

The Sural Flap: Anatomical Basis, Technical Refinements, And Clinical Applications in Lower Extremity Reconstruction

Roberto Alejandro Sosa Murillo¹, Homero Onésimo Sosa Murillo², Oliver Jessua Sosa Murillo³, Daniel Herrera Hernández⁴, Carlos Andrés Villamar Gutiérrez⁴, André Alessandro Madrid Perdomo⁵, Bojórquez Mora Félix Steven⁶, Cano Palacios Francisco Javier⁷, Evelyn Gabriela Murillo Valdez⁷, Fernando Martínez Cuspiner⁸, Edgar Oswaldo Sánchez López⁹

¹Centro Médico Lic. Adolfo López Mateos

²Universidad Michoacana de San Nicolás de Hidalgo

³Centro Estatal de Atención Oncológica

⁴Hospital General Regional No. 1, IMSS, Tijuana, Baja California

⁵Hospital Centro Médico Tuxpam

⁶Hospital Regional Dr. Manuel Cárdenas de la Vega, ISSSTE

⁷Hospital Regional Dr. Cárdenas de la Vega, ISSSTE

⁸Hospital Universitario de Saltillo

⁹Hospital Culiacán, ISSSTE

ABSTRACT

Background: Reconstruction of soft tissue defects in the distal lower extremity remains a complex surgical challenge due to limited local tissue availability, poor vascularity, and the frequent need to cover exposed critical structures. The sural flap, particularly the reverse-flow sural neurocutaneous flap, offers a reliable, technically straightforward, and cost-effective solution for these defects.

Objective: This manuscript provides a comprehensive review of the anatomical basis, technical considerations, surgical refinements, clinical indications, outcomes, and complications associated with the sural flap. It also explores its role in modern reconstructive algorithms and compares its efficacy to alternative reconstructive options.

Methods: A thorough literature review was conducted using PubMed, Scopus, and Embase databases to evaluate studies from 1983 to 2025 related to the sural flap, including anatomical studies, clinical trials, cohort studies, and case series. The data were analyzed to provide an evidence-based review of the flap's performance in reconstructive surgery.

Results: The sural flap consistently demonstrates high success rates (85–95%) across various indications, with low donor site morbidity and acceptable aesthetic and functional outcomes. Technical modifications, including the supercharged and adipofascial variants, have expanded its indications and minimized complications such as venous congestion and partial flap necrosis.

Conclusion: Despite advances in microsurgical free tissue transfer, the sural flap remains a fundamental option for lower limb reconstruction, particularly in patients with comorbidities, resource-limited settings, or when free flaps are contraindicated. Its anatomical reliability, ease of harvest, and versatility underscore its continued relevance in modern reconstructive surgery.

KEYWORDS: Sural Flap, Reverse Sural Flap, Lower Extremity Reconstruction, Soft Tissue Defects, Pedicled Flap, Microsurgery Alternatives, Flap Complications

ARTICLE DETAILS

Published On:
06 June 2025

Available on:
<https://ijmscrs.com/>

INTRODUCTION

Soft tissue reconstruction of the lower extremity, especially the distal third of the leg, ankle, and foot, presents a formidable challenge to reconstructive surgeons. These regions have limited local tissue availability, and any reconstructive effort must address both functional restoration and aesthetic considerations. Additionally, these defects frequently expose critical underlying structures such as bones, tendons, and orthopedic implants, requiring well-vascularized tissue for optimal healing.

While free flaps are the gold standard for complex reconstructions, their use is often limited by the requirement for microsurgical expertise, long operative times, high costs, and patient comorbidities that increase perioperative risks. In contrast, the sural flap offers a reliable, relatively simple alternative with reproducible results. Since its first description by Donski and Fogdestam in 1983, the sural flap has undergone several modifications, including the development of the reverse-flow sural flap, which has greatly expanded its utility for distal limb coverage.

This manuscript aims to provide a detailed analysis of the sural flap's anatomical basis, technical refinements, clinical indications, outcomes, and complications, and to position it within the broader reconstructive ladder.

ANATOMICAL AND SURGICAL FRAMEWORK ANATOMICAL CONSIDERATIONS

The sural flap is a neurocutaneous flap primarily based on the vascular axis accompanying the sural nerve and the lesser saphenous vein. The primary blood supply arises from septocutaneous perforators of the peroneal artery, typically located between 4 and 7 cm proximal to the lateral malleolus. These perforators anastomose with the vascular network of the sural nerve and the vasa nervorum, creating a reliable reverse-flow vascular system that supports distal-based flap designs.

The sural nerve, a sensory nerve formed by the union of the medial sural cutaneous nerve (from the tibial nerve) and the peroneal communicating branch (from the common peroneal nerve), serves as a critical anatomical landmark during flap harvest. The lesser saphenous vein also contributes to venous drainage and must be preserved or appropriately managed to avoid venous congestion.

Indications

The sural flap is indicated for soft tissue reconstruction of defects located in:

- The distal third of the leg
- The Achilles tendon region
- The lateral and medial malleolar regions
- The heel and plantar regions (selected cases)
- Dorsal and plantar foot defects

Specific clinical situations include:

- Traumatic soft tissue injuries with exposed tendons or bone
- Chronic non-healing ulcers, particularly in diabetic and

vascular-compromised patients

- Coverage following oncologic resections of cutaneous malignancies
- Post-infective defects following osteomyelitis or chronic infections
- Coverage of orthopedic implants after open fracture fixation

SURGICAL TECHNIQUE OVERVIEW

1. **Patient Preparation and Positioning:** The patient is positioned supine or in a lateral decubitus position with the affected leg externally rotated for optimal exposure.

