

The Distally Based Superficial Sural Artery Flap for Coverage of Calcaneal Defects

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SUMMARY

The reconstruction of soft tissue defects of the lower third of the leg, heel and the calcaneal area has improved considerably as a result of increased popularity of reverse sural flap over the last 20 years. The use of skin grafts, local flaps and free muscle transfer for calcaneal area has numerous limitations. The aim of this study is to evaluate the efficacy of sural artery flap for soft tissue defects cover the calcaneal region. This is a descriptive study which includes 20 patients who presented with soft tissue defect in the calcaneal region. The study was conducted at Plastic and Reconstructive Surgery Department of Federal Postgraduate Medical Institute Shaikh Zayed Hospital Lahore, over a period of 5 years from January 99 to January 2004. A total of twenty patients with soft tissue defects of heel and calcaneal area requiring coverage were included. Preoperative data, the age and sex of each patients, cause and site of defects, the flap dimensions and transposition, postoperative results and complications were recorded. Out of 20 patients, 11 were males and 9 were females with range of age from 8 to 50 years. Road traffic accidents was the cause of the defects in 16 (80%) patients (wheel spoke injury in 6 (30%) patients, Marjolin's ulcer 4 (20%) patients. The site of 20 defects comprised 12 (60%) heel, 2 (10%) heel+ tendo-Ahilles, 4 (20%) Calcaneum, 2 (10%) heel+ Calcaneum. The flap dimensions ranged from 4 to 15cm in length and 3 to 12cm in width. Postoperatively 19 (95%) flaps survived completely while marginal necrosis with infection was seen in 1 (5%) patient. Among 19 patients, 3 (15%) patients had oedema in initial days. There was no considerable morbidity at donor site and all the patients had satisfactory functional outcome. On the whole the distally based superficial sural artery flap is very useful for lower limb reconstruction, particularly for an area around heel and calcaneum. The surgical technique is safe, shorter duration and technically less demanding as compared to the alternative, i.e. free microvascular flaps.

INTRODUCTION

The loss of soft tissue defect around tendo-Achilles, ankle and heel represents a challenging reconstructive problems because of the lack of locally available tissue, relatively poor circulation of the skin and weight bearing requirements of the region. Therapeutic options include local, regional, and free flaps. Each of these methods, however, has some drawbacks limiting its clinical application.

A local flap¹ as a surgical solution may not be possible either because of inadequate tissue available to be moved from areas adjacent to the defect or because of limited flap mobilization. An inferiorly based soleus muscle flap² is associated

with limitations of bulkiness and unreliability owing to the flap's variable vascular anatomy distally. Reversed septocutaneous flaps³⁻⁶ such as the peroneal artery flap, anterior tibial artery flap, and posterior tibial artery flap are other options. When using such flaps, however, a major artery is killed and an already injured lower leg might be jeopardized. Microsurgery⁷⁻⁹ can be used to remedy these problems, but such a technique requires a microvascular surgical team and appropriate equipment.

Since Masquelet et al¹⁰ firstly described the concept of the distally based neurocutaneous island flap supplied by the vascular axis around the sural nerve, similar flaps¹¹⁻¹³ have been reported subsequently and shown to be appropriate for the

reconstruction of medium to large defect of the ankle and heel. In most of these reports attention was focused only on the accompanying arteries of the sural nerve.

The sural nerve descends between the 2 heads of the gastrocnemius and pierces the deep^{14,15,16} fascia in the middle third of the leg. The superficial sural artery arises from the popliteal artery. Then it reaches the sural nerve after 2 to 3 cm and gives off further branches to the skin and upper part of the calf, which correspond the subfacial course of the nerve. The superficial sural artery follows the course of sural nerve, regularly giving off the small branches to it. The artery gives small branches to the skin in lower one third of the leg. Anastomosis with the peroneal artery is constant. Three to 5 septocutaneous vessels arises from the peroneal artery and anastomose with the vascular network of the nerve.

