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Reconstruction of the Foot and Lower Leg Defects by Reverse Sural Flap

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Abstract: This study included 17 cases with foot and lower leg defects admitted to Hospitals from January 2011 to April 2013. Their age ranged between 7 and 50 years with a mean of 28.5 years. They were 13 males and 4 females. The patients presented with a variety of leg and foot defects. All patients underwent different surgical procedures specificified for each case. The sural fasciocutaneous flap is a good option in reconstruction of difficult and complex wound in lower leg and foot especially on ankle joint, malleoli, heel, and posterior plantar.
Keywords: lower-extremity trauma, Soft-tissue reconstruction, Sural flap, handheld Doppler.

INTRODUCTION

For centuries, amputation remained the only mean of dealing with the massively traumatized or infected lower extremity [1]. The major problem in soft-tissue reconstruction of the lower third of leg, heel, and ankle region is the poor vascularity and limited mobility of the skin [2]. Plastic surgeons are called upon to address the wounds that result from trauma, infection and excision of malignancy. The first task is to convert the existing wound into a healing wound by surgical methods as well as application of modern wound-healing techniques. Most wounds can then be closed using simple measures, such as delayed primary closure, skin grafts, and local flaps. Some wounds, however, require more sophisticated techniques that mandate an intimate knowledge of the local angiosomes, arterial blood supply, and flap anatomy [3]. Traditionally, local flaps, as muscle and random pattern skin flap, were used for resurfacing of soft tissue defects around the foot and ankle region but their use is limited by their size and arc of rotation.

Reverse flow flaps such as anterior tibial artery flap and posterior tibial artery flap require the sacrifice of major arteries in already traumatized limb [4-6].

Other reverse flow flaps as lateral supramalleolar fasciocutaneous flap which is mainly vascularized by the perforating ramus of the peroneal artery and some time take additional supply from anterolateral malleolar artery, also shows high incidence of complication due to short vascular pedicle which does not permit planning of large flap, in addition to vulnerability of these vessels to injury by original trauma. Another example of local flaps is the lateral calcaneal artery skin flap which can cover soft tissue defects on Achilles tendon or posterior heel and some time plantar heel, this flap which is proximally based, includes the lateral calcaneal artery, lesser saphenous vein, and sural nerve, but the drawbacks of this flap are the small size of skin provided by this flap and short arc of rotation in addition to the contour defect of the donor site on the lateral calcaneal area. Free flap is currently the treatment of choice for large soft tissue defects of the distal extremity, but It is however a technically demanding procedure. The range between small lower extremity soft tissue defects which managed by simple procedures and large defects which mandate a more complex technique as free flap, gives a wide area for research to invent a less demanding choice, with effectiveness and reliability to treat medium sized soft tissue defects [4-6].

PATIENTS AND METHODS

This was a prospective study conducted during the period between January 2011 to April 2013, at in Al-Wasity teaching hospital, Al-Shaheed Gazi Al-Hariri hospital for surgical specialties and Al-Sader teaching hospital, included 17 patients (13 males and 4 females), aged 7 to 50 years, operated upon by using reverse flow sural fasciocataneous flap for soft tissue defects of foot, ankle and lower third of leg. The causes of defect were blast injury (4 patients), trauma (11 patients), post surgical debridement of nonspecific ulcer

with previous failed skin graft in (1 patient), and diabetic foot in (1 patient). Defects were localized to, the heel in six patients (with or without adjacent areas involvement), the ankle in two patients, Achilles tendon area in four patients, distal third of leg in four patients, and one patient with a history of amputation stump ulcer of hind foot had previously been treated by debridement. The summary of patients' data is shown in (Table 1).

All patients prepared preoperatively by thorough examination, investigations which involve hemoglobin level, PCV, random blood sugar, renal function test, radiological examination, in addition to the specific investigations according to case requirement as ECG, chest X-ray,....., etc. Hand held doppler examination to localize perforators done for all patients. Local wound examination, measurement of dimensions, as well as preoperative photo was taken.

