

Reconstruction Of Lower Limb Wounds With Reverse Sural Fasciocutaneous Flap

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Abstract:

Background: The lower limbs pose challenges for reconstruction in cases of complex injuries due to less distensible skin and scant subcutaneous tissue. Satisfactory muscular flaps are limited to the proximal two-thirds of the leg, while graft use is constrained. The sural flap, with its diverse sources of nourishment, provides a viable alternative, particularly for treating complex wounds in the distal region of the legs and feet without microsurgery. This study aims to provide a theoretical review and report the experience of the plastic surgery department at Hospital de Base Dr. Ary Pinheiro with the use of the reverse sural flap in treating wounds at the distal end of the lower limb, after simpler reconstruction options have been exhausted.

Materials and Methods: Patients were selected from the hospital's orthopedic service. The procedure involved wound cleansing, lesion measurement to determine the length of the reverse sural flap pedicle, and flap dissection including the deep fascia, lesser saphenous vein, and medial sural nerve. Closure of the donor area and flap transposition were performed without tourniquets. In specific cases, a second surgical stage was performed for pedicle release with a minimum interval of three weeks. Additional measures were taken for patients with pre-existing medical conditions.

Results: The study included seven reverse sural flaps in male patients with lesions mainly in the distal part of the leg, ankle, and calcaneus, including bone exposure, tendon exposure, or orthopedic material. Some complications, such as partial necrosis, arose, especially in patients with underlying medical conditions, requiring interventions such as pedicle release to ensure flap viability. Despite some aesthetic concerns, most patients reported satisfactory results.

Conclusion: The reverse sural flap is an effective and versatile alternative for treating injuries in the distal third of the leg and ankle, offering comparable or superior results to microsurgical procedures, with relatively simple applicability and reduced surgical time. Its use should be disseminated and improved to better meet the needs of the population, including in areas with bone infection.

Key Word: Surgery, Plastic; Surgical Flaps; Lower Extremity; Plastic Surgery Procedures; Sural Nerve.

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I. Introduction

The lower limbs present specific characteristics that limit reconstruction options in cases of complex or extensive injuries, posing a challenge for surgeons.¹ In these areas, the skin has less distensibility, scant subcutaneous tissue, and limited muscular tissue interposition, making it easier for noble structures such as bones and tendons to be exposed when injured.^{2,3,4} These particularities greatly reduce the possibilities of local flaps. Satisfactory muscular flaps are limited to the proximal two-thirds of the leg.⁵ The use of grafts is limited by poor wound granulation with a scant vascular bed and eventual exposure of noble tissues. Crossed flaps require prolonged immobilization, making patient acceptance difficult. With these local restrictions, free microsurgical flap would be the preferred choice as a treatment option, but lack of human and material resources limits its use.³

In 1981, Pontén's studies made the use of fasciocutaneous flaps a viable alternative to microsurgical flaps for treating injuries in both upper and lower limbs.⁶ In 1983, Donski and Fogdestan described a distally based fasciocutaneous flap based on perforators of the fibular artery to cover a calcaneal tendon. However, it was in 1992 that Masquelet et al. detailed the principles of sural neurocutaneous flap vascularization for treating soft tissue wounds in the lower third of the leg.⁷

The sural flap behaves as an axial flap and has three sources of nourishment: the vascular plexus of the deep fascia, the superficial medial sural artery (accompanying the medial sural nerve), and the arteries accompanying the lesser saphenous vein, which is responsible for venous return.^{1,2}

Based on the reconstructive ladder, the reverse sural flap emerges as an option for reconstruction earlier than free microsurgery.⁴ The reverse sural flow flap is one of the few options, without microsurgery, for treating complex wounds in the distal region of legs and feet.²

The aim of this study is to conduct a theoretical review and present the experience of the plastic surgery department at Hospital de Base Dr. Ary Pinheiro with the use of the reverse sural flap for treating wounds at the distal end of the lower limb when simpler reconstruction options have been exhausted.

II. Material And Methods

Patients were recruited from the institution's orthopedic service between november 2023 and february 2024. The procedure began with wound cleansing. Measurements of the lesion and its distance from the flap and pivot point (5 cm above the lateral malleolar line) were taken to determine the pedicle length. These measurements were transferred to the posterior region of the leg, using a midline between the medial and lateral portions of the gastrocnemius muscle as a reference determined by palpation. An incision was made at the upper edge, and subcutaneous tissue was dissected in a beveled and ascending manner, leaving a fasciocutaneous border larger than the skin portion. The lesser saphenous vein (medial to the nerve) and the medial sural nerve were isolated, ligated, and sectioned. It was observed that, in the proximal portion of the leg, the vein is located in the suprafascial plane and the nerve in the subfascial plane; and in the middle third, both are suprafascial. The fascia was fixed to the skin to prevent detachment. Flap dissection continued, always including deep fascia, lesser saphenous vein, and medial sural nerve, shaping it to keep these structures in their midline, maintaining a skin strip approximately 2 cm wide in its longitudinal axis², until reaching its lower limit, where sural branches of the fibular artery are concentrated. Donor area closure was performed with primary suturing when possible or partial skin grafting; flap transposition and fixation followed.³

Surgeries were performed without the use of tourniquets. When necessary, a second surgical stage was performed for pedicle release, occurring at least three weeks after the initial procedure. No prior autonomization technique was performed, but it is feasible for wounds suspected of partial local vascular compromise or associated with pre-existing conditions such as hypertension and diabetes.



