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Ostectomy and Medial Plantar Artery Flap Reconstruction for Charcot Foot Ulceration Involving the Midfoot

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ABSTRACT

Charcot foot is a serious complication of diabetes, characterized by deformity and overlying ulceration. The condition most commonly affects the midfoot. However, little information is available on the use of a medial plantar artery flap to treat diabetic midfoot ulceration. The purpose of the present study was to evaluate the versatility of ostectomy and medial plantar flap reconstruction for midfoot plantar ulceration associated with rocker-bottom deformity secondary to Charcot foot. Four patients underwent ostectomy and medial plantar flap reconstruction. Before flap reconstruction, the devitalized soft tissues and bone were radically resected. After the infection had been controlled, the ulcerated portion was minimally excised, and the bony prominence underlying the ulcer was removed. A medial plantar artery flap was applied to the ulcer. The donor site was covered with a split-thickness skin graft or artificial dermis. In all patients, the ulcers healed and independent ambulation was achieved. However, 1 patient experienced ulcer recurrence, and subsequent infection necessitated a major amputation. Limb salvage is challenging in the setting of deformity and intractable plantar ulceration. The advantages of medial plantar artery flap reconstruction are that tissues with a rich blood supply are used to cover the exposed bone, and the flap can withstand the pressure and shear stress of the patient's body weight. However, a dominant artery in the foot is sacrificed. Therefore, the patency of the dorsalis pedis artery must be confirmed in every patient. The results of the present study have demonstrated that a medial plantar artery can be an effective alternative for diabetic patients with a plantar ulcer secondary to Charcot foot.

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Limb salvage in Charcot foot is challenging in the setting of a severe deformity and intractable plantar ulceration. Charcot foot is a limb-threatening destructive process that occurs in patients with sensory, motor, and autonomic neuropathy associated with medical diseases such as diabetes mellitus (1). The condition most commonly involves the midfoot, and progressive deformity and collapse over time can lead to plantar midfoot ulceration.

The standard treatment of Charcot plantar ulceration is off-loading (2). However, some severe cases will have extensive soft tissue defects and high plantar pressure caused by the bony prominence beneath the ulceration. Such patients cannot be effectively treated with nonoperative measures, such as off-loading and local wound care. Ostectomy is a viable option to treat rocker-bottom deformity with a bony prominence causing ulceration, as long as the remainder of the foot is stable. The bony prominence can be removed directly from the ulcerated area or indirectly through surgical excision along the base of the exostosis. Ostectomy enables the establishment of a plantigrade foot that can be appropriately accommodated (3,4).

In 1979, Shanahan and Gingrass (5) first reported the use of a medial plantar artery flap to cover heel defects. In 1981, Harrison and Morgan (6) used a fasciocutaneous island flap based on the cutaneous branch of the medial plantar artery to treat calcaneal defects. The method was popularized during the 1980s, and today, the medial plantar flap has been widely used for heel and plantar reconstruction. It has been applied to tissue defects after trauma, tumor ablative surgery, chronic ulcers, open amputation stamping, unstable scarring, and electronic injury (7–10). The flap has the ideal thickness and durability to withstand the pressures and shear stress of body weight. Other advantages include minimal donor site morbidity and reliable vascularity (11). However, the application of the medial plantar artery flap for Charcot foot ulceration has not been well described. Medial plantar artery flap reconstruction might shorten the treatment duration and provide good functional outcomes.

The purpose of the present study was to evaluate the efficacy of ostectomy and medial plantar flap reconstruction to treat midfoot

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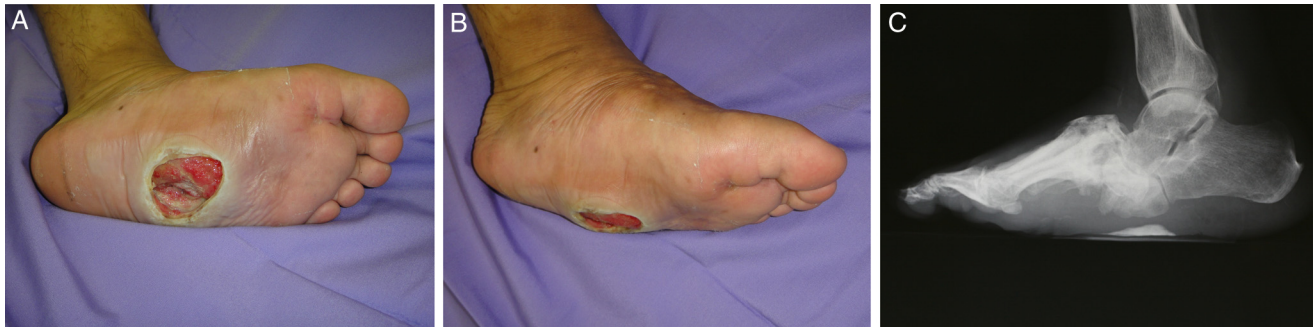

Fig. 1. (*A* and *B*) Charcot foot ulceration in a 42-year-old male with diabetes mellitus. (*C*) Radiographs showing midfoot collapse and bony prominence as a result of the dislocated cuboid.

plantar ulceration associated with rocker-bottom deformity caused by Charcot foot in patients with diabetic neuropathy. We present our experience with a small group of patients, provide the details of our technique, and report the short- and intermediate-term outcomes.

