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Proximally Based Split Abductor Hallucis Turnover Flap for Medial Hindfoot Reconstruction: A Case Report

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ABSTRACT

Limited reconstructive options exist for soft tissue defects of the foot and ankle because of a lack of surrounding tissue. Although microsurgical free flaps have become a popular treatment modality for this anatomic region, pedicled muscle flaps can provide robust coverage of small foot wounds with significantly less donor site morbidity. One such muscle is the abductor hallucis, which can be used as a proximally based turnover flap to cover medial hindfoot defects. However, complete distal disinsertion of the muscle may lead to loss of support over the medial arch and first metatarsophalangeal joint, leading to pes planus and hallux valgus. In this case report, we describe a modified technique of a split abductor hallucis turnover flap for a young patient with a chronic, traumatic medial heel wound complicated by calcaneal osteomyelitis. By preserving part of the muscle's distal tendinous attachment, this technique allows for adequate soft tissue coverage while maintaining long-term biomechanical function.

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Traumatic soft tissue defects of the foot and ankle are difficult to heal because of the limited availability of surrounding tissue, which may quickly result in bone, tendon, or joint exposure (1). Primary closure would require large quantities of bone resection, leading to biomechanical instability that is prone to future breakdown. Secondary closure and/or skin grafting is a poor option in the setting of exposed bone because of an inadequate recipient bed and repetitive shear forces. Local random flaps have limited reach and are unreliable in chronically inflamed wounds (1). As one moves up the reconstructive ladder, the choice of definitive treatment lies between pedicled muscle flaps and microsurgical free flaps.

Although the use of free flaps is highly successful at achieving soft tissue coverage in foot and ankle defects, they are associated with high perioperative cost, significant donor site morbidity, and prolonged hospital stays (1). As such, for small defects involving exposed tendon, joint, and/or bone, local muscle flaps can provide a simpler alternative (2). Rotation of vascularized muscle into the defect brings

immediate perfusion to the area, thereby promoting wound healing and resistance to infection (1).

The choice of muscle flap depends on the location of the defect. For medial midfoot, heel, and ankle defects, the abductor hallucis (AH) flap is ideal. Versatile and reliable, the AH can be raised as a proximally based, distally based, or conjoined flap. However, the long-term complications of disinserting the entire muscle (i.e., effect on gait, medial arch, and hallux stability) are not well studied. In this report, we present the case of a young patient with a traumatic medial ankle wound complicated by osteomyelitis who was treated with a proximally based split AH turnover flap, leading to complete wound healing and functional recovery at 12-month follow-up.

Case Report

Informed consent was obtained from the patient and her parents to present this case report. The patient is a 16-year-old healthy female who developed a nonhealing wound on her right medial heel after undergoing surgical removal of an entrapped needle 7 months before presentation. Despite long-term antibiotic therapy, local wound care, and serial debridement, the patient's wound failed to improve. She was treated at our institution from February 2018 to December 2018.

On presentation to our wound care center, the patient's ulcer measured 0.4 × 0.3 × 1.7 cm, probing to bone (Fig. 1). Her radiographs

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Fig. 1. Initial presentation of patient's chronic wound; depth is down to bone.



Fig. 2. Initial lateral radiograph with round lucency noted in calcaneal body.

showed a defect in the calcaneus, suspicious for osteomyelitis (Fig. 2). An examination with magnetic resonance imaging with contrast could not exclude calcaneal osteomyelitis (Fig. 3). Rheumatologic workup was

negative for systemic autoimmune disease. Arteriography demonstrated iatrogenic injury to the posterior tibial artery but adequate retrograde flow to the heel via the dorsalis pedis artery.

After initial debridement and biopsy, the final soft tissue/bone defect measured $2.0 \times 1.0 \times 4.0$ cm. Although postoperative soft tissue and bone cultures were persistently negative, the histopathology of a calcaneal bone biopsy confirmed the presence of chronic osteomyelitis (Fig. 4). Intravenous cefazolin therapy was initiated.

