

DORSAL DISLOCATIONS OF THE FIRST METATARSOPHALANGEAL JOINT: Review of the Literature and Case Presentation of a Jahss Type III Injury with Rationale for Surgical Repair

Charles C. Edwards, DPM

D. Scot Malay, DPM, FACFAS

While dorsal dislocations of the first metatarsophalangeal joint have been described in the medical literature with increasing frequency over that past several decades, the injury remains relatively uncommon due to the inherent stability of the joint. Despite the increasing understanding of the anatomy, biomechanics and pathomechanics of the injury; no consensus as to conservative versus surgical treatment exists due to the widely variable published reports. This paper reviews the anatomy, biomechanics/pathomechanics, and classification of these injuries with a review of the related literature. We then present the case of a Jahss Type III injury which was surgically repaired and describe the rationale for open repair of this and other types of first metatarsophalangeal joint dislocations.

PERTINENT ANATOMY AND BIOMECHANICS

The first metatarsophalangeal joint is a ginglymoarthrodial (hinge-like) joint comprised of the articulation between a round metatarsal head and the shallow recess of the base of the proximal phalanx.³⁰ This joint derives the majority of its stability from strong capsular and ligamentous attachments as well as the fibrous plantar plate containing the tibial and fibular sesamoids. Several crossing tendons add further stability to the joint, predominantly in the sagittal and transverse planes. These include the conjoined medial (abductor hallucis and medial head of flexor hallucis brevis) and lateral (adductor hallucis and lateral head of flexor hallucis brevis) tendons which completely invest the medial and lateral sesamoids, respectively. These conjoined tendons continue distal to each sesamoid as the sesamophalangeal ligaments which insert into the plantar base of the first proximal phalanx.

According to Root, et al. a minimum of 65°-75° of first metatarsophalangeal joint dorsiflexion is required for normal locomotion during propulsion. At the end range of hallux dorsiflexion the sesamoids complete up to 1 cm

of distal excursion on the plantar first metatarsal head to lend biomechanical advantage to the first ray flexors. This allows for near-vertical positioning of the metatarsal, permitting the dorsal articular surface of the metatarsal head to articulate with the base of the proximal phalanx.³⁰

PATHOMECHANICS AND CLASSIFICATION

Hyperextension injuries of the first metatarsophalangeal joint occur when the hallux is forcibly dorsiflexed on the head of the first metatarsal under axial load.²⁷ The injury may be staged by evaluating the progression of disrupted soft tissue and/or bone as increasing dorsiflexory force on the axially loaded first metatarsal occurs.⁶ The first stage is usually comprised by the rupture of the weaker proximal capsular attachment beneath the metatarsal neck. The hallux is then allowed additional range of motion and rides up onto the dorsal surface of the first metatarsal head, drawing the plantar plate and sesamoids distally and dorsally. The medial and lateral conjoined tendons are drawn taut on either side of the metatarsal head effectively entrapping it in a plantar flexed attitude. At this stage the medial and lateral collateral ligaments and the intersesamoidal ligament are not disrupted. This injury as described has been classified as a Jahss Type I injury,⁶ which is usually not amenable to closed reduction. This is due to interposition of the plantar plate and sesamoids within the joint, as well as the "noose" of conjoined tendons encircling the metatarsal head and neck. Open reduction is typically required and involves transection of the deep transverse metatarsal ligament and/or one of the conjoined tendons proximal to a sesamoid to provide enough soft tissue laxity to allow for reduction.

With additional force and hyperextension of the joint, one or both of two events in the second stage of injury occur. In the first scenario, the intersesamoidal ligament ruptures allowing the hallux to migrate even

further dorsally and proximally over the first metatarsal head. On an anteroposterior radiograph a wide separation between the sesamoids to the medial and lateral aspects of the first metatarsal head can be easily visualized. This has been described as a Jahss Type II-A injury.⁶ In the second scenario, the intersesamoidal ligament remains intact and either the tibial, or less commonly the fibular, sesamoid fractures. An anteroposterior radiograph with this type of injury depicts wide separation of the sesamoids with the avulsed portion of the affected sesamoid pulled either medially or laterally, and the remainder of the fractured sesamoid on the opposite side of the metatarsal head. This has been classified as a Type II-B injury.⁶ Variant Type II injuries or Type II-C¹⁶ injuries have been proposed to account for those cases in which both rupture of the intersesamoidal ligament and fracture or separation of a bipartite sesamoid occur. Type II injuries are generally reducible by closed means due to the decreased soft tissue strictures as the sesamoid complex becomes disrupted. However, if a sesamoid is fractured transversely or a previously bipartite sesamoid becomes separated as in a Type II-B pattern, the distal sesamoidal fragment may be drawn dorsally and distally with the proximal phalanx and interfere with attempts at closed reduction.

A third injury classification, Jahss Type III, was added to describe those injuries in which the sesamoid complex remains intact but does not dislocate or subluxate distally and dorsally with the proximal phalanx. This occurs when the plantar sesamophalangeal ligaments (the continuation of the medial and lateral flexor hallucis brevis tendons distal to their respectively enveloped sesamoids) are ruptured. An anteroposterior or lateral radiograph of this injury shows dorsal dislocation of the plantar phalanx with proximal retraction of the sesamoids. These injuries are usually readily reducible by closed means.

Regardless of the classification, it is understood that great force is required to dorsally dislocate this inherently stable joint. Ipsilateral injuries to the foot are commonly present due to the force and mechanism of injury. It stands to reason that the process of dislocating the concave phalangeal base over the convex metatarsal head can cause significant damage to the articular surface of the metatarsal head. Chondral or osteochondral defects should be suspected, and the presence of cartilagenous wafers which have been shorn from the metatarsal head may lead to additional morbidity after initial healing of the soft tissue structures occurs. Adelaar has described two additional chronic sequelae of first metatarsophalangeal joint dislocation. Adhesive capsulitis occurs with exuberant scarification of the disrupted capsulo-ligamentous complex, which may

cause secondary wear of the articular cartilage of the joint. Bony hallux limitus, which may precede the injury to the first metatarsophalangeal joint, exhibits dorsal osteophytes where osseous and soft tissue structures were traumatized.³¹

REVIEW OF THE LITERATURE

The authors have reviewed 26 papers printed in the English language since 1974 describing 43 cases of first metatarsophalangeal joint dorsal dislocations. There have also been published papers dealing with plantar,¹³ medial²⁵ and lateral¹⁷ dislocations of this joint. These injuries are not included or discussed in this paper.

It is generally accepted in the literature that Type I