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Abductor hallucis muscle flap with circular external fixation for Charcot foot osteomyelitis: a case report

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Complicated soft tissue defects of the diabetic foot often call for alternative methods to traditional primary closure. Despite the popularity of microvascular free flaps, local muscle flaps can offer reliable reconstruction for these challenging wounds with shorter surgical times and reduced complication rates. In this article, the authors describe the successful use of the abductor hallucis muscle flap and external fixation for soft tissue reconstruction of a chronic Charcot foot wound and osteomyelitis in a diabetic patient.

Keywords: *muscle flaps*; *diabetic foot*; *osteomyelitis*; *Charcot neuroarthropathy*; *external fixation*

Extensive wounds following trauma or osteomyelitis in the diabetic foot and ankle frequently demand creative techniques for sound reconstruction. Diabetic patients can experience multiple complications to the lower extremity as a result of chronic ulcerations, contiguous osteomyelitis, and Charcot neuroarthropathy, establishing a unique reconstructive challenge (1). Muscle flaps provide durable coverage over exposed bone and tendons using adjacent well-vascularized tissue. They were first introduced by Ralph Ger as a means to cover leg wounds by increasing local vascularity and promoting skin graft take (2). Several useful intrinsic muscle flaps for the foot have been published, however, limited reports exist regarding their utility in the setting of Charcot foot osteomyelitis.

While microvascular-free flaps have demonstrated a pivotal role in foot and ankle reconstruction with their versatility and reliable long-term outcomes, reconstructive surgeons must consider alternatives for patients that may not be good candidates for the long operating times and extensive anesthesia risk associated with these procedures. This patient population typically presents with multiple co-morbidities and the inability to remain non-ambulatory to the pathological extremity. With these considerations in mind, the authors present the use of the abductor hallucis muscle flap and external fixation in a case involving a chronic foot wound complicated by diabetic Charcot neuroarthropathy and osteomyelitis.

Case report

A 52-year-old female presented with a 6-month history of ulceration to the dorsal aspect of the left foot. She related the wound first occurred due to an injury involving a fall from a doorstep 1 year prior and admitted to intermittent swelling and difficulty ambulating ever since. The patient underwent surgical debridement twice for repeated infections at the wound site. Her primary care physician had most recently initiated local wound care by a home health provider on a daily basis consisting of moist gauze dressings since she lived alone and had no other caretakers. She denied being on current antibiotics but stated she was given antibiotics prior to each of her surgeries for the foot. She reported using a wheelchair for the majority of her activities due to her unstable gait. Her past medical history was significant for poorly controlled diabetes mellitus, hyperlipidemia, hypertension, peripheral neuropathy, and glaucoma. She denied drug allergies or use of tobacco or alcohol.

Physical examination revealed a well-nourished individual in no distress and stable vital signs. The left lower extremity demonstrated loss of protective sensation, palpable dorsalis pedis and posterior tibial pulses, and pitting edema circumferentially about the foot and ankle.

This study was presented at the 6th Annual International External Fixation Symposium (IEFS) Resident/Fellow Competition, December 2010, San Antonio, TX, USA.

