

Original Research Article

Extended reverse sural artery pedicle flap: a versatile and reproducible option for coverage of ankle and foot defects

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ABSTRACT

Background: Coverage of soft tissue defects around distal third of the leg, particularly ankle and foot is a common situation faced by a plastic and reconstructive surgeon. Options available for such defects are limited due to scarcity of additional soft tissue that can be used without exposing tendons or bone. Associated conditions such as major vascular compromise, comorbidities and lack of facilities or expertise make free tissue transfer less preferred. Distally based sural artery flap has been a frequently used flap in such conditions, easy to perform and has reproducible results. We extended the reach of the flap and reproduced the results.

Methods: We performed extended reverse sural artery pedicled flaps in 19 patients who presented to us between 2015 to 2017 with soft tissue defects around ankle and foot. Patients included 15 post RTA, 2 diabetic foot, 1 post resection defect and 1 post burn contracture release defect. Size of the defect ranged between 8x6cm to 14x10cm. Average follow up period was ranging from 8 months to 2.5 years.

Results: All the flaps healed well without any obvious complications except one patient in whom marginal necrosis (2 cm margin of distal most flap) was observed and was secondarily treated with skin grafting.

Conclusions: We observed that extended reverse sural pedicle flap is a rapid, reliable option for coverage of soft tissue defects around ankle and heel, sparing major vessel compromise and lengthy surgical procedure during free tissue transfer. This flap should be the first option for the patients with trauma and defects over weight bearing foot in whom peroneal axis vessels are preserved.

Keywords: Ankle soft tissue defects, Extended reverse sural artery flap, Reverse sural artery flap, Soft tissue defect coverage around foot

INTRODUCTION

Scarcity of the usable soft tissue around the lower third of the leg, ankle and foot presents a challenge for coverage of soft tissue defects in this part of lower extremity. On the other hand, trauma and defect around ankle and foot is common presentation to a plastic surgeon. Often, age related comorbidities and additional vascular compromise

complicates the situation and further narrows the options available. Use of free tissue transfer to cover these defects often need to sacrifice major vessel of the leg limiting its utility in addition to need of expertise and lengthy procedure hours. Hence, a more commonly used reliable and rapid coverage option for such defects around the ankle and foot is distally based sural pedicle flap.^{1,2}

The reverse sural artery flap is an adipofasciocutaneous flap based on vascular axis of sural nerve which receives its blood supply from its communications with peroneal artery perforators around lateral malleolus.³ We observed that its reach can be extended by including sural nerve in the distal most part of the flap by dissecting it along its course below the fascia, between the gastrocnemius heads. In this study we tried to check the reliability, reproducibility and safety of the technique of using Extended reverse sural artery pedicle flap.

METHODS

During 2015 to 2017, we treated 19 patients of soft tissue defect around ankle and foot presented to Plastic and

Reconstructive surgery unit at Dr D Y Patil medical college, Pune with extended reverse sural artery flap (Table 1).

They included 14 males and 5 females. The etiology included 15 post road traffic accidents including wheel spoke injury, 2 diabetic foot, 1 post resection defect and 1 post burn contracture release defect. The defect site included ankle, medial aspect of ankle, weight bearing heel and dorsum of foot. Mean follow up time was ranging from 8 months to 2.5 years.

Preoperatively the patients were screened for patency of peroneal perforators especially the one at around 7-8cm from lateral malleolus using Doppler ultrasound probe.

Table 1: Details of patient data, flap dimensions and results.