To minimize donor site morbidity and facilitate early mobilization, we elected to use a local intrinsic muscle flap, namely the AH flap. The osteomyelitic bone within the calcaneus was debrided, and polymethylmethacrylate cement impregnated with vancomycin and tobramycin was used to fill the void. A Doppler examination was then used to identify the dominant pedicle in the proximal AH. An incision was made along the length of the muscle from the mid-instep to the medial malleolus. To prevent the development of hallux valgus, the AH muscle belly was split, with the deep portion of the muscle and tendon insertion remaining intact distally. Muscular dissection began on the dorsal surface and proceeded down the sagittal plane until visualization of the tendon, at which point the muscle was split along the tendon from distal to proximal (Fig. 5). Minor perforators were ligated to facilitate flap elevation. The distally elevated muscle was then inset into the defect as a turnover flap (Fig. 6), with Doppler confirmation of adequate flow through the pedicle. The distal donor site was closed primarily over a microflap drain, and a split-thickness skin graft harvested from the groin was used to cover the proximal muscle flap (Fig. 7). Postoperative radiographs show the presence of the antibiotic cement filling the calcaneal defect (Fig. 8).

The patient was discharged on postoperative day 3 with non-weightbearing restrictions in a posterior splint. On the 2-week follow-up, she began toe-weightbearing exercises. On the 1-month follow-up, her skin graft was well adhered, the muscle flap appeared well perfused, and full weightbearing status was reinstated. The patient continued to take intravenous cefazolin for 4 weeks and then transitioned to oral cephalexin for 6 weeks. At the 9-month follow-up, the patient admits to 1/10 pain occasionally at bottom of foot with a positive Tinel sign to the lateral plantar nerve. The flap



Fig. 3. Magnetic resonance images with contrast shows (A) increase in signal intensity to calcaneus on short T1 inversion recovery and (B) postcontrast enhancement of bone marrow on T1.

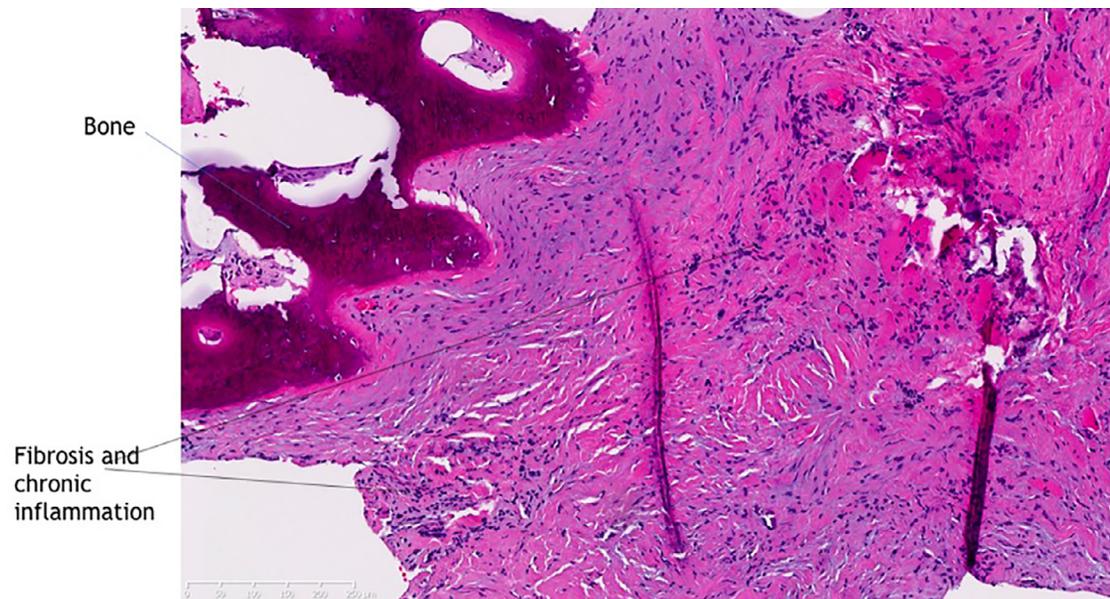


Fig. 4. Histomicrograph of calcaneal bone biopsy (hematoxylin and eosin stain, original magnification $\times 5$) revealed fibrosis and chronic inflammation, suggestive of chronic osteomyelitis.

remains viable (Fig. 9). At 12 months postreconstruction, the patient has completely resumed normal physical activity without signs of recurrent infection.

Discussion

Soft tissue defects of the foot and ankle pose unique reconstructive challenges due to the lack of tissue availability (1). When the defect involves bone, joint, and/or tendon, the 3 goals of reconstruction should include preservation of bone to maintain biomechanical stability, protection of underlying structures, and coverage with healthy tissue to promote healing and resist infection (1).

Classically, surgical management of complex wounds can follow the progression of the reconstructive ladder. In the foot and ankle, however, primary closure places excessive tension on the wound edges and/or requires significant bone resection (1). Secondary closure and skin grafting are also suboptimal due to the poor

recipient bed over exposed bone/tendon (1). Finally, local random flaps typically fail because of limited mobility and unreliable blood supply (1).

