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REVERSE FLOW SURAL FLAP;

A VERSATILE METHOD FOR THE MANAGEMENT OF SOFT TISSUE DEFECTS OF DORSUM OF FOOT, ANKLE AND HEEL.

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ABSTRACT… Background: Soft tissues injuries at foot especially at heel expose the tendons, bones and especially joints, which leads to risk of infections and necrosis. These often result from trauma (spoke wheel), tumors, systemic diseases and their wounds such as venous ulcers and diabetic foot wounds. Surgical planning of these defects remains a challenge due to shortage of local scar free tissue and reliable blood supply. The current study is conducted to evaluate observe the purposeful benefits of reverse sural artery flap to cover wounds at dorsum of foot, ankle & heel. **Study Design:** Descriptive, experimental study. **Setting:** Department of Plastic & Reconstructive Surgery, Dow University of Health Sciences & Dr. Ruth KM Pfau Civil Hospital Karachi. **Period:** January 2015 to January 2018. **Material & Methods:** All patients who presented with wounds at heel, dorsum of foot, and exposed calcaneus or Achilles tendon were included. A peroneal based perforator identified by hand held Doppler, a superficial vein, and the sural nerve were included in the pedicle. Patients were followed during the first 6 postoperative months. Postoperative outcomes like flap congestion, tip necrosis and flap failure were noted. **Results:** Total of 36reverse low sural flaps were done for the soft tissue coverage of the 24 heel defects, 8 ankle defects and4 dorsum of the foot defects. Twenty eight patients were male and eight were females and age ranged from 6 to 36 years (mean 21). Partial flap failure was seen in 3 cases and complete flap failure in 2 cases. There were no serious donor site complications and all patients were satisfied with the functional and aesthetic outcome postoperatively. **Conclusion:** Reverse sural artery flap is very suitable in providing soft tissue coverage of the wounds of heel and dorsum of foot. Harvesting sural flap is dependable and safe as it does not ends in any major postoperative donor site morbidity.

Key words: Injury of Dorsum& of Foot, Peroneal Artery Based Perforator, Achilles Tendon, Sural Artery Flap.

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INTRODUCTION

Due to recent urbanization and high speed vehicles an increase in road traffic accidents resulting in fractures, multiple traumatic injuries and extensive soft tissue defects are commonly seen.[1,2] Complete soft tissue coverage is extremely challenging[3]; due to unreliable blood supply after traumatic injury and thin subcutaneous tissue over the lower leg, heel and malleolus. As trauma and other degloving injuries often involve skin & subcutaneous tissue, underlying bone, ligamentous structures & exposes the tendon and bones directly[4,5], which leads to risk of infections and necrosis. Lower extremity trauma most often occurs with two wheeler or four wheeler vehicle accidents' and frequently involves tibia. Spoke wheel injuries lies among the most common injuries in motorcycle riders. This kind of injury commonly occurs when foot gets struck in between the spokes of the wheel. Skeletal tumors most commonly involve the tibia. Removal of the tumors with safe margins often results in large wounds with exposed uncovered bone and tendons or neurovascular structures; moreover irradiation of the surrounding tissue makes doubtful primary closure. Chronic wounds of lower limb in patients with systemic illness like diabetes and peripheral vascular diseases appear as non-healing venous ulcers or diabetic foot. Reconstruction of these defects with soft tissue coverage also demands for fat padding of calcaneus as it is the primary weight bearing

bone transferred from the tibia. Classification that grades the tissue damage extension: Type I: Skin loss with bone or tendon not exposed. Type II: Skin loss with either exposure or rupture of Achilles tendon. Type III: Skin loss with Achilles tendon defect, exposed or fractured calcaneus. Type IV: Mangled foot with neurovascular bundles damaged.[6]

Following the reconstructive ladder options like secondary healing, primary closure, grafts, local or regional flaps, and distant flaps and at the last free flaps[7,8] can be considered to cover the lower limb defects. Skin grafts cannot be used to cover the bones and tendons which are non-vascularized or devoid of periosteum and paratenon respectively.[9,10] Due to rupture or traumatic fibrosis of perforators and localized tissue, pedicle tissue cannot be used as flaps for coverage. Being at the top of reconstructive ladder; free flaps are the most suitable option to cove the defect[11] though demands highly trained and experienced surgeons who can operate microvascular surgeries for long hours. Some studies shows raising the pedicle with skin rather than islanding the flap has more reliability and lesser complications.[12]

This study was conducted to weigh the results of reverse sural artery flap for covering the wounds of ankle, heel and dorsum of foot.

