

EXTENDED REVERSE SURAL FLAP FOR LOWER LIMB COVERAGEBiswajit Mishra¹¹Assistant Professor, Department of Plastic Surgery, M. K. C. G. Medical College and Hospital, Brahmapur.**ABSTRACT****BACKGROUND**

The reverse sural artery flap has been a workhorse for the reconstruction of distal third of leg, ankle, sole and foot. Major limitation of reverse sural flap has been venous congestion particularly when harvested from proximal third of the leg.

Objective- To evaluate the efficacy, safety of the extended reverse sural flap from proximal third of the leg.

MATERIALS AND METHODS

A prospective study was conducted at the department of plastic surgery on twenty patients who needed soft tissue reconstruction in the distal third of the leg, ankle, heel, forefoot and midfoot due to various cause. In all cases flap was extended proximally to the upper third of the calf and neurovenoadipo fascial pedicled sural fasciocutaneous flap was harvested.

RESULTS

There were only two cases of marginal necrosis. None of the patients had complete necrosis. Two patients developed hypertrophy of the flap margin.

CONCLUSION

Distally based neuroveno adipofascial pedicled sural fasciocutaneous flap can be safely extended to proximal third of the leg and is a reliable option for reconstruction of the defects in the foot, ankle and sole.

KEYWORDS

Neuroveno Adipofascial Pedicle, Reverse Sural Flap, Peroneal Perforator.

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BACKGROUND

Soft tissue reconstruction of the distal third of the leg, ankle, sole and foot is a challenge for reconstructive surgeon. Microvascular reconstruction has revolutionised the treatment option and now is the first choice for lower limb defects.¹ However it needs technical expertise, trained assistance for flap monitoring and urgent reexploration for the salvage of the flap. Angiosomes as outlined by Taylor were defined as a three-dimensional anatomic unit of tissue fed by a source artery.² The peroneal artery angiosome extends laterally to central raphe overlying the Achilles tendon and medially by anterior edge of the lateral compartment. It supplies muscles in deep posterior compartments, the fibula, lower lateral portion of soleus muscle, the lateral half of Achilles tendon and the lower distal two thirds of peroneus longus and brevis muscle. Perforating vessels from peroneal artery supply posterolateral skin of the leg. The superficial sural artery which branches off of the posterior tibial artery connects with the sural nerve in the proximal third of the leg. The

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artery gives off branches to the tissue and the skin along the course of the nerve as it continues distally to foot.

Even if the artery is not well defined along the course of the nerve (65%) the nerve is still enclosed in a vascular network of perforators from sural artery (35%) that will ensure a true vascular axis along the course of the nerve. This forms the basis for reverse sural artery flap.³ Peroneal septocutaneous perforators anastomose with superficial sural arterial network within the distal two thirds of the leg.³⁻⁵ Peroneal artery gives numerous perforators along posterolateral septum and the distal one is located 5 cm above the lateral malleolus which form the pivot point of the reverse sural flap.³ Traditionally reverse sural flap is considered to be safer when raised from distal two third of leg. Most common cause of flap necrosis is venous congestion. Studies have shown that lesser saphenous vein is mainly responsible for venous drainage of the flap. Lesser saphenous vein also gives venocutaneous perforators which is the major contributor to the perfusion of the skin in the upper half of the leg.² Wider pedicle of at least 4 cm has been suggested to prevent flap congestion. So, by combining above principles we designed an extended reverse sural artery with extension in to proximal third of lower leg and it was raised with a wider pedicle with preservation of the more number of peroneal perforator and by inclusion of lesser saphenous vein at the base.

The purpose of the study is to study the safety, efficacy and success of the extended reverse sural artery flap.



MATERIAL AND METHODS

This prospective study was conducted in the Department of plastic surgery between 2013 August and 2015 November. 20 patients were included in the study. All required soft tissue reconstruction in the lower third of the leg, over tendoachilles, dorsum of foot, weight bearing heel and sole of the foot. In 6 patients defect was over the dorsum of the foot and distal lower third of the leg which were too large to be covered by standard flap. In another 6 patients, defects were in the weight bearing areas of the heel. 4 patients were diabetic and chronic smokers.⁴ patients had suffered high

velocity trauma and degloving of the skin near lateral malleolus. In all these patients, reliability of the lower most perforator was doubtful. So, we planned to shift the pedicle proximally and harvest the flap from upper third of the leg. The demographic data of all the cases including age, sex, cause, size of the defect, pivot point of the pedicle, comorbid condition and complication were recorded (Table 1). The outcome was noted in terms of complete /partial flap survival, successful coverage of the recipient defect and other complication.

