

## Neuro Sural Flap Review of the Literature

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### Abstract

### Original Research Article

Reconstruction of loss of substance of the lower third of the leg, the heel and the forefoot is a real problem. New knowledge of the cutaneous vascularization, emanating from the neurovascular axes, has led to the discovery of new cutaneous flaps, including the sural neurocutaneous flap. It is a good alternative for the coverage of moderate losses of substance of the heel and the lower third of the leg. The aim of this retrospective study is to report our experience and to evaluate the reliability of the weaned sural neurocutaneous flap in the coverage of the lower third of the leg. This study took place in the Department of Plastic, Reconstructive and Burn Surgery of Al Kortobi Hospital in Tangier, Morocco. This is a retrospective study including six patients with skin loss of the lower third of the leg and in whom coverage was performed by sural neuro cutaneous flap, the study period was between March 2021 and June 2022. Six patients were included in this study, there were 3 males and 3 females, their age ranged from 19 to 60 years with an average age of 40 years. In the series studied, the origin of the loss of substance was predominantly tumoral (2 cases of squamous cell carcinoma and 1 case of synovial sarcoma) and post-traumatic (2 cases). The location of the loss of substance is predominantly on the right side compared to the left side. Their location is distributed as follows: the heel (1 case), the lower 1/3 of the leg (2 cases), the dorsal aspect of the foot (1 case), the lateral malleolus (1 case) and the medial malleolus (1 case). There are many techniques for the management of loss of substance of the lower limb: directed healing, pedicled flap, or even free flap. Reconstruction of loss of substance of the lower limb by pedicled flaps is now a good therapeutic choice. The sural neurocutaneous flap is recognized as a flap whose dissection is technically uncomplicated and which makes it possible to cover significant loss of substance in the lower limb.

**Keywords:** Neurocutaneous sural flap - Loss of substance - Lower leg – Scar – Cutaneous laxity – Pedicled.

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## INTRODUCTION

The healing of substance loss (SL) around the ankle is difficult. It poses three problems: the precarious vascularity of the region, the limited amount of soft tissue, and the frequency of underlying lesions [1]. The sural fasciocutaneous flap allows coverage of these losses of substance (LOS) [2, 3].

Fasciocutaneous flaps were first described by Ponten in 1981 [4]. The sural neurocutaneous flap was described by Donski and Fogdestam in 1983 [5]. In 1991, the work of Masquelet provided an anatomical and surgical description of this flap [2]. The sural nerve enters the groove defined by the head of the gastrocnemius muscles [6, 7]. Its distal part then travels

down and laterally to the lateral malleolar region [7, 8]. The vascularization of the sural flap is based on a retrograde flow [9, 10].

Venous drainage is by retrograde flow forcing the valves of the lateral saphenous vein [11, 12]. It can be lifted fasciocutaneously, fascio-subcutaneously or with part of the gastrocnemius muscles [13, 14]. Some complications have been reported, such as flap necrosis, aesthetic sequelae, and sensory disorders [3, 4].

The aim of this retrospective study is to report our experience and to evaluate the reliability of the weaned sural neurocutaneous flap in the coverage of the lower third of the leg.

## PATIENTS AND METHODS

This study took place in the Department of Plastic, Reconstructive and Burn Surgery of the Al Kortobi Hospital in Tangier, Morocco.

It is a retrospective study including six patients with skin loss of substance of the lower third of the leg and in whom coverage was performed by sural neurocutaneous flap, the study period was between March 2021 and June 2022.

An operating form was developed including epidemiological and pathological data of the field,

	Gender	Age	Medical history	Etiology	Located in	Local condition	Complications
Case 1	Male	56	Smoking	squamous cell carcinoma	Heel	Clean	-
Case 2	Female	22	-	Synovial Sarcoma	lateral malleolus	Clean	-
Case 3	Male	19	-	Post traumatic	lower third of the leg	Clean	-
Case 4	female	60	Diabetic	squamous cell carcinoma	medial malleolus	Clean	-
Case 5	male	45	-	Post traumatic	lower third of the leg	Clean	-
Case 6	Female	21	-	Post traumatic	medial malleolus	Clean	-

In the series studied, the origin of the loss of substance was predominantly traumatic incidents (3 cases) and tumor pathologies (2 cases of squamous cell carcinoma and 1 case of synovial sarcoma).

The site of substance loss is predominantly on the right side compared to the left side. Their location is distributed as follows: the heel (1 case), the lower 1/3 of the leg (2 cases), the dorsal aspect of the foot (1 case), the lateral malleolus (1 case) and the medial malleolus (1 case).

### Case Report

A 55-year-old patient with a squamous cell carcinoma of the right heel evolving for 1 year. We proceeded to a wide resection with delayed reconstruction after histological results (15 days) by a neurocutaneous flap with external distal pedicle.



