Original Article

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Extended Reverse Sural Artery Flap's Safety, Success and Efficacy - A Prospective Study

Plastic Surgery Section

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ABSTRACT

Background: One of the challenges in reconstructive surgeries, faced by a majority of surgeons, is the soft tissue defect management around the lower-third of the leg, plantar and dorsal feet. Due to the sensitive location and other related difficulties, only limited options are available in this region. A durable flap is the preferred option for coverage of such defects.

Objective: To evaluate the safety, success and efficacy of the extended reverse sural artery flap which was harvested, with extension to proximal-third of the leg.

Methodology: This prospective study was conducted at Department of Plastic Surgery, on 18 consecutive patients with soft tissue defects and exposed bones, tendons and joints of distal-third of leg and foot. We harvested medium to large sized reverse sural artery flaps with extensions to the upper third of the calf, to cover the defects found in the distal tibia, ankle, heel, foot, and sole.

Results: A majority of flaps provided a good coverage for defects. Two cases developed marginal necrosis of flaps in the distal border, which was treated with use of secondary skin grafts. Four flaps developed venous congestions. In other patients, minor complications such as rupture of suture inset, development of ulcer over insensate flap, since only one patient developed ulcer and another one patient developed inset rupture and graft loss occurred. In 16 cases, the final outcome was unaffected by any complications.

Conclusions: Extension of reverse sural artery flap to the proximal third of the leg was safe and reliable and it was efficiently used to treat patients with large and far wounds of distal leg, foot and sole.

Keywords: Reconstructive surgery, Complications

INTRODUCTION

To reconstruct defects of the foot and ankle, the first option is free tissue transfer. However, a need of microsurgical expertise and a prolonged operating time remain its disadvantages [1]. In 1992, Masquelet et al., [2] described neuroskin island flaps, distally based sural artery and nerve flaps. Since then, many studies have been performed on its anatomical and clinical aspects, which was commonly referred to as "reverse sural artery island flap" and it has become a routine acceptable technique which is used for lower-limb reconstructions. In the standard conventional technique, the flap is usually not harvested from the proximal third of the leg, due to deep course of sural nerve. The proximal extension of the distally based neurofasciocutaneous sural flap has been considered to be random type of flap that provides a long length. However, its survival is unpredictable [3,4]. Conventionally, reversed sural flaps have been used to cover soft tissue defects. However, they just fall short of the critical area which has to be covered. Location of the flap is a major limitation (the middle third of the leg). Ayyappan et al., [5] extended flap territory proximally to upper third of leg, with commendable results. We designed a large distally based sural nerve flap with an extension to proximal third of the leg. Based on the conventional reversed sural flaps, in addition to the proximal extension, a wide-based pedicle was included to facilitate better venous drainage and to decrease oedema post operatively.

The purpose of this study was to evaluate the efficacy, safety, and success rate of the reverse sural artery flap which was harvested, with an extension to proximal third of the leg, for use in soft tissue reconstructions done in and around ankle joints.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Plastic and Reconstructive Surgery, Bangalore Medical College and Research Institute, over a period of 21 months (September 2010 to June 2012). Eighteen patients were included in this study. All had soft tissue defects in lower-third of leg, Achilles tendon, heel, malleoli and in dorsum of foot. Exclusion criteria: all subjects with scarring or wounds on the posterior calf or pedicle.

In four patients, although the defects had occurred in the ankle, or distal leg, they were too large to be covered by a standard sural flap which was extracted from the middle third of the leg. In 12 patients, defects had occurred in the foot, sole, or weight bearing heel; which were far away from reach of a sural flap, from the middle third of the leg. Some of these wounds were very large as well. As the other two patients were diabetics and smokers, to be on the safer side, as we could not rely on the lowermost perforator obtained from the peroneal artery as the only blood supply to the flap pedicle, we shifted the pivot point 7 to 8 cm proximal to the lateral malleolus, to incorporate more perforators in the flap. Consequently, we had to shift the skin paddle to the proximal calf. Some of the patients had two or three of the above mentioned conditions, simultaneously.

The demographic data of all cases, including age, gender, cause, size and site of the defect, exposure of bone/tendons, presence of chronic osteomyelitis, and any co-morbid conditions, were recorded [Table/Fig-1]. All cases with exposed bones or fractures were radiographed. Pre-operatively, dimensions of the flap, level of proximal flap margin when it was designed on the leg (which would be the distal flap end when it was mobilized over the defect), capillary refills or any congestion which had occurred at the end of the procedure, were recorded. In the immediate post-operative period, the flap was monitored for any venous congestion which had occurred. The outcome was noted in terms of complete or partial flap survival, successful coverage of the recipient defect, and other complications.