Sl. No.	Age (years)	Sex	Site of the Defect	Size of the Defect	Pivot Point	Co morbid Condition	Complication
1.	7	Female	Dorsum foot	10 cm x 6 cm	7cm	-	Scar hypertrophy of the margin
2.	23	Male	Lateral malleolus	7 cm x 8 cm	7cm	-	
3.	38	Male	Lateral malleolus and ankle	8 cm x 4 cm	7cm	-	Donor site skin loss
4.	43	Female	Dorsum of forefoot and midfoot	18 cm x 12 cm	7cm	diabetic	
5.	54	Male	Tendoachilles and heel	6 cm x 7 cm	5cm	diabetic	
6.	25	Male	heel	5 cm x 7 cm	7cm	-	Donor site skin loss
7.	36	Male	Middle third and lower third of tibia	12 cm x12 cm	7 cm	-	
8.	38	Female	Lower third tibia	8 cm x 4 cm	7 cm	-	Minor wound dehiscence
9.	49	Male	Ankle	6 cm x 8 cm	7cm	-	-
10.	29	Male	Hind foot	10 cm x 10 cm	7cm	diabetic	Marginal necrosis
11.	33	Female	heel	8 cm x 6 cm	7 cm	-	-
12.	40	Male	tendoachilles	6 cm x 4 cm	5 cm	-	-
13.	18	Male	Lower third tibia	8 cm x 6 cm	10 cm	-	-
14.	21	Female	Tendoachilles and heel	8 cm x 8 cm	7 cm	-	-
15.	23	Male	Lower third tibia	8 cm x 7 cm	7cm	-	-
16.	24	Female	Dorsum of lateral aspect of foot	10 cm x 8 cm	7 cm	-	Marginal necrosis 1 cm
17.	46	Male	Ankle joint	7 cm x 6cm	7 cm	-	-
18.	16	Female	Hind foot	10 cm x 6 cm	7 cm	-	-
19.	32	Male	Lower third leg	10 cm x 6 cm	7 cm	-	--
20.	21	Female	Dorsum foot	12 cm x 10 cm	7 cm	-	-

Flap Design and Operative Technique

All the cases were operated under spinal anaesthesia. Patient was placed in prone position. Tourniquet was applied. Adequate wound debridement was done. Defect size was measured. Flap size was determined by adding 1 cm for flap contraction and tension free closure of the flap.⁶ Peroneal artery perforator was detected by 8Hz Doppler probe which forms the pivot point of the flap. An imaginary line between midpoint of popliteal fossa to the midpoint between tendoachilles and calcaneum forms the axis of the flap. The distal portion of the flap was tapered to allow primary closure of the defect. Proximal incision was first made. lesser saphenous vein was identified, ligated, divided and included in the flap. Sural nerve was identified subfascially in between two heads of gastrocnemius. Loose

areolar layer between the nerve and deep fascia was preserved. This nerve is sutured to the dermis of the proximal margin of the skin flap to prevent shearing of the perforators. The skin island is dissected up to the deep fascia. Pedicle of the flap was designed either adipofascial or flap was raised as a peninsular type of flap. When adipofascial pedicle was planned the skin along the axis of the flap was elevated for a distance of 2 cm on the either side of the central axis of the flap. Then dissection precedes from proximal to distal till flap reaches the defect. No attempt was made to skeletonise the perforator in any case. Tourniquet was deflated and flap was allowed to perfuse for 20 minutes. Dermal bleeding was noticed from the tip of the flap. Flap in setting was done without any tension. The pedicle and the secondary defect were skin grafted. In some

cases, large defective flap was harvested in a peninsular design so as to get additional perfusion from the base. Flap was monitored post operatively for the signs of venous congestion. Patients who presented with acute infection were given two-week course of culture specific antibiotic. A bulky noncompressive dressing was done to avoid pressure on the pedicle. Limb elevation was done to improve venous drainage. Sutures were generally removed just before patient is permitted to begin weight bearing ambulation. Elastocrepe bandage was given from 10th post-operative day with gradual dependency started between 12 to 15 days till 21 days. Active and passive physiotherapy of the joints started on 10th post-operative day. After 21 days, gradual immobilization was started with intermittent weight bearing. Pedal oedema was managed with strict bed rest and elevation followed by use of elastic crepe bandage once patient is permitted to place the limb in dependent position. During bed rest, low molecular weight heparin is given to avoid deep vein thrombosis.

Case Report 1

Patient with a defect over lateral malleolus and dorsum of foot. (Fig. 1)

Defect after debridement. (Fig. 2) Harvesting of distally based adipofascial pedicled flap. (Fig. 3) Mild necrosis of the flap (Fig. 4).

Case Report 2

Defect over heel in a leprotic patient (Fig. 5). Post op result (Fig. 6).

