

ORIGINAL ARTICLE

Distally based medial adipofascial flap for medial leg defects: An orthopedic-led orthoplastic experience

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ABSTRACT

Background: Soft-tissue reconstruction of middle- and distal-third medial leg defects remains challenging, especially in centers without plastic surgery support. The distally based medial adipofascial flap, although not widely popular or commonly used in routine practice, is a reliable and reproducible option that can be performed by orthopedic surgeons with dedicated orthoplastic training.

Methods: A retrospective observational study was conducted on 11 patients treated between May 2019 and October 2024 at a tertiary trauma center. All patients presented with soft-tissue defects of the middle or distal medial third of the leg due to fracture-related infection (FRI) or open fractures requiring orthoplastic management. All procedures were performed by trained orthopedic surgeons using a distally based medial adipofascial flap, followed by skin grafting. Primary outcomes included flap survival, early postoperative complications, late complications, and mid-term functional results. Minimum follow-up was 12 months.

Results: Soft-tissue coverage was performed for FRI in six patients and for open fractures in five. All flaps survived and achieved definitive wound healing. Early complications occurred in seven cases, including venous congestion, partial distal necrosis, or limited graft loss; all were managed conservatively without compromising final coverage. No late flap-related complications were observed. One patient underwent below-knee amputation due to progression of pre-existing peripheral vascular disease, unrelated to flap viability.

Conclusion: The distally based medial adipofascial flap is a reliable, safe, and technically straightforward solution for the reconstruction of medial leg defects. When performed by orthopedic surgeons, it enables integrated



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skeletal and soft-tissue management even in the absence of microsurgical services, expanding reconstructive opportunities within an orthoplastic framework. (www.actabiomedica.it)

Key words: medial adipofascial flap, lower-limb trauma, soft-tissue coverage

Introduction

Open lower-limb injuries and fracture-related infections (FRI) pose a major challenge due to extensive soft-tissue damage, high infection risk, and the need for timely skeletal stabilization. Defects of the middle and distal medial third of the leg are particularly demanding, given the limited local soft-tissue options and the inherent difficulties of performing free-flap reconstruction in non-tertiary centers without routine microsurgical services. In this context, the orthoplastic approach—integrating skeletal fixation with soft-tissue reconstruction—has gained increasing relevance, aiming to reduce infection and amputation rates, shorten hospital stay, and improve functional outcomes (1, 2). As this multidisciplinary model expands, orthopedic surgeons in centers without on-site plastic surgery are increasingly required to adopt orthoplastic principles and perform reliable coverage procedures independently. The distally based medial adipofascial flap, first described by Lin et al. and later supported by Heymans et al., has emerged as a safe, versatile, and technically straightforward option for lower-leg defects, including those with exposed bone (3, 4). Its simplicity, reliability, and preservation of major vascular pedicles make it particularly suitable for orthopedic-led reconstruction in settings where microsurgical support is unavailable. The present study describes the first orthoplastic experience of orthopedic surgeons performing distally based medial adipofascial flaps for distal medial leg defects. We retrospectively analyzed 11 patients treated for post-traumatic soft-tissue loss or fracture-related infection, focusing on short- and long-term complications, flap behavior, and mid-term functional outcomes, highlighting the feasibility of

this technique in orthopedic hands without dedicated plastic surgery involvement.

Material and methods

This retrospective study included all patients who underwent a distally based medial adipofascial flap between May 2019 and October 2024 for soft-tissue defects of the middle and distal third of the leg. All procedures were performed by two of three orthopedic surgeons with orthoplastic training and a dedicated interest in limb reconstruction, each having completed formal theoretical preparation and specialized courses in orthoplastic techniques. Skeletal fixation, when required, was selected based on fracture pattern, anatomical location, and surgeon preference. Patients were followed clinically until both flap healing and fracture union were achieved, with a minimum follow-up of 12 months. The primary objective of this study was to evaluate short- and long-term complications associated with the distally based medial adipofascial flap, with particular attention to factors influencing postoperative outcomes and flap behavior over time. The study emphasizes the feasibility and reliability of this flap as a reconstructive option performed by orthopedic surgeons without the immediate availability of plastic surgery support.

