Use of Reverse Sural Artery Flap in Lower Leg Defects in 32 Patients

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ABSTRACT

Aim: Soft tissue reconstruction of distal third of leg, heel and ankle region is a difficult problem because of poor vascularity and limited mobility of skin. The free tissue transfer is used to be the choice of reconstruction most of the cases. The reverse sural artery flap with its ideal flap thickness, minimal donor site morbidity, wide arc of rotation and safe vascularity makes it a better alternative for covering such defects in the peripheral outset. To study retrospectively the role of various modifications of reverse sural artery flap to reach the defect and for better survival of flaps.

Materials and Methods: 32 cases of reverse sural artery flaps operated at Chalmeda Ananda Rao Institute of Medical Sciences and other hospitals during the period of 2012 February to 2014 December. It is a retrospective study conducted in our institute. 32 cases of distal leg and foot defects, who underwent reverse sural artery flap coverage were included in the study.

Results: All the flaps were survived. Of which in 12 cases marginal necrosis and in 5 cases partial necrosis was noted. All the flaps survived during the follow up period of 1 year with good functional outcome.

Conclusion: The reverse sural artery flap with its modifications is a very useful for the defects of distal leg, heel and ankle.

Keywords: Reverse sural artery, neurocutaneous flap, peroneal perforator

INTRODUCTION

The management of compound injuries of lower third of leg and foot remain a great challenge to the reconstructive surgeon in view of the poor vascularity and limited mobility of the skin. Tendon, bone and implants are frequently exposed because of the thin subcutaneous tissue. In most of the cases, these wounds are best addressed by free tissue transfer. The free tissue transfer has limitations of time, expertise and infrastructure requirement and can be technically difficult in the peripheral outset which requires a team approach and associated with substantial donor site morbidity.

Different local flaps for foot defects including dorsalis artery flap, abductor hallucis and abductor digiti minimi muscle flaps have inadequate tissue and limited arc of rotation (Medial plantar artery flap). Lower leg defects can be covered with different fasciocutaneous flaps designed basing on the perforators from the posterior tibial artery, peroneal artery and anterior tibial artery.

We favoured the reverse sural artery fascio-cutaneous flap1 in most of our cases of lower leg soft tissue defects for its ease of dissection, limited donor site morbidity and the preservation of the major vessels in the limb. The ideal thickness and safe vascularity with a wide arc of rotation has made the flap versatile in the reconstruction of lower leg and foot reconstructions. Its long pedicle enables to cover defects around ankle and foot as far as the base of toes (Proximal extension of skin paddle).2

Key points for the successful reverse suraI flap include doppler evidence of patent peroneal perforators, placement of lazy-T shape incision below the skin paddle over the distal gastrocnemius muscle bellies, inclusion of lesser saphenous vein along with wide adipo-fascial pedicle to augment venous drainage along with sural nerve.3

The reliability increases if the mesentry of the sural artery which runs along with the sural nerve is included in the
skin paddle. And also the anastomosis of the sural artery with the peroneal perforator at 5cm above the lateral malleolus is preserved.

The advantages of reverse sural fasciocutaneous flap are ease of dissection, complete coverage at one stage, no need of microsurgical expertise, minimum complications, its long pedicle enables to cover defects around ankle and foot as far as the base of toes. (proximal extension of skin paddle and the use of distal most pivot point increased the probability.)

Anatomical considerations

Peroneal artery

About 5-6 septocutaneous perforators arise and run along the posterior peroneal septum between the styloid process to the lateral malleolus to spread out and anastomose longitudinally at the level of the deep fascia. Apart from these multiple musculocutaneous perforators from the lateral and flexor muscle groups.

It terminates into lateral malleous artery and lateral calcaneal artery. These two branches also send off cutaneous perforators about 3 and 1 cm above the tip of the lateral malleolus respectively. These can be used as pivot points of flap and successfully modify the flap for the coverage of the distal foot.