MATERIAL AND METHODS

This descriptive, experimental study was conducted at Department of Plastic and Reconstructive Surgery, Dow University of Health Sciences & Dr Ruth KM Pfau Civil Hospital Karachi, from January 2015 to January 2018. It included 36 patients; 28 were males and 8 were females, with soft tissue defects over heel, ankle and dorsum of foot. The age, gender, cause, duration, site and size of the defects, measurements of flap, placing of pedicle underneath the skin or above the skin, postoperative results and complications were recorded. Preoperatively long bone x-rays were done in all patients to rule out the presence of osteomyelitis. Patients with calcaneus fractures, external fixator application, and osteomyelitis, and peripheral vascular disease, traumatic or irradiated tissue adjacent to wound, excluded. Along with that, patients with injury adjacent or over the region of peroneal artery perforators were excluded. Multiple mechanical debridement and dressing were done to prepare the wound for coverage.

All patients were followed in outpatient clinic for flap outcome and complications for 6 months. Total flap loss was considered as major complications.

SURGICAL TECHNIQUE

Patient was laid in standard lateral or prone position under general or spinal anesthesia and tourniquet control. Before raising the flap, wound was debrided and irrigated, flap was harvested in reverse sural design with pivot point at 5–6 centimeters proximal from the lower end of lateral malleolus. Hand held Doppler ultrasound was used for the assessment of perforators. Upper limit of the flap was extended till the center of upper and middle third of the leg, whereas patients' who required longer pedicle to cover the defect upper limit was extended till the proximal third of leg using delay phenomenon first in minor OT room under local anesthesia and then the elevation and inset of flap was done after 10 days. The skin island was incised deep up to the layer of the fascia. The sural nerve was divided proximally, ligated and buried between muscles and the short saphenous vein and sural artery was ligated. Flap was dissected from proximal to distal end. In majority of patients skin island was passed through a wide subcutaneous tunnel into the defect (Figure-1) while in some patients flap was passed above the normal skin to reach the wound, hence no tunneling was done and graft was placed underneath the raw surface of flap (Figure-2) and pedicle was then divided after 3 weeks. Tourniquet was released to check the vascularity of flap and control of bleeding.

Donor area of the flap was provided coverage with partial thickness skin graft in all the cases and the flap was inset on the defect with Prolene (3/0 Ethicon Inc., Cornelia, Georgia, USA). Dorsal slab was given to all patients. Postoperatively patients were laid in lateral position with elevation

of operated limb to alleviate pressure from the pedicle. Patients were allowed to walk after 4–6 weeks.

RESULTS

Total 36 patients were included in the study with defect in the heel in 24 patients, at ankle in 8 patients and at dorsal surface of foot in 4 patients. The area of the wounds measured from 4–13 cm in length and 5- 11 cm in width. History of the wounds varied from 3 weeks to around 2 months.

In 26 patients the center of upper and middle third of the leg was taken as upper limit for the flap where as in 10 patients proximal third of leg was taken as upper limit using delay phenomenon.

In 30 patients; skin Island was tunneled, while in 6 patients flap was interpolated between donor and recipient areas. (Table-I)

Twenty nine flaps survived without any complications. Complete failure of flap in 2cases and compression and hematoma at the site was found to be the main cause, while 3 flaps showed partial failure which was skin grafted later (Figure-3). On an average total hospital stay was around one week.

Dorsal splint was provided for 3 weeks and healing time of the wound was around 4 weeks. None of the patients came with the signs of neuroma formation or any flap donor site complications. Graft donor site; mostly thigh, also showed no major complication. Difficulty in gait and weight bearing were not exhibited after 3 months.

