

Versatility of Reverse Sural Artery Flap for Heel Reconstruction

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Introduction:

The heel has two parts, weight bearing and non-weight bearing part. Soft tissue heel reconstruction has been a challenge due to its complex nature of anatomy, weight bearing part of foot and the mechanism of injury requiring reconstruction. The pattern of injury includes from simple laceration to a complex wound with loss of soft tissue and fracture involving various degrees of calcaneus.

Most common pattern of heel injury is due to road traffic accidents especially the foot caught in the moving motor bike wheel. The resultant soft tissue defect may be large or small.

The treatment option for complex large soft tissue defect of weight bearing part of the heel reconstruction has been invariably flaps containing thick skin, pliable subcutaneous tissue with strong fascia planes REF. Historically, most commonly used flaps for large soft tissue defect are radial forearm flap, deltoid flap, lateral arm flap, scapular/parascapular flaps, sural artery flaps either as free tissue transfer or pedicle flaps REF. For small defect of the heel; local pedicle options are medial plantar flap, abductor digiti minimi muscle, abductor hallucis brevis muscle, flexor digitorum brevis muscle, lateral calcaneal flap; a muscle free flap gracilis, serratus, or rectus abdominus muscle.

The reverse sural artery fasciocutaneous flap depends on the tibiotalar sural artery that nourishes the sural nerve (1). The artery originates from a peroneal perforator 5 cm above the lateral malleolus and courses with the sural nerve. The flap can cover any ankle or rear foot defect.

Material and Methods:

This study includes 25 total number of patients with traumatic heel injury and Seven cases of traumatic soft tissue heel reconstruction performed with reverse sural artery flap and one patient out of seven required fracture fixation for calcaneus with screw by the single author between July 2011 and June 2016.

The age range from 9 years to 36 years.

Four patients required split thickness skin graft for donor site closure in the calf while in three patients donor defect was closed primarily.

Results:

All patients wound managed with the reconstruction of heel by using reverse sural artery fasciocutaneous flap healed within a month post operatively and on three month follow up have normal gait with full weight bearing and no recurrent ulceration or wound breakdown.

Conclusion:

The use of reverse sural artery flap for weight bearing large tissue defect of the heel remained versatile for its near similar anatomy. It can provide coverage as large as 8X12 cm, has sensibility, and has a wide arc of rotation due to long pedicle. It is excellent for heel defects and medial/lateral ankle, lower leg, and hindfoot defects.

Key words: Flap, Sural Artery, Heel

Introduction:

Reconstruction of soft tissue defects of the foot remains a complex and challenging undertaking despite advances in the transfer of fasciocutaneous, musculocutaneous, and composite tissue flaps.

A proper understanding of the anatomy of the foot, the weight bearing interface for

ambulation, is essential to the successful reconstruction of foot injuries. The skin on the plantar aspect of the foot varies from region to region, being thickest (up to 3.5mm) over the heel and metatarsal heads and thinner over the toes and instep. A moderate amount of subcutaneous fat is intermingled with fibrous connective tissue, providing a cushion for weight bearing. The plantar fascia is continuous with the deep fascia of the foot's dorsum after attachment to the sides of the first and fifth metatarsal.

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On the foot dorsum and in the Achilles region, the skin is thinner and more mobile; same reconstructive techniques employed for the plantar surface is entirely inappropriate for these two locations. Because the reconstructive options vary according to location, it is best to differentiate between four distinct locations: the Achilles area, ankle and foot dorsum; the plantar forefoot; the plantar midfoot; and the plantar hindfoot. The compartments of the sole of the foot are similar to those of the palm of the hand. Knowledge of these compartments facilitate their decompression when it is clinically indicated.

The timing of the soft tissue repair is an important factor. The wound goes through three stages: the acute phase, during the first five days after surgery, when the wound is contaminated but not infected; the subacute phase, from the first to sixth week, when the wound is colonised and infected; and the chronic phase, after the sixth week, when the infection is limited to the scar and bone sequestra. The most critical determinant of successful reconstruction is thorough debridement of all devitalised tissue and early soft tissue coverage.

The aim should be the early definitive reconstruction of the heel after exclusion of any major injury to other parts of the body. Various options available for heel reconstruction with loco regional flaps and free tissue transplantation.

Once the flap design and identification of pedicle is ensured with the basic knowledge of neurovascular anatomy in this region, the reverse sural artery flap for heel reconstruction is a simple and safe method and versatile flap for its ease of harvesting and application.

Material and Methods:

During five years period from July 2011 to June 2016, total number of 25 patients treated for traumatic heel wound. Out of twenty five,

seven (28 %) required flap coverage for weight bearing part of the heel. The reverse sural artery fasciocutaneous flap reconstruction performed for all seven patients with the age range from 9 years to 36 years.

Results:

The advantage of this flap is a constant and reliable blood supply without sacrifice of major arteries or sensory nerves. It also has the potential for reinnervation and performed in a single stage without microsurgery(3).

Discussion:

The reconstructive surgeon must have a complete knowledge of the anatomy of the foot, the bone architecture, the longitudinal and transverse arches, the compartments, and the role that each plays during this process.