Age	Sex	Etiology	Defect Site	Defect Size	Comorbidity	Post-operative Complication
28	M	RTA	Ankle joint and Exposed Tendon	12*9	-	-
40	M	RTA	Ankle Joint	12*10	-	-
35	F	RTA	Weight bearing Heel	10*7	-	-
22	M	Post burn scar excision	Dorsum of foot	11*9	-	-
28	M	RTA	Medial side of foot	13*10	-	-
55	M	Diabetic Foot	Dorsum of foot	12*10	Diabetic	-
18	M	RTA	Tendoachilles and hindfoot	8*7	-	-
52	F	Post tumour excision	Weight bearing heel	9*6	Diabetic	-
20	M	RTA	Medial side of foot	13*9	-	-
25	M	RTA	Medial malleolus exposed implant	8*6	-	-
38	M	RTA	Tendoachilles and weight bearing heel	13*9	-	-
20	F	RTA	Weight bearing heel pad	8*7	-	-
27	M	RTA	Ankle and Dorsum	11*8	Smoker	-
32	M	RTA	Ankle with exposed tendon	12*9	-	--
45	M	Post Cellulitis	Dorsum of foot	12*9	Smoker	-
36	F	RTA	Distal third leg with ankle	9*6	-	-
16	M	RTA	Tendoachilles and hindfoot	14*10	-	-
58	M	Trophic ulcer	Weight bearing heel	10*8	Diabetic	Distal most 2cm flap necrosis
20	M	RTA	Weight bearing heel	12*9	-	-

Surgical technique

Preoperatively, the course of the sural nerve was marked along the line from the midline between gastrocnemius heads in the popliteal fossa to the point between the lateral malleolus and tendoachilles. Perforator of the peroneal axis around 7-8cm from the lateral malleolus was also marked using handheld Doppler probe. Debridement of the raw area was done and defect size measured. Flap was marked accordingly in the upper

third of the calf with distal margin within 2-3cm from the popliteal crease. Reach of the flap was confirmed by planning in reverse.

The flap dissection was started from the distal most part of flap. Sural nerve and Lesser saphenous vein were identified and divided (Figure 1). The sural nerve was incorporated in the flap by dissecting it between the gastrocnemius heads subfascially. The dissection was then continued along the medial and lateral borders after securing the fascia with the skin. Fasciocutaneous

Perforators of the peroneal axis and musculocutaneous perforators through gastrocnemius muscle were divided as the dissection progressed. Dissection was completed till the pivot point as per marking (7-8cm from the lateral malleolus). The pedicle width of at least 5cm was maintained, an inch on each side of the pivot perforator and to include short saphenous vein.



Figure 1: Sural nerve and short saphenous vein at the distal end of flap.

The vascularity of the flap was confirmed at the distal most part. Even in our diabetic patients we found it adequately vascular and hence flap delay was not done. The flap was then inset at the defect site and secured in place. Splint was applied to restrict movements of the limb. All the procedures were done by the same author. The flap dimensions ranged from 8x6cm to 14x10cm. Final inset of the flap after division of the pedicle was done after 3 weeks.

RESULTS

Defects around ankle and weight-bearing foot along with exposed tendons were successfully covered with the flap. Post-operative course was uneventful and the flaps healed well, with the exception of one.



Figure 2: Case 1. (A) Medial extent, (B) Lateral extent of the defect around ankle with exposed Tibialis anterior tendon.



Figure 3 Case 1. (A) Medial view, (B) Lateral view at Postoperative 2 year follow up showing supple and cosmetically satisfying flap coverage.

Figure 2 shows pre-operative images of the case 1 having post-traumatic soft tissue defect over left ankle anterior aspect from medial to lateral malleolus along with exposed Tibialis anterior tendon and tibia.



Figure 4: Case 19. (A) Medial extent and (B) lateral extent of the defect over weight-bearing heel and hindfoot.

Figure 3 shows two year follow up of case 1 patient showing well healed and supple flap with cosmetically satisfying appearance.

Figure 4 shows pre-operative images of case 19 having post-traumatic soft tissue gangrenous changes over right heel and defect extending over hindfoot and lateral aspect upto lateral malleolus.

Figure 5 shows post-operative images of Case 19 where Extended reverse sural flap was used to cover weight bearing heel which is completely healed and donor area covered with split thickness skin graft.

In an elderly diabetic trophic ulcer patient, the flap suffered partial necrosis of the distal most part (2cm of

distal most margin) which was treated with skin grafting. The flaps and donor site skin grafts otherwise were very well accepted cosmetically to the patient satisfaction (Figure 6). The flaps showed supple skin in late follow-up period. None of the patients required any other supplementary procedure such as flap thinning or revision inset.