**Figure 1: Squamous cell carcinoma of the heel**

etiologies of skin loss of substance and time between tissue loss and coverage. All of our patients were suitable for coverage with a sural flap, given that the sensitivity of the external aspect of the homolateral foot was preserved and the integrity of the posterior aspect of the leg was maintained.

## RESULTS

Six patients were included in this study, there were 3 males and 3 females, their age ranged from 19 to 60 years with a mean age of 40 years.



**Figure 2: Loss of substance in the heel**



**Figure 3: Flap placement**



**Figure 4: Good flap integration 30 days post-op**

### Case Report

A 22-year-old female patient with a synovial sarcoma in the right lateral malleolus that had been evolving for 6 months underwent excision with deferred reconstruction after histological result by a neurosural flap.



**Figure 5: Coverage by a neurosural flap of the loss of substance after tumoral removal**



**Figure 6: Good flap integration 30 days post-op**

### DISCUSSION

There are several techniques for the management of lower limb defects: directed healing, pedicled flap, and even free flap. As demonstrated by Chesnier *et al.*, [13], reconstruction of lower limb defects using pedicled flaps is nowadays a good therapeutic choice. Since its description in 1992 by

Masquelet [14], the sural neurocutaneous flap has been recognized as a flap whose dissection is technically uncomplicated and which allows the coverage of important substance losses in the lower limb. Numerous technical modifications have been developed in recent years to reduce the failure rate and to increase the length of its pedicle: anastomosis of the sural vein and a vein of the recipient site to improve venous return flow [15], and a distal pedicle sural flap with a pivot point located at the retromalleolar groove [16].

This flap is very useful in traumatology of the lower limb at the level of the distal quarter of the limb, the ankle, and even the foot [17], but also in oncology to repair a loss of substance secondary to carcinological excision surgery [18].

Venous drainage of the sural neurocutaneous flap is the main complication encountered in the literature. It has been demonstrated that venous drainage of this flap is achieved by connecting the fascial network and the concomitant veins of the saphenous vein [19,20]. The wider the pedicle, the better the venous drainage. Therefore, in many cases, the skin paddle must be large and the donor site cannot be closed directly. The scarring that is already significant due to the calf scar is further increased by the donor site of the skin to be grafted.

### Surgical Technique

The patient is positioned in the prone position with a tourniquet at the root of the limb. The first step is the preparation of the site to receive the flap: by trimming, debridement, careful hemostasis and cleaning with serum. The axis of the sural nerve with the vascular axis is located at the midline of the calf. The pivot point is located 5 cm above the lateral malleolus in adults and 4 cm in children. The size of the flap is based on a previously prepared template specifying the dimensions of the loss of substance. The limits of the flap to be harvested are drawn at the level of the calf without exceeding a line located four fingerbreadths from the popliteal fossa. At this point, the upper hemi-circumference of the flap is incised down to the fascia, exposing the sural pedicle, which can be easily identified. Nerve, vein and artery are ligated proximally but remain intimately attached to the flap. The flap is raised including the neurovascular axis with its cellulosic atmosphere. The flap is lifted with the muscle fascia from proximal to distal to the pivot point.

A skin trench is made to allow the passage of the fascial-subcutaneous rail. The tourniquet is released before the flap is rotated, and perfect hemostasis by ligation is ensured. Sometimes, a subcutaneous tunnel is made for the passage of the flap to the medial and anterior part of the ankle. However, it must be wide enough to avoid strangulation of the flap. The flap fills the SDB and is fixed with semi-submerged stitches without drainage.



A semi-occlusive dressing is applied, based on vaselined tulle and fenestrated opposite the flap. The donor site is either sutured or grafted with a total skin, most often deferred. After the operation, the limb must be immobilized and must not rest on the flap or its pedicle under any circumstances. The patient remains bedridden for three days; the limb is elevated to help venous return. Walking is allowed from the fourth day without support.



**Figure 7: Drawing and removal of the flap. Insofar as the skin paddle can be positioned on the junction positioned on the junction of the muscular chiefs**



**Figure 8: Placement of the flap at the heel**

#### Advantages of the technique

The technique described here allows us to harvest a wide pedicle, which results in a better venous return and consequently an increase in the success of the flap [21] without increasing the scarring. By avoiding harvesting a thin or thick skin graft, we also decrease the risk of hypertrophic or keloid scarring at the skin harvesting site. Grafting at the dermatome is painful and healing is long, unsightly and sometimes a source of concern for our patients. At the same time, this device allows us to reduce the operating time by avoiding the time required to take the graft and the draping of a region other than the leg. The aesthetic interest is twofold because the grafted skin at the donor site has the same structure and coloring as the rest of the skin of the leg. As the resected skin flap is the same size as the remaining skin flap, we have never had any problems with closure as the skin laxity in the calf has generally been good in our experience. It has the same advantages as all distal pedicle sural neurocutaneous

Anticoagulation in an iso-coagulant dose is prescribed. Support is prohibited until the flap has healed. We recommend elastic compression after healing, to improve tissue integration of the flap.