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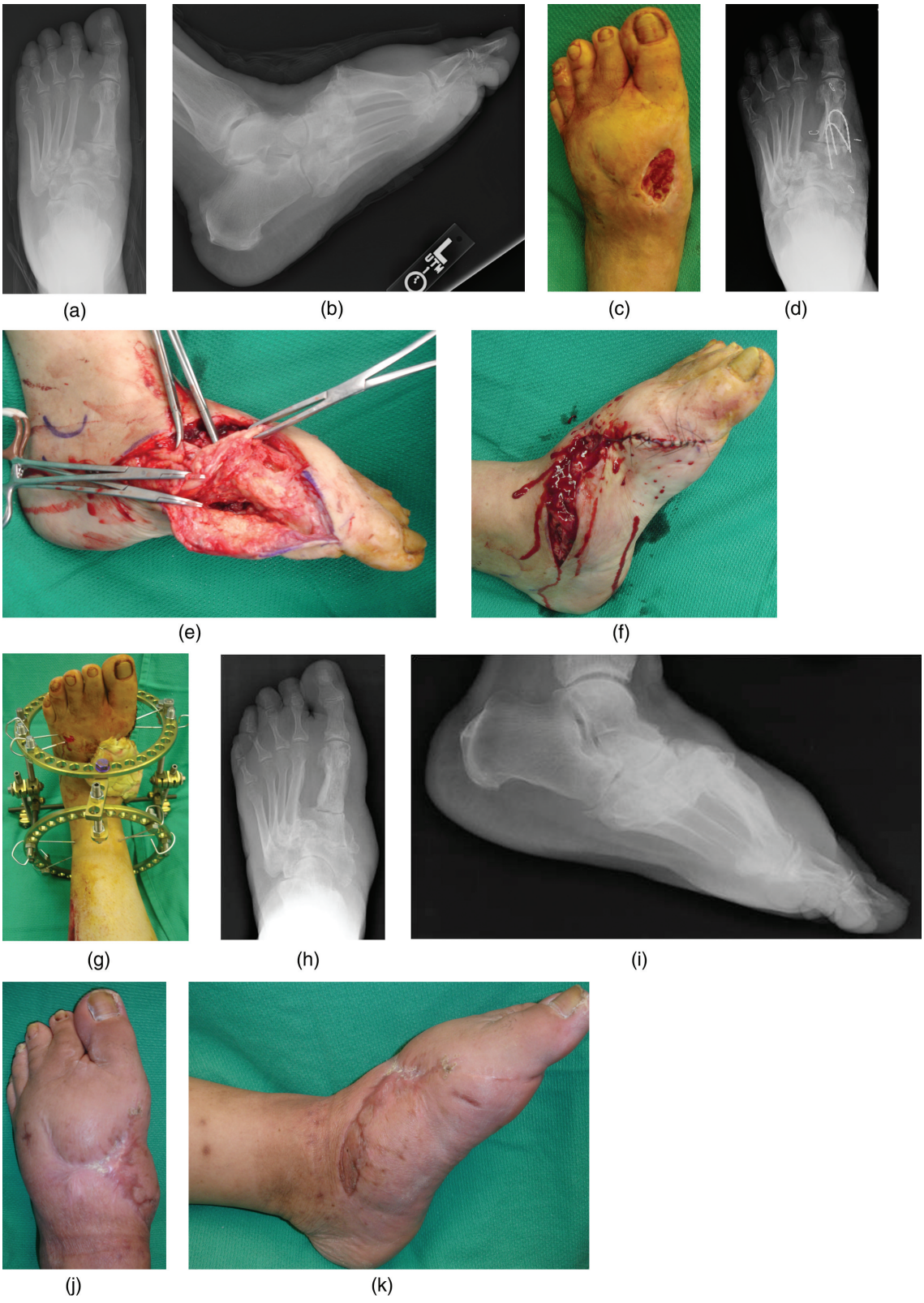

Fig. 1 (*Continued*)

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A full-thickness ulceration with fibrogranular base was located at the dorsal aspect of the foot measuring 4.5 cm × 2.1 cm with probing to bone, expressible purulence, and periwound erythema. Plain film radiographs and computed tomography of the foot and ankle revealed lateral subluxation of the second through fifth tarsometatarsal joints with dorsal subluxation of the metatarsal bases with osseous fragmentation, cystic osteolysis, and remodeling, in addition to partial collapse about the first tarsometatarsal joint. Magnetic resonance imaging showed extensive marrow edema and enhancement involving the first metatarsal suspicious for osteomyelitis. This constellation of clinical and diagnostic imaging findings were most consistent for Charcot midfoot neuroarthropathy superimposed with osteomyelitis (Fig. 1). Preoperative laboratory analysis, chest radiographs, and electrocardiogram were unremarkable. Non-invasive vascular testing consisting of ankle-brachial index, toe-brachial index, pulse-volume recordings, and segmental pressures showed no evidence of occlusive arterial disease; in addition, formal vascular surgery consultation deemed the patient appropriate for limb salvage without further vascular intervention.

The patient was taken to the operating room for ulcer excision, first metatarsal ostectomy with bone biopsy, as well as bone and soft tissue cultures. Bone cultures showed growth of *Enterobacter cloacae*, while histopathological inspection confirmed chronic osteomyelitis of the first metatarsal base. Two days later, a revisional surgical debridement was performed with partial resection of the first metatarsal base and placement of tobramycin-impregnated antibiotic cemented beads at the resultant defect. Infectious disease consultation recommended intravenous Cefepime based on susceptibility results for a total of 6 weeks duration. The patient maintained non-weight-bearing status during this period with immobilization in a posterior splint and monitoring of the wound in the outpatient setting at 2-week intervals. Upon completion of systemic antibiotic therapy and with no clinical evidence of acute infection, the patient underwent revisional ulcer excision, bone culture, removal of the antibiotic cemented beads, and irrigation. Further debridement at the proximal first metatarsal and dorsal exostectomy of the first tarso-metatarsal was performed to address the sequestrum identified. Due to the extent of the soft tissue defect with exposed bone and joint, the abductor hallucis muscle was harvested for coverage. The tendon was identified at its insertion distally and transected. The muscle was skeletonized from the tendon in a distal to proximal direction, taking care to protect the dominant proximal arterial supply, while all distal minor pedicles were isolated and tied off. The distal remnant tendon was sutured to the first metatarsophalangeal joint capsule, and the muscle was then rotated proximally and superiorly over the medial column defect. Primary closure of the skin was obtained distally while the remaining muscle flap was covered with a split-thickness skin graft harvested from the lateral aspect of the ipsilateral leg. To reduce seroma formation and motion at the graft site, a bolster dressing was secured by skin staples. An off-loading circular external fixator was then applied to the foot and ankle for strict non-weight-bearing and stabilization of the foot and ankle. Six weeks later, the circular external fixator was removed and the limb immobilized in a below-knee cast with subsequent gradual transition to a walking boot and finally custom-molded extra depth shoes. At 11 months post-operatively, the patient continued to ambulate well without further infection, collapse, or skin breakdown (Fig. 1).