Figure 5: Case 19 post operative follow up showing a well accepted flap and well healed donor area.



Figure 6 Aesthetically acceptable donor site of flap with well-preserved contour.

DISCUSSION

The present study provides sufficient evidence to apply this technique as a safe, easy and applicable method in defects around ankle and foot. The results show low rates of ischemia, venous congestion, dehiscence, infection and flap necrosis.

Soft tissue defects of the distal third of the leg, ankle, heel, and foot are difficult to reconstruct. The sural flap is a useful and reliable reconstructive option in patients with soft-tissue defects of the foot and lower leg.^{1,2} Despite these successes, flap necrosis and other complication rates remain significant. Several studies described different rates from 5% to 36%.⁴⁻⁸ Kneser et al, also did not observe any complete or near complete flap necrosis in their study.⁹ These studies have been performed on patients with small to moderate sized defects on the distal part of the leg, Achilles tendon, ankle, malleolus and heel.^{9,10} Large soft-tissue defects of the heel; sole and dorsum of the foot are a challenging problem and are usually treated by free tissue transfer as free flaps provide reliable single-stage coverage.^{2,3,9}

However, there are some disadvantages to this technique which are: donor-site morbidity, increased operation time, the use of a major vessel of the leg and the necessity of microsurgical expertise. An alternative approach for large defect coverage of these areas is the distally based fasciocutaneous sural flap. The major advantages of the distally based fasciocutaneous sural flap are a quick and safe surgery, a wide arc of rotation of the flap, preservation of major arteries of the leg, and acceptable donor-site morbidity.^{2,9} At the other hand, the disadvantages are perfusion problems, venous congestion, partial necrosis and length limitation. The proximal extension of the distally based sural flap has been considered a random type flap and its survival is not predictable.^{4,5,11}

Some of authors have presented modifications to secure the extension of the Fasciocutaneous Island to the proximal leg. Such modifications included delaying, a pedicle wider than usual, and harvesting a midline cuff of the gastrocnemius muscle with the flap.^{6-8,10} Venous supercharging is a microsurgical technique that should be considered in patients with venous insufficiency.² It has been shown that delay can significantly increase blood circulation in the distal portion of the random pattern skin flaps.^{10,14,15} Some authors had previously mentioned about adipoareolar tissue between the two heads of the gastrocnemius muscle and made a mesentery like structure that was important for flap elevation.^{12,16}

The upper limits of the flap's dimensions have been best explored by Ayyappan and Chadha, who have reported that they left as little as 1 to 2cm of skin distal to the popliteal crease with a pivot point only 4 to 5cm proximal to the lateral malleolus.¹⁷ To finalise, we considered many studies about distally based sural flaps.

We reached to a conclusion that the survival of a large sural flap is the result of the function of many different parameters: vascular risk factors, patient's age, smoking, defect size, kinking of the pedicle area, insufficient skin mobilization at the base of the flap, tunneling of the flap, and large flap dimensions as well as tissue trauma due to accidents which may have negatively influenced perfusion of the entire flap.

We used extended distally based sural flap for large defect on the ankle and foot as an alternative to free flap. The benefits of the proximal design of the flap were larger flap and pedicle lengthening, which cover a larger area without stretching or tension on suture line. Widening of the pedicle preserved venous and arterial connection and helped to prevent pedicle kinking and flap transfer. The pivot point was located in seven to eight cm proximal to the lateral malleolus. The dissection stopped there, which preserved all cutaneous perforators including a perforator from the lateral calcaneal artery and posterior lateral malleolar artery, and one to three septocutaneous perforators from the peroneal artery. No delay was done in our study.

The result of this study can be considered a favorable result compared to other reports. The large defects were situated on the foot and were caused by varying etiology as described earlier. To mention, no complete or near complete flap necrosis was observed in this study. Finally, all patients underwent successful reconstruction with the sural flap. In conclusion, extended distally based sural flap is a reliable and safe alternative to free tissue transfer for large defect reconstruction of the ankle and foot with comparable aesthetic results.

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