Surgical Technique

With assistance of handheld Doppler, localization of peroneal artery perforators is made especially the one located on 5 cm above lateral malleolus which is very important in survival of the flap. The skin island is then outlined so as to match the recipient site defect, and the dimensions of the flap can be extended to involve the upper third of leg just short from popliteal crease (5-6 cm). A line is then marked from a point halfway between the Achilles tendon and the lateral malleolus at the ankle extending to the midline between the two heads of the gastrocnemius muscle (which is the centre of the flap). This roughly describes the course of the medial sural cutaneous nerve and lesser saphenous vein. Under general anesthesia, the patient is placed in a prone position and the flap is raised under tourniquet control with assistance of loupe magnification. The sural nerve with it's accompanying artery are divided proximally and the short saphenous vein is ligated, all of them are included with the flap. Dissection then begins proximodistally with involvement of deep fascia. Exposure of pedicle is done by longitudinal incision through the skin covering the pedicle downward with undermining on both sides to facilitate elevation of flap and it's carrying pedicle. At the level of retromalleolar region, all the local subfascial fat must be included in the flap, because it contains perforators coming from the peroneal artery that supposed to supply the perineural arterial plexus around sural nerve. The width of the carrier pedicle is about 3 to 4cm. Pedicle dissection continues toward the pivot point (just above the perforators mapped out by Doppler), usually 5-7.5 cm superior to the lateral malleolus. Hemostasis is achieved with bipolar diathermy after the tourniquet deflation. The elevated flap is transposed to the defect, and the raw area of the carrier pedicle and the donor site is skin grafted unless direct closure is possible as we did in one patient with small size flap (5x4 cm). Flap delay has been done for 2 cases by completely raising the flap and then suturing back in its donor site, then the flap transferred to its recipient site after 10 days as a second procedure. Corrugate drain used in some cases, to drain from underneath the flap for only 24 hours, and the dressing was completed by using Vaseline gauze as a first layer, followed by povidone iodine 10% soaked gauze pack as a second layer, then dry gauze as a third layer, which was wrapped by cotton, and the dressing as a whole secured by crepe bandage, but a window through the dressing had been left for flap monitoring purposes (Figure-1).

Post Operative Care

The Patient is usually kept in supine flat position in bed with elevation of leg by either using a pillow with application of supportive pad under heel, or a sling around lower third of leg secured to a holder maintaining elevation of foot above the chest level. Flap monitoring must be done for the first two postoperative days by skin color and turgor, temperature, capillary refill, and pin prick test. Flap congestion mandated removal of some stitches in some patients. At first post operative day, dressing was changed and in those who have corrugate drain, it was removed at this time. At third post operative day, the patient is discharged home after checking the flap and ensuring optimal skin graft take. On discharge, the patient is kept on light dressing and instructed to continue elevate the limb as long as possible to avoid dependent congestion to be seen after one week. All patients are kept on injectable third generation cephalosporin during hospitalization period, which later discontinued after discharge. Stich removal at 14th post operative day, with exposure of skin graft donor site at the same time. Patient was instructed to avoid full weight bearing on the limb till 6th week after operation, and after that to be started ambulate gradually. Patient was followed up regularly, by at least one visit monthly.

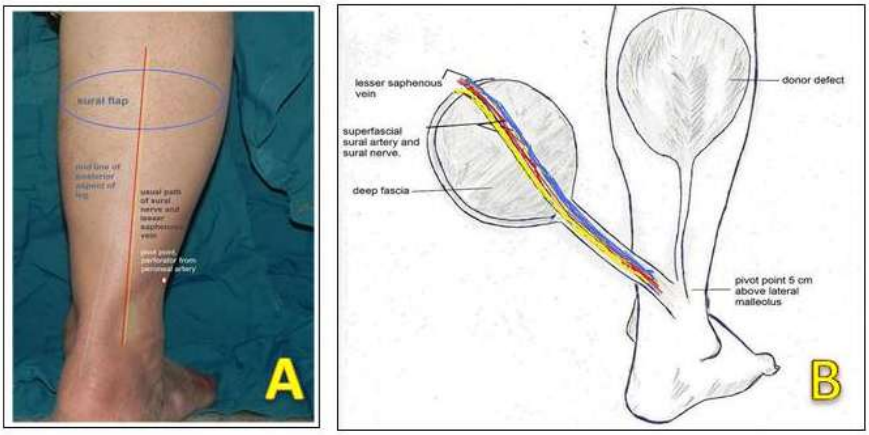

Fig-1: A-FlapLandmark, B-Rraised flap with pedicle containing sural nerve, median superficial sural artery and lesser saphenous vein, the deep fascia is also included with the flap [7]