Pre-operative evaluation included identification of the site of peroneal perforators, above the lateral malleolus, by using a hand-held Doppler. Two or three perforators were identified above the lateral

Patient No.	Age (yr)/ Gender	Cause	Site of Defect	Flap Size, cm	Associated Problems	Complication	Extra Procedure
1	15/M	RTA	Medial side of foot and dorsum	18x12	None	None	None
2	67/M	RTA	Tendoachilles and Weight bearing heel	15x11	Diabetic	Wound dehiscence, partial graft loss	SSG
3	56/M	Post necrotizing fasciitis soft tissue defect	Medial side of foot and dorsum	16x10	Diabetic	Mild congestion of flap, partial graft loss	SSG
4	19/M	RTA	Medial side of foot	13x10	None	None	None
5	25/M	RTA	Dorsum of foot	12X11	None	None	None
6	22/M	RTA	Ankle joint and Dorsum	11x8	Smoker	None	None
7	22/F	RTA	Lateral side of foot and lateral aspect of heel	15x8	None	None	None
8	35/M	RTA	Ankle joint and Dorsum	11x9	Smoker	Mild congestion of flap	None
9	55/M	RTA	Lateral side of foot	10x7	None	None	None
10	16/M	RTA	Lateral side of foot and dorsum of foot	11X8	None	None	None
11	28M	RTA	Tendoachilles and Weight bearing heel	13X 9	None	None	None
12	18/M	RTA	Weight bearing Heel pad	11x7	None	Congestion and marginal necrosis present	SSG
13	20/F	RTA	Dorsum of foot	9x8	None	None	None
14	20/F	RTA	Weight bearing Heel pad	10x8	None	Developed trophic ulcer over pressure bearing area	None
15	22/M	Fall from height	Weight bearing Heel pad	10x7	None	None	None
16	28/M	RTA	Tendoachilles and Weight bearing heel	11X8	None	None	None
17	35/M	RTA	Dorsum of foot	10X8	Smoker	Congestion and marginal necrosis present	SSG
18	15/F	RTA	Weight bearing Heel pad	7X6	None	None	None

[Table/Fig-1]: Demographics, technical and result data. RTA- Road Traffic Accident, SSG- Split Thickness Skin Graft

malleolus. The pivot point of the pedicle was chosen according to the distal coverage requirement, but was limited by the lower-most perforator, about 5 cm, which is the most constant peroneal perforator from lateral malleolus tip.

Flap Design and Operative Technique

An extended, reverse, sural fasciocutaneous flap relies on the sural nerve vascular axis, which consists of the median superficial sural artery, along with lesser saphenous vein. This axis courses between the heads of gastrocnemius muscle and its several cutaneous branches anastomose with approximately 3–5 septocuataneous perforators from the peroneal artery. These anastomoses ultimately form the reverse flow arterial supply of the reverse sural flap, which is located in the posterior crural septum, beginning 5 cm proximal to the lateral malleolus and extending proximally. Saphenous vein provides principal venous drainage of the flap. Its identification and distal preservation are vital for the success of flap. A reverse flow can occur due to the presence of bridging vena commitants, that by passes the venous valves [6]. In addition, de-nervation of the veins, which occurs during flap elevation, causes valvular incompetence.

The procedure was done under regional anaesthesia, with patients in prone position. The axis of the flap was directed towards an imaginary line which connected the midpoint of popliteal fossa, to a point which was behind the lateral malleolus. The flap was based distally, with a pivot point which was located 5–7 cm above the lateral malleolus. In the distal two thirds of the leg, both the sural pedicle and the short saphenous vein have a suprafascial course, and hence, both pedicles were included in the flap. In the upper part of the leg, the flap also included both the suprafascial short saphenous vein and subfascial sural nerve and median sural artery.

