

Distally Based Sural Fasciocutaneous Flap for Coverage of Foot Defects

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ABSTRACT

The distally based sural fasciocutaneous flap is an important skin flap that can be used for coverage of soft tissue defects in heel and foot. It is a reliable flap, easily elevated, with large arc of rotation. Thirty five flaps were performed in 34 patients admitted to the Plastic, Reconstructive Surgery Unit, Mansoura University. All flaps were survived except two showed distal tip necrosis that healed uneventfully without the need for further operations. Delay procedures were done in 5 flaps by 2 lateral incisions to make the flap more longer. The main advantage of this flap is its constant and reliable blood supply without the sacrifice of any major artery. It is also safe, and easy procedure that can be used for difficult wounds.

INTRODUCTION

Soft tissue coverage of the lower limb is a formidable challenge, and the difficulty is more pronounced in the most distal areas of the leg and foot [1]. These areas are easily susceptible to trauma, and are the site of numerous trophic problems (e.g. pressure sore, chronic ulcers, and trophic injuries) [2].

The possibilities of coverage of such defects are few, the flap chosen should be easy to excise quickly with minimal discomfort to the patient, and should provide durable coverage for the defects [2,3]. Anatomical studies of the blood supply to the skin, deep fascia, and the septocutaneous perforators have encouraged the harvesting of very large fasciocutaneous flaps in the leg. Poter in 1980 first described the concept of fasciocutaneous flaps of the lower limb. He had stressed on the advantage of fasciocutaneous flaps and their reliability and safety in lower leg reconstruction [4].

Overall, in the limbs, large superficial subcutaneous veins are accompanied by superficial sensory nerves, which are displaced longitudinally. Therefore many distally or proximally based longitudinal flaps must incorporate these large superficial veins (e.g. the great and lesser saphenous veins in the lower leg [5,6].

Neurocutaneous flaps are one of the most recent innovations described for upper and lower limb reconstruction. Masquelet and his colleagues introduced the neuroskin flap concept, that skin island flaps can be supplied by the vascular axis of sensory superficial nerves in the leg [2].

This report introduces the neural island flap concept which represents a consistent and reliable skin flap design supplied by the intrinsic vasculature of cutaneous nerve. The purpose of this study was to specify the results of thirty five distally based sural neurofasciocutaneous flaps in reconstruction of planter heel and lateral calcaneal and medial malleolar areas.

PATIENTS AND METHODS

Thirty five flaps were performed in 34 patients admitted to the Plastic, Reconstructive Surgery Unit, Mansoura University. Two flaps were done in one patient. These 34 patients consisted of 23 men and 12 women with their age ranged from 10 to 65 years. The flaps were used for treatment of soft tissue defects due to trauma (n=22), pressure sore (n=7), diabetic ulcer (n=4) and burns (n=2). The reconstructed areas were the plantar heel (n=19), the lateral heel (n=13) and above medial malleolus (n=3). All the flaps were fasciocutaneous. The width of flap varied from 3 to 6cm at the tip and 3cm at its base. It extends up to 17cm in length. Surgical delay of the flaps as done as separate step in 5 cases with large planter heel ulcers to increase flap length and survival. The patients were evaluated for the presence of neuroma at the donor site and the presence of ulceration on the flap.

Surgical Technique:

The patient is placed in a prone position and the flap is raised under tourniquet control. The surface markings are the lateral border of the Achilles tendon medially and the margin of the

fibular shaft laterally. Distally, the lateral incision may extend up to the lateral malleolus, while the medial incision runs along the lateral border of the Achilles tendon up to its insertion on the tuberosity of the calcaneum or the edge of skin defect to be covered as shown in Fig. (1).

