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Distally based reverse sural artery flap as an interpolation flap

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ABSTRACT

Background: Coverage of soft tissue defects of the foot and ankle has imposed a challenging situation to the plastic surgeon. Some patients have contraindications for microsurgery, thus limiting the options for local tissue transfer. The Reverse sural artery flap is frequently used for reconstruction of distal third leg, ankle, and heel. The major disadvantage of RSA flap is compression of pedicle within subcutaneous tunnel leading to venous congestion and distal flap necrosis. To overcome this problem, we describe an interpolation flap technique in which subcutaneous tunneling of neurovascular structures is avoided.
Methods: 13 cases of distally based RSA flaps as interpolation flap were performed for soft tissue defects in dorsum of foot, heel pad, malleoli, and TA region during the period 2014 to 2016.
Results: With this procedure no flap loss was observed in this series and only a few minor complications occurred. The pedicle is divided in a second stage operation.
Conclusions: We conclude that transferring the flap in 2 stages without use of tunnel improves the reliability of flap and decreases the chances of necrosis.

Keywords: Reverse sural artery, Interpolation, Lower extremity reconstruction

INTRODUCTION

In an extensive work on cadavers, Taylor described the angiosome concept and its clinical applications.[1] Taylor mentioned that vessels hitchhike along with the nerves. Based on this finding vascularization of the superficial nerves of the leg were studied in detail by Taylor and Ham.[2] However little attention was paid to the blood supply to the skin from the arteries accompanying the cutaneous nerves until Masque let et al reported using colored latex injection studies in 1992 that the arteries gave off several cutaneous branches in the suprafascial course and described the concept of neuroskin island flap.[3] They also demonstrated the possibility of safely raising a distally based island flap based on the vascular axis of the sural nerve.

The reverse sural artery flap is frequently used for reconstruction of distal third leg, ankle, and heel. The major disadvantage of RSA flap is compression of pedicle within subcutaneous tunnel leading to venous congestion and distal flap necrosis. To overcome this problem, we describe an interpolation flap technique in which subcutaneous tunnelling of neurovascular structures is avoided.

METHODS

All patients with small to moderate defects in the foot and ankle region which required coverage with the superficial sural artery flap were included in this study. Thirteen patients with small and moderate defects of the foot and ankle were treated with a distally based sural artery flap

from 2014 to 2016 at the Department of Plastic Surgery, Nizam's Institute of Medical Sciences, Hyderabad.

Operative technique

With the patient in lateral position as shown in Figure 1 the flap markings are outlined. We have not been using the Doppler (4 Hz, 8 Hz probes) routinely in all cases. Only in those cases where the zone of trauma is extending into the region of the perforator do we use the Doppler. A line was drawn from midpopliteal point to midpoint of tendoachilles and lateral malleolus which was the central axis of the flap .The flap was then outlined and centered on this line according to the size of the defect taking care that the lateral limits do not cross the mid-axial lines on either sides. The pivot point is marked along the axis at 5 cm from the tip of the lateral malleolus. The flap is elevated under tourniquet. The incision was first made along the superior border of the flap. The lesser saphenous vein, sural nerve, and accompanying vessels were ligated at the superior border. Subsequently the flap is elevated from above downwards at a subfascial level and stopping short at that site where the flap comfortably reaches the defect as in Figure 2. During this step care is taken to include as many venous tributaries of the short saphenous vein as possible. The flap is brought into the defect by rotating it from 90 to 180 degrees to reach the recipient site and inset without tension as given in Figure 3. The donor defect is covered with a split thickness skin graft and so is the undersurface of the pedicle. If the raised flap was not large enough to cover the defect then the flap would be used to cover exposed bone and tendon and the remaining raw area would be covered with split skin graft. An external fixator was applied to tibial bone in patients where coverage was needed for dorsum of foot with exposed tendons and ankle joint as shown in Figure 3. In patients with TA rupture and non-healing ulcer dorsal pop slab was applied with foot in slight plantar flexion and the patient was placed in semi prone position postoperatively.

RESULTS

The mean age of the patients was 44 years with a range of 5 to 70 years. The male to female ratio was 10:3. Majority of patients had defects due to trauma resulting from road traffic accidents. Table 1 summarizes the causes of defects. The size of the defect varied from 8 × 4 to 14 × 16 cm.

The defects covered with the flap were on the lateral malleolus (3 patients), dorsum of the foot (4 patients), weight bearing portion of the heel (4 patients) and tendoachilles (2 patients). K-wires were used for fixation of fractures of calcaneum and lateral malleolus. One patient had diabetes mellitus. All the flaps survived. There was marginal necrosis in the flap in 2 cases. The necrotic portions were debrided and were healed secondarily. All donor sites healed uneventfully.

Table 1: Patient's demographic data.

