

Research Article

Complex Heel Defect: A Comprehensive Study on Combined Regional Flaps For Sensate and Stable Coverage

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Abstract

Background: Heel defect has remained a challenging situation for reconstructive surgeons. In large post traumatic defects, the goal is to provide a sensate and stable soft tissue coverage, especially for the weight-bearing part of the heel. The paucity of local tissue options makes the scenario difficult to deal with.

Objective: This study is aimed to reconstruct large defect, involving both the weight-bearing and non-weight-bearing part of the heel by combining two regional flaps.

Methodology : A retrospective study, comprising of 11 patients from January 2016 to December 2019 with large traumatic heel defects, operated in our setup with combined medial plantar and reverse sural artery flap within 72 hours of injury. Follow up period was 6 months postoperatively.

Results: All flaps survived well except one reverse sural flap, which was congested and later debrided and 2 had distal edge necrosis which were managed conservatively. All the reverse sural flaps were noted to have lymphedema, but only 3 patients opted for debulking surgery. The functional outcome was excellent, with all the patients being able to walk normally, both barefoot and with footwear. The weight-bearing area was sensate, a clear advantage of utilizing instep skin.

Conclusion: In our experience, the combined strategy of utilizing local tissue for large heel defects, not only provides a sensate, stable, and reliable coverage but also avoids the lengthy procedure of free tissue transfer that in the end would not be able to give similar results.

Keywords | Complex heel defects, Sural flap, Medial plantar flap

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Introduction

Heel injuries with extensive soft tissue loss remained challenging for reconstructive surgeons.¹ The heel has an anterior weight-bearing and posterior non-weight bearing area. In large post-traumatic soft tissue defects, the main aim is to provide a sensate and stable soft tissue coverage to the weight-bearing part of the heel for normal ambulation.² The reconstruction is difficult in this complex anatomical region owing to the poor blood supply and lack of local tissue availability.³ The provision of sensate and stable soft tissue padding in the weight-bearing part along with the soft and supple

cover in the non-weight bearing part is the goal of reconstruction.

Various strategies and procedures have been proposed and implied in the past for the coverage of large heel defects but none of them was sufficient enough to cover the defects involving anterior and posterior areas of the heel.^{4,5} In recent times, medial plantar artery flap, reverse sural artery flap and free tissue transfer is being done in many centers which provide an adequate amount of tissue to cover complex heel defects, but medial plantar artery flap has the superior edge on the reverse sural flap as mentioned in previous studies.^{6,7} Masquelet

and Romana in 1990 described that reconstruction with medial plantar artery most closely resembled the skin surface and there is less donor site morbidity postoperatively.⁸ Medial plantar artery flap can replace "like with like tissue", this specialized tissue is harvested from the non-weight bearing medial arch of the foot and is placed directly on the weight-bearing area of the heel.⁹ It provides a sensate and weight-bearing fat pad to the heel.⁷ Similarly, the reverse sural artery flap is a distally based fasciocutaneous flap used for coverage of defects that involve the distal third of the leg, ankle, and foot.¹⁰ The major advantage of reverse sural artery flap is a constant blood supply that is not sacrificed or manipulated.^{11,12} However, the disadvantage of this flap is venous congestion that can lead to early postoperative flap necrosis, but with improvement in surgical technique, the survival outcome is getting better.^{13,14} Zheng L et al reported complete survival of the flap in twenty-three cases, with excellent reconstruction outcome for small to moderate soft tissue defects with dead space in heel and ankle, especially those with weight-bearing area defect.¹⁰

The medial plantar artery flap can only provide coverage to the anterior weight-bearing part of the heel, though a carefully planned sural flap or free flap can cover the most areas of the heel but the skin will be insensate and won't be suitable for weight-bearing, that can lead to ulceration of the skin, and the patient must wear customized footwear. In this study, we described our experience of employing the utility of combining two regional tissues to reconstruct a large heel defect, involving weight-bearing and non-weight-bearing parts of the heel, that is, medial plantar artery flap and reverse sural artery fasciocutaneous flap. The aim is to provide a tough tissue similar to heel at the weight-bearing area from the instep tissues and coverage of posterior heel with soft pliable tissue from the calf in selected cases.