Sural artery

is a branch from the posterior tibial artery descends from the popliteal fossa between the two heads of gastrocnemius muscle, runs in the deep fascial layer and courses inferiorly superficial to the gastrocnemius muscle slightly lateral to the posterior midline along with the sural nerve and small saphenous vein in the loose fibro adipose connective tissue connected to the fasciocutaneous island by a mesentry (Ayyappan and Chadda).

The sural artery has direct cutaneous branches only in the superficial portion i.e. in the lower 2/3 of leg. So the proximal extension of the flap is a random type and the survival is unpredictable.

A constant communicating branch from the sural artery with the peroneal perforator at 5cm from the tip of the lateral malleolus makes the flap versatile. This allows to rise the flap on reverse flow with a pivot point at 5cm from the malleolus and this islanded fasciocutaneous flap with its adipofascial subcutaneous pedicle, can be used to cover many of the defects of the lower end of the leg and foot as far down as the base of the toes.

MATERIALS AND METHODS

The present study is based on the 32 reverse sural artery flaps done at Chalmeda Ananda Rao Institute of Medical Sciences, Karimnagar, Telangana, India over a period of January 2012 till December 2014 and also at different hospitals during the same period. Majority were post traumatic soft tissue defects and remaining were post infective non healing ulcer and hypertrophic scarring with contracture at ankle with unstable area. 9 patients had tendoachilis injury, 6 cases had extensor tendon injury on dorsum of foot.

Routine investigations along with specific investigations like x-ray of the affected limb, Doppler studies were done when indicated. Some patients who are electively admitted requiring the soft tissue reconstruction are also subjected to the complete clinical and laboratory investigations and sent for pre anesthetic check-up.

Technical details

The standard Technique

Epidural or spinal anaesthesia is given in all cases. Patient is placed in lateral position or prone position according to the site of the defect.

Planning: The posterior aspect is divided into 3 parts. The middle third around 12X14cm fasciocutaneous skin flap can be raised depending on the size of the defect.

Marking: of the perforators with hand Doppler is done to confirm the position of the perforator at 5cm above the lateral malleolus.

Under spinal anaesthesia in lateral decubitus position and under tourniquet control, the incision is made along the midline of the calf along which small saphenous vein along with sural artery runs and with the pivot point located at 5cm from the tip of the lateral malleolus. (Figure:1)

Then the lateral incisions are given and the fasciocutaneous flap with sural nerve and small saphenous vein along with its mesentry (Figure-2) into the skin paddle. After thorough debridement, the probable size of the defect is marked. The flap is designed with the axis along the midline of the calf along which small saphenous vein along with sural artery runs and with the pivot point located at 5cm from the tip of the lateral malleolus. (Figure:1)

Marking: of the perforators with hand Doppler is done to confirm the position of the perforator at 5cm above the lateral malleolus.

Under spinal anaesthesia in lateral decubitus position and under tourniquet control, the incision is made along the upper border of the flap up to the muscle. Sural nerve and small saphenous vein are identified and cut. Sural artery, a small arterial twig coming out between the gastrocnemius heads is included along with its mesentry (Figure-2) into the skin paddle.

Then the lateral incisions are given and the fasciocutaneous flap with sural nerve and small saphenous vein along with its mesentry including the sural artery, is raised from the muscle belly. Few musculocutaneous branches coming out are coagulated. The flap is islanded by incising the inferior border to subdermal level. Lazy s incision is given in the midline. And subcutaneous pedicle is dissected including the fibro fatty fascial layers up to the pivot point which is located at the site of entry of perforator at 5 cm above the lateral malleolus (Figure-3).
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Figure 1: Marking of the flap. Small saphenous vein, sural artery and sural nerve and the pivot point

Figure 2: Sural artery emerging between the two heads of the gastrocnemius along with the sural nerve

Figure 3: Skin paddle turned to the defect with its pivot point

Figure 4: Communicating branch

Figure 5: Flap inset without any tension over the pivot point

Figure 6: Flap inset and ssg over the pedicle

Figure 7: SSG over the donor site
A constant communicating branch to the 5 cm perforator is identified and preserved (Figure-4). And the flap is rotated to the defect. Hemostasis secured. And the flap is given inset into the defect without causing any tension over the pivot point (Figure 5).