The blood supply to the sural artery flap is derived from the small arteries that accompany the sural nerve along its course just superficial to the deep fascia in the posterior aspect of the distal two thirds of the lower leg. In most patients, this will be a "vascular network," although one may occasionally see a well-defined median superficial sural artery accompanying the nerve. There are numerous anastomoses between this network and the peroneal artery. The most important of these is the most distal one approximately 5 cm cephalad to the lateral malleolus.

The doppler probe is a useful adjunct in mapping the flap pre-operatively. The flap should be outlined over the central third of the calf after the identification of the pedicle in lower one third of the leg. The pedicle consists of a less than 1 cm wide strip of subcutaneous tissue and fascia containing the sural nerve, its associated arteries, and the lesser saphenous vein (Pic 1 G, Pic 2 B)(4). The sural vessels ligated proximally at the junction of upper one third and middle one third of the leg and flap based on sural vessels inferiorly in the leg is raised with reverse flow

from the ankle and foot perforators derived from the dorsalis pedis, posterior tibial and peroneal vessels.

The flap is outlined over the raphe between the two heads of the gastrocnemius muscle. A line is drawn from the inferior edge of the flap to the pivot point for the pedicle approximately 5 cm above the lateral malleolus.

I prioritize identification of the pedicle by start making incision at the pivot point. Through this incision, the sural nerve and the lesser saphenous vein are identified just superficial to the deep

fascia. The next step after identification of the pedicle is to harvest the required dimension of flap from the middle third of the calf. The sural nerve and lesser saphenous vein is ligated proximally and flap raised with the deep fascia to protect the aforementioned structures.

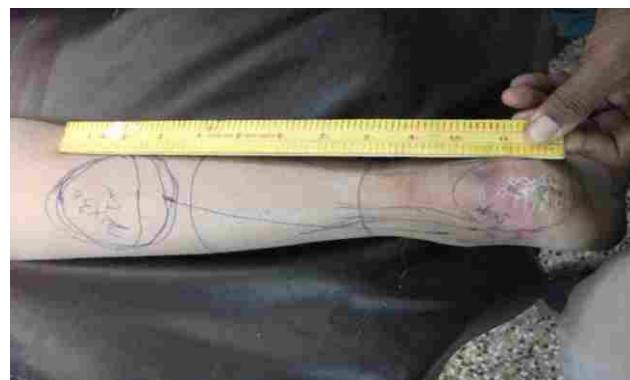
The author preference for flap pedicle by developing a 0.5 - 1 cm wide strip of subcutaneous fat and fascia that harbors the sural nerve and lesser saphenous vein. The flap and pedicle may then be separated from the underlying muscle and paratenon layers. The arc of rotation is 180 degree providing coverage to the heel defect (Pic 1 H). This flap may also provide coverage to the posterior heel-Achille, anterior ankle and dorsum of foot. The donor site may be closed primarily if it is small or with a split-thickness skin graft if it is larger (Pic 1 I, Pic 2 G).



Picture 1 A: Unstable chronic scar tissue on the calcaneus, patient using crutches for walking.



Picture 2 B: Area of unstable scar tissue planned for excision.



Picture 1 C: Sural flap centered over the lesser saphenous vein



Picture 1 D: Defect over the calcaneus after debridement



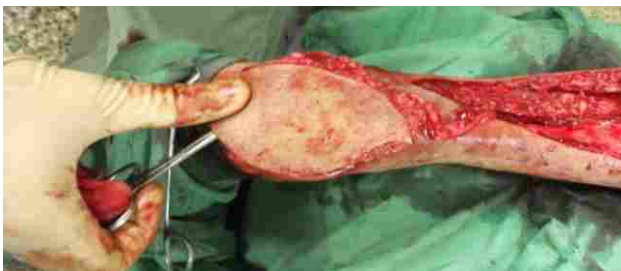
Picture 1 E: Incision over the pivot point of pedicle, identification of the pedicle



Picture 1 F: The flap has been elevated to include the lesser saphenous vein and the sural nerve.



Picture 1 G: A 0.5 to 1 cm width of fascia containing these structures composes the "pedicle"



Picture 1 H: Pedicle is rotated 180 degree to cover the defect with the flap



Picture 1 I: The flap is inset over the defect and the donor site is skin grafted



Picture 1 J: Appearance 3 months after the reconstruction



Picture 1 L: Full weight bearing



Picture 1 M: Normal gait



Picture 2 A: Defect over the calcaneus after debridement.



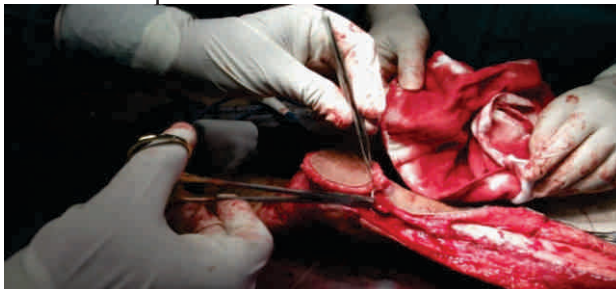
Picture 2 B: A 0.5 to 1 cm width of fascia containing these structures composes the "pedicle".