RESULTS

Seventeen patients were included in this study. Their mean age was 28.5 (Range 7 – 50) years. Male to female ratio was 3.4: 1. All the flaps were fasciocutaneous type. Skin island dimensions ranged from 5 to 15 cm length, and 4 to 10 cm width. The cause of defect, site, and associated problems were varied among patients. The flap size, survival, complication and extra procedures done to patients are summarized in table-2. Split thickness skin graft harvested from back of thigh had been used to cover the flap donor site in all cases except one case with small sized flap, in addition to that, grafting of exposed carrier pedicle in certain flaps when they are didn't introduced through a tunnel, had been done, and all the grafted areas showed adequate take (Table 1-5).

Table-1: Summary of patients' data

Patient	Age (year)	Gender	Cause of Defect	Location of Defect	Associated Problems
1	44	Male	Blast injury	Amputation stump (hind-foot)	Hindfoot amputation with fitted shoe
2	15	Male	Post traumatic ulcer	Distal third of leg	Lower tibia oblique fracture
3	50	Female	Post traumatic ulcer	Achilles tendon area	Exposed Achilles tendon
4	35	Male	Road traffic accident	Heel &medial malleolus	Exposed medial malleolus
5	31	Female	Non specific ulcer	Heel	Obesity
6	7	Female	Road traffic accident	Ankle & medial malleolus	Ankle dislocation
7	27	Female	Diabetic foot	Heel & plantar area	Diabetes
8	23	Male	Post traumatic ulcer	Heel	None
9	30	Male	Road traffic accident	Ankle & lateral malleolus	Fractured tibia
10	9	Male	Road traffic accident	Achilles tendon area	Fractured tibia
11	30	Male	Post traumatic ulcer	Achilles tendon area	exposed Achilles tendon
12	50	Male	Road traffic accident	Achilles tendon area	Fractured tibia& exposed Achilles tendon
13	30	Male	Blast injury	Heel and plantar area	Fractured tibia
14	30	Male	Blast injury	Heel & medial malleolus	Fractured tibia
15	32	Male	Road traffic accident	Distal third of leg	Fractured tibia and fibula
16	35	Male	Blast injury	Distal third of leg	Fractured tibia with malunion
17	15	Male	Road traffic accident	Distal third of leg	Fractured tibia with bone loss (8 cm)

Table-2: Flap survival

Flap survival	Number of patients	%
Complete	13	76.5
Complete after delay	2	11.8
Incomplete	2	11.8

Table-3: Flap size

Flap Size	Mean + SD*	Range
Length	8.9 + 2.6	5 - 15
Mean width	5.8 + 1.6	4 - 10

Table-4: Postoperative Complication reported among the studied group

Complication	Number of patients	%
Venous congestion	4	23.5
Donor site hypertrophic scar	3	17.6
Distal tip necrosis	1	5.9
Marginal necrosis	1	5.9
Wound dehiscence	1	5.9

Table-5: Extra procedures required in the management of the studied cases

Procedure	Number of patients	%
Supercharge by anastomosis of lesser saphenous vein with one of greater saphenous vein tributaries	1	5.9
Delay, then flap elevation and inset	2	11.8
Advancement of the flap to cover the remaining defect	1	5.9
Total	4	23.5

Fig-2: Case1. 44 year old man, with history of previous war injury and Chopart's amputation of Rt. foot. He presented with chronic ulcer due to friction of amputation stump with fitted shoe (A). (B). Raising of sural fasciocataneus flap. (C). Inset of flap in addition to supercharging technique to enhance lesser saphenous vein drainage. (D), (E). Final result after more than one year

Fig-3: Case 4. 35 year old man, a victim of RTA with degloving injury to Lt. heel and medial malleolus (A). (B). Raising of sural fasciocataneus flap. (C). Inset of flap. (D). Final result after 8 months, there is a mild hypertrophic scar in the donar site