Methodology

This is a retrospective descriptive study, spanning over 4 years from January 2016 to December 2019, conducted at the Department of Plastic and Reconstructive surgery at a tertiary care hospital. As a teaching hospital, written consent is taken routinely from all the patients for possible use of data for research purposes, keeping the identity anonymous. The data was retrieved from the registry of Hospital Information Management System (HIMS) and reviewed for large traumatic heel defects reconstructed with combined sural and medial plantar artery flap. Total 11 patients were included in the study. The data

was assessed for demographic profile, mechanism of injury, involved limb, associated injuries, early complications (hematoma/bleeding, infection, venous congestion, flap failure) and late complications (infection, lymphedema, contour abnormalities, flap loss), flap survival, and follow-up. The outcome was assessed in terms of walking ability barefoot and with routine footwear/shoes, flap texture (soft/supple, firm, and hard/contracted) and presence of protective sensation over the transferred flap.

Wound debridement was done in 8 patients immediately after the injury to remove all devitalized tissue and to prepare the wound for reconstruction. All patients underwent heel coverage with combined pedicled locoregional medial plantar and reverse sural artery flap within 72 hours of injury. A standard reverse sural artery flap was used for the coverage of the posterior non-weight bearing area of the heel. The sural flap was harvested; the deep fascia, sural nerve, artery, and short saphenous vein were included in the flap. The medial plantar artery flap was harvested based on the superficial branch of the medial plantar artery, lateral sensory branch of the medial plantar nerve was included in the flap after neurolysis to gain additional length. The flap was rotated 180° to cover the anterior weight-bearing area of the heel.⁷ Donor sites of both the sural and medial plantar artery flap were covered with split-thickness skin grafts. Figure-1-3, showing pre and postoperative photographs of the procedure. Partial weight-bearing was allowed at 6 weeks while full weight-bearing was allowed at 12 weeks after the procedure. All patients were advised for flap and foot care. Follow up period was 6 months postoperatively. SPSS version 25 was used for statistical analysis.



Figure 1: Complex heel defect (A), medial plantar artery flap inset, and bolster dressing on graft at the donor site (B)



Figure 2: Completely covered heel defect (C and D), after 1 week of the flaps inset



Figure 3: Sural flap debulking after 6 months of flap inset (E), Follow-up after 12 months of the procedure (F)

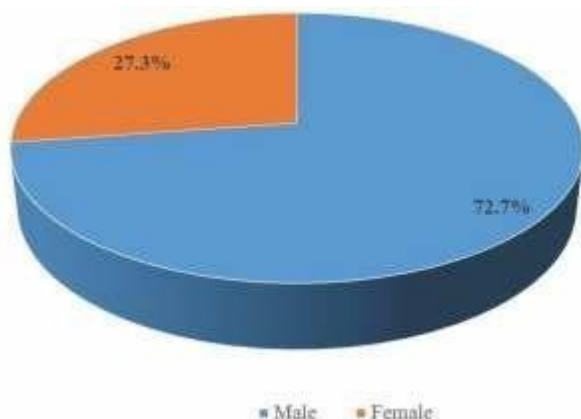


Figure 4: Gender distribution

Results

Total 11 patients were operated for the coverage of large heel defects with combined reverse sural and medial plantar artery flap with a mean age of 31+ 8.6 years, out of which 8 (72.7%) were male and 3 (27.3%) were female [Figure-4]. Most of the patients (54.5%) were field workers. Mechanism of injury was road traffic accident in majority of the patients, that is, 9 (81.8%) and blast injury in 2 (18.2%) patients while the right

Table 1: Frequency distribution

Age	Years (\pm SD)	31 (\pm 8.6)
Occupation	Students	2 (18.2%)
	Desk job	3 (27.3%)
	Field Job	6 (54.5%)
Mechanism of injury	Road Traffic Accident	9 (81.8%)
	Blast Injury	2 (18.2%)
Involved limb	Other	0 (0.0%)
	Right	7 (63.6%)
Associated Injuries	Left	4 (36.4%)
	Yes	1 (9.1%)
The revision or Additional procedure	No	10 (90.9%)
	Yes	1 (9.1%)
	No	10 (90.9%)

lower limb was the most affected limb. One patient out of 11 was presented with associated injury i.e. open wound at thigh [Table-1].