Surgical technique

The procedure followed a structured four-step orthoplastic workflow. We adopted the surgical principles described by Heymans et al. for the retrograde-flow variant of the distally based medial adipofascial flap (4, 5). Pre-operative planning included supine positioning and

a thorough vascular assessment using handheld Doppler performed by a vascular surgeon from our department. Posterior tibial perforators along the medial distal leg were mapped, with particular attention to identifying the most distal reliable perforator, typically located a few centimeters proximal to the medial malleolus. This perforator served as our anatomical reference and determined the distal limit of flap harvest. A tourniquet was applied to optimize visualization. Flap design was tailored to the dimensions of the defect and centered on the last viable perforator identified pre-operatively. A medial incision approximately 1 cm posterior to the tibial crest was performed. The skin was elevated carefully, maintaining an adequate adipofascial layer to preserve subdermal vascularity and reduce the risk of marginal skin necrosis. Soft-tissue handling prioritized protection of the posterior tibial neurovascular bundle and its perforating branches. Flap elevation proceeded from proximal to distal, isolating the adipofascial layer while preserving its continuity with the selected posterior tibial perforator, which acted as the reverse-flow pedicle. Perforators not included in the pedicle were coagulated under direct vision. The perforator identified pre-operatively was preserved without need for intraluminal dissection, maintaining physiological perfusion through the anastomotic network between posterior tibial and peroneal perforators. Once completely mobilized, the flap was gently rotated into the defect, ensuring that the pedicle remained free of compression or torsion. The deep fascial surface was oriented superficially, while the subcutaneous face was placed in contact with the recipient bed to promote integration. The flap was then prepared for split-thickness skin grafting, and either negative-pressure wound therapy or a suction drain was applied according to the surgeon's preference and wound conditions. After flap inset, a split-thickness skin graft was placed. Post-grafting management consisted either of a suction drain or, more commonly, of paraffin gauze (Connettivina Plus[®]) covered with negative-pressure wound therapy (NPWT). NPWT was applied at -80 mmHg for five days and was used in all cases except one, in which a drain - the only instance in the series - was inserted. This approach allowed continuous evacuation of local secretions and maintained an optimal wound environment for graft

take. A dermal substitute was used only in cases of graft necrosis. In these patients, reoperation was performed for debridement and removal of the necrotic graft, followed by the application of PELNAC[™] (Gunze, Japan). The superficial silicone layer was removed after approximately three weeks, and subsequent advanced dressings were used until complete healing.

Skin-graft donor sites were managed either with primary closure, when tissue laxity allowed it, or left to heal by secondary intention when direct closure was not feasible. Post-operative care included strict limb elevation, avoidance of compressive dressings along the pedicle course, and progressive mobilization once graft stability was confirmed. A representative clinical case is shown for illustrative purposes (Figures 1-4).



Figure 1. Patient with open biosseus fracture of the left leg (gustilo 3B) and degloving injury of the foot, area of exposition of 5x3,5 cm. Initially treated with external fixation, debridement and Negative Pressure Wound Therapy (NPWT). Shown in the photo 7 days after trauma, after external fixator removal.



Figure 2. Coverage of the tibia exposition area with a distally based medial adipofascial flap of the leg.



Figure 3. Skin graft from homolateral thigh, 7 days after surgery.

Results

A total of 11 patients underwent soft-tissue reconstruction with a distally based medial adipofascial flap. The cohort included 7 men (70%) and 4 women (30%), with a mean age of 53.6 years (range 19–74). The mean follow-up was 22.9 months (range 12–36). Demographic and clinical characteristics are summarized in Table 1, while individual comorbidities, diagnosis, and postoperative outcomes are detailed in Table 2. In three cases, partial necrosis of the split-thickness skin graft was observed and treated with the application of a dermal substitute PELNAC™ (6). After three weeks, the superficial silicone layer was removed, and wound healing was subsequently achieved through advanced dressings (Table 2). Soft-tissue reconstruction was performed for fracture-related infection (FRI) in 6 patients (54.5%) and for open fractures in 5 patients (45.5%). In five trauma cases, flap coverage

was performed as part of a staged management strategy following orthopedic damage control surgery, at a mean of 7 ± 3 days after injury. All flaps demonstrated successful healing at final follow-up. Early postoperative complications occurred in 7 patients (63.6%), consisting of partial or distal flap necrosis, flap congestion, and/or partial skin graft loss. One patient underwent subsequent lower-limb amputation due to progressive peripheral vascular disease unrelated to flap performance. No late flap-related complications were observed.

Discussion and conclusion

Orthoplastic principles in lower-limb trauma have evolved significantly since Godina's seminal work in the 1980s, and the "fix-and-flap" paradigm has established early soft-tissue coverage as a cornerstone

in open-fracture management (7). While much of the evidence originates from plastic-surgery units, many trauma hospitals—particularly non-academic centers—lack immediate microsurgical availability. In this context, reproducible local flap strategies



Figure 4. Patient with lower leg reconstruction 7 months after trauma.