The skin and fascia are incised. The sural nerve is divided proximally and the short saphenous vein is ligated. Dissection then begins proximodistally and raised rapidly without any particular difficulty, at the lateral retromalleolar groove. At this level, all the local subfascial fat must be included in the flap, because it contains branches coming from the peroneal artery that supposed to supply the perineural arterial plexus around sural nerve. The flap is raised including all the deep fat along the

lateral margin of the Achilles tendon up to its insertion. This permits a 180 degree rotation (clockwise in the left foot and anticlockwise in the right foot). Donor site is closed primarily in small flaps and the remaining were covered by split-thickness skin grafts. Surgical delay in 5 cases was done by 2 lateral incisions on both sides of the flap down to the deep fascia. This is done one week before elevating the flap. Three weeks after flap elevation patient was admitted to the theatre to divide the flap. The distal part was returned to original donor site.

Postoperative Care:

A splint with a wide heel area is applied for 21 days. Full weight-bearing on the heel is not permitted before the sixth week.

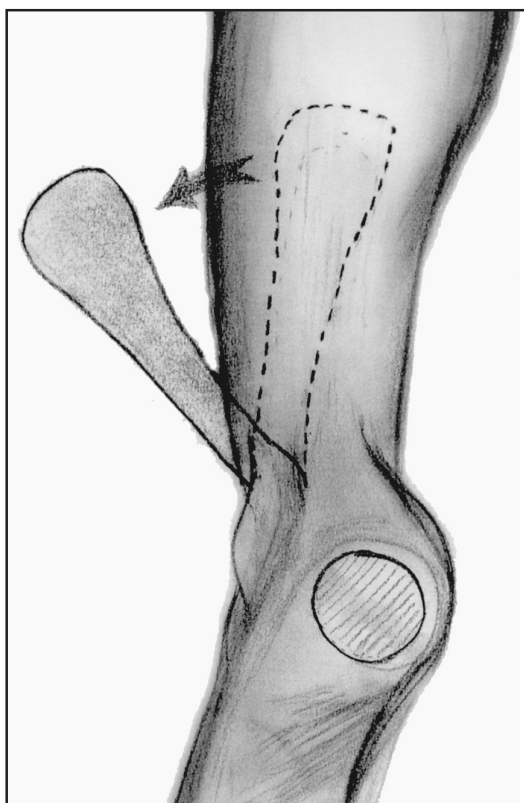


Fig. (1-A): Planning of the flap.

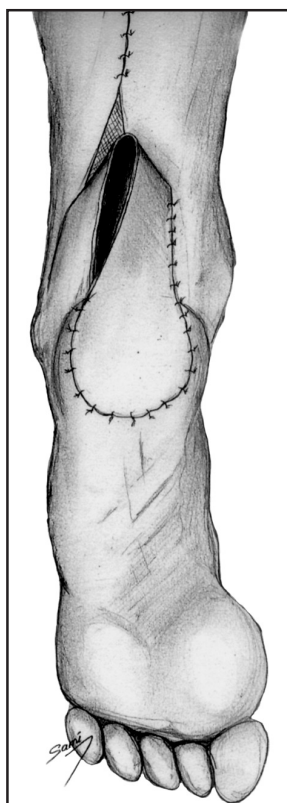


Fig. (1-B): Flap inset on a heel defect.

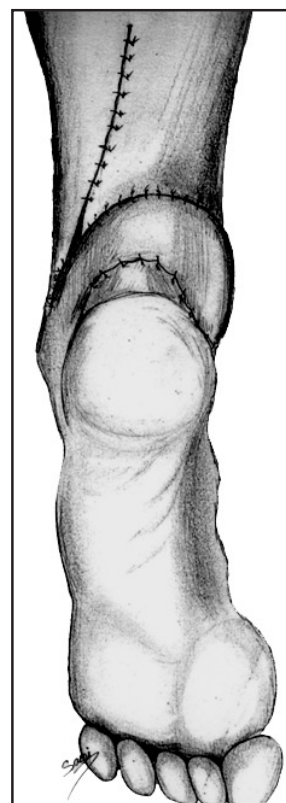


Fig. (1-C): Flap inset on a medial malleolar defect.