The Reverse sural artery flap is a useful flap for defect reconstruction in the distal leg, ankle and heel. The advantage of distally based fasciocutaneous sural flap is that it can reach the ankle and the calcaneal areas due to long pedicle and is easy and relatively quicker to elevate. Furthermore there is no sacrifice of major arteries^{11,12,13}. So the present study was conducted to evaluate the efficacy of sural artery flap for soft tissue defects cover the calcaneal region.

Surgical technique

The recipient area is debrided under tourniquet control (Fig. 1). The course of sural nerve and fasciocutaneous perforator passing through the posterior intermuscular system in lower third of the leg was marked by the line joining the center of popliteal fossa and lateral malleolus with patient in prone position (Fig. 2). The pivot point of the flap is 5cm above the tip of lateral malleolus. The dissection of the flap is done under tourniquet control with patient in prone position. The flap is raised on the middle part of the calf, corresponding to lower part of the gastrocnemius muscle (Fig. 3). The subdermal layer was dissected to expose the sural nerve, the superficial sural vessels and the lesser saphenous vein. The nerve and the vessels are ligated proximally and dissection is carried out up to retromalleolar groove. The subcutaneous fascial

pedicle is elevated with width of 2 cm to include the neurovascular axis (Fig. 4). The lateral extent of dissection is up to fibula and on medial extent is the lateral border of tendo-Achilles. The dissection is stopped 5 cm above the lateral malleolus where perforator from the peroneal artery communicates with the vascular plexus of sural nerve. The flap is now transposed through a tunnel to the recipient area (Fig. 5). If there is any risk of compression of the pedicle, division of the skin bridge between the donor site and the defect is done. In these cases, pedicle is usually covered with a split thickness skin graft. The donor site is then covered with a split thickness skin graft (Fig. 6). A full-leg posterior splint with well-padded dressing is applied making sure that there is no compression on the pedicle. The central part of the flap is left exposed for observation. The dressing is changed on 5th postoperative day. The flap usually heals by 3rd week but full weight bearing on flaps used for heel defects is postponed up to 6th week.

MATERIALS AND METHODS

This study was conducted at department of plastic and reconstructive surgery, Federal Postgraduate Medical Institute Shaikh Zayed Hospital Lahore, over a period of 5 years during January 1999 to January 2004. It included 20 patients with Soft tissue defects of the calcaneum and heel. A distally based superficial sural artery flap was performed in each patient. The age and sex of each patient, cause, dimension of flap, transposition of pedicle (through a tunnel or laid open and covered with a skin graft), postoperative results and complications were recorded. X-rays of the heel was done in all cases to evaluate the condition of the underlying bone and to rule out osteomyelitis. All patients were followed up in out patients department for six months. The setting of the flap and functional outcome was recorded.

RESULTS

Over a period of 5 years during January 1999 to January 2004, a total of 20 reverse sural flaps were performed in 20 patients with soft tissue defects of the heel area. Out of 20 patients, 11 were males and 9 were females. The age ranged from 8 to



Fig. 1. Soft tissue defect after excision of Marjolin's ulcer.

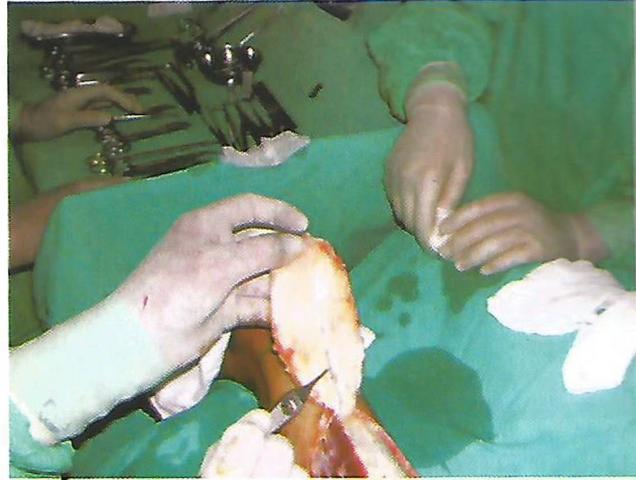


Fig. 4. Flap pedicle showing sural nerve and saphenous vein.



Fig. 2. Flap marking.



Fig. 5. Flap transposition anterior to tendo-Achilles.