2. **Flap Design:**

The flap is designed along the posterior aspect of the leg, typically extending from the popliteal fossa to the lateral malleolus. The pivot point is carefully determined based on the location of the peroneal perforators, usually 5–7 cm above the lateral malleolus.

3. **Flap Elevation:**

The flap is elevated in a subfascial plane, preserving the sural nerve, lesser saphenous vein, and accompanying vascular plexus. Care is taken to minimize tension on the pedicle.

4. **Flap Transfer:**

The flap is tunneled or transposed directly to the defect site, ensuring an adequate arc of rotation. Tension-free inset is critical to prevent ischemia.

5. **Donor Site Closure:** Depending on the size of the flap, the donor site can be closed primarily or covered with a split-thickness skin graft.

Technical Modifications and Variants

- **Reverse-Flow Sural Flap:** The most widely used variant, allowing coverage of more distal defects due to its robust reverse-flow vascularization.
- **Supercharged Sural Flap:** Involves microvascular anastomosis of the peroneal perforator to augment arterial inflow and venous outflow, reducing the risk of venous congestion and necrosis.
- **Adipofascial Sural Flap:** Harvests only the fascia and adipose tissue, useful for thin, pliable coverage over tendons and delicate structures.
- **Islanded Sural Flap:** Designed with a narrow skin paddle and pedicle, enhancing mobility and reach.



Figure 1 Surgical marking, the lateral malleolus is identified on its posterior surface and the popliteal fossa at the level of the raphe of the gastrocnemius muscles.



Figure 2. Surgical defect in Hollenbeck's zone c



Figure 3. Rotation and graft application taking



Figure 4. Defect cover-up

CLINICAL OUTCOMES AND COMPLICATIONS OUTCOMES

Clinical series have consistently reported success rates between 85% and 95% for the sural flap in lower extremity reconstruction. Functional recovery is typically satisfactory, with patients regaining ambulatory capacity and stable coverage of critical structures.

- **Aesthetic Outcomes:**

While donor site scarring is generally acceptable, hypertrophic scarring and pigmentation changes have been noted, particularly in patients with darker skin tones.

- **Sensory Deficits:**

Due to sacrifice of the sural nerve, a zone of hypoesthesia typically remains over the lateral aspect of the foot. However, this is often well tolerated by patients.

Complications

- **Partial Flap Necrosis:**

Occurs in 5–15% of cases, often due to venous congestion. This can be managed conservatively or with debridement and secondary grafting.

- **Venous Congestion:**

The most common complication. Strategies to minimize this include preserving the lesser saphenous vein or supercharging the flap.

- **Donor Site Morbidity:**

Minimal, with most defects covered successfully with skin grafts.

- **Flap Edema and Delayed Healing:**

Particularly in diabetic or vascular-compromised patients.

CONCLUSION

The sural flap remains a vital reconstructive option for soft tissue defects of the lower extremity. Its ease of harvest, anatomical

reliability, and versatility allow for effective management of a wide range of clinical scenarios, even in resource-constrained environments. While microsurgical free flaps offer unparalleled reconstructive possibilities, the sural flap continues to serve as an indispensable tool, particularly for moderate-sized defects and in patients unsuitable for prolonged surgeries.

Ongoing research and technical innovations, such as flap supercharging and improved flap monitoring techniques, promise to further enhance the utility and outcomes of the sural flap. As reconstructive surgery continues to evolve, the sural flap retains its relevance as a cost-effective, dependable, and technically accessible option for lower extremity reconstruction.

REFERENCES

- I. Lin, C. H., Hsieh, Y. H., C Lin, C. H. (2021). The medial sural artery perforator flap in lower extremity reconstruction. *Clinics in Plastic Surgery*, 48(2), 249-257.
- II. Bangura, M. L., He, L. A., Zeng, T., Chirima, T. C., Tran, S. T., Kang, W., ... C Luo, H. (2025). Long-Term Efficacy and Surgical Outcomes of Sural Neurovascular Flap Applications in Distal Lower Limb Wound Reconstruction: A Single-Center Retrospective Study of Patients Treated in Jingzhou City From 2012 to 2018. *Health Science Reports*, 8(5), e70753.
- III. Hashmi, P. M., Musaddiq, A., Hashmi, A., C Zahid, M. (2022). Comparison of distally based sural artery and supramalleolar flap for coverage of dorsum of foot and ankle defects; a cross-sectional study of 53 patients. *Annals of medicine and surgery*, 73, 103109.
- IV. Nikkhah, D., Rawlins, J., C Pafitanis, G. (Eds.). (2023). *Core Techniques in Flap Reconstructive*

The Sural Flap: Anatomical Basis, Technical Refinements, And Clinical Applications in Lower Extremity Reconstruction

- Microsurgery: A Stepwise Guide*. Springer Nature.
- V. Ferry, A. M., Gimenez, A. R., Abu-Ghname, A., Xue, E. Y., Pederson, W. C., Lazo, D. Á.
- VI. A., C Maricevich, M. (2022). Reconstruction of complex lower extremity defects. *Current Surgery Reports*, 10(7), 83-93.
- VII. Ferry, A. M., Gimenez, A. R., Abu-Ghname, A., Xue, E. Y., Pederson, W. C., Lazo, D. Á.
- VIII. A., C Maricevich, M. (2022). Reconstruction of complex lower extremity defects. *Current Surgery Reports*, 10(7), 83-93