All medial plantar artery flaps survived well while 3 of the 11 sural flaps developed complications. Out of those 3 flaps, one was congested initially and ended up with partial flap loss which was debrided and required surgical revision later. Two sural flaps had distal edge necrosis and were managed conservatively with dressings. All sural flaps were noted to have lymphedema, but only three patients opted for debulking surgery. The functional outcome was excellent, with all the patients being able to walk normally both barefoot and with shoes. The texture was soft and supple for both medial plantar artery flap and reverse sural flap in all the patients. The weight-bearing area was sensitive in all the patients.

Discussion

Plastic and reconstruction surgeons globally encounter formidable challenges, particularly when addressing soft tissue defects in the complex anatomy of the heel. The intricacies involve both anterior and posterior sections, with the anterior heel covered by robust thick skin, ideal for weight-bearing, while the posterior heel requires supple coverage.^{15,16}

Numerous operative procedures, including muscle flaps, have been attempted over the years, but have proven insufficient for addressing large defects^{6,17-20} Sommerlad and McGrouther also explained in a study that how majority of these techniques are neither sufficient nor desirable to cover large defects.⁵

In the contemporary medical landscape, several health-care centers are incorporating procedures such as the medial plantar artery flap, reverse sural artery flap, and free tissue transfer to address complex heel defects. Notably, these techniques offer enough tissue for coverage. However, it is worth noting that previous studies have highlighted the superior advantages of the medial plantar artery flap over the reverse sural flap in this context but the size of it is insufficient to cover the large defects involving anterior and posterior heel.²⁵

An innovative investigation conducted by Shanan and Gingrass outlined the utilization of the medial plantar artery fascio-cutaneous flap, establishing it as a cornerstone in contemporary foot and ankle reconstruction.^{21,9} Medial planter artery flap not only demonstrates its effectiveness in providing appropriate soft tissue coverage through its sensate skin but also stands out for offering the most adequate blood supply and innervation. This distinction arises from its unique feature, encompassing two pedicles that include both the superficial and deep branches of the medial plantar artery.²²⁻²⁴ A noteworthy advantage of selecting this flap lies in the potential recovery of sensation in the skin, attributable to the inclusion of sensory nerves within the flap.⁷ Conversely, the reverse sural artery flap presents itself as a viable alternative for addressing posterior heel defects, especially in instances where the medial plantar artery flap falls short in providing sufficient coverage.²⁵ This alternative involves harvesting soft skin from the posterior leg, containing lower peroneal septo-cutaneous perforators in a reverse configuration, thus justifying its nomenclature. It is essential to acknowledge, however, that this method is associated with the development of tissue edema over time.^{26,27} While it can deliver sensate and pliable soft tissue coverage from the posterior leg to the weight-bearing regions of the heel, it's important to note that the skin obtained through this method may not be suitable for weight-bearing. In the case of extensive and intricate heel defects, relying solely on either of these flaps proves insufficient to adequately cover the wound. Free tissue transfer emerges as an alternative, capable of providing ample coverage for such large defects; however, it is crucial to recognize

that the skin acquired through this technique may also not be conducive to weight-bearing. Recognizing the limitations of individual flaps, our study advocates for the combined use of both the local flaps in a single procedure to effectively cover extensive, complex heel defects.

Compared to free microvascular tissue transfer, combined local flaps were simple, involving a concise surgical duration, minimal blood loss, and added convenience of being a one-step surgical procedure as discussed by J. Benito-Ruiz et al in a study.²⁸ The mean hospital stay in our patients was very less (mean 6 days) as compared to the patients with free tissue transfer done by Yücel et al¹ and there was no need for extensive monitoring as in cases of free tissue transfer.

The results of our study were almost similar to the results of the study done by J. Benito-Ruiz et al,²⁸ as all of the medial plantar artery flaps survived and all the patients regained sensation and were able to walk normally with or without routine footwear. The regained sensations are inferior when compared to the normal foot as reported in a study by Siddiqi et al.²⁹ Out of 11 only one of the sural flaps suffered partial flap loss, which was managed by debridement and readjustment. The utilization of local tissue for the coverage of complex heel defects not only provides sufficient sensate skin but also aids early restoration of the normal walk and improved quality of life.

Conclusion

Drawing from our firsthand experiences, we assert that fascio-cutaneous flaps, specifically the instep medial planter artery flap for addressing anterior heel defects and the reverse sural flap for managing posterior heel defects, stand as the primary preference in our reconstruction algorithm for soft-tissue heel defects. The utilization of free flaps can be considered in complex situations when none of the aforementioned flaps can be feasibly executed.

Conflict of Interest: *None*

Funding Source: *None*

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