



Empty Toe Phenomenon: A Rare Presentation of Closed Degloving Injury of the Foot



Adam L. Bingham, DPM¹, Lawrence M. Fallat, DPM, FACFAS²

¹Foot and Ankle Specialty Clinic, Russellville, AR

²Diplomate, America Board of Podiatric Surgery, Director, Podiatric Surgical Residency, Beaumont Hospital-Wayne, Wayne, MI

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ABSTRACT

Traumatic degloving injuries of the lower extremity are commonly diagnosed by soft tissue deficits and separation of soft tissue planes. The management of open degloving injuries is well documented with established treatment protocols. Because closed degloving injuries of the lower extremity are so rare, the protocol management is not well established. Unlike open degloving injuries, evidence of soft tissue injury and detachment of the tissue planes can be subtle. Owing to the rarity of these injuries, little has been described regarding the long-term outcomes. In the present report, 2 closed degloving cases are presented. The first case presented is of a 27-year-old railroad worker who sustained a severe closed degloving injury of his foot with digital soft tissue envelope transposition. The second case involved a 60-year-old automobile manufacturer, whose foot was crushed by a hydraulic fork lift, creating a degloving injury of the third, fourth, and fifth toes. The follow-up duration from the date of injury for patient 1 was 26 months and for patients 2 was 16 months. The purpose of presenting these cases is to report these rare injuries with the treatment, complications, and outcomes.

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Traumatic open degloving injuries typically present with varying amounts of partially or completely detached skin and soft tissue. These injuries are easy to visualize and diagnose by the obvious tears and detachment of tissue. Because open degloving injuries are more common, many case studies and studies have been reported describing various protocols for treatment with both short- and long-term outcomes.

Closed degloving injuries are rare and occur as a result of a violent shearing force applied across the skin surface that separates the skin and subcutaneous soft tissue from the deeper fascia planes without rupture of the dermal or epidermal tissue plane. The shear force transects the perforating vessel anastomoses between the tissue planes, creating a resultant void, liquefied fat necrosis, and vascular injury (1,2). This results in large hematoma formation, venous congestion, and inhibition of revascularization of the superficial tissue. The detached tissue then relies primarily on the subdermal plexus for its nutrient supply. Often, the loss of the blood supply results in rapid gangrenous necrosis of the superficial soft tissues.

From our review of the peer-reviewed published data, only 5 cases have been documented describing “empty-toe” and “closed degloving

injuries” specific to the lower extremity. The earliest case was reported by Matelic and Manoli (3) in 1994. They described a crush injury with degloving and translocation of the fifth digit into the fourth web space. This was managed with simple closed reduction, which restored the blood flow. The patient was placed in a cast shoe for 1 week, after which he returned to his normal activities with no subsequent complications (3). In 1998, Flaherty et al (4) described a similar traumatic crush injury involving the second digit with transposition of the distal and intermediate phalanx vertically beneath the proximal phalanx. Because of the severity of the crush injury, the digital soft tissue envelopes were unsalvageable, and the patient underwent transmetatarsal amputation (4). Additional cases have been reported by Tarleton et al (5), Singh and Downing (6), and Tang et al (7), who all described fifth digit degloving and translocation to the fourth web space. All 3 cases resulted in surgical amputation or auto-amputation of the affected digit. The purpose of the present report was to report 2 cases of these rare injuries with the treatment, complications, and outcomes.

Case Report

Patient 1

A 27-year-old male railroad worker was treated from September 2012 through November 2014. He presented to the emergency

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Address correspondence to: Lawrence M. Fallat, DPM, FACFAS, Podiatric Surgical Residency, Beaumont Hospital-Wayne, 33155 Annapolis Street, Wayne, MI 48184.

E-mail address: lfallatdpm@aol.com (L.M. Fallat).



Fig. 1. (A) View showing significant edema and separation of toes. (B) No resistance was present with dorsiflexion of digits.

department (ED) after injuring his right foot while at work. As a railroad employee, he was riding on a gondola train car and was trying to engage the hand brake when he slipped. In an attempt to prevent falling, he grasped the side ladder of the railroad car, but his right foot slid in front of the train car wheel and was crushed. The patient presented to our institution's ED for evaluation. He was in good health without a significant medical or surgical history. He had allergies to penicillin, mangos, and whole wheat. His family history was significant for stroke, diabetes mellitus, and arthritis; his social history was noncontributory. The patient was not taking any home medications. At the initial presentation, he was alert and oriented with a Glasgow coma scale score of 15, with the injury localized only to the foot, without extension to the ankle, knee, hip, abdomen, head, neck, or back. No other penetrating trauma was identified. The lower extremity examination revealed intact biphasic dorsalis pedis and posterior tibial pulses. The patient had significant 2 plus edematous soft tissue changes, and a superficial 2-cm laceration medial to the navicular tuberosity (Fig. 1). The patient was unable to move the lesser digits, and fluctuance of toes 2 through 5 was present, with no resistance to manipulation. Sensation was mildly diminished to the hallux but intact to the remainder of the foot. The patient's pain was 10 of 10 on the visual analog scale for pain that decreased to 6 of 10 with intravenous hydromorphone.

Radiographs and computed tomography (CT) of his right foot revealed dislocation of the right hallux interphalangeal joint and dislocation and translocation of the right second digit (proximal, intermediate, and a segmental portion of the distal phalanx), with reentry into the hallux soft tissue envelope. Complete translocation of the third digit (proximal, intermediate, and distal phalanx) had occurred, with reentry into the second digit soft tissue envelope. The fifth digit was also transposed, with reentry into the fourth digit soft tissue envelope, in conjunction with the fourth digit, and a nondisplaced cuboid fracture and fracture involving the first tarsometatarsal joint (Fig. 2). Additional radiographs of the

patient's knee, tibia, fibula, and ankle revealed unremarkable findings.

Neurovascular checks performed every hour revealed a progressive decrease of sensation to the toes. At 4 hours after the initial ED evaluation, the loss of sensation had progressed from the great toe to the lesser toes and had extended proximally to the level of the metatarsophalangeal joints. Because compartment syndrome was suspected, immediate surgical intervention was recommended. The procedures were planned to include compartment pressure measurement with decompression if indicated and reduction of the translocated digits.

The patient was taken to surgery directly from our institution's ED. Spinal anesthesia was performed, and the patient received clindamycin 300 mg intravenously preoperatively. Using compartmental pressure instrumentation, the intracompartmental pressure was 75 mm Hg in the second interosseous space, 64 mm Hg in the third, 60 mm Hg in the deep central, 25 mm Hg in the lateral, and 28 mm Hg in the medial compartment. Fasciotomies of the second and third interosseous and deep central compartments were performed.

Closed reduction of the translocated toes was performed with intraoperative fluoroscopic assistance. Gentle distraction and closed reduction was successful in relocating the fourth and fifth digits. Toes 2 and 3 were nonreducible by this technique, and surgical relocation into their respective soft tissue envelopes was accomplished through dorsal incisions and manual relocation. Because none of the digits would remain in their soft tissue envelopes, Kirschner wires (K-wires) were used to maintain the reduction and stabilize toes 2 through 5 (Fig. 3). It was also noted that each digit had complete tears of the extensor tendons with retraction into the proximal foot. To minimize any additional trauma, it was thought that the tendons could be repaired at a later date. To prevent additional retraction, the tendons were tacked to the adjacent soft tissue with simple sutures. The interphalangeal joint of the great toe could not be reduced with a closed approach; thus, a lazy S incision was placed over the

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