Fig. 3. Flap raised.



Fig. 6. Donor site covered with split thickness of skin graft.

Table 1: Summary of patients.

Patient	Age/Sex	Etiology	Site of defect	Dimension (cm)	Complication
1	40 / Male	RTA	Heel	6 x 4	Oedema
2	26 / Male	Wheel spoke injury	Heel	15 x 7	None
3	52 / Female	RTA	Heel	12 x 8	None
4	20 / Male	RTA	Heel+ Calcaneum	8 x 5	None
5	13 / Male	Wheel spoke injury	Heel	4 x 3	None
6	32 / Male	Marjolin Ulcer	Heel	6 x 4	None
7	29 / Female	RTA	Calcaneum	9 x 6	Oedema
8	11 / Male	Wheel spoke injury	Heel + Tendo Achilles	4 x 3	None
9	16 / Female	RTA	Heel	5 x 4	None
10	38 / Male	Marjolin Ulcer	Calcaneum	10 x 7	None
11	29 / Female	RTA	Heel	8 x 6	Hypertrophy donor area
12	8 / Male	Wheel spoke injury	Heel + Tendo Achilles	4 x 3	None
13	22 / Female	RTA	Heel	6 x 6	None
14	15 / Female	RTA	Calcaneum	7 x 5	None
15	20 / Male	Wheel spoke injury	Heel	11 x 6	Oedema
16	12 / Female	RTA	Heel + Calcaneum	6 x 4	None
17	30 / Female	Marjolin Ulcer	Heel	12 x 8	None
18	50 / Male	Marjolin ulcer	Heel	11 x 7	Marginal Necrosis
19	17 / Female	RTA	Heel	8 x 6	None
20	14 / Male	Wheel spoke injury	Calcaneum	15 x 5	None

50 years with a mean of 29 years. Road traffic accident was the cause of the defects in 16 (80%) patients (wheel spoke injury in 6 (30%) patients) and Marjolin's ulcer in 4 (20%) patients (Figs. 7-12). The site of 20 defects comprised 12 (60%) heel, 2 (10%) heel and tendo-Achilles, 4 (20%) Calcaneum, 2 (10%) heel and Calcaneum. The age, cause, site of defect, dimension and complications of each patient are shown in Table 1. In all cases, defects were covered with reverse sural island flap with an addition of skin graft in 2 patients. Sixteen flaps were transposed to the recipient site through a tunnel, while pedicle of 4 flaps was laid open and covered with split thickness skin graft.

The flap dimensions ranged from 4 to 15cm in length and 3 to 8cm in width. Postoperatively 19 (95%) flaps survived completely while marginal necrosis was observed in 1 flap. Partial necrosis, which was observed in 1 (5%) patient, was debrided and secondary closure was done. Out of 19, 3 (15%) patients developed minimal oedema in initial days which was settled by conservative management. One patient developed hypertrophic scar at donor site which was treated with compression and massage. All patients had satisfactory functional outcome and were ultimately able to have full

weight bearing within 2 months.

DISCUSSION

Reconstruction of soft tissue defects at the calcaneal, ankle and malleolar region have been quite a challenging job for reconstructive surgeons. The defect can be due to tumour, trauma and trophic ulceration involving the underlying bone as well, resulting into exposed tendo-Achilles and calcaneum¹²

Skin grafts cannot be used to cover the exposed tendon and bones. Similarly local flaps, cross leg flap and free vascular flaps all have number of limitations in their use as compared to distally based superficial sural artery flap for soft tissue coverage of defects in hind foot area.¹⁷

Regarding the anatomical considerations the design of the skin paddle can be outlined anywhere on the suprafascial course of the nerve. The flap must include the deep fascia. The pedicle is composed of subcutaneous and fascial tissue, including the nerve, the artery, and the saphenous vein when it exists. The saphenous vein is the data line for the course of the nerve.^{18,19}



Fig. 7. Soft tissue loss over tendo-Achilles caused by wheel spoke injury in a 13 years boy.