Discussion

Vascularized muscle flaps provide several advantages in the coverage of difficult foot and ankle wounds. They provide increased blood supply, improved oxygen transport, and direct delivery of host defense mechanisms. These traits coupled with increased delivery of antibiotics allow muscle flaps to directly facilitate treatment of underlying osteomyelitis. Their consistency and rotational characteristics allow them to readily conform to most any recipient wound configuration. Furthermore, well-vascularized tissue combined with the elimination of dead space can decrease local bacterial counts.

The abductor hallucis muscle is one of six intrinsic muscles reported useful for foot and ankle defects (3). It is a Type II muscle defined as being supplied by one major proximal pedicle and minor distal pedicles. Successful coverage of wounds at the calcaneus, medial malleolus, and medial midfoot has been reported using

Fig. 1. Pre-operative radiographic (a, b) and clinical (c) pictures showing the full-thickness ulceration with fibrogranular base and bone exposure in a patient with a left Charcot foot osteomyelitis. The patient underwent ulcer and bone excision with soft tissue and bone cultures and bone biopsy. The histopathological analysis was positive for osteomyelitis of the first metatarsal base, and a revisional surgical debridement was performed with the insertion of cemented antibiotic-impregnated beads (d). The patient was brought back to surgery 6 weeks later for removal of the cemented antibiotic beads, further surgical debridement, and final wound closure. Intraoperative picture of the abductor hallucis muscle flap harvesting (e) and rotation proximally and superiorly over the medial column defect (f). This exposed muscle was covered by the application of a split-thickness skin graft and secured with a bolster dressing. An off-loading circular external fixator was also applied for strict non-weight-bearing, flap monitoring, and stabilization of the left lower extremity (g). Final radiographic (h, i) and clinical (j, k) pictures at 11 months post-operatively, following gradual transition to a walking boot, and finally custom-molded extra depth shoes. The patient continued to ambulate without further infection, collapse, or skin breakdown.

the abductor hallucis muscle (4–7). The flap is advantageous since donor site morbidity is minimal and harvest does not harm the weight-bearing area; additionally, the majority of the donor site can be closed primarily while the muscle is easily covered with a split-thickness skin graft. A disadvantage can be the small muscle bulk at the distal portion in some patients that may not be adequate for coverage of the entire exposed bone. In any case, thorough debridement of grossly infected tissue prior to application of the muscle flap is vital to the success of the procedure. A study by Attinger et al. reported that local muscle flaps are ideal for closure of defects $\leq 3 \times 6$ cm^2 at the foot or ankle with exposed bone, joint, or tendon (8).

Free tissue transfer has been the biggest competition for muscle flaps in step-wise reconstruction of the lower extremity. Microvascular techniques have allowed for a variety of options for soft tissue coverage with predictable outcomes. However, these procedures are associated with longer duration of surgery and high peri-operative costs (8). Higher complication rates have also been found inpatients with multiple co-morbidities, likely related to increased anesthesia risk for lengthy procedures. The use of intrinsic muscle flaps like the abductor hallucis can help circumvent these issues through relatively short surgical times; shorter hospital stays; and faster, dependable healing rates.

Primary closure of extensive wounds may require removal of large portions of underlying bone to prevent complications. The use of the abductor hallucis muscle flap in our case report allowed for complete coverage of the defect without having to resect more underlying bone than needed. This is a critical consideration in cases of Charcot neuroarthropathy since further resection of bone can disrupt the overall stability of the foot. On the same note, circular external fixation permits a stable biomechanical construct to help prevent subsequent dislocation and collapse (9). External fixation further offers offloading to the flap and easy access for flap monitoring compared to conventional casting or splinting methods. This technique can also be used in staged Charcot reconstruction to augment osseous procedures (5).

The most commonly encountered complications of muscle flaps are related to technical mistakes. Careful atraumatic technique with loupe magnification is imperative during harvest and rotation of the pedicled muscle flap (3). A handheld Doppler is useful to check viability of the dominant pedicle (8). Circular external fixation should only be used by the experienced reconstructive surgeon who is well aware of the technical demands associated with this modality both intra-operatively and post-operatively.

Conclusion

Diabetic foot wounds with superimposed Charcot neuroarthropathy and osteomyelitis remain a challenge for reconstructive surgeons. The abductor hallucis muscle flap with circular external fixation can be an ideal for diabetic patients affected by multiple co-morbidities based on the straightforward approach with short operation time compared to microvascular free flap techniques for wound coverage. Despite the effectiveness of these techniques, one should not underestimate the importance of careful patient selection and adherence to stand principles of infection management in this high risk patient population. Future long-term studies regarding the use of intrinsic muscle flaps of the foot in conjunction with circular external fixation will hopefully shed light on the long-term effectiveness of these reconstructive procedures in diabetic patients.

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