performed by orthopedic surgeons are essential for timely limb salvage. The distally based medial adipofascial flap demonstrated high reliability in our cohort, with successful healing in all patients and complication rates comparable to published data on free flaps. Despite high-risk features such as diabetes, smoking, and peripheral vascular disease, no flap loss occurred, reinforcing the robustness of this technique in a real-world trauma population. As previously reported for pedicled flaps, complications were generally minor and manageable, typically related to distal congestion or superficial necrosis. In our cases where extensive skin graft necrosis occurred, a dermal substitute such as PEL-NAC™ was used to optimize the wound bed, promote neodermis formation, and limit donor-site morbidity. This approach enabled controlled granulation and facilitated secondary healing with advanced dressings without the need for repeated surgical interventions. Partial skin-edge necrosis and small delayed-healing areas may occur, but they do not compromise final outcomes. Diabetic patients may be more vulnerable to congestion-related issues, warranting heightened vigilance (8). This flap is technically straightforward, does not require microsurgical expertise or equipment, and can be performed concomitantly with fracture fixation—reducing operative delays that could predispose to infection and delayed union. This aligns with the orthoplastic vision described by Masquelet and others, emphasizing that orthopedic surgeons can safely integrate skeletal stabilization and soft-tissue

Table 1. Patient demographics, laterality, surgical indication and follow-up.

| Case | Sex | Age | Laterality | Surgical indication | Follow up (months) |
|------|-----|-----------|------------|---------------------|--------------------|
| 1 | M | 62 | Right | Open Fracture | 30 |
| 2 | M | 30 | Right | FRI | 32 |
| 3 | F | 67 | Left | Open Fracture | 20 |
| 4 | M | 29 | Right | Open Fracture | 12 |
| 5 | M | 44 | Right | FRI | 17 |
| 6 | M | 67 | Right | FRI | 32 |
| 7 | M | 19 | Right | Open Fracture | 18 |
| 8 | F | 74 | Right | Open Fracture | 19 |
| 9 | F | 60 | Left | FRI | 12 |
| 10 | M | 67 | Right | FRI | 24 |
| 11 | F | 71 | Right | FRI | 36 |
| | | Mean 53,6 | | | Mean 22,9 |

Table 2. Patient comorbidities, fracture pattern and complications.

| Case | Comorbidities | Diagnosis | Early complications | Late complications | Suction Drain / Wound Matrix |
|------|---|---|---|--------------------|------------------------------|
| 1 | Diabetes, peripheral vascular disease, and alcohol abuse | Trimalleolar fracture | Partial skin graft lost | None | No/ No |
| 2 | None | Fracture-related infection after trimalleolar fracture | Marginal necrosis of the flap with distal flap loss | None | No/ No |
| 3 | None | Open tibial shaft fracture | None | None | No/ No |
| 4 | None | Open tibial shaft fracture | None | None | No/ No |
| 5 | Active smoker | Fracture-related infection on a previously treated tibial pilon fracture | Distal loss of the flap associated with skin graft necrosis | None | Yes/No |
| 6 | Peripheral vascular disease involving the superficial femoral artery, and diabetes | Fracture-related infection on a previously treated tibial pilon fracture | Uneventful flap course; amputation performed later for vascular disease | None | No/ No |
| 7 | None | Open tibial shaft fracture | Flap congestion, partial flap loss, and skin necrosis | None | No/Yes |
| 8 | Peripheral arterial disease | Open tibial shaft fracture | Flap congestion and partial flap necrosis; reoperation with dermal substitute application | None | No/Yes |
| 9 | Active heavy smoker | Fracture-related infection on a previously treated tibial shaft fracture | Flap congestion, partial flap loss, and skin necrosis | None | No/Yes |
| 10 | Peripheral vascular disease, diabetes, and active smoking | Fracture-related infection after trimalleolar fracture | Partial flap necrosis | None | No/No |
| 11 | Active smoking, malnutrition, diabetes mellitus, and history of Takotsubo syndrome. | Fracture-related infection on a previously treated distal tibial fracture | No complications | None | No/No |

coverage using local flaps when microsurgical support is unavailable (9). Technical precision remains paramount. The primary concern is venous congestion; therefore, an adequate pedicle width, generous subcutaneous tunnel, avoidance of kinking, and inclusion of the great saphenous vein when feasible are recommended. Delayed healing at skin edges may occur, particularly in patients with comorbidities, warranting close postoperative monitoring. This study has

limitations, including its retrospective nature, small cohort, and single-center design. The absence of a direct comparison with free-flap reconstruction precludes definitive outcome equivalence. Additionally, results may reflect institutional experience and may not be generalizable to centers without established orthopedic practice. Function was assessed through patient-reported outcomes, introducing potential subjective variability. Despite these constraints, the distally based

medial adipofascial flap represents a reliable, reproducible, and practical solution for medial middle- and distal-third tibial defects. When executed with careful technique and guided by an orthoplastic perspective, it provides an effective option for timely limb-salvage reconstruction, particularly in environments where microsurgical coverage is not immediately available. This study supports the role of orthopedic surgeons as capable providers of integrated fracture and soft-tissue management using local flap techniques, in line with the principles championed by Masquelet.

Ethic Approval: In accordance with institutional policies and national regulations, formal Institutional Review Board (IRB) approval was not required for this retrospective study based exclusively on the review of existing clinical records. All patient data were fully anonymized prior to analysis.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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Declaration on the Use of AI: None.

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