was made 4 cm above the midpoint of the lateral malleolus and Achilles tendon, and the midpoint of the popliteal fossa was another point. The line between these two points was considered the flap axis. The size of the flap could not exceed the popliteal fossa as the upper border and the midline of medial and lateral lower leg for both sides. The flaps were separated from the proximal to the distal sides at the depth of the superficial layer of the deep fascia. Care was taken to protect the intact perforators of the inter-muscular septum, small saphenous vein, and vascular network around the medial sural cutaneous nerve.

It is vital to preserve the intact peroneal artery perforators around the rotation point when dissociated 4 to 9 cm above the lateral malleolus, and to maintain continuity from the peroneal artery to its perforators. The peroneal artery is ligated and cut 1 cm from where the perforators join the peroneal artery (Figure 1). Then the peroneal artery distal to the flap pedicle is isolated, so that the flap size meets the need for fore- and midfoot wounds. A triangle of skin is preserved at the flap pedicle and the flap is transposed into the defect through a sub-

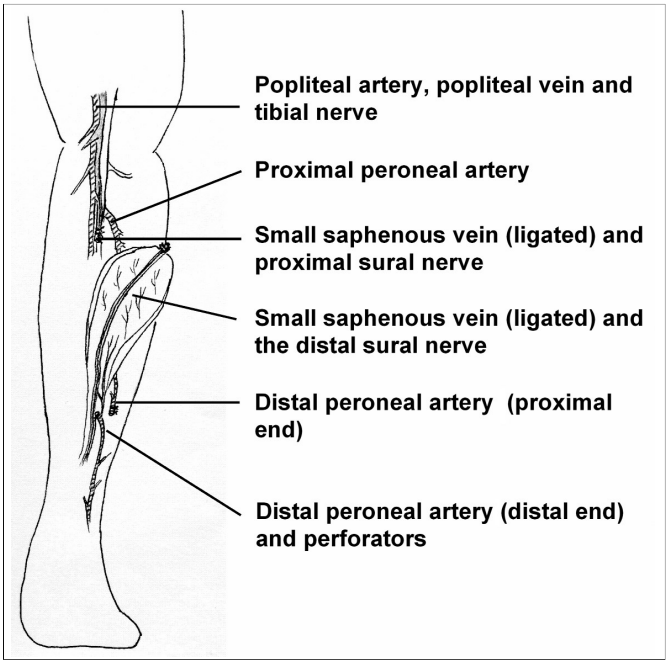

Figure 1: The schematic diagram of distal peroneal artery and perforator pedicle flap grafting (posterior view).

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Received: August 18, 2018; Revised: January 18, 2019; Accepted: January 18, 2019

Table I: Demographic and clinical data of patients.

Mean age (years) 38.5 ±11.12	
Gender	
Male	16 (76.19%)
Female	5 (23.81%)
Mode of injury	
TI*	9 (42.86%)
CIHO**	8 (38.10%)
RI***	3 (14.29%)
EI****	1 (4.76%)
Mean size (cm^2)	85 ±15.25
Site of wound on foot	
Forefoot	3 (14.29%)
Midfoot	6 (28.57%)
Both	12 (57.14%)
Flap success	
Complete survival	19 (90.48%)
Partial necrosis without dehiscence	2 (9.52%)
Pattial necrosis with dehiscence	0
Total necrosis	0

** traffic injury; ** crushing injury by heavy objects; ***reamer injury; ****electrical injury.*

cutaneous tunnel. The skin and tissues on both sides of this tunnel are dissected and sutured with the triangle of skin to relieve tension, thereby reducing the pressure on the vascular pedicle. The skin donor sites are covered with a split-thickness skin graft (STSG).

In all, 21 patients (16 males, 5 females) with mid- and forefoot injuries were enrolled: 3 forefoot, 6 midfoot, and 12 combined injuries (Table I). The left foot was affected in 13 cases and the right in 8 cases. The patients' age ranged from 17 to 62 years. The injuries resulted from traffic accidents (9 cases), crushing by heavy objects (8 cases), reamer injuries (3 cases), and electrical injury (1 case). The defects ranged from 4×5 to 11×20 cm^2 (mean area 85 cm^2).

All 21 flaps survived, although two had partial necrosis of the distal margin. The necrotic tissue became scabbed and desquamated about 2 weeks postoperatively, which did not affect wound healing. The skin donor sites healed primarily after STSG. The follow-up averaged 6.4 months (range 2-11). The appearance, texture, and flexibility of all flaps were good. The ankle range of motion was similar to that of the unaffected side. No scar contractures, ulcers, tenderness, or other complications affected the grafted flaps. The donor sites healed satisfactorily, although with some pigmentation (Figure 2).

The key points of PNAP flap grafting are as follows:

We made flaps along the sural nerve; these flaps should actually be called pedicled sural neuro-fasciocutaneous flaps. The flap pedicles consisted of 1.5 cm of fascia around the sural nerve and peroneal artery with its perforators, so these were, strictly speaking, double pedicle flaps. There is a thicker peroneal artery perforator about 9 cm above the lateral malleolus when the flap is being separated.[3] Preserve it and continue to

Figure 2: Using distal peroneal artery and pedicled perforator flap grafting to treat dorsal skin and tissue defection of the midfoot.
(a) Skin and tissue defection with tendon exposure of the midfoot after vacuum sealing drainage. **(b)** Designing the flap on the calf according to the size of the defect during operation, the arrow indicating the swatch cut during the operation that showed the shape and the size of the defect. **(c)** Separation of the peroneal artery and the distal peroneal artery. The thick arrow shows the excised peroneal artery, and the thin arrow shows the perforations. **(d)** Good blood supply to flap. **(e)** Incised skin between the wound and flap pedicle to make a cutaneous tunnel, sutured the flap and the edge of the wound. **(f)** Two months after the grafting.

separate the peroneal artery to the root of this perforator and then ligate the proximal peroneal artery. The perforators and distal peroneal artery must be intact and patent. Continue to separate the distal peroneal artery until the pedicle reaches sufficient length, so that the flap can cover the wound without tension. Generally, the separated distal peroneal artery must be longer for forefoot wounds, and another peroneal artery perforator located 4 cm above the lateral malleolus needs to be separated.[4]

Although both types of flaps are derived from peroneal artery perforators, the traditional pedicled sural neuro-fasciocutaneous flaps are formed either without cutting off or further freeing the distal peroneal artery, which results in a poor blood supply because of excessive pulling when used to repair mid- and forefoot injuries. In comparison, our flaps are successfully avoided this deficiency by increasing the flap pedicles, which involves cutting both distal peroneal arteries and further freeing the pedicles so as to ensure a tension-free wound covering. PNAP flaps have significant advantages in repairing anterior and middle foot wounds.

Preoperative Doppler ultrasonography is necessary. When the posterior tibial artery is not detected, the peroneal artery originates directly from the popliteal artery, which occurs in 8% individuals.[5] In this case, our procedure should be avoided because cutting the peroneal artery would have a significant effect on the blood supply of the foot.

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