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Lowering the pivot point of sural neurofasciocutaneous flaps to reconstruct deep electrical burn wounds in the distal foot

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ARTICLE INFO

Article history:
Accepted 15 August 2012

Keywords:
Sural neurofasciocutaneous flap
Foot
Electrical burns
Color Doppler flow imaging

ABSTRACT

Due to the thinness of the skin and soft tissues in the foot, tendons and bones tend to become exposed and necrotic after injury; therefore, it is difficult to reconstruct foot injuries, especially distally. Reconstruction with free skin flaps is highly risky as it demands technologies and equipment, while patients suffer greatly from the use of cross-leg skin flaps. Sural neurofasciocutaneous flaps are often used for reconstruction of wounds in the lower leg, malleolus, and the proximal end of the foot but are not feasible for wound repair in the distal foot; this is because, with the pivot point of 5–7 cm above the tip of the lateral malleolus, the flaps are not able to cover defects in the distal foot. In this study, we used a sural neurofasciocutaneous flaps with a lowered pivot point for reconstruction of distal foot wounds caused by electrical burns. An ultrasound flow detector and Doppler flow imaging were used to detect the diameter, the perforating point and the blood flow of the lateral retromalleolar perforator. Twelve patients with the perforator diameter greater than 0.6 mm and the peak systolic flow more than 0.15 m/s were included. The pivot point of sural neurofasciocutaneous flaps was lowered to 0–3 cm above the tip of the lateral malleolus and the size of the flaps ranged from 6 cm × 5 cm to 12 cm × 18 cm. Eleven of the 12 flaps survived completely. One flap developed necrosis approximately 1 cm at the far point but was managed successfully by daily dressing. We demonstrated that lowering the pivot point of sural neurofasciocutaneous flaps is feasible for reconstruction of distal foot injury with the advantages of reliable blood supply and easy operation. The use of Doppler flow imaging provides useful information for the design of the flaps.

1. Introduction

A large number of electric injuries occur in China every year, especially in the undeveloped middle-west areas. Local medical institutions are not able to provide adequate treatment to the patients as their equipment and skills are not up to date. Meanwhile, it is impractical for the poverty-stricken patients to travel a long distance to seek medical care in large medical institutions. Consequently, the patients may suffer from decreased body function or disabilities that may pose a heavy burden to the family of the patient or even to the whole society. Necrosis of tendons, muscles and bone tissues often occurs in electrical injuries of foot and most of the injuries are combined with large-scale damage of foot skin and soft tissues. These deep wounds and the lack of shift near flap areas as well as fascia vessel damage and unreliable blood supply render the repair of foot injuries, especially the middle and distal foot injuries, extremely difficult. The commonly used therapeutic approaches include free flap repair, mix-leg flap repair or even amputation. Repairs with free and mix-leg flaps demand both skills and equipment. In addition, such repairs are costly and highly risky with inevitable sacrifices of major vessels and extensive wounds. Therefore, practical and

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0305-4179/$36.00
http://dx.doi.org/10.1016/j.burns.2012.08.014

Table 1 – Details of perforating branches.

Patient number (*n*)	Number of perforators (*n*)	Position of perforators above lateral malleolus (cm)	Number of perforators ≥ 0.6 mm in diameter	Position of the largest perforator above lateral malleolus (cm)	Proximal end diameter of the largest perforator (mm)	Peak systolic flow (m/s)
1	2	1.0–2.0	2	2.0	1.0	0.22
2	2	1.9–2.5	2	1.9	0.9	0.19
3	3	0.5–2.5	1	1.1	1.2	0.26
4	2	1.0–3.0	2	3.0	0.9	0.19
5	3	0.5–2.5	1	1.2	1.1	0.24
6	3	0.2–2.6	2	2.6	1.0	0.23
7	3	0.6–2.8	2	2.1	0.7	0.17
8	2	1.3–2.7	1	1.3	1.2	0.24
9	2	0.3–2.5	2	2.5	0.8	0.19

feasible approaches are needed for repairing distal foot injuries in local medical institutions to allow patients who live in remote and poor areas to receive a safe and easy operation without relying on special equipment. With the rotation point of 5–7 cm above the lateral malleolus, reverse nervus suralis fascia flaps are not able to repair middle and distal foot injuries. In this study, we lowered the rotation point of flaps to 0–3 cm above the ankle joint in order to repair distal foot electrical injuries. By using this technique, we have successfully treated 12 patients since 2007. All the patients showed good shape of flaps with the injured foot functioning well. Our study therefore demonstrated the clinical feasibility of lowering the pivot point of flaps in reconstruction of far-end foot injuries.

2. Patients and methods

Twelve sural neurofasciocutaneous flaps with a lowered pivot point had been used for reconstruction of far-end foot wounds caused by electrical burns since 2007. The inclusion criteria for patient enrollment includes: age greater than 18 years but less than 60 years; in good health without cardiovascular diseases, and diabetes mellitus; no shank trauma history or combined injuries in the injured leg; no obvious infection in the wounded area; and hospitalization less than 3 days before the study entry. Patients with more than two perforating points (three cases) and patients with lateral retromalleolar perforators greater than 0.6 mm in diameter and more than 0.15 m/s in the peak systolic flow (nine cases, Table 1) were included.

Of these 12 patients, nine were male and three were female, with an age range of 18–55 years. The patients were admitted to hospital within 6 h to 3 days after injury. The defects were in the middle of the planta or at the dorsum of the distal end of the foot, accompanied by necrosis of phalanges. All defects were debrided in 1–3 days after hospitalization and covered by sural neurofasciocutaneous flaps with a lowered pivot point. The size of the flaps ranged from 6 cm × 5 cm to 12 cm × 18 cm with the pedicle width of 4 cm (Table 2).

3. Surgical procedure

1. Ultrasound flow detector and color Doppler flow imaging were used to locate the perforating branches of the arteria fibularis in the subfascial compartment between the lateral

Table 2 – Patient details.

Patients number (age/sex)	Site of the defect	Flap		
		Size (cm^2)	Rotating point (above the lateral malleolus/cm)	Results
1. 38/M	Distant dorsum of the left foot	12 × 10	2.5	Successful
2. 32/M	Distant dorsum of the right foot	6.5 × 8	1.9	Successful
3. 42/M	Lateral dorsum of the left foot	6.5 × 8.5	1.5	Necrosis of the end (~1 cm)
4. 38/M	Distant dorsum of the left foot	12 × 8	3.0	Successful
5. 27/M	Distant dorsum of the right foot	7 × 9.5	1.5	Successful
6. 36/M	Distant dorsum of the right foot	8.5 × 5	2.5	Successful
7. 21/F	Distant dorsum of the right foot	9.5 × 6.5	2.3	Successful
8. 55/F	Distant dorsum of the right foot	6 × 6	1.0	Successful
9. 27/M	Middle of the left planta	12 × 18	2.0	Successful
10. 18/M	Distant dorsum of the left foot	6 × 8	0	Successful
11. 46/M	Distant dorsum of the right foot	10 × 6	2.0	Successful
12. 27/F	Distant dorsum of the right foot	7 × 6	2.0	Successful