Fig-4: Case7; a 27 year old woman, with diabetic foot ulcer involving heel and posterior plantar region (A). (B). Raising of sural fasciocataneus flap. (C). Inset of flap with grafting of remaining part of plantar region which was not covered by the flap, by split thickness skin graft. (D). Final result after 1 year

Fig-5: Case 9; a 30 year old man, a case of RTA with degloving injury to the ankle and lateral malleolus (A). (B). Delay procedure of sural fasciocataneus flap had been done. (C). Flap after 2 weeks from it's transposition to the site of trauma. (D). Final result 6 months later

Fig-6: Case 16. 35 year old man, a case of blast injury with degloving of Lt. ankle and medial malleolus (A). (B). Raising of sural fasciocataneus flap. (C). Inset of flap. (D). Final result after 4 months

DISCUSSION

The management of lower-extremity trauma has evolved over the last two decades to the point that many extremities that would have required amputation are now routinely salvaged. Treatment requires a team approach with the orthopedic, vascular, and plastic surgeons [8] the primary goal of surgical reconstruction of the lower extremity wound is to restore or to maintain function. Functionality first demands a stable skeleton capable of supporting the patient's weight, with a stable surrounding soft tissue envelope. The presence or rehabilitative potential of muscles and joints along with proprioception and plantar sensibility will determine functional level [9].

The retrograde sural nerve flap is a versatile neurofasciocutaneous flap that is useful for lower leg, ankle and heel defects in addition to the majority of rearfoot defects, whatever the kind of defects and regardless the time (acute or chronic), even in a traumatic limb or in an elderly age group unless there is an obvious comorbidity which can jeopardize the flap as peripheral arterial disease or venous insufficiency. Varicose leg veins which involve the lesser saphenous don't considered as a contraindication to sural flap surgery and the flap raised in those legs with varicose veins passed uneventfully. The major donor deficit of the flap is the loss of sensibility along the lateral aspect of the foot but this deficit by itself rarely a complaint by these patients [10-12].

Our study dealt with seventeen cases 4 females and 13 males. Defects site were in most of cases in heel (6 cases, some of them showed involvement of adjacent regions in addition to heel as medial malleolus 2 cases, and plantar area 2 cases), and with lesser frequency, distal third of leg (4 cases), Achilles tendon area (4 cases), ankle joint (2 cases), and amputation stump (hindfoot) (1 case), while in Hasegawa *et al*., study [8] (21 cases), the site of defect was heel (7 cases, one of them is plantar aspect of the heel), medial malleolus (7 cases), lateral malleolus (5 cases), and anteromedial part of leg (2 cases). In Yelmis *et al*., study 10 (17 cases), the site of defect was heel (9 cases, one of them is plantar aspect of the heel), lateral malleolus (3 cases), Achilles tendon and ankle at the same frequency (2 cases for each), and medial malleolus (1 case).

Flap length ranges between 5 and 15 cm, while it's width ranges between 4 and 10 cm. Two of our patients were underwent delay procedure, one of them was a heavy smoker and the other had a big defect of about 9x4 cm (7 years old child), another one of our patients underwent supercharge procedure, to reduce the venous congestion, as the flap had introduced through a long tunnel. This coincide to certain extent with Hasegawa et al. study where the length of flap was between (3 and 13 cm), and the width ranged between (2 and 10 cm). Our study also concurred with Yelmaz *et al*., study, where the flap length ranged between (4 and 15 cm), and the width was between (3 and 12 cm).

Flap carrying pedicle width was 3-4 cm to ensure containing sural nerve, lesser saphenous vein and associated vessels, while those in Hasegawa *et al.*, study was of 2 cm width, and 2-3 cm width of those in Yelmis *et al*., study [13]. The pivot point of our flap was 5-7.5 cm above lateral malleolus to preserve the lower most peroneal perforators, while in both studies of Hasegawa *et al*., [8] and Yelmis *et al*., [13], the pivot point was 5 cm above lateral malleolus.

In our study, 2 flaps (11.7%) showed partial necrosis, one of them showed marginal necrosis due to sever venous congestion, which was underwent trimming and advancement to cover the defect, another one showed distal tip necrosis and sloughing, because the tip had been planned as an acute angle, which caused ischemia to this point, the flap was left to heel by secondary intention, and both cases passed uneventfully. Four other flaps (23.5%) appeared congested for few days, but resolved spontaneously later on, our action was just removing few stitches responsible for tension. Another flap (5.8%) showed wound dehiscence at distal tip, left to heal by secondary intention. Regarding the donor site, 3 cases (17.6%) show hypertrophic scar treated by pressure and local steroid application, but this scar does not appear to affect the leg contour obviously. While in Yelmaz *et a*l., study, the complications were, venous congestion in 2 cases(11.7%) which have been attributed to passage of the pedicle through a subcutaneous tunnel, so they exteriorized the pedicles of the remaining flaps, partial necrosis in 2 cases(11.7%) in whom they excluded the sural nerve and hypertrophic scar in 2 patients. While in Hasegawa et al. study, the complication was oedema of flap in one case (4.7%), and tip necrosis in one flap (4.7%) (Where the flap didn't include the deep fascia), transient venous congestion occurred in many cases but Hasegawa *et al*., didn't mention the exact number of them or the action done to manage the condition. From this comparism, the complication regarding venous congestion in our work is more than those for Yelmis *et al.*, [13] and Hasegawa *et al.*, [8] studies. While regarding partial necrosis, it was equal to Yelmis *et al.*, [13] study and more than that of Hasegawa *et al.*, [8] study, but by comparism the dimensions of the flap in our study which has mean length measured 8.88 cm and mean width 5.76 cm with that of Yelmis *et al*., study which has mean length of 8.11 cm and mean width 6.02 cm and that of Hasegawa *et al.*, [8] study with mean length of 6.52 cm and mean width 4.23 cm, this will show that the size of the flap used in our study is larger than that depicted by Yelmis *et al.*, [13] and Hasegawa *et al.*, studies, so the size of flap play an important role in these complications in addition to the other comorbid conditions as an obesity (in one patient) and frequent surgeries with excessive scar formation in the lower leg due to fractured tibia and malunion in another patient, as both of those patients showed venous congestion of the flap, but the opinion adopted by Yelmis *et al*., about decrease the possibility of venous congestion by exteriorization of the pedicle did not rather concur with our results, as we introduced the pedicle through a tunnel in 6 cases, only 2 of them showed venous congestion, but the matter is to ensure that the width of the tunnel is suitable to the pedicle to pass easily, if it is not wide enough, so it can be expanded by dilatation or traction. Two major advantages of this flap as noted by Hasegawa et al. First, this surgery is easy and quick. The flap can be designed easily, and the operation time

of elevating the flap is short. Second, major arteries are not sacrificed. Therefore, this flap surgery can be performed in a traumatic leg with damaged major arteries [8, 14].

Yilmaz *et al*., described the major advantages of this flap as the relatively large size that can be harvested with little donor-site deformity or morbidity. Dissection of the flap is easy, with no microvascular anastomosis is required. Blood loss during the operation is minimal. If a thin flap is required, the fasciofat flap can be used. If a neurosensorial flap is necessary, the lateral sural cutaneous nerve can be transferred with the flap and coapted to a recipient nerve in the defect to be reconstructed. It is a one-stage procedure unless delaying of flap is required. This flap has a wide arc of rotation on its pedicle at approximately 5 cm superior to the lateral malleolus and is useful for reconstruction of defects on heel, malleoli, ankle, and foot. As this flap is a fasciocutaneous flap, the flap durability is excellent on weight-bearing areas [7, 9].

The main disadvantage of sural neurofasciocutaneous flap is sacrifice of sural nerve with subsequent loss of sensation on lateral aspect of foot, and some complain of numbness. Donor site scar or depression may be considered as unacceptable disadvantages in women. Another disadvantage is bulky flap in obese patient which may mandate a debulking surgery to permit the foot fitting in shoe [15].

CONCLUSIONS

The sural fasciocutaneous flap is a good option in reconstruction of difficult and complex wound in lower leg and foot especially on ankle joint, malleoli, heel, and posterior plantar regions as it showed

- Easy elevation and inset, preclude the need of microsurgical technique, and can be transferred as a single-stage procedure, unless flap delay is depended, so second stage is required.
- Reliable with constant blood supply and the major arteries of leg and foot are not sacrificed.
- Delay procedure can assist in increase the dimensions of the flap to cover relatively large defects.

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Ethical issues

Data were collected in accordance with the World Medical Association declaration of Helsinki 2013– Ethical principles for medical researches involving human subjects. Signed consents were obtained from all patients and the agreement of officaial hospital office were approved.

Conflict of Interest: Authors declared that they have none.

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REFERENCES

1. Sherman R, Isenberg JS. Principles of Soft-Tissue Reconstruction of the Lower Extremity. In Georgiade GS, Riefkohl R, Levin LS. eds., Georgiade Plastic Maxillofacial and Reconstructive Surgery. 3rd edition. Pennsylvania; Lippincott Williams &Wikins; 1997, P. 1138 – 1142.
2. Buluç L, Tosun B. A modified technique for transposition of the reverse sural artery flap. Plastic and reconstructive surgery. 2006 Jun 1; 117(7):2488-92.
3. Attinger CE, Ducic I. Foot and ankle reconstruction. In: Thorne CH, ed., Grabb and Smith plastic surgery. 6th edition. Philadelphia: Lippincott Williams &Wikins; 2007, 689-707.
4. Ahmed SK, Fung BK, Ip WY, Fok M, Chow SP. The versatile reverse flow sural artery neurocutaneous flap: a case series and review of literature. Journal of orthopaedic surgery and research. 2008 Dec; 3(1):15-23
5. Touam C, Rostoucher P, Bhatia A, Oberlin C. Comparative study of two series of distally based fasciocutaneous flaps for coverage of the lower one-fourth of the leg, the ankle, and the foot. Plastic and reconstructive surgery. 2001 Feb;107(2):383-92.
6. Grabb WC, Argenta LC. The lateral calcaneal artery skin flap (the lateral calcaneal artery, lesser saphenous vein, and sural nerve skin flap). Plastic and reconstructive surgery. 1981 Nov; 68(5):723-30.
7. Tang M, Mao Y, Almutairi K, Morris SF. Three-dimensional analysis of perforators of the posterior leg. Plastic and reconstructive surgery. 2009 Jun 1; 123(6):1729-38.
8. Hasegawa M, Torii S, Katoh H, Esaki S. The distally based superficial sural artery flap. Plastic and reconstructive surgery. 1994 Apr; 93(5):1012-20.
9. Kasabian AK, Karp NS. Lower-Extremity Reconstruction. In: Thorne C H, ed., Grabb and Smith plastic surgery. 6th edition. Philadelphia: Lippincott Williams &Wikins; 2007, 676-688.
10. Baumeister SP, Spierer R, Erdmann D, Sweis R, Levin LS, Germann GK. A realistic complication analysis of 70 sural artery flaps in a multimorbid patient group. Plastic and Reconstructive Surgery. 2003 Jul 1; 112(1):129-40..
11. Attinger CE, Ducic I. Foot and Ankle Reconstruction. In: Aston SJ, Beasley RW, Thorne CH, eds., Grabb and Smith plastic surgery. 5th

edition. Philadelphia: Lippincott-Raven; 1997, 1059-1075.
12. Cavadas PC, Bonanad E. Reverse-flow sural island flap in the varicose leg. Plastic and reconstructive surgery. 1996 Oct 1; 98(5):901-2.
13. Yilmaz M, Karatas O, Barutcu A. The distally based superficial sural artery island flap: clinical experiences and modifications. Plastic and reconstructive surgery. 1998 Dec; 102(7):2358-67.
14. Parrett BM, Pribaz JJ, Matros E, Przylecki W, Sampson CE, Orgill DP. Risk analysis for the reverse sural fasciocutaneous flap in distal leg reconstruction. Plastic and reconstructive surgery. 2009 May 1;123(5):1499-504.
15. Mackenzie DJ, Seyfer AE. Reconstructive surgery: lower extremity coverage. Mathes Plastic Surgery. 2nd ed. Philadelphia, PA: Elsevier. 2006.