Case No	Age (years)/ Gender (M/F)	Etiology	Site of defect	Size (cm)	Outcome	Secondary Surgery
1	7/M	Spoke wheel injury	Heel	3x4	Flap survived	Nil
2	26/M	RTA	Dorsum of foot	10x8	Flap survived	Nil
3	25/F	Spoke wheel injury	Ankle	5x4	Flap survived	Nil
4	28/M	Spoke wheel injury	Ankle	5x3	Flap survived	Nil
5	36/F	Spoke wheel injury	Ankle	5x5	Flap survived	Nil
6	10/M	RTA	Heel	4x4	Flap survived	Nil
7	12/M	RTA	Heel	3.5x4	Flap survived	Nil
8	15/F	Spoke wheel injury	Heel	4.5x4	Flap survived	Nil
9	36/M	Diabetic Ulcer	Heel	4x5	Partial failure	Debridement & Skin grafting
10	20/F	Spoke wheel injury	Heel	4x3	Flap survived	Nil
11	35/M	RTA	Heel	5x5	Flap survived	Nil
12	25/F	Spoke wheel injury	Heel	5x5	Flap survived	Nil
13	20M	RTA	Heel	4.5x5	Flap survived	Nil
14	34/M	Diabetic Ulcer	Heel	5x6	Complete failure	Managed conservatively
15	11/M	RTA	Heel	5x4	Flap survived	Nil
16	33/F	RTA	Heel	5x6	Partial failure	Debridement & Skin grafting
17	33/M	Spoke wheel injury	Heel	3.5x5	Flap survived	Nil
18	33/M	RTA	Heel	3.5x4	Flap survived	Nil
19	33/M	RTA	Dorsum of foot	9x7	Flap survived	Nil
20	20/M	Spoke wheel injury	Heel	4x3	Flap survived	Nil
21	22/M	Spoke wheel injury	Heel	4x5	Flap survived	Nil
22	20/M	RTA	Heel	4x6	Flap survived	Nil
23	35/F	RTA	Heel	3x4	Flap survived	Nil
24	14/M	Spoke wheel injury	Heel	3.5x4	Flap survived	Nil
25	14/M	Spoke wheel injury	Ankle	5x4	Flap survived	Nil
26	29/M	Spoke wheel injury	Heel	3.8x5	Flap survived	Nil
27	11/M	RTA	Ankle	5x5	Flap survived	Nil
28	31/M	RTA	Ankle	3x5	Complete failure	Managed conservatively
29	26/M	Spoke wheel injury	Heel	4.5x5	Flap survived	Nil
30	33/M	Spoke wheel injury	Ankle	3x4	Flap survived	Nil
31	27/ M	RTA	Heel	5x5	Flap survived	Nil
32	29/M	RTA	Heel	5x6	Flap survived	Nil
33	31/F	RTA	Ankle	5x5	Partial failure	Debridement & Skin grafting
34	32/M	Post burn contracture	Dorsum of foot	9x7	Flap survived	Nil
35	21/M	RTA	Heel	4x3	Flap survived	Nil
36	35/M	Post traumatic contracture	Dorsum of foot	9x6	Flap survived	Nil

Table-I. Details of patients, mode & site of injury, and outcome of surgery:

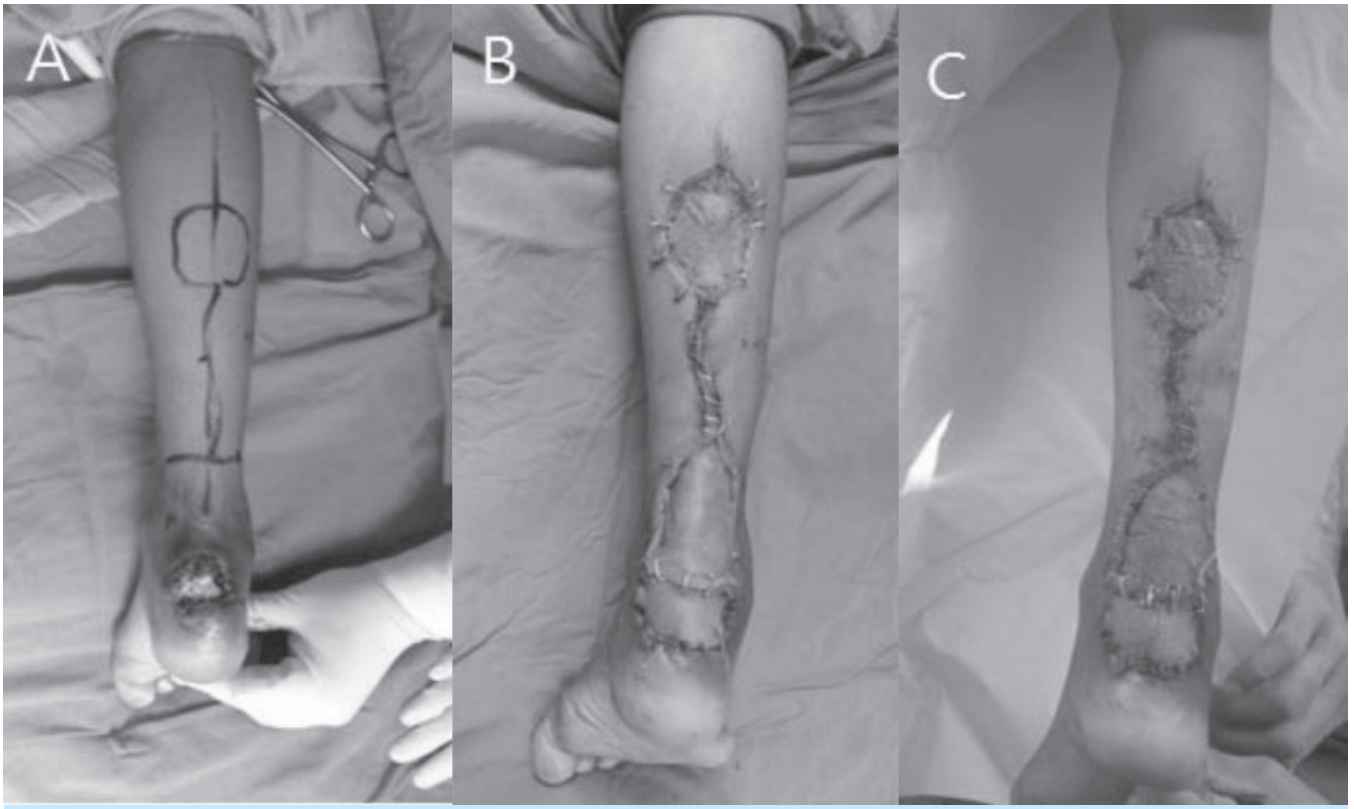

Figure-1. (A). 18-year-old male with spoke wheel injury of right foot; defect after debridement, pedicle & flap outline marked. (B). Flap elevated and inset over the primary defect & secondary defect resurfaced with split skin grafting. (C). Healed wound with well taken skin graft at the donor site after 3 weeks.