Pedicled muscle flaps, first popularized by Ger in the 1960s (1), can achieve all 3 of the reconstructive goals when used in the appropriate setting. Unfortunately, the advent of microsurgery in the 1970s led to a decline in the use of local muscle flaps (1). Although microsurgical free flaps have a 96% success rate in lower extremity reconstruction, they are associated with significant donor site morbidity, long operative time, long hospital stay, and possible recontouring procedures (1). Local muscle flaps of the foot offer an elegant alternative to free flap transfer, because they involve straightforward dissections, minimize functional deficits, and preserve donor site aesthetics (1). Furthermore, pedicled muscle flaps are preferred in wounds with osteomyelitis because of their robust blood supply (1,3). In a case series of 6 patients with calcaneal osteomyelitis, Ortak et al (4) demonstrated that local muscle flaps led to clinical and radiographic resolution of infection in 100% of patients. In the present case, the patient's young age and active nature



Fig. 5. Dissection of abductor hallucis muscle. The muscle was split along the sagittal plane, through the tendinous portion, and released from its insertion point distally.



Fig. 6. Flap inset. Once the split abductor hallucis muscle was freed distally, the flap was turned over on its proximal pedicle to cover the medial heel defect.



Fig. 7. Skin graft and donor site closure. The donor site of the abductor hallucis flap was closed primarily, and the recipient site was covered with a split-thickness skin graft.



Fig. 9. Results at final follow-up. The skin graft and donor site incision were well healed. The muscle flap provided adequate bulk over the bony heel defect.

necessitated a treatment modality that would minimize donor site trauma and expedite functional recovery. The decision to pursue an intrinsic muscle flap spared her a protracted hospital course, allowing her to return to school and resume weightbearing by the second and fourth postoperative weeks, respectively.

Despite their advantages, pedicled muscle flaps are limited by bulk and mobility, so careful preoperative planning and patient selection are essential to obtaining a successful outcome. Optimal candidates should have wounds that are small and within reach of the selected muscle. In 2002, Attinger et al (1) demonstrated that in small soft tissue defects (<3.0 × 6.0 cm) of the foot and ankle, local muscle flaps achieved a 96% success rate, which was identical to the success rate of free flaps used in the coverage of larger defects. Based on the results of this study, our patient's wound (2.0 × 1.0 × 4.0 cm) was likely treatable by local muscle flap reconstruction. Given the wound's location in the medial hindfoot, the AH was the flap of choice.



Fig. 8. Postoperative lateral radiograph shows the presence of the antibiotic cement filling the calcaneal defect.

The AH arises from the medial process of the calcaneus and surrounding fascia and inserts into the medial proximal phalanx of the hallux (5). Supplied by 1 major proximal pedicle (medial plantar artery) and 2 minor distal pedicles, the AH is a type II muscle flap (2). Most commonly based on a proximal pedicle, the AH has also been used as a distally based or conjoined flap (2,4,5). However, the functional deficits following AH flap reconstruction are not well described. Anatomic and kinematic data indicate that the AH plays an important role in gait and acts as a dynamic support of the medial arch (6). Electromyographic studies have demonstrated significant myoelectric activity in the muscle during the late stance and toe-off phases (7). Furthermore, the AH helps maintain first metatarsophalangeal joint alignment and stability through isometric contraction (6). Sonographic studies have found that reduced muscle size is associated with hallux valgus (8). Therefore, full disinsertion of the AH may predispose the patient to pes planus or hallux valgus. To minimize the risk of these complications for our patient, we chose to split the AH and leave the deep portion of the muscle with the tendinous insertion intact, thereby providing residual medial arch and first metatarsophalangeal joint support. The proximally based split AH turnover flap offers a simple modification of a classic technique that may provide comparable soft tissue coverage of medial hindfoot defects while minimizing potential functional complications.

In conclusion, soft tissue defects of the foot and ankle pose unique reconstructive challenges because of the lack of available surrounding tissue. Although free flaps are highly successful at providing adequate coverage in this region, local muscle flaps offer comparable results with less morbidity when performed in small defects. Specifically for medial heel defects, the AH is the flap of choice, but traditional distal disinsertion of the muscle may lead to gait disturbances and hallux valgus. In the present case, we demonstrate the efficacy of the proximally based split AH turnover flap in the treatment of a medial hindfoot defect complicated by osteomyelitis, leading to complete wound healing and functional recovery on long-term follow-up.

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