RESULTS

A total of twenty cases were operated in our series. 12 were male and 8 were female. Age ranged from 7 years to 54 years. Defect size ranged from 6 cm x 4 cm to 18x12 cm. Pedicle width ranged from 2.5 cm to 4 cm. Pivot point ranged from 5 cm above lateral malleolus to 7 cm above lateral malleolus. None of the flap had complete necrosis. Only two flap had marginal necrosis. Both these cases were done in an emergency setting immediately after skeletal fixation. Inadequate debridement with residual infection may be a cause for this flap necrosis at the tip. None of the flap had any necrosis even in the diabetic cases.



Figure 1. Defect Around Lateral Malleolus and Dorsum of Foot



Figure 2. After Debridement



Figure 3. Adipofascial Flap Being Raised. Arrow Points the Adipofascial Pedicle



Figure 4. Immediate Post-op Result



Figure 5. Non Healing Ulcer Over Tendoachilles Region



Figure 6. Flap Raised from Upper Third Leg. Single Black Line Indicates the Level of Knee Joint. Pivot Point 7 cm above Lateral Malleolus



Figure 7. Well Settled Flap. Immediate Postop Result

DISCUSSION

Ever since Ponten,⁶ described superflap for lower extremities reconstruction several studies have been done to determine the vascular supply of the lower limb and flap harvesting.

Reverse sural flap was described by Masquelet et al³ Donski and Fogdestam,⁷ described a distally based fasciocutaneous flap based on the perforator situated 15 cm above the lateral malleolus and with an adipofascial pedicle of 5 cm width to cover defect over tendoachilles region. Several authors have reported that conventional flaps were harvested from middle third of the leg mainly depend on the median superficial artery and artery has cutaneous branches only on its superficial course in the lower two thirds of the leg. Hence proximal extension has been considered to be random pattern type and survival is not predictable.^{3,8,9,10}

Al Qattan,¹¹ took a midline cuff of gastrocnemius muscle containing buried sural pedicle to increase the proximal limit of the flap. This technique allowed the preservation of the mesenteric connection between sural pedicle and overlying fascia. Anatomic studies have shown that superficial sural artery from popliteal artery, septocutaneous perforator from posterior tibial artery, peroneal artery and myocutaneous perforators from gastrocnemius and soleus form a three-dimensional vascular architecture of the posterior lower leg integument. There is axially of the circulation of the fascial, paraneural (sural) and perivenous (lesser saphenous) vascular plexus. There is also 4-5 axial communication between this longitudinal neuro-venoadipofascial plexus and posterolateral septocutaneous perforator issued from peroneal artery. With distal axial perforator perfusion, blood flow can reach a long distance in the lower resistance longitudinal vascular plexus and result in survival of a large flap. Nakajima,¹² in his studies showed that the accompanying arteries of the both lesser saphenous vein and sural nerve exist independently. They give rise to venocutaneous perforators to the skin along the entire length of the vein no matter what is the course of the vein. Majority of the blood supply skin in upper half of the calf is provided by accompanying arteries of the vein with little contribution by neurocutaneous perforators. In the lower half of the flap blood supply is shared equally between both venocutaneous and neurocutaneous perforators. It is uncertain how large a flap can be raised and it is uncertain to study relation between the size of the perforator and dimension of the skin island.¹³ Whether to include lesser saphenous vein at the distal end of the flap is debatable. As demonstrated by Imanishi et al¹⁴ small caliber network of veins surround the sural nerve which run along the length of

lesser saphenous vein accompanying sural artery which allows bypass valves of the lesser saphenous vein. Xu et al¹⁵ advocated ligation of lesser saphenous vein at the pivot point. In his series, he observed venous congestion is due to intact lesser saphenous vein which was not sufficient enough to provide venous drainage and after ligation of the vein at the pivot point congestion was absent. Delay of the flap.¹⁶ supercharging.¹⁷ increase of pedicle width to 4cm are some of the methods described to increase the survival of the flap. Baumeister,¹⁸ studied the factors associated with increase flap necrosis. Diabetes, Peripheral vascular disease and chronic venous insufficiency increase the flap necrosis by five-fold to six-fold. Age alone is not a risk factor. Underlying osteomyelitis and tight subcutaneous tunnel also increase the risk of flap necrosis.

In our study pivot point was shifted proximally to 7 cm above malleolus. Shifting the flap pivot point proximally includes increase the number of perforators so that flap perfusion is increased. Venous congestion is the main cause of flap failure. To avoid this problem, we have included the lesser saphenous vein in all cases as lesser saphenous vein is the main venous drainage of the flap. Adipofascial pedicle has been used in most of the cases. The advantage of adipofascial pedicle is that it has an increase in arc of rotation. To decrease the venous congestion, we have never tunnelled the pedicle. The intervening skin between the defect and pivot point was opened and the pedicle is skin grafted. The graft settled very well in all cases with acceptable cosmesis. We have never delayed the flap or supercharged the flap. The flap essentially relies on the communication between the perforators of peroneal artery and superficial sural artery. Propeller flap have been described by skeletonising the perforators and rotating the flap through 180 degree. Skeletonising the perforator also increase the chance of spasm and kinking thus increasing the chance of flap failure. We have not skeletonised the perforator in any cases. Keeping the septum intact and keeping an amount of loose areolar tissue prevents the flap failure.