Patients and Methods

We conducted a retrospective study of 4 patients with Charcot foot who had undergone ostectomy and medial plantar artery flap reconstruction from June 2008 to March 2012. All ulcers were plantar to the lateral column. The indication for this procedure was the presence of extensive skin and soft tissue defects of the plantar with osteomyelitis (Fig. 1). None of the lesions were treatable by simple wound closure or skin grafting. None of the patients had instability of the midfoot.

The preoperative characteristics of the patients are listed in the Table. Of the 4 patients, 3 were male and 1 was female. The mean age was 44.7 (range 41 to 49) years. All 4 patients had developed Charcot foot as a result of diabetic neuropathy. Semmes–Weinstein monofilament testing revealed that all patients had sensory loss on the plantar surface and heel. Also, 3 patients had end-stage renal disease and were undergoing hemodialysis. The ulcers were recurrent and had been present for an average of 14.3 (range 4 to 39) months before surgery. In all patients, conservative treatment, including off-loading and local wound care, had failed, and 1 patient had undergone previous skin grafting without ostectomy of the underlying bony prominence.

All the patients were preoperatively evaluated for peripheral artery disease; they underwent duplex scans, and no vascular occlusion or stenosis in the lower extremity was detected. Transcutaneous oxygen tension on the foot and ankle was normal in all the patients.

Operative Procedure

The patients underwent wound bed preparation before flap reconstruction. The presence of osteomyelitis was determined by magnetic resonance imaging and a positive culture on histopathologic examination after bone biopsy. Surgical debridement was performed with radical resection of the devitalized soft tissue and infected bone. Patient 1 required 3 surgical debridement treatments to eradicate the necrotic tissue. The other 3 patients underwent 1 surgical debridement. Intravenous antibiotics were used for $\geq$4 weeks. Wound bed preparation was continued until the signs of increased bacterial burden (i.e., wounds with debris, increased exudate, friable tissue, and smell from the wound) had diminished. After the infection was controlled, negative pressure therapy was used to treat the wounds for 3 weeks.

Just before flap reconstruction surgery, a handheld Doppler ultrasound device was used to mark the medial plantar artery. Under tourniquet control, the ulcerated portion, including the callus around the wound edge, was minimally excised. Plantar midfoot ostectomy was performed to excise the bony prominence that had caused the ulcer. The flap was designed on the instep of the foot, and was the same size as the defect. The long axis of the flap was parallel to the medial plantar artery as previously marked. The skin incision was started from the medial margin of the flap, and the flap was dissected in a subfascial plane above the abductor hallucis muscle. Next, the medial plantar artery was identified, and the fasciocutaneous flap was elevated, including the plantar fascia and medial plantar vessel bundle. The flap was elevated until it easily reached the defect, without any tension. The tourniquet was released and hemostasis confirmed. The flap was transferred to the defect and sutured carefully to cover the excised bone surface and avoid creating any dead space (Fig. 2). Suction drains were placed under the flaps. The donor site was covered with a split-thickness skin graft in patients 1 and 2. In patients 3 and 4, tendon was exposed in the donor site. Initially, an artificial dermis was used to cover the site, and secondary skin grafting was performed 3 weeks after the flap surgery.

Follow-Up

All the patients were referred for rehabilitation in the early postoperative period. Partial weightbearing was allowed after 4 weeks. After the postoperative edema had resolved, each patient received a custom-made insole and Charcot restraining orthotic walker (CROW). Ambulation was resumed between postoperative weeks 5 and 6. The

Table
Patient characteristics

Patient No.	Age (y)	Gender	Wagner's Classification	Comorbidities	Ulcer Duration (mo)	HbA1c (%)	Flap Result	Follow-Up (mo)	Outcome
1	47	Female	III	Diabetes	7	7.7	Complete flap survival	42	Ulcer recurrence, below-the-knee amputation
2	41	Male	III	Diabetes, ESRD	39	5.5	Complete flap survival	41	No recurrence
3	42	Male	III	Diabetes, ESRD	7	5.3	Complete flap survival	23	No recurrence
4	49	Male	III	Diabetes, ESRD	4	5.6	Complete flap survival	19	No recurrence

Abbreviations: ESRD, end-stage renal disease requiring hemodialysis; Hb1Ac, hemoglobin 1Ac.

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