Journal of Prestieesci in Surgery
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PrestieeSci
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Volume 01, Issue 01

Reverse Sural Flap for Post Traumatic Soft-Tissue Defects of Leg Ankle and Heel – Our Experience

-Abhishek Sharma

Corresponding Author: Abhishek Sharma, MS. MCh., Senior Consultant, Director and Head Dept of Plastic Surgery, All Is Well Multispecialty Hospital Burhanpur, Madhya Pradesh, India.
Email: drabhisheksharma7@gmail.com

Abstract

Treatment and management of severe wound defects related to leg and ankle injury are sometime very challenging. Microsurgical repair is one of the best options. However, it is bit difficult and hectic to transfer free tissue from other body parts due to donor site morbidity, longer duration, bulky tissue, recipient vessel risks, sophisticated expertise, and high costs of the equipment and treatment. Meanwhile, the reverse Sural flap has been considered as the ultimate method of tissue restoration. This study was conducted in 36 patients who were admitted at our Centre in the department of Plastic Surgery. The patients had multiple ankle and leg tissue defects. After the diagnosis our plan involved surgical debridement, tendon repair if involved, and reverse sural flap rotation. Despite the difficulties in working environment and advanced learning experience, our patients fully recovered within 3 weeks. Proving that reverse sural flap is one of the few available options in the protection of vital structures such as tendons, nerves, bones, in the distal areas of the leg, ankle, and foot especially when we lack a strong microsurgery team and equipment.

Keywords: Case study • Distal Leg and Ankle Reconstruction • Reverse Sural Flap

Introduction

The medial calf integument is a potential donor site for a free flap based on musculocutaneous branches of the medial sural artery, was first described by Taylor and Daniel, following cadaver investigation in 1981 [1]. Other description given by Pontén that Fasciocutaneous Sural Flap as an excellent reconstructive option for lower extremity defect, particularly around the knee [2]. Couple of years later Donski and Fogdestram presented the distally based Fasciocutaneous Sural Flap [3]. Montegut and Allen who explained the Sural flap as a viable alternative for the gastrocnemius Myocutaneous Flap [4]. At the level of the lower leg sural flap proved a considerable versatility from the knee to the ankle and heel as well as for other anatomical regions. The most common usage of the flap is for the distal-third leg defects.

Surgical anatomy

The sural branches of the peroneal artery and the posterior tibial artery give the main arterial supply of the medial calf. The medial and lateral sural arteries arise from the popliteal artery above the tibiofemoral join. Sometimes the popliteal artery gives only one common sural artery that subsequently divides into medial and lateral branches. It is very rare to see none or more than one medial sural artery [5,6]. The medial superficial sural artery runs above the fascia sometimes accompanying the medial sural cutaneous nerve before entering the fascia at the mid-calf level [7]. At the level of Tibio-femoral join line the sural arteries accompany with a motor branch of the tibial nerve enter the deep surface of medial and lateral heads of the gastrocnemius muscle. Cutaneous branches (medial and lateral superficial sural arteries) supply the skin of the posterior leg [8]. The short saphenous vein provides the venous drainage of the region. It runs along the midline of the calf accompanying the median sural artery between two heads of gastrocnemius, penetrates the fascia and enters into the popliteal vein in the mid popliteal fossa. The Medial sural nerve is surrounded by plexus of small vessels which innervates the calf and the lesser saphenous vein [9,7]. Superficially, the sural nerve, the sural artery or arteries and the short saphenous vein are the structures supplying the sural flap [10,11]. The calf perforators mainly originate from medial sural arteries and peroneal artery. The medial sural artery gives rise at least one large perforator while the lateral sural artery perforators are inconsistent in location or absent [12,13]. On average, there are 4 perforators, of 0.2 mm-0.5 mm in diameter, which are Musculo-fasciocutaneous between the suprafascial sural neurovascular axis and the deep gastrocnemius muscle [14]. The perforators tend to course obliquely after leaving the heads of gastrocnemius, before piercing the deep fascia [12]. When the superficial sural vessels are greater than 1mm in diameter, the musculocutaneous perforators are insignificant. The results of the anatomical study on 20 lower limbs of human cadavers carried out by the authors of the present article [6], showed an average of 1.9 muscular perforating vessels with an outer diameter between 0.4-1.1 mm originating from the medial sural artery. Each perforator presented a Vena Comittant of 0.6-1.1 mm in diameter. The perforant caliber proved to be inversely proportional to the number of vessels: in the specimen containing 5 perforant vessels, the caliber varied from 0.4 to 0.6 mm while in those presenting 1-2 perforants, the diameter was of 0.9-1.1 mm. The closer to the line between the popliteal fold and the medial malleolus the perforants are situated, the larger both the diameter and the length of the vascular pedicle are. 90% of the perforators have a pedicle that is large enough to facilitate any requisite microanastomosess. All these results are very similar to the conclusions of the previous studies developed internationally [12-16].