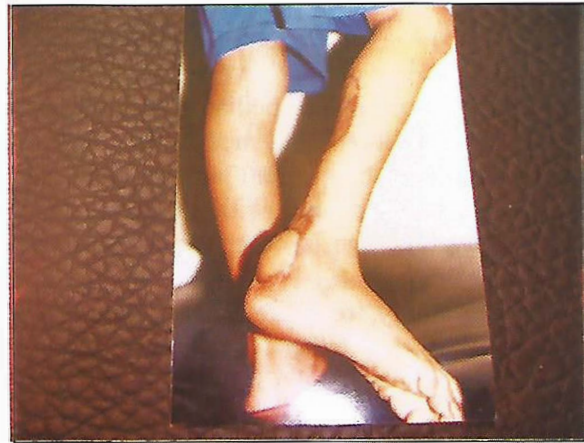


Fig. 8. Healed post-operative result after 5 months.



Fig. 9. Marjolin ulcer in a long standing scar over tendo-Achilles and calcaneum.



Fig. 10. Healed flap and donor site after 2 weeks.



Fig. 11. Soft tissue loss over calcaneum caused by road traffic accident in a 29 year old female.



Fig. 12. Healed flap after 2 weeks.

The age ranged in present study was 8 to 50 years with a mean of 29 years, youngest being 8 years of age. It showed that reverse sural artery flap is safe and reliable in the pediatric age group and may be used in children with success. In comparison to previous studies, the present patient population is relatively of younger age, with an average of 29 years. The average age in other studies was 46.9,¹¹ 40,²⁰ 33.5 years.²¹

In this study, road traffic accident was the major cause of the defects in 16 (80%) patients (wheel spoke injury in 6 (30%) patients. This is comparable to other studies in which trauma was described as 71.4% by Rajacic *et al.*,²² 88% by Fracalvieri *et al.*,²³ 84% by Almeida *et al.*²⁴ This is in contrast to the study described by Baumeister *et al.*,²⁵ in which unstable/chronic ulcers was the dominant causative factor in 75% of patients.

Yilmaz *et al.*¹² reported that the largest flap used in their series measured 12 cm in width and 15 cm in length. The maximum dimension of the flap in present study was 8 x 15 cm, which is comparable to this and with other studies reported by Rasheed *et al.*²⁰ and Ayyappan *et al.*²¹

The success rate of sural artery flap in present study is 80%. Five percent of the flaps showed partial necrosis. It is comparable to study described by Hasegawa *et al.*² (5%), Touam *et al.*²¹ (5%). However this rate is lower than the rates previously reported by Yilmaz *et al.*¹² (12%), Rajacic *et al.*²² (14%), Baumeister *et al.*²⁵ (36%). The higher success rate of sural artery flap in present study is due to the fact that the sural artery flap is used in younger patients with post-traumatic defects (80%).

Reverse sural artery flap is a useful flap for defect reconstruction in the distal leg, ankle and heel. The major problem encountered with the reverse sural artery flap is its unreliability. It may be compromised by venous congestion and peripheral arterial insufficiency when the flap is transposed with its pedicle through a tunnel subcutaneously^{26,27}. We recommend that sural nerve and deep fascia must be taken with the flap to raise it more safely. The pedicle should be mobilized enough to allow adequate rotation. When risk of compression is noted then pedicle should be laid open instead of transporting through a tunnel and exposed pedicle should be skin grafted.

The advantage of distally based fasciocutaneous sural flap is that, they can reach the ankle and the calcaneal areas due to long pedicle and they are easy and rapid to create. Furthermore there is no sacrifice of major arteries, it can be created in single stage with no need of microsurgical technique.¹¹⁻¹³ The procedure is associated with minimal blood loss with maximum duration of only up to 2 hours. There is no functional or cosmetic morbidity at the donor site. However these are insensate flaps that are indicated for moderate defects and sacrifice of sural nerve leads to hypoesthesia at the lateral part of the foot. In a few cases the donor site may have an unacceptable scarring especially in women^{12,20}.

CONCLUSION

On the whole, this flap is very useful for lower limb reconstruction especially the hind foot region because of long vascular pedicle. The technique is simple, quick and reliable with minimal morbidity at the donor site.

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