RESULTS

Thirty three flaps had complete success as shown in Figs. (2-5). Color and viability of the flaps were good up to the tip of the flaps. Two flaps developed distal tip necrosis. One of the two complicated flaps occurred in a patient with diabetic vasculopathy and the other in a patient with atherosclerosis. Debridement of necrotic tissue allowed healing within two to three weeks without the need

for further skin grafts or any further flap. No ulceration was found in either weight-bearing nor non weight-bearing flaps. Also, no patient complained of neuroma at the donor site. In patients underwent surgical delay careful dissection of the nerve pedicle revealed a highly vascular pedicle with prominent perineural vessels. The length of these flaps were increased by about 3-5cm than normal to reach up to 22cm.



Fig. (2-A): 60 years old man with post traumatic chronic calcaneal ulcer 5 years ago.



Fig. (2-B): Flap plan.



Fig. (2-C): Flap inset, 3 months after operation, healed completely. Donor site was grafted.



Fig. (3-A): 35 years old woman with chronic heel ulcer.



Fig. (3-B): Planning of the flap delay was done before raising of the flap to increase its length.



Fig. (3-C): Ulcer completely covered 5 months later.



Fig. (4-A): 50 years old male with chronic post traumatic ulcer on lateral aspect of mid foot.



Fig. (4-B): Flap elevation and setting into the defect.



Fig. (4-C): Flap separation, 3 months after separation.

Fig. (4-D): 1 year after separation of the flap.



Fig. (5-A): Male child aged 8 years with post burn chronic ulcer on medial malleolus.



Fig. (5-B): Flap planning.



Fig. (5-C): Elevation of the flap.



Fig. (5-D): 2 weeks after separation of the flap all grafted area was removed.



Fig. (5-E): Donor site after grafting with skin.

DISCUSSION

Study of the vascularity of the leg has revealed that there are linear areas of increased perfusion along the course of main arteries. This anatomic characteristic led to demonstration of perforators originating from each underlying artery and recognition of the potential for flap donor sites [7].

Reconstruction of defects on the ankle, malleoli and heel remains a demanding task for plastic surgeons. Trauma, and other deforming process can involve soft tissue, underlying bone and ligamentous structures. The heel is a weight-bearing area and liable to frequent trauma. In addition the skin over this area is tight and has poor circulation [7].

Since the thinking of the problem of heel defects several ways and techniques were applied for heel coverage starting from skin graft [8,9], to several types and modalities of flaps including muscle flaps [10,11], septocutaneous flaps [12,13], axial flaps [14,15] and free flaps [16,17,18]. Random pattern flaps can be raised but they have high incidence of failure.

Fasciocutaneous flaps have enlarged the plastic surgeon ability to cover exposed bone or tendon in the leg and heel. Fasciocutaneous flaps have challenged some principles such as safe length/width ratio and the concept that the flaps should be proximally based in the leg [19]. But still short to cover planter heel defects. The medial

planter island flap is the flap of choice for heel defects because it involves the transfer of skin that can tolerate considerable local pressure (i.e. adaptable to weight-bearing and sensate). However, the island flaps have two unavoidable prerequisites, namely good peripheral vascularity and experienced surgeon [7]. Other local island flap like lateral calcaneal artery skin flap [20] is a neurovascular flap which include lateral calcaneal artery, lesser saphenous vein, and sural nerve. It is effective and reliable local flap for soft tissue defects of the heel. The short coming of this flap is its size and its inability to be used for large defects.

Free flaps require a team of surgeons and paramedicals and a good equipped place for treatment of these defects, especially when they are extensive.

Since 1980s the reverse flow island flaps and distally based flaps have been used for wound coverage and considering the consistent existence of an intrinsic vasculature of cutaneous nerves that spans all the length of the nerve [21] and their skin branches [22,23]. In 1992, Masquelet reported that the blood supply to the skin comes from accompanying superficial sensory nerves [2]. These arteries gives off several cutaneous branches in the suprafascial course [22-24].