Figure 1-9: Wound with exposure of orthopedic synthetic material; Retail planning; Dissection and isolation of the small saphenous vein. Released Retail; Flap fixed to wound; Primary closure of the donor area; 19th PO

III. Results

In this study, seven reverse sural flaps were performed, all in male patients. The lesions were located in the distal part of the leg in four cases, ankle in two cases, and calcaneus in one case; four of them had bone exposure, one had tendon exposure, and two had exposure of orthopedic synthesis material. Three cases developed partial necrosis of the distal extremity, requiring debridement (two of them on the 9th and one on 14th, postoperative days) and flap refixation, without compromising the result. In one of these cases, the patient had severe schizophrenia and osteomyelitis with minimal bed positioning adjustment, relying on the pedicle, which contributed to distal necrosis; and in the other two cases, patients had chronic osteomyelitis. Pedicle release was necessary in four cases, and in one case, an incision was made in the skin and subcutaneous tissue medial to the pivot point for pedicle accommodation; another case awaits autonomization for subsequent release. At the end of treatment, five patients considered the result excellent, one disapproved of the flap.

Table no 1: Patients undergoing wound reconstruction with reverse sural fasciocutaneous flap.

Patient	Sex	Age	Mechanism	Location	Wound	Complications	Comorbidities
1	Male	29	Automobile accident	Distal third of the leg	Bone exposure	Partial necrosis	Osteomyelitis
2	Male	49	Automobile accident	Ankle	Exposure of orthopedic material	-	-
3	Male	58	Fall from height	Distal third of the leg	Bone exposure	Partial necrosis	Severe schizophrenia Osteomyelitis
4	Male	18	Automobile accident	Distal third of the leg	Exposure of orthopedic material	-	-
5	Male	11	Septic arthritis	Ankle	Tendon exposure	-	-
6	Male	13	Septic arthritis	Calcaneus	Bone exposure	-	-
7	Male	64	Gunshot wound	Distal third of the leg	Bone exposure	Partial necrosis	Osteomyelitis

IV. Discussion

Defects in the distal lower extremity, ankle, heel, and foot pose challenges for reconstructive surgeons due to anatomical peculiarities such as skin elasticity, poor circulation, reduced subcutaneous tissue, and bony prominences.⁴ The free microsurgical flap would be the most formal indication, but it is difficult to perform and unavailable in most centers. The reverse sural flap has proven to be an extremely viable alternative, with easier applicability, shorter surgical time, low morbidity, and excellent resolution, for locations where microsurgical techniques are not available.³

In this study, the reverse sural flap was primarily used for wounds located in the distal region of the leg, also being applied to wounds in the ankle, heel, and foot, in complex wounds with bone exposure, tendon exposure, orthopedic synthesis material, and osteomyelitis.^{2,3,7,8} Its use was also indicated in elderly patients and those with comorbidities.³ In our case series, most patients were victims of automobile accidents, suffering crush injuries, open fractures, and tissue maceration, resulting in reduced perilesional tissue perfusion.⁵ One case involved a patient with a shotgun wound type with tibial and fibular involvement (comminuted fractures), osteomyelitis, and local tissue compromise.



Figures 10-12: Evolution of flap necrosis and results after debridement and release

The flap's morbidity is directly related to the technique and patient care with the pedicle; in our case series, we observed that local conditions such as osteomyelitis initially increased morbidity significantly; however, after appropriate adjustments, there was an improvement in the infectious condition. Confirmation of cure has not been possible to date, but the results are very encouraging.

A multicenter review study revealed varied complication rates ranging from 5-58% among publications, with China having the lowest complication rate (13.6%); Brazil showed an average of 50% in the evaluated articles. Other records show an average of 25% complications; our case series presented 33%, with partial flap necrosis being the main complication, consistent with the literature, followed by venous congestion, epidermolysis, total necrosis, infection, and hematoma.⁴ In our case series, we did not have total necrosis; the complications were partial necrosis of the flap distally, without compromising the outcome, and we believe that osteomyelitis contribute for higher morbidity.



Figures 13-16: Wound with bone exposure; retail marking; distal partial necrosis; result after debridement and pedicle release.

The flap retains the disadvantages of a fasciocutaneous flap, such as limitation of skin extension, presence of unesthetic scars in the donor or recipient area, and hypoesthesia of the lateral regions of the legs and foot. To reduce unesthetic scarring, the skin portion of the flap is limited to a width that allows primary closure.^{2,3} Subdermal tunnel transposition can be used; however, it may favor venous congestion due to low skin distensibility, increasing morbidity.³

The flap has advantages such as technical ease, reliable pedicle, wide arc of rotation, preservation of major vessels of the lower limb, minimal morbidity in the donor area, ability to cover relatively large defects, good support for weight-bearing, and improved vascularization of areas affected by osteomyelitis, with increased blood supply to the area favoring treatment.^{3,5}



Figures 17-20: Wound with exposure of orthopedic synthetic material on the ankle; Dissected reverse sural flap; Reverse sural flap fixed to the wound; Result after release with an unsightly appearance.

V. Conclusion

The reverse sural flap demonstrates good versatility in settings with limited resources for microsurgical procedures, becoming one of the few alternatives for treating injuries in the distal third of the leg and ankle, with relatively easy applicability, faster surgical time, and often superior results compared to microsurgery. Thus, its technique should be disseminated and improved for the greater benefit of the population. Although associated

with higher morbidity, it can be used in areas of local bone infection with good outcomes, serving as a viable alternative in such cases.

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