S. no	Age	Sex	Cause of defect	Site of defect	Defect size (cms)	Associated Problems	Complications
1	44	M	Non healing ulcer	heel	8 × 10	Diabetes	Nil
2	52	M	RTA	Tendoachilles	8 × 7	Compound TA rupture	Nil
3	47	M	Train accident	heel	8 × 4	Heel pad avulsion	Nil
4	43	F	Non healing ulcer	Dorsum of foot	10 × 8	Diabetes	Marginal necrosis
5	27	M	RTA	Heel	8 × 6	Compound # calcaneum	Nil
6	30	F	RTA	Lateral malleolus	8 × 10	Compound # lateral malleolus	Nil
7	45	M	RTA	Dorsum of foot	6 × 8	Exposed extensor tendons	Marginal necrosis
8	49	M	RTA	Heel	6 × 8	Compound # calcaneum	Nil
9	40	M	RTA	Lateral malleolus	12 × 10	Compound # lateral malleolus	Nil
10	50	M	RTA	Dorsum of foot	6 × 8	Exposed extensor tendons	Nil
11	5	F	RTA	Dorsum of foot	8 × 6	Exposed extensor tendons & joint	Nil
12	25	M	RTA	Lateral malleolus	8 × 6	Compound # lateral malleolus	Nil
13	70	M	RTA	Heel and Tendoachilles	10 × 8	Compound # calcaneum	Nil

RTA- Road Traffic Accident; # - Fracture

DISCUSSION

Reverse sural artery flap is one of the best options for covering defects in the distal lower leg, heel, and foot.[4] According to our experience, the flap is suitable for reconstruction of small to moderate defects in these regions defects can reach base of the metatarsal bones in the dorsum of foot. The flap can reconstruct the defects caused by trauma, chronic osteomylitis, chronic venous ulcers, unstable scars, tumor resections, and so on. In this study, the patients were younger, with an mean age of 44 years; most of the soft-tissue defects were caused by trauma. No close relationship between age, sex, regions of defects, and partial necrosis was observed. Surgical technique and experience of operator play an important role in viability of the flap. According to the anatomic investigation, Yang and Morris reported that the size of vascular territory of the flap was relatively constant and upper margin of the flap was localized at a level 10 cm below the knee.[5] Posterior aspect of the lower leg was usually divided into three zones to describe the proximal limitation of the flap; some authors suggested that top-edge of the flap should not exceed the junction between upper 1/3 and lower 2/3 of the lower leg.[6,7] Mohamed and Osama recommended that limitation of the upper border of the flap should be 2 cm above the gastrocnemius muscle bellies bifurcation.[5] Pivot point of the flap usually located 5 cm to 8 cm above the tip of lateral malleolus.[8,9] Ponte´n introduced first the concept of fasciocutaneous flap in 1981.[10] Reverse sural artery flap was regarded as a type A fasciocutaneous flap by Morgan et al., but the flap in this study should belong to a type B fasciocutaneous flap according to the classification introduced by Cormack and Lamberty, because there is a single sizeable fasciocutaneous perforator of peroneal artery contained at the base of the flap.[11,12] The flaps harvested in this study are similar to perforator-plus fasciocutaneous flap described by Mehrotra and peninsular pedicled peroneal arterial perforator flap described by Lu et al.[13,14] The flaps have characteristics of both perforator flaps and fasciocutaneous flaps in which length -width ratio plays an important role in viability of the flaps. These flaps obtain dominant blood supply from the perforators of the peroneal vessels; Width of the base of flap is associated with arterial supply and venous drainage.[15] Vascular axis of reverse sural artery flap is oriented longitudinally. In our study, the flap was used as an interpolation flap with an inherent blood supply to support the flap while attached to the recipient defect until neovascularisation has been ensured between the flap and recipient bed as shown in Figure 4 and 5. The delayed second stage division of the flap after inosculaion and neovascularisation render the tissue independent of the pedicle.

The advantages of the distally based superficial sural artery flap are:

- Easy and quick to perform
- Safe
- Preservation of major vessels of the leg
- Minimal morbidity

The major disadvantage of this interpolation flap is that it requires flap division in second stage. The flap division was done usually after 4-6 weeks. The excess flap is returned to the donor site as given in Figure 6 and 7.

Figure 1: Defect over the anterior aspect of ankle.

Figure 2: RSA flap elevated.

Figure 3: Flap inset.

Figure 4: 3 weeks post op follow up lateral view.

Figure 5: 3 weeks post op follow up medial view.

Figure 6: Six months follow up after RSA flap detachment in another patient.

Figure 7: Donor area after excess flap return.

CONCLUSION

The distally based superficial sural artery fasciocutaneous flap supplied by peroneal perforator is an excellent choice for the coverage of small to moderate defects in the distal thirds of leg, foot and ankle in uncomplicated wounds. This procedure does not sacrifice any major vessel and does not need microsurgical expertise. Venous congestion did not occur in any of the flaps. We conclude that transferring flap in two stages without the use of a tunnel improves the reliability of flap and eliminates the risk of venous congestion. It provides good contour and texture to recipient area.

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