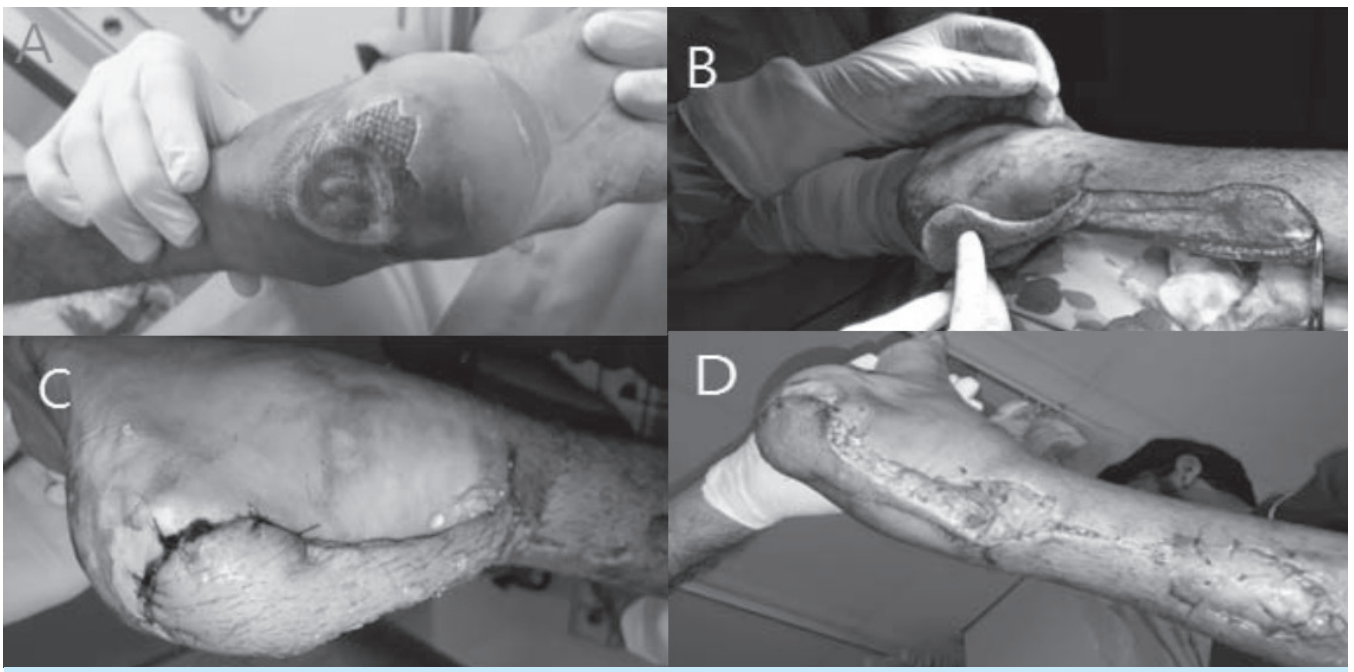

Figure-2. (A). Soft tissue defect over heel of a 33-year-old male due to RTA. (B). Reverse Sural flap raise using a cutaneous pedicle. (C). Flap after 1 week. (D). Donor site and pedicle covered with split thickness skin graft.

Figure-3. (A). 34-year-old male patient with spoke wheel injury in RTA. (B). Flap showing venous congestion; resulted in complete failure.

DISCUSSION

Skin grafts provides the most easiest and quickest way to cover any wound, but since it's this significance cannot be utilized to cover any bare tendon, or bone. Likewise random pattern local flaps in lower limb have restricted range of motion and arc of rotation.[13] In these parameters free flaps provides unlimited qualities like adjustable size of soft tissue, expandable pedicle length, dependable thickness of soft tissue, and more or less variable composition of tissue in flaps. However requires[14] long operative time and microsurgical expertise limits its use. More over in developing countries expensive infrastructure cannot be availed at every hospital.

Therefore reverse sural artery flap provide easy reconstruction option in our setup. Though local perforator flaps are gaining tradition for providing coverage.[15]

The peroneal artery based sural flap was introduced by Donski and Fogdestam and then familiarized by Masquelet et al.[15,16] The reverse vascularity to sural angiosome depends upon median, medial and lateral superficial sural arteries. Perforators of peroneal artery provide vascularity to this reverse flap.[17] Perforators of posterior tibial artery also feed this flap.[18]

Among the 5 cases that developed partial or complete necrosis, wounds over the ankle were the most common, followed by wound over dorsum of the foot; and only one flap ended with necrosis at dorsum of foot with diabetic ulcer. Hence, it can be concluded that outcome of distal wound defects has higher liability to get necrosis, more so among patients with diabetic ulcers.[18,19] Cases that lead to partial failure were debrided and covered with split thickness skin graft. Only a few patients followed with complain of numbness of over dorsolateral surface of foot. Though being reverse sural is harvested as insensate flap; patients did not showed up with trophic ulcer, this query demands further research.[20,21,22]

Thus, the reverse sural fasciocutaneous flap based on peroneal perforators is a rapid, non-cumbersome and versatile technique, eliminating the need of microvascular surgery.

CONCLUSION

About to all of the cases resumed their activities after three months of the surgery; it exhibits that distally based sural artery flap is a versatile & dependable option for providing cover at defects of the distal lower extremity and the results are uniformly acceptable with minor complication rates.

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CONFLICT OF INTEREST

The authors has no conflict of interest.

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CREATIVITY COMES FROM
A CONFLICT OF IDEA.

"Donatella Versace"

AUTHORSHIP AND CONTRIBUTION DECLARATION

Sr. #	Author-s Full Name	Contribution to the paper	Author=s Signature
1	Hyder Ali	Cheif plastic surgeon involved in performing all surgeries, postoperative follow-up of patients, finalapproval of the manuscript and responsible for accuracy and integrity of resutls.	
2	Faraz Adil	Original design and writing of manuscript and assisting chief surgeons while performing surgeries.	
3	Farah Idress	Critical review of manuscript. Assist in surgeries and posoperative care & follow-up of patient.