Donor site along with the subcutaneous pedicle is covered with split thickness skin graft (Figure-7). Limb is immobilized so as to avoid any tension on the pedicle.

Post operative course: the patient is positioned in the semi-prone / prone position for 2 week period. Flap viability is observed every day. Antibiotic and analgesic along with platelet aggregation inhibitors like pentoxyphylline and ecosprin low dose (75mg) is given for 1 week. And primary dressing is done on 7th day. And the suture removal done after 3 weeks. And partial weight bearing started slowly after 4 weeks in patients. Total weight bearing is done after 8 weeks.

Splinting continued for 6 weeks when tendoachilis is repaired and partial weight bearing after 8 weeks and total weight bearing after 12 weeks.
Case 3: Defect over the back of heel standard flap

Case 4: Heel avulsion with TA injury

Case 5: Ankle soft tissue defect

Case 6: Small defect over dorsum

Case 7: Avulsion of heel
Case 8: For weight bearing heel

Case 9: Extensive soft tissue defect dorsum of foot

Case 10: Dorsal defect on foot

Case 11: Compound #calcaneum
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RESULTS

All the flaps survived. 1 cm marginal necrosis in 8 cases (Figure). Flap donor site is healed well in all cases. Skin graft over the subcutaneous pedicle is lost in 18 cases and all were healed by secondary intention except in 2 cases ssg was done secondarily. Proximal extension was taken in 3 flaps. 2 of these large paddle were survived with superficial edge necrosis. Partial necrosis noticed in one case (fig) where 1/3 of the flap is lost which required debridement and ssg. Post op follow up of 8 weeks revealed partial weight bearing was possible only in 9 cases. Full weight bearing in 3 months in these cases. Remaining patients in view of the associated tendoachillis rupture and partial and marginal necrosis as well as the graft loss weight bearing was delayed by 2 more weeks. Donor site morbidity is minimal except for scarring and transient numbness in the sural nerve distribution.

DISCUSSION

Masquelet et al[1] introduced the sural flap in 1992. He first described as a distally based neuro cutaneous flap, a skin island flap supplied by the vascular axis of sural nerve. This has been used widely for reconstruction of foot and ankle soft-tissue defects. The distal pivot point of the flap is designed at the lowest septocutaneous perforator from the peroneal artery of the posterolateral septum which is, on average 5 cm (4-7 cm) above the lateral malleolus.

The main consideration during the procedure was keeping the vascular plexus around the sural nerve, sural artery, and lesser saphenous vein in the loose fibro-adipo-areolar tissue between the two heads of the gastrocnemius muscle intact and connected to the fasciocutaneous island. This was named a mesentery-like structure by Ayyappan and Chadha.[4]

Accompanying arteries of the lesser saphenous vein and sural artery, their relationship in the lower two thirds and proximal third of the leg, and their independent role in survival of flaps were discussed in detail by Nakajima et al.[3] Imanishi et al.[5] later explained the role of concomitant veins of accompanying arteries of the lesser saphenous vein in venous drainage of distally based sural flaps, despite the presence of venous valves. Respecting the major role of the lesser saphenous vein, in fact, these authors preferred to use the name of distally based lesser saphenous-sural veno-neuro adipofascial pedicle fasciocutaneous flap.[3,5]

Many modifications were tried in different studies to secure proximal extension of fasciocutaneous island delaying a wider than usual pedicle[6,9,13] supercharging[8,11,17] and harvesting a midline cuff of the gastrocnemius muscle with the flap.[2,18] Others tried to solve this problem without proximal extension of the flap; such modifications included exteriorizing the pedicle,[19] mobilizing the peroneal perforator in the intermuscular septum,[20,21,27] and cross-leg sural flap.[20]
As mentioned by Masquelet et al. the flap circulation mainly depends on the median sural artery and that this artery has direct cutaneous branches only in its superficial portion (i.e., in the lower two-thirds of the leg), hence, the proximal extension of the flap has been considered a random type flap and its survival is not predictable.