Distally based sural fasciocutaneous flap is vascularized by the median superficial sural artery with reverse flow as this artery takes septocutaneous perforators from the peroneal artery in the distal part of the leg. Additionally, the sural nerve has

an intrinsic arterial system. These systems anastomose freely in the suprafacial plexus.

In our Series, the Distally-based Sural Flap Functional Adequately. It has the Following Advantages:

- Two staged simple procedures were done without the need of microsurgical techniques.
- Elevation of the flap is easy and quick. The vascular supply to the arterial network of the sural area is constant and reliable and there is no need to sacrifice any major artery [25,26].
- The pedicle is long and the skin island can be transferred as far as to the instep area.
- For weight-bearing heel coverage, the flap potentially provides a protective sensation. The morbidity of harvesting the sural nerve is minimal.
- For moderate to large defects, the well vascularized flap can obliterate dead space and defete infection.
- In small flaps, the donor site can be closed primarily with minimal morbidity [25-28].

The distally based sural fasciocutaneous flap is a versatile and reliable procedure useful in reconstruction of the lower limb. This flap remains a good choice for reconstructive surgery of calcaneal and malleolar areas. Also, the vascular network of this flap could be a perfect source for the delay phenomenon. The length of the flap can be increased to cover larger defects.

The main disadvantages of this flap are the sacrifice of the sural nerve and donor site scar as distal part of donor site is grafted with skin graft. Some authors reported raising flap and sparing sural nerve [27], but it is too risky for the vascular supply of the flap. This study and other studies [28] showed that inspite of cutting sural nerve all patients showed improvement of sensation with time on the lateral side of the foot.

Conclusions:

The distally-based sural fasciocutaneous flap is a reliable procedure to repair difficult wounds such as plantar heel and lateral calcaneal areas. The main advantages of this flap are the reliable blood supply, maintenance of major arteries, easy elevation, large arc of rotation and direct closure of donor areas for small flaps. The morbidity of this flap is negligible being limited to that arising from division of the sural nerve. This does not produce any serious problem, especially if the adjacent nerves, the superficial and deep peroneal nerves are intact.

For us distally based sural fasciocutaneous flap become the flap of choice for covering defects on malleolus and heel.

REFERENCES

- 1- Raveendran S.S., Perera D. and Yoganathan: Superficial sural artery flap a study in 40 cases. Br. J. Plast. Surg., 57: 266, 2004.
- 2- Masquelet A.C., Romana M.C. and Wolf G.: Skin island flaps supplied by vascular axis of the sensitive superficial nerves: Anatomic study and clinical experience in the leg. Plast. Reconstr. Surg., 89: 1115, 1992.
- 3- Morris A.M. and Buchan A.C.: The place of the cross-leg flap in reconstructive surgery of the lower leg and foot: A review of 165 cases. Br. J. Plast. Surg., 31: 138, 1978.
- 4- Ponten B.: The fasciocutaneous flap: Its use in soft tissue defects of the lower leg. Br. J. Plast. Surg., 34: 215, 1981.
- 5- Chang S., Gu Y. and Li J.: The role of the large superficial vein in survival of proximally based versus distally based sural veno-neuro-fasciocutaneous flaps in a rabbit model Plast. Reconstr. Surg., 115: 213, 2005.
- 6- Akyurek M., Safak T., Sonmez E., Ozkam O. and Kecik A.: A new flap design: Neural island flap. Plast. Reconstr. Surg., 114 (6): 1467, 2004.
- 7- Harrison D.H. and Morgan B.D.: The instep island flap to resurface planter defects. Br. J. Plast. Surg., 34: 315, 1981.
- 8- Lister G.D.: Use of an innervated skin graft to provide sensation to the reconstructed heel. Plast. Reconstr. Surg., 62: 157, 1978.
- 9- Maquieira N.O.: An innervated full-thickness skin graft: To restore sensibility to finger tips and heels. Plast. Reconstr. Surg., 53: 568, 1974.
- 10- Hartrampf C.R.Jr., Schefflan M. and Bostwick J.: The flexor digitorum brevis muscle island flaps. A new dimension in heel reconstruction. Plast. Reconstr. Surg., 66: 264, 1980.
- 11- Townsnd P.L.G.: An inferiorly based soleus muscle flap. Br. J. Plast. Surg., 31: 210, 1978.
- 12- Yoshimura M., Imura S., Shimamura K., Yamauchi S. and Nomura S.: Peroneal flap for reconstruction in the extremity: Preliminary report. Plast. Reconstr. Surg., 74: 402, 1984.
- 13- Chang S.M., Zhang F., Yu G.R., Hou G.L. and GU Y.D.: Modified distally based peroneal artery perforator flap for reconstruction of foot and ankle. Microsurgery, 24: 430, 2004.
- 14- Lin S.D., Chou C.K. and Lin T.M.: The distally based lateral adipofacial flap. Plast. Reconstr. Surg., 1: 96, 1998.
- 15- Voche P., Merle M. and Stussi J.D.: Lateral supra-malleolar flap: Experience with 42 flaps. Ann. Plast. Surg., 54: 49, 2005.
- 16- Meland N.B.: Microsurgical reconstruction: The weight bearing surface of the foot. Microsurgery, 11: 54, 1990.
- 17- Goldberg J.A., Adkin P. and Tsai T.M.: Microvascular reconstruction of the foot: weight-bearing pattern gait