CONCLUSION

We propose the following steps to achieve high success rates.

1. Adequate debridement.
2. Dissection under tourniquet.
3. Use of loop magnification.
4. Proximally shifting the pivot point to 7 cm above the lateral malleolus in high risk cases.
5. Avoiding the skeletonisation of the perforator.
6. Include a wider adipofascial pedicle approximately 4 cm and include lesser saphenous vein at the base.
7. Avoid compression of the base of the flap and pedicle of the flap.
8. Postoperative limb elevation.

Utilizing these principles, we suggest that reverse sural artery can be safely extended proximally.

REFERENCES

- [1] Hsieh CH, Liang CC, Kueh NS, et al. Distally based sural island flap for reconstruction of a large soft tissue defect in an open tibial fracture with occluded anterior and posterior tibial arteries-a case report. *Br J Plast Surg* 2005;58(1):112-115.
- [2] Taylor GI, Palmer JH. The vascular territories (angiosomes) of the body: experimental study and clinical applications. *Br J Plast Surg* 1987;40(2):113-141.
- [3] Masquelet AC, Romana MC, Wolf G. Skin island flaps supplied by the vascular axis of the sensitive superficial nerve: anatomic study and clinical experience in the leg. *Plast Reconstr Surg* 1992;89(6):1115-1121.
- [4] Rajacic N, Darweesh M, Jayakrishnan K, et al. The distally based superficial sural flap for reconstruction of lower leg and foot. *Br J Plast Surg* 1996;49(6):383-389.
- [5] Dolph JL. The superficial sural artery flap in distal lower third extremity reconstruction. *Ann Plast Surg* 1998;40(5):520-522.
- [6] Teo TC. Perforator local flaps in lower limb reconstruction. *Cir Plast Iberlatinamer* 2006;32:15-17.
- [7] Ponten B. The fasciocutaneous flap, its use in soft tissue defects of the lower leg. *Br J Plast Surg* 1981;34(2):215-220.
- [8] Donski PK, Fogdestam I. Distally based fasciocutaneous flap from the sural region. A preliminary report. *Scand J Plast Reconstr Surg* 1983;17(3):191-196.
- [9] Hollier L, Sharma S, Babigumira E, et al. Versatility of the sural fasciocutaneous flap in the coverage of lower extremity wounds. *Plast Reconstr Surg* 2002;110(7):1673-1679.
- [10] Price MF, Capizzi PJ, Watterson PA, et al. Reverse sural artery flap: caveats for success. *Ann Plast Surg* 2002;48(5):496-504.
- [11] Hassanpour SE, Mohammadkhah N, Arasteh E. Is It safe to extract the reverse sural artery flap from the proximal third of the leg? *Arch Iran Med* 2008;11(2):179-185.
- [12] Nakajima H, Imanishi N, Fukuzumi S, et al. Accompanying arteries of the cutaneous veins and cutaneous nerves in the extremities: anatomical study and a concept of the venoadipofascial and/or neuroadipofascial pedicled fasciocutaneous flap. *Plast Reconstr Surg* 1998;102(3):779-791.
- [13] Al-Qattan MM. 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 pedicle. *Ann Plast Surg* 2001;47(3):269-274.
- [14] Ayyappan T, Chadha A. Super sural neurofasciocutaneous flaps in acute traumatic heel reconstructions. *Plast Reconstr Surg* 2002;109(7):2307-2313.
- [15] Imanishi N, Nakajima H, Fukuzumi S, et al. Venous drainage of the distally based lesser saphenous sural veno-neuroadipofascial pedicled fasciocutaneous flap: a radiographic perfusion study. *Plast Reconstr Surg* 1999;103:494-498.
- [16] Xu G, Jin LL. The coverage of skin defects over the foot and ankle using the distally based sural neurocutaneous flaps: experience of 21 cases. *J Plast Reconstr Aesthet Surg* 2008;61(5):575-577.
- [17] Kneser U, Bach AD, Polykandriotis E, et al. Delayed reverse sural flap for staged reconstruction of the foot and lower leg. *Plast Reconstr Surg* 2005;116(7):1910-1917.
- [18] Tan O, Atik B, Bekerecioglu M. Supercharged reverse-flow sural flap: a new modification increasing the reliability of the flap. *Microsurgery* 2005;25(1):36-43.