In contrary, it was noticed some tiny vascular connections from the sural artery itself to the fasciocutaneous island in the proximal third of the leg, which can be called miniature perforators. (Ayyappan and Chadha) So, the proximal extension of a reverse sural flap is considered as an axial flap and not a random one. And if these delicate vessels are not preserved and incautiously detached from the fasciocutaneous paddle, the proximal part of the flap will be converted to a completely random one and a major ischemic event should be expected.

In another study, Zhang and Chang identified new pivot points are for this distally based flap in an anatomic study of 30 fresh cadavers. The results showed the existence of cutaneous perforators from the terminal branches of peroneal artery, the posterior lateral malleolar artery and lateral calcaneal artery at about 3 and 1 cm above the tip of lateral malleolus respectively, which can be used as arterial pivot points for the flap. A communicating branch between the lesser saphenous vein and the peroneal venae comitantes was found, accompanied by the perforator of the posterior lateral malleolar artery. This study modified the vascular pivot point of a distally based sural flap, safely designed at 1.5 cm proximal to the tip of the lateral malleolus. This modified flap provides a valuable tool for repair of foot and ankle soft-tissue defects.

The results of the study showed that the reverse sural artery fasciocutaneous flap is an effective method for reconstruction of soft tissue defects around the foot and ankle. Of many modifications of the flap were tried especially the proximal extension of the calf, by carefully preserving the miniature perforators is found to be very useful and allowed us to take 15X10cm flap. It was noted for the safe flap elevation and to reduce venous congestion, hence to reduce flap failure, the following modifications to be adopted.

Proper planning including preoperative identification of peroneal artery perforator sites by hand Doppler study.

To take proximal extension of the flap, tiny branches from the muscle as they are to be preserved either by taking a midline cuff of gastrocnemius muscle along with tiny perforators from the sural artery in the proximal third. Sural flaps as big as 17X16cm can be harvested (Syed Kamran Ahmed & Boris Kwok Keung Fung et al.)

Donski and Fogdestam described distally based fasciocutaneous flap based on the perforators of the peroneal artery around the ankle and their communications with the superficial sural artery. The inclusion of both sural and peroneal systems improves venous drainage and makes the pedicle more substantial to avoid any kink while taking the flap to foot. Flap as big as 26X13 cm can be harvested.

Subcutaneous pedicle should be kept wide 3-4cm and skin grafting should be done instead of subcutaneous tunnel. The inclusion of small saphenous vein is mandatory. To reduce venous congestion further, leech therapy can be advocated. Anastomosis with one of the donor veins in the foot may be an alternative.

The numbness in the sural nerve territory is self-limiting. Usually resolved in three months. And to avoid painful neuroma nerve stump needs to be buried in the deep muscular plane.

The other important complication includes partial or total necrosis of the flap (a less frequent observation). Marginal loss of the flap is common. The probability of the partial necrosis increases when the top edge of the flap in the upper 1/9 of the calf, when the length width ratio of the flap is 5:1 or more, for when the width is more than 8cm or more,(Wei JW and DongZG et al). The flap with top edge locating in the lower 7/9 of calf is safe and reliable.

Donor site morbidity was minimal. Unsightly scar on the calf can be avoided by taking only adipofascial flap.

CONCLUSION

Reverse sural artery flap is very popular method of soft tissue reconstruction in lower limb trauma with lower third and foot defects. All most all cases were settled without any further major procedure. With the better understanding of the perforator anatomy, use of modifications like proximal extension of flap, wider subcutaneous pedicle and shifting of vascular pivot point further distally towards tip of lateral malleolus make the flap further better option for successful reconstructions of big defects either and also as distally as the base of the toes in the foot. This islanded flap though insensate, gives durable skin cover in the heel as well. Thus this flap is considered to be a better alternative to the free tissue transfer.

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CONFLICT OF INTEREST
The authors declared no conflict of interest.

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