

The Subcalcaneal Fat Pad: An Innovative Space for Passage of the Pedicle in Free Flap Reconstruction of Lateral Heel Defects

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Summary: Soft-tissue defects of the lateral heel remain a challenge for reconstructive surgeons. Although a reliable vascular supply for free flap anastomosis is available anteriorly from the anterior tibial vessels and medially from the posterior tibial vessels, the vascular anatomy of the lateral side lacks suitable donor vessels for free flap anastomoses. Although the pedicle can be passed either ventrally beneath the skin or dorsally between the Achilles tendon and calcaneus, these passages are hardly applicable for lateral heel defects. We identified the space between the plantar surface of the calcaneus and the plantar aponeurosis as an innovative approach for reconstruction. Therefore, we propose the subcalcaneal fat pad as an alternative and reliable route for the passage of the flap pedicle to the posterior tibial vessels in free flap reconstruction of soft-tissue defects in the lateral calcaneal region. Consequently, the vascular pedicle can be safely anastomosed to the posterior tibial vessels. This approach provides a new option for recipient vessels in free flap reconstruction. (*Plast Reconstr Surg Glob Open* 2023; 11:e5412; doi: 10.1097/GOX.0000000000005412; Published online 17 November 2023.)

SURGICAL TECHNIQUE

We used this new technique on a 22-year-old woman with a chronic ulcer complicated by a superinfection and radiographically confirmed osteomyelitis of the calcaneus. Apart from her incomplete paraplegia, which she received after an accident, the patient was healthy. The ulcer developed on ground of a bland trauma while stepping stairs. Probably, due to improper positioning, the initial superficial wound turned into a chronic pressure ulcer. The wound measured 5 × 5 cm and presented with a deep dead space reaching the calcaneus (Fig. 1). The operation was performed under general anesthesia, simultaneously by two teams. One team was responsible for the dissection of the recipient vessel on the medial ankle, and the other team raised the free gracilis muscle flap. The free gracilis muscle flap was harvested as previously described.^{1,2}

Initially, the lateral wound and the calcaneus were extensively debrided laterally. The recipient vessels were prepared for anastomosis via a short incision over the medial side of the ankle. To tunnel the pedicle, we opened a space in the fatty tissue immediately inferior to the calcaneal bone using an Overholt clamp. The length of the space depends on the width of the calcaneus and the surrounding soft-tissue. Then, a suction tube was tunneled through the distinct subcalcaneal space. The suction tube broadened the diametrical size of the space until it measured approximately 1 cm in diameter. In the next step, the flap was inset, and the donor vessels were pulled laterally to medially under suction. The vein and artery from the dominant gracilis pedicle were anastomosed end-to-end with the posterior tibial vein and medial plantar artery, respectively (Fig. 2). The venous anastomosis was performed using a 2.5-mm coupler system (Synovis Micro Companies Alliance, Birmingham, Al). The artery was anastomosed under microscopy. Due to local anatomical characteristics and the limited space surrounding the pedicle, an end-to-end anastomotic technique demonstrated superiority over end-to-side anastomosis. The medial plantar artery was chosen as the recipient artery so that in the case of compromised blood flow by either the anterior tibial or peroneal artery, the posterior tibial artery could still serve as a backup through its second-end branch of the lateral plantar artery. Finally, the muscle flap was covered with a meshed skin graft (Fig. 3). To avoid postoperative

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Fig. 1. A photograph of the initial preoperative presentation of the patient: a 5×5cm chronic nonhealing ulcer with calcaneal osteomyelitis.

complications like edema, venous congestion or vascular crisis, immobilization and thrombose prophylaxis are recommended. Immobilization should last approximately 4 weeks in sum. Thereby, for the initial 2 weeks, total immobilization followed by 2 weeks of partial immobilization are advised. After 4 weeks, the wound was stable enough for full weight-bearing and normal walking. The patient's postoperative clinical course was uneventful.

One year after surgery, the muscle had shrunk to the original heel skin level, and a debulking procedure was not necessary. Apart from hyperkeratosis over the area of the transplanted skin, no complications were reported (Fig. 4). Due to the defect coverage, the patient is now able to put full load on her foot again and has returned to performing the activities of daily living.

DISCUSSION

We found that the space through the subcalcaneal fat pad offered an innovative route to safely tunnel the vascular pedicle of a free flap from the lateral calcaneal area medially to the posterior tibial vessels.

Our finding is important because free flap transfer in the region around the lateral ankle and heel is often delicate and complicated, owing to the paucity of reliable donor vessels. Currently, the established approach for anastomosing the vascular pedicle to the posterior tibial vessels is passage through the calcaneal subtendinous space. That approach was first introduced by Rockwell et al.³ Accordingly, the space under the

Takeaways

Question: The paucity of recipient vessels at the lateral foot poses difficulties for free flap reconstruction of lateral heel defects. How can the vascular pedicle at the lateral heel be safely passed laterally to medially?

Findings: In case of a complex lateral heel defect requiring free flap coverage, we found that the vascular pedicle can be easily tunneled laterally to medially through the subcalcaneal fat pad.

Meaning: In free flap reconstruction of lateral heel defects, the subcalcaneal fat pad provides safe passage for the vascular pedicle.