- analysis and long-term follow up. *Plast. Reconstr. Surg.*, 92: 904, 1993.
- 18- Chen S.L., Chuang C.J., Chou T.D., Chen T.M. and Wang H.J.: Free medial sural artery perforator flap for ankle and foot reconstruction. *Ann. Plast. Surg.*, 54: 39, 2005.
- 19- Benito-Ruiz J., Yoon T., Guisantes Pintos E., Monner J. and Serra-Renom J.M.: Reconstruction of soft tissue defects of the heel with local fasciocutaneous flaps. *Ann. Plast. Surg.*, 52: 380, 2004.
- 20- Grabb W.C. and Argenta L.C.: The lateral calcaneal artery skin flap. *Plast. Reconstr. Surg.*, 68: 723, 1981.
- 21- Lund Borg G.: Intraneural circulation. *Orthop. Clin. North. Am.*, 19: 1, 1988.
- 22- Nakajima H., Imanishi N., Fukuzumi S., Minable T., Aiso S. and Fujino T.: Accompanying arteries of the cutaneous nerves in the extremities: Anatomical study and a concept of the venoadipofacial and/or neuroadipofacial pedicled fasciocutaneous flaps. *Plast. Reconstr. Surg.*, 102: 779, 1998.
- 23- Taylor G.I., Gianoutos M.P. and Morris F.: The neurovascular Plast. Reconstr. Surg., 94: 1. Territories of the skin and muscles: Anatomic study and clinical implications, 1994.
- 24- Nakajima H., Imanish N. and Fukuzumi S.: Accompanying arteries of the lesser saphenous vein and sural nerve: Anatomic study and its clinical applications. *Plast. Reconstr. Surg.*, 103: 104, 1999.
- 25- Jeng S.F. and Wei F.C.: Distally based sural island flap for foot and ankle reconstruction. *Plast. Reconstr. Surg.*, 99: 744, 1999.
- 26- Suga H., Koshima Y., Harii K., Asato H. and Takushima A.: Distally based sural flap for reconstruction of the lower leg and foot. *Scand. J. Plast. Reconstr. Surg. Hand Surg.*, 38: 16, 2004.
- 27- Costa-Ferrira A., Reis J. and Phino C.: The distally based island superficial sural artery flap: Clinical experience with 36 Flaps. *Ann. Plast. Surg.*, 46: 308, 2001.
- 28- Le Forum B., Caye N. and Pannier M.: Distally based sural fasciomuscular flap: Anatomic study and application for filling leg or foot defect. *Plast. Reconstr. Surg.*, 107: 67, 2001.