All our patients were followed up until complete healing, then at three months, six months, and one year, to evaluate the healing time, the aesthetic quality of the flap, and sensory disturbances.

flaps, i.e. a simple technique without vascular sacrifice, allowing coverage of the distal third of the leg, the ankle and the dorsal aspect of the foot.

In the series that we studied, the lesions mainly concerned the lower third of the leg and the ankle, but according to the authors, the flap is just as effective for covering the foot [22]. Reconstruction of the heel is a recognized indication, but, as Rajacié [25] and Grant [28] point out, the sural flap should be considered more as a variant than the technique of choice for reconstruction of the skin texture bearing zone, and the resulting conflict between the edges of the flap and the sole of the foot often results in hyperkeratosis that alters the results. The sural flap is well adapted to cover ankle substance losses, but the length of its pedicle may be insufficient for coverage of the forefoot [28], an area that remains inaccessible to a standard neurocutaneous flap [25]. Oberlin *et al* [28] have proposed technical modifications that widen the arc of rotation of the flap, which can thus reach the metatarsophalangeal joints.

The size of the defect varies greatly in the different series. It depends on the mechanism of the loss of substance.

In the series by Yildirim [26], where the etiologies were dominated by traumatic loss of substance (electrical burns), the surface area of the defect was very large (175 cm<sup>2</sup>). In the Isenberg series, where all the skin lesions are chronic (ischemic lesions and skin ulcers), the surface area of the defect is relatively small (32 cm<sup>2</sup>). The neurocutaneous flap can reach a large size and cover up to 180 cm<sup>2</sup> [25, 29]. It can be cut in the popliteal fossa [25, 29], but at the risk

of distal suffering, since a large part of it is vascularized at random [29, 30].

The initial lesion and the flap being made varies in the different series. In the series by Vergara-

Amador [22], it is 1 to 2 weeks. This is due to the etiologies, which in this study are represented by trauma and tumor pathologies.

Authors	Success rate	Complications
Vergara-Amador[20]	100%	-superficial necrosis of the flap. -marginal necrosis due to venous congestion. - Positive evolution
Isenberg	100%	-no
Yildirim <i>et al.</i> , [64]	86%	-partial necrosis of the flap
Rasti [21]	100%	-marginal necrosis evolving favorably
V. Pinsolle <i>et al.</i> , [19]	100%	-no.
Voche [66]	85%	- marginal necrosis due to venous congestion. -venous distress.
Zhu [67]	90%	-loss of distal part of the flap
Notre série	100%	- positive evolution

The success of the sural neurocutaneous flap is evident from the success rates in the various series and in our own.

It is a reliable technique even in patients with vascular disorders and/or neuropathies such as can be generated by diabetes, 'the modifications of the microcirculation require an adaptation of the operative technique.

No patient complained of sensory disturbances secondary to the sacrifice of the sural nerve, which encouraged us to avoid the use of nerve-sparing techniques, which are more difficult to dissect with an increased risk of injury to the pedicle.

In most patients with a post-traumatic history, the skin in the lower third of the leg is often atrophic, adherent and/or scarred. In these cases, subcutaneous detachment can be dangerous due to the risk of pedicle compression and potential necrosis of the skin bridge [23, 24, 31]. Using a temporary external pedicle may be an alternative for these patients; although this procedure requires secondary weaning of the pedicle and may complicate the postoperative course in terms of care, it has the advantage of sparing the skin in the distal third of the leg.

The most recurrent complications are partial or total necrosis of the flap, and venous congestion due to poor drainage of the flap [22, 26].

It has been shown that the drainage of such flaps is in fact mainly performed by the concomitant veins of the saphenous vein and their connection with the fascial network. Consequently, the wider the pedicle, the better the venous drainage. A reasonable ratio between the size of the skin paddle and the width of the pedicle must always be respected.

Distal marginal necrosis, which is a consequence of venous congestion, most often evolves into spontaneous healing.

## CONCLUSION

The sural flap is used to cover the loss of substance of the ankle and the lower half of the leg. It is suitable for all ages with multiple indications, in emergencies or to treat chronic pathologies or even tumors. It is not technically demanding and represents a reliable alternative to muscle and fascial flaps of the leg.

The vascular reliability and the absence of major functional or aesthetic after-effects are all reasons why it is preferred to other flaps.

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