A flap was marked as per defect dimension, with 1 cm extra for flap contraction and a better tension free inset. Dissection was started at the proximal border of the skin paddle. Sural nerve, artery and lesser saphenous vein were identified and they were ligated 1 to 2 cm proximal to the proximal border of the skin paddle, between two heads of the gastrocnemius. Sural nerve and artery are located deeper between the two heads of the gastrocnemius, while the lesser saphenous vein is mostly superficial. Utmost care was taken to expose and release the sural pedicle meticulously, by pushing the two heads of the gastrocnemius muscle aside gently, and keeping tiny perforators and accompanying vascular plexus intact, which were located in the loose fibro-adipo-areolar tissue, between the two heads of gastrocnemius. In wide flaps, the lateral sural nerve, if it was present, and its accompanying artery, were also included in the flap. The skin was elevated along with fascia. Elevated flap was transposed to the defect and raw area of the carrier pedicle and the donor site was skin grafted. Foot elevation was provided in all the cases and pressure over the flap and grafted region was strictly avoided.

RESULTS

A total of 16 patients had sustained injuries following road traffic accidents and one each had sustained injuries after falling from a height and after post surgical debridement. Defect sizes ranged from 6 x 5 cm and 17 x 13 cm and sizes of flaps which were harvested, ranged from 7 x 6 cm to 18 x 12 cm. The following measurements were observed; proximal borders of flaps: 4 to 5 cm from the popliteal skin crease, pedicle width; 3-4 cm, pivot point; 5-7 cm away from lateral malleolus. Patients were followed up in OPD for 4 months to one year.

It was categorically found that none of the flaps had failed completely. Although four cases developed venous congestions, two developed marginal necrosis with distal flap loss, which required debridement and split-thickness skin grafting. Among these cases, one was a known smoker.

On further analysis, two cases of partial graft loss were found, which were regrafted. Both patients were diabetics. One case with inset dehiscence and other which had developed a tropic ulcer, were noticed [Table/Fig-2]. However, none of these complications affected the final outcome of the flap. Illustrative examples have been given in [Table/Fig-3-5].

DISCUSSION

The main cause of soft tissue defects in distal third leg, ankle, tendoachilles region, heel and foot dorsum in our study was road accidents, which was similar to that seen in another study done

[Table/Fig-2]: Case no 14 trophic ulcer developed over insensate flap

[Table/Fig-3]: Post debridement wound defect case no 1, large well settled extended reverse sural artery flap distal end of flap extending almost up to base of 1st toe ,donor site well healed

[Table/Fig-4]: Case no 5 defect over dorsum of foot covered with extended reverse sural artery flap

[Table/Fig-5]: Case no 14 and 18 flap cover for weight bearing heel

by Chen et al., [7]. One of the difficult and demanding plastic surgery procedures is the complete and safe reconstructions of these defects in the absence of microsurgery facilities. Free flap reconstruction is one of the viable options which is available. However, it has limitations of time, expertise and infrastructure requirement [5]. Reverse sural artery flap, which was described by Masquelet et al., [2], was the basis for our extended reverse sural artery flap. Several authors have reported that conventional flaps which were harvested from middle third of leg mainly depended on the median sural artery and that this artery had direct cutaneous branches only in its superficial portion, in the lower two thirds of the leg. Hence, proximal extension of the flap has been considered to be a random type of flap and its survival is not predictable [2,3,8,9]. Extension of flap into proximal third of leg to increase flap survival the miniature vessels which lie in a delicate fibro-adipo-areolar tissue between the two heads of the gastrocnemius muscle and a mesentery like structure connected to the deep fascia should be preserved and harvested along with the flap [4,5,9]. Including the short saphenous vein within the flap will enhance both the venous drainage and arterial supply of flap. Several other modifications include delaying of flap [10,11]. It has been shown that a delay can significantly increase blood circulation in the distal portion of the random pattern skin flap [12] and harvesting a midline cuff of the gastrocnemius muscle with the flap [13]. Venous supercharging, a microsurgical technique, may be considered in cases with venous insufficiencies [14]. Several studies [4,15,16] have demonstrated that the short saphenous vein had its own accompanying arteries and they also demonstrated long veins that ran along the short saphenous vein. They were found to communicate them at some places, hence played role in bypassing its valves.

CONCLUSION

This study categorically gave favourable results as compared to previous studies. No complete or near complete flap necrosis was found at all. All patients underwent successful reconstructions with the use of sural flaps, without any serious adverse events being reported.

From our experience, we can say that use of extended sural flap for defects on the proximal third of the leg was a safe, efficient and successful option which was worth considering.. It could be used to treat patients with large and far wounds, from the distal leg to the foot and sole, with more versatility and easier reach of the recipient. It can be used as an alternative to free tissue transfers done for large defect reconstructions of the foot.

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