Picture 2 C: The flap has been elevated to include the lesser saphenous vein and the sural nerve.



Picture 2 D: The flap has been elevated to include the lesser saphenous vein and the sural nerve.



Picture 2 E: Pedicle is rotated 180 degree to cover the defect with the flap.



Picture 2 F: Flap inset and donor site closure



Picture 2 G: The flap is inset over the defect and the donor site closed primarily.



Picture 2 H: Full weight bearing after 3 months.



Picture 2 I: Normal gait after 3 months.

These procedures are often not possible in dealing with patients with significant peripheral vascular disease.

Apart from loco regional flap reconstruction for heel defect, other options include microvascular composite free tissue transplantation. Useful donor sites are the deltoid, lateral arm flaps, scapular and parascapular free flaps (5-7).

Cutaneous sensibility of the reconstructed weight bearing portions of the foot with either loco regional pedicle flaps or free tissue transplantation, did not appear to be necessary to maintain a functional and well-healed extremity (8,9).

All patients who have undergone reconstructive foot surgery require a structured, well planned, multidisciplinary recovery program to ensure success. All patients are maintained on a non-weight bearing regimen for at least three weeks after the procedure that place suture lines on the plantar surface of the foot. The use of strict bed rest and wheelchairs after reconstruction varies with the nature of the procedure performed. Control of pedal edema is important and may be accomplished with bed rest and elevation along with the careful use of back slab made of dynacast or plaster of paris while the patient is on bed rest for 2 weeks. Four weeks postoperatively, patient is encouraged to begin weight-bearing ambulation and elastic compression stocking worn upto 3 months postoperatively for better contouring and reshaping of the flap and control of pedal edema.

An increased risk of complication with this flap have reported in multimorbid group of patients (10). In our series, all patients were healthy with no comorbid disease.

For larger defects, the reverse sural artery flap can be modified by inclusion of a midline "cuff" of gastrocnemius muscle containing the buried sural pedicle is harvested with the flap in the upper part of the leg (11).

Conclusion:

The reverse sural artery flap is a most versatile, fasciocutaneous flap that nourishes from the peroneal perforator 5 cm above the lateral malleolus. This flap can cover any size ankle or hind foot defect with the least donor site deformity, unsightly scarring only if skin grafted. The advantages of this flap are: easy and quick dissection, hence saving operating time, minimal morbidity of donor site and preservation of major arteries of the leg (12).

References:

1. Hasegawa M, Torii S, Katoh H, et al. The distally based sural artery flap, *Plast. Reconstr. Surg.* 93: 1012, 1994.
2. Godina, M Early microsurgical reconstruction of complex trauma of the extremities, *Plast. Reconstr. Surg.* 78:285, 1986.
3. Jeng, Seng-Feng M.D.; Wei, Fu-Chan M.D. Distally Based Sural Island Flap for Foot and Ankle Reconstruction; *Plast. Reconstr. Surg.* 99: 744, 1997.
4. Masquelet AC, Romana MC, Wolf G: Skin island flap supplied by the vascular axis of the sensitive superficial nerves: anatomic study and clinical experience in the leg. *Plast Reconstr Surg* 1992;89:1115.
5. Franklin JD: The deltoid flap: anatomy and clinical applications. In Buncke HJ, Furnas DW, eds: *Symposium on Clinical Frontiers in Reconstructive Microsurgery*, vol 24. St Louis, CV Mosby, 1984.
6. Russell RC, Guy RJ, Zook EG, Merrell JC: Extremity reconstruction using the free deltoid flap. *Plast Reconstr Surg* 1985;76:586.
7. Katsaros J, Schusterman M, Beppu M, et al: The lateral upper arm flap: anatomy and clinical application. *Ann Plast Surg* 1969;22:143.

8. May JW, Halls MJ, Simon SR: Free microvascular muscle flaps with skin graft reconstruction of extremity defects of the foot: a clinical and gait analysis study. *Plast Reconstr Surg* 1985;75:627.
9. Stevenson TR, Mathes SJ: Management of foot injuries with free muscle flaps. *Plast Reconstr Surg* 1986;78:665.
10. Baumeister, Steffen P. M.D.; Spierer, Roberto M.D.; Erdmann, Detlev M.D et al: A Realistic Complication Analysis of 70 Sural Artery Flaps in a Multimorbid Patient Group: *Plastic & Reconstructive Surgery*: July 2003 - Volume 112 - Issue 1 - pp 129-140.
11. Al-Qattan; A Modified Technique for Harvesting the Reverse Sural Artery Flap From the Upper Part of the Leg: Inclusion of a Gastrocnemius Muscle "Cuff" Around the Sural Pedicle; *Annals of Plastic Surgery*: Sept 2001 - Volume 47 - Issue 3 - pp 269-278.
12. Rajacic N, Darweesh M, Jayakrishnan K, Gang R K, Kojic S. The distally based superficial sural flap for reconstruction of the lower leg and foot; *British Journal of Plastic Surgery*: Volume 49, Issue 6, September 1996, Pages 383-389.