Designing and Surgical technique

Situated between the two heads of the gastrocnemius muscle over the midline raphe and between the popliteal fossa and the mid leg, Cormack and Lamberty described that sural flap is the longest fasciocutaneous flap of the leg [17]. This flap can safely extend three quarters of the leg proximally [18]. Flap planning implies the thorough identification and selection of perforators overlying the lateral malleolus [12]. The Pencil Doppler probe is most helpful in identifying the perforators. For flap dissection, prone position is ideal position. The flap is marked between the two gastrocnemius muscle bodies, on the skin in the form of an ellipse centered on the raphe whose projection is visible on the posterior aspect of the leg. The incision given on the lateral and superior borders of the flap and continues in the subfascial plane until the nerve is identified in the median raphe. Then the incision continues on the other boundaries of the flap till the subfascial dissection with the ligation of all the perforators from the gastrocnemius belly and the inclusion of the septum between the muscles in the flap. The sural nerve is attached to the fascia at the superior border of the flap.

Applications in clinical practice

The sural flap proved a considerable and versatile flap at the level of the lower leg from the heel ankle to knee as well as for other anatomical regions. The flap mostly used for the distal-third defects of the leg. The reverse sural flap allows the soft tissue reconstruction without the need for microsurgery. Flap does not sacrifice any of the three major arteries to the distal extremity. It

has various indications for difficult defects even in the most obese or vascular compromised patients [8,19,20]. The most important advantages of using this flap are sparing the major artery, the relatively simple dissection and the low donor site morbidity.

On the other hand, some critical aspects also to be considered. The most important one is venous congestions and flap ischemia. Harvesting the pedicle with 3 cm of tissue on either side and with the overlying skin intact supercharging [21], flap delay, are some procedures that help overcoming this complication [22,5,18,23,24]. Most authors mention the unpleasant scar at the donor site, mainly if the closure needs a skin graft. Because sural nerve is harvested with the flap, so loss of sensibility on the lateral aspect of the foot might cause certain problems [7].

Material and Methods

We present a prospective case series study of the sural fasciocutaneous flap carried out in our hospital between June 2021 to Dec 2022. This case series study comprised thirty-six patients, thirty-five man and one woman with an average age of 33 years and with a mean follow-up duration of 10 months (6-22 months). All patients presented with a history of road traffic accident distal part of leg or heel pad of the foot and large soft-tissue defects; in twenty-eight patients had defects of the tibial bone due to crushing injury. Out of twenty-eight 13 patients had medial malleolar defect, 7 had heal defects. Eight had defect over lateral malleolus.

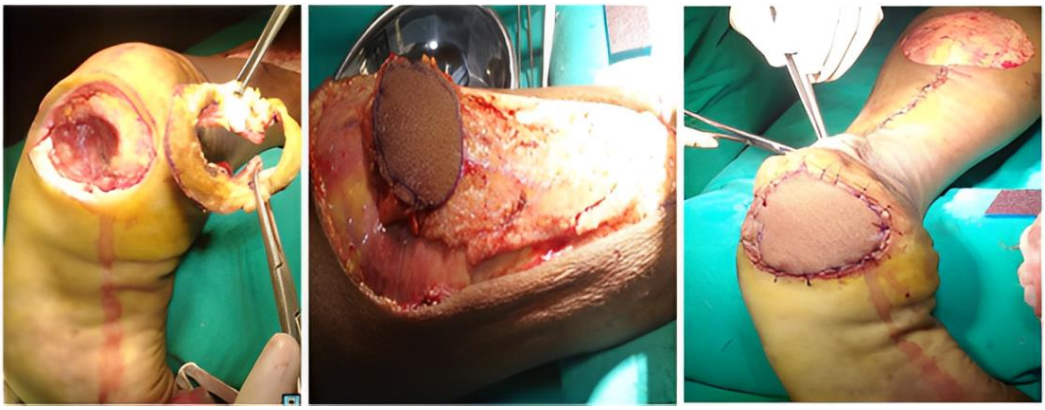

Figure 1. Reverse Sural Flap for heal defect.

