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Original Research Paper

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DISTAL ONE THIRD LEG AND FOOT DEFECT RECONSTRUCTION WITH PEDICLED REVERSE SURAL ARTERY FASCIOCUTANEOUS FLAP: A COMPREHENSIVE WOUND MANAGEMENT APPROACH

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ABSTRACT

Introduction: To express the versatility of reverse sural artery fasciocutaneous flap used for coverage of difficult wounds in the lower third of the leg and the foot. **Material and Methods:** From January 2017 to April 2022, total 45 pedicled reverse sural artery flaps were performed; out of them 22 flaps were exclusively done for foot reconstructions. All patients were males having varying degrees of skin and soft tissue loss with exposed bone [tibia, calcaneum, metatarsals]. Age group ranged from 7 to 65 years. Perforators were based on the sural artery. **Results:** The flap size ranged from 15x8 cm [120 cm2] to 25x10 cm[250cm2]. Successful coverage with good functional and aesthetic appearance was achieved in all patients. Donor sites were closed with split thickness skin graft in all cases. **Conclusion-** Reverse sural artery fasciocutaneous flap can be considered as a workhorse flap for the reconstruction of moderate to large soft- tissue defects of the lower leg and foot. It is relatively easy to execute, with no special needs for microsurgical instruments and with a low rate of complications and good post-operative results.

KEYWORDS : Distal one third leg, Foot, Reverse Sural-Artery Fasciocutaneous flap[RSAFF], Reconstruction

INTRODUCTION

Soft- tissue reconstruction of the lower one third leg and foot defects have been a challenging task as compare to upper and middle one third leg defects due to paucity of soft -tissue and exposure of tendo-achillis in the lower one third leg. Now-a- days free flaps are considered as ideal option to cover such defects. Before this microsugical era, these wounds were covered by cross-leg flap which was quiet debilitating for the patients.[1,2] Pedicled reverse sural artery flap has emerged as a reliable option for such defects where free flaps are not feasible either due to associated co-morbidities, lack of recipient vessels, surgical expertise or infrastructure. In 1992 Masquelet described the sural artery neurocutaneous flap, which was based on the blood supply of accompanying superficial sural nerve [2]. Since then it is being used with some modifications and it has emerged as a workhorse flap for distal third leg and foot defects. The aim of this article is to highlight the versatility of the reverse sural flap for wound coverage of the lower third of the leg and the foot.

MATERIAL AND METHODS

All patients who underwent reconstruction of distal lower one third of leg and foot defects with a Reverse sural artery flap between 2017-2022 were included in the study. From January 2017 to April 2022, total 45 pedicled reverse sural flaps were performed for different complex soft tissue defects over lower one third of leg and foot; out of them exclusive foot reconstructions were performed in 22 patients (age: 7-65 years). Out of 45 patients,33 were referred by orthopaedic surgeon and 12 were referred by oncosurgeon.

All 45 pedicled reverse sural flaps were harvested by a single plastic surgeon. Review of cases and data analysis was done.

Median follow up was 12 months (range: 6–24 months). These patients had either exposed tibia, ankle joint, calcaneum metatarsals and even distal phalynx of great toe with soft tissue loss over lower third of leg and foot due to different conditions (trauma, Diabetic -foot, chronic osteomyelitis, cancer excision). Surgical delay was done in 10 cases [three stage procedure] and rest 35 cases were performed as two - stage procedure.

Table 1

Patient	Age (Yrs)	Indication of Delayed pedicled reverse sural flap cover (3 stage)	Location of Defect	Flap size (cm)	Stage	Outcome	Comorbidities
1	22	Post road traffic accident (RTA) soft tissue defect	Dorsum of forefoot	10x9	3	Good {flap survived}	Smoker
2	65	Post road traffic accident	Calcaneum and plantar aspect of midfoot	20x10	3	Well settled flap	Tobacco chewer, Uncontrolled Diabetes Mellitus type 2
3	45	Diabetic foot	Planter aspect of Midfoot and Hindfoot	22x9	3	Well settled flap	Diabetes Mellitus type 2,HTN
4	25	RTA	Dorsum of Midfoot	18x10	3	Surgical site infection (managed conservatively), No flap loss	Smoker with peripheral vascular disease
5	30	RTA	Ankle joint	15x10	3	Well settled flap	HTN with peripheral vascular disease
6	46	RTA	Dorsum of Forefoot	15x8	3	Flap healthy	HTN, DM Type 2
7	51	RTA	Dorsum of midfoot	9x7	3	Flap healthy (Delayed recovery with prolonged hospital stay)	Morbidly obese(BMI>40),HTN, DM Type2

8	60	Diabetic foot	Calcaneum and plantar aspect of midfoot	19x11	3	infection at suture line of midfoot flap inset (managed conservatively), no flap loss	Uncontrolled DM type 2(HbA1c >8) with HTN
9	49	Squamous cell carcinoma(SCC) Heel	Midfoot and calcaneum	20x13	3	Flap healthy	Smoker, HTN
10	9	RTA	Great toe and mid-foot	19X8	3	Flap healthy	-

Surgical Technique

Procedure was performed under spinal anaesthesia and patient was placed in either lateral decubitus or prone position. Pre-operative perforators were marked with hand held doppler. About 3-5 perforators were found at an average distance of 5-6 cm proximal to the lateral malleolus. The lowest perforator was found around 5 cm above the lateral malleolus [roughly three finger width] in all cases which was considered as the end point of flap elevation. This is the critical point as it remains the pivot point of the flap as well.

The axis of the flap was centered over the midpoint of popliteal fossa to the midpoint between the lateral malleolus and tendoachilles. The pedicle was at least 5 cm wide in all cases to avoid problems related to venous drainage. Planning in reverse (a template of the defect and flap was made with lint-piece and mock-transfer of the flap) was done and flap was marked. The flap was designed slightly longer than needed in each case. Under tourniquet control, flap elevation was started proximally, skin was incised down to the level of the deep fascia with the 15 no surgical blade. The sural nerve, median superficial sural artery, and lesser saphenous vein were ligated with vicryl 2-0 RB as part of the proximal dissection. This vascular pedicle was included in the flap and the flap elevation was continued in sub-fascial plane distally till the flap could reach the farthest edge of the defect easily or to the proposed pivot point. Flap was inset without any twist in the vascular pedicle and the donor site was closed primarily to the greatest extent, remaining donor-site and exposed vascular pedicle were covered with the split thickness skin graft taken from the opposite thigh. Plaster of paris splint was given to all patients for maintaining limb position and to avoid any pressure over the vascular pedicle in post-operative period. Average operating time was 60 minutes.

Surgical -Delay Technique

Patients requiring coverage over dorsum of foot and great -toe(forefoot), patients with associated comorbidities [Diabetes mellitus, hypertension, ischemic heart disease, peripheral vascular disease and smokers; utilizing the delayed technique and harvesting the skin paddle over an extended time period improves the chances of flap survival. Most proximal portion of the flap was incised and vascular pedicle was ligated under local anaesthesia and the delay period ranged from 7-10 days.

Post -operative course: limb was elevated and stich- line was cleaned with normal saline and Neosporin antibiotic ointment was applied. Initially flap was monitored for any change in colour, temperature and turgor of the tissue. After 3 weeks, pedicle was divided and remaining tissue was inset at its native place. After first stage of surgery, usually patients were discharged on post operative day 5 and they were called for follow up in out- patient department for flap monitoring. Patients were readmitted for the pedicle division and final flap insetting on post-operative day 20(3weeks) and they were discharged on the same day after the surgical procedure was done under local anaesthesia.

In short, following were the three stages:
Stage 1: surgical delay [Not required in every case only needed in cases of suspected decreased vascularity], done under local anaesthesia
Stage 2: flap elevation and wound coverage, done under spinal anaesthesia
Stage 3: vascular pedicle division and final insetting, done under local anaesthesia.

Blood Supply

It is supplied by vasa nervorum along the sural nerve which is accompanied by the lesser saphenous vein. The medial superficial sural artery courses above the fascia before penetrating the fascia at the mid- calf level. The pivot point is about 5 cm above the tip of the lateral malleolus. Flap receives its retrograde arterial flow via septocutaneous perforators coming from the peroneal artery and directly anastomose with the medial superficial sural artery. [7-10,19]

RESULTS

There were no major complications in any patient. Post-operative recovery was uneventful. There was venous congestion in four flaps but that was resolved on its own in post op period. None of the patient required revision surgery.

Sutures were taken out on post-operative day 15 onwards, depending upon the wound-condition.

DISCUSSION

Free flaps are the preferred choice to cover the defects of distal third of the leg but when free flaps are not feasible other options like pedicled muscle flaps [peroneus brevis], fasciocutaneous flaps, adipofascial flaps, perforator flaps [posterior tibial artery, peroneal artery], medial planter artery flap, cross leg flap[life-boat] and reverse sural flap can be considered for complex wound coverage [3-4,11-14,21-23].

In presence of vascular compromise of the affected limb or exposure of dorsum of foot, earlier cross leg flap was being used but now-a- days Delayed reverse sural artery flap has emerged as a good option for such difficult wounds [5,22]. Generally, free flaps are superior to other methods because they allow reconstruction in single stage with well vascularized tissues. However, they require good infra-structure [microscope, micro-instruments, micro-sutures], well-trained surgical team, intensive care unit and prolonged operative time. In any case, goals of the reconstruction are to provide stable soft-tissue coverage, preserve sensation, and patient should be able to walk without assistance in post -op period. As evidenced by recent literature, reverse sural artery fasciocutaneous flap is a reliable option for such defects. The flap is robust enough even for heel and foot wound coverage [20-23].

Anatomical Basis Of Flap

As described by Masquelet et al. [2], the distally based superficial sural artery flap is supplied by a superficial sural artery through a reverse flow, which takes contribution from the septocutaneous perforators of the peroneal artery in the distal part of the leg. In the calf region, sural nerve (SN) is accompanied by the lesser saphenous vein (LSV) which plays an important role in venous drainage of the flap[16,17,19].

On the posterior part of the lower leg, the accompanying artery of the sural nerve is named the sural superficial median artery (SSMA) and the accompanying artery of the lateral cutaneous sural nerve is named the sural superficial lateral artery (SSLA) [8,17].

Anatomical relations between LSV and SN are important for the topography of the flap. LSV originates in the rete venosum

of the lateral malleolus and ascends to the tendoachillis above the deep fascia. On the upper fourth of the calf, it enters the deep fascia and lies in the adipofascial tissues and finally it drains into the popliteal vein. The SN, surrounded by a fascial sheath ascends in the adipofascial tissues above deep fascia, together with the LSV in the lower half of the leg. It enters the deep fascia at the middle point of the calf. In the proximal fourth of the calf, it ascends within the sheath that covers the LSV, usually dipped between the heads of the gastrocnemius muscle, and reaches the tibial nerve in the popliteal fossa[8,17].

Masquelet flap can be considered a venoneurocutaneous flap. In all the cases, the sural nerve was sacrificed and some of patients complained of a slight paresthesia of the lateral aspect of the foot although all of them recovered well[2,17,20-23].

Various nomenclature has been given to this flap. The term "neurocutaneous flap" was proposed by Masquelet while Hasegawa termed it as "distally based superficial sural artery flap [18]. Cavadas and Bonanand called it as "reverse flow sural island flap (RSIF)"[19].

There are several modifications to this flap:

- Reverse sural artery flap with fasciocutaneous pedicle (2 stage reconstruction)
- Reverse sural artery island flap with adipofacial pedicle (1 stage reconstruction)
- Delayed reverse sural artery flap with fasciocutaneous pedicle (3 stage reconstruction; reserved for compromised vascularity)

Islanded flap can be performed as a single stage procedure but it requires more meticulous surgical dissection and time as compare to the conventional one. Chances of venous congestion and distal flap necrosis also get increased as the flap is islanded and the pedicle width is decreased [10,19]. Supercharging of the reverse sural flap to reduce venous congestion and edema and to increase the reliability of the flap has been well documented in the literature but it requires microvascular expertise [6].

Raising a reverse sural island flap is a much easier effort than raising the peroneal or anterior tibial flaps, the latter sacrifice the deeper arteries and veins, hence less invasive because the major vessels are left undisturbed. Furthermore, even in cases where complications like distal flap necrosis or venous congestion were present, the adipofascial layer of the flap survived very well, enabling covering of the remaining wound. So, these flaps can be considered safer than the peroneal and the anterior tibial artery flaps [10,16-19].

Literature supports that anastomosis occur mostly at a level 5cm above the lateral malleolus [2, 16-21]. The RSIF is often at risk for venous congestion, there are studies to confirm that the selection of the cases must be very careful when applying a RSIF, to yield better results and less complication rate. Disadvantages of the flap are very few, sensory changes on the lateral aspect of the foot; bulkiness of the flap when it comes to be applied on the foot, this was corrected in six of our cases by debulking 12 months after the application of the flap[10,19].

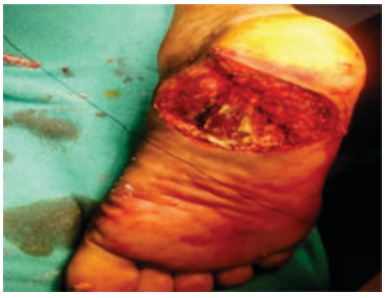

Figure 1a. Post Cancer Resection Defect

Figure 1b. Planning And Marking Of The Flap

Figure 1c. Intraoprative View After Insetting Of Reverse Sural Artery Fasciocutaneous Flap(RSAFF)

Figure 1d. Rsaff On Post-operative Day 15 After Suture Removal (Follow-up OPD)

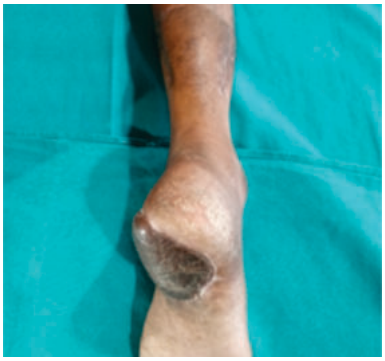

Figure 1e. Well Settled Flap After Pedicle Detachment And Insetting

Figure 1f. Comparison From The Opposite Healthy Limb

Figure1g. Well Settled Flap Ready To Bear The Body Weight Without Any Secondary Procedure(Debulking)

Figure1a-g. Reverse Sural Artery Fasciocutaneous Flap For Midfoot Plantar Reconstruction

Figure2a. Intra-operative View Showing Pedicled Reverse Sural Artery Fasciocutaneous Flap For Heel Reconstruction

Figure2b. Well Settled Flap After Pedicle Division And Insetting (Post-operative Day 21)

Figure2a-b. Reverse Sural Artery Fasciocutaneous Flap For Heel Reconstruction In A Known Case Of Type 2 Diabetes Mellitus And Hypertension (Diabetic Foot)

CONCLUSION

Reverse sural artery facsiocutaneous flap is a very useful tool for the reconstruction of complex defects of the lower leg and foot, easy to be raised with minimal blood loss moreover preservation of the major vessels of the lower limbs is possible and with a very low rate of failure and complications. It is more convenient and pocket friendly for the patients as compare to cross-leg flaps and free flaps.

Conflict of Interest – None

Informed Consent – obtained from all patients and from parents in cases of children.

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