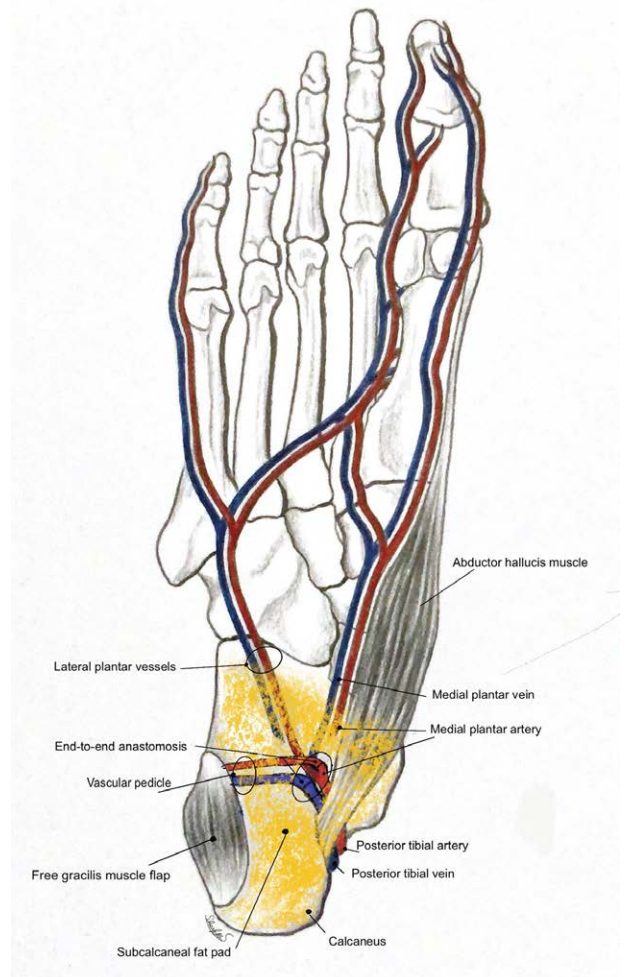


Fig. 2. A graphic depiction that shows the end-to-end anastomosis of the free flap donor vessels and the corresponding recipient vessels (medial plantar artery and posterior tibial vein) at the medial ankle after passage of the vascular pedicle through the subcalcaneal fat pad.

Achilles tendon constitutes a safe and long-lasting alternative to pass the donor vessels from lateral to medial in the case of free flap reconstruction of wounds at the lateral ankle.



Fig. 3. An intraoperative image of the left heel showing the location and approximate spatial extent of the subcalcaneal space in the subcalcaneal fat pad. One can see the suction tube, which was tunneled through the distinct space.



Fig. 4. Photograph depicting the defect closure area on the lateral heel 15 months after surgery. The free gracilis flap presents in-level with the surrounding tissue. A small area of hyperkeratosis can be seen in the defect closure area.

A myriad of surgical methods have been investigated to treat soft-tissue defects. Local flaps, like the distally based sural flap, showed good outcomes in lower leg reconstruction, even in patients with morbidities.⁴ However, in direct comparison, free muscle flaps outrank local flaps with better aesthetic outcomes and lower donor-site complication

rates.⁵ We believe that this is especially significant in young patients, where aesthetics should be considered an integral part of reconstruction. In contrast to local flaps, free muscle flaps offer the advantage of eliminating the deep dead space. Furthermore, because of their well-vascularized tissue, free flaps provide a superior healing environment in cases of osteomyelitis. Preoperatively, our patient presented with a nonhealing chronic soft-tissue defect of the lateral heel. The wound was complicated by the extensive nature of the ulcer, with a deep-seated bone infection. Notably, our patient had a distinct tattoo on her anterior thigh that we avoided deforming while harvesting the free flap.

After weighing the potential risks and benefits, the free gracilis muscle flap seemed to be the most suitable for our patient. Its use has proved viable in multiple clinical indications, including soft-tissue defects of the head and neck¹ and of the lower extremities, including reconstruction of extended wound defects in patients diagnosed with pyoderma gangrenosum⁶ and chronic osteomyelitis of the foot and ankle.⁷ The gracilis muscle flap provides several benefits. First, in contrast to other free muscle flaps, harvesting the gracilis muscle does not have major functional consequences. Second, its minimal donor-site morbidity has been verified.⁸⁻¹¹ Although free fascial flaps like the anterior thigh flap are a good alternative, from an aesthetic point of view, the free gracilis muscle flap outranked. It has been proven to offer the benefits of a more favorable and discrete scar location and a shorter scar length.⁹

A disadvantage of gracilis muscle flaps, however, is their comparably short pedicle length, with a mean of 70 mm.¹² Although, the calcaneal subtendinous space offers a shortened mean distance,³ tunneling the pedicle from the lateral heel under the Achilles tendon to reach the medially located posterior tibial artery, and its venae concomitant involves a zig-zag route that is prone to complications.

Consequently, for soft-tissue defects that are located at the heel and further caudal to the calcaneal subtendinous space, its use creates difficulties. In contrast, the space through the subcalcaneal fat pad is superior in tunneling the pedicle from the lateral to the medial side in lateral heel defects by offering a more direct route.

Moreover, the anatomic region is constructed to transmit high pressures and bear high loads.¹³ Therefore, it can concurrently function as a cushion for sensitive vascular structures, such as the vascular pedicle. Another strong factor favoring the space through the subcalcaneal fat pad is its reduced risk of entrapment by surrounding structures. Considering that stress and overuse of the Achilles tendon leads to swelling,¹⁴ the space between the calcaneus and the Achilles tendon bears the risk of compromise and subsequent endangerment of the perfusion to the flap.

In summary, we propose that the subcalcaneal fat pad offers a simple, direct, and protected space to tunnel the vascular pedicle laterally to medially in free flap reconstruction of lateral heel defects.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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