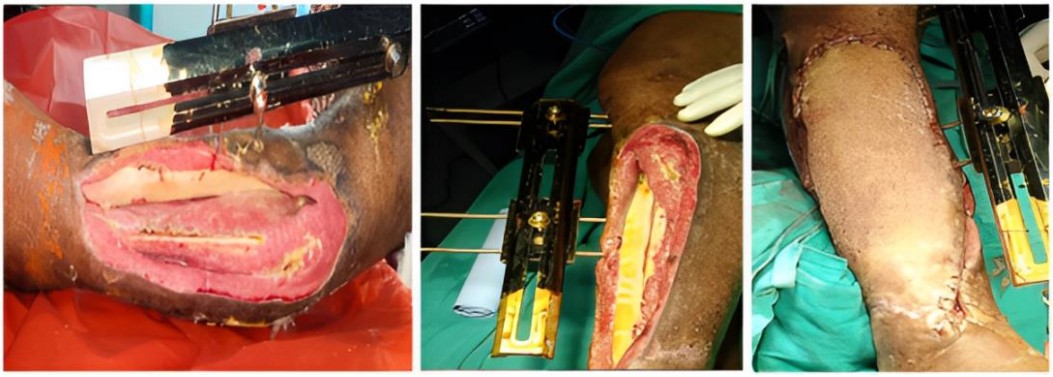

Figure 2. Reverse Sural Flap for exposed leg bones.

The remaining eight patients had bone exposed soft-tissue defects in the distal of the leg. This reverse fasciocutaneous flap was planned based on blood supply provided from perforators of the peroneal artery and perforators from the posterior tibial artery,

venocutaneous perforators from the short saphenous vein, and neuro-cutaneous perforators from the sural nerve [7,12]. The classical blood supply of the reverse sural flap is provided by septo-cutaneous perforators arising from the peroneal artery. Each leg has three to six perforators located approximately 4 cms – 7 cms proximal to the lateral malleolus. Patient aged above 45 years, severe leg trauma, tobacco chewer, smoker with peripheral vascular disease, chronic venous insufficiency where vascularity of distal portion of flap was doubtful and long flap needed were selected for flap delay procedure. Delay was performed a week before the final flap raising procedure, distal portion of flap with random supply (5-10 cm) was cut up to dermis completely and re stitched it again during delay. Other co-morbidities like diabetes mellitus, hypertension, addressed and managed accordingly with help of medicine department to minimize healing issues and future complications. We gave priorityto reverse sural flap in these patients with co-morbidity because peripheral vascular disease is a generalized disease affecting through body same complication can occur with free flap and with venous insufficiency also. Patient with deep vein thrombosis and venous insufficiency were excluded from study.

Outcome

In our study we reported 22% complication rates in a high-risk patient population, including patients with peripheral vascular disease, diabetes mellitus, acute and chronic venous insufficiency. All the defects were covered successfully, without any major complications. Usually, only a minor marginal loss of tip of flap was observed, which was easily solved with a secondary healing. In most flaps venous congestion cleared in a few days. In three patients, a flap delay procedure was used and a positive impact was observed on the flap viability. There were no complaints related to the sacrifice of the sural nerve like numbness or paraesthesia on the lateral border of the foot. It did not create major problems and disappeared within couple of months. The functional result was very good in all the patients, while the aesthetic appearance was acceptable even in female patient.

Discussion

Venous congestion leading to partial or complete flap loss is the most feared complication. However similar risk factors associated with microsurgery lead to higher complication rates in lower extremity reconstruction with free tissue transfer as well. Leg elevation, insertion of a intravenous catheter in the proximal stump of the short saphenous vein, or venous supercharging may overcome this problem. A flap delay procedure has been recommended by some authors to prevent these complications [22,5,26-33]. A flap delay implies redirecting the blood flow either by transecting the vessel or by cutting the lateral edges of the skin island [18,23].

Conclusion

The reverse sural flap is very useful in the foot, ankle and lower leg soft tissues defect reconstruction whenever microsurgical free transfer facility or expertise for microsurgery not available. Drawbacks of this flap are the volume of the flap, which is sometimes not suited for the reconstructed area, and thus the aesthetic appearance, and an additional unsightly donor site defect, but the properties related with mechanics and the integrity are very good. Venous congestion leading to partial or complete flap loss, is most common complication so it would not be an ideal in patients with obvious acute or chronic venous stasis. The reverse sural island flap should no longer be considered as a flap of secondary choice to free tissue transfer, but it is equally valuable alternative for small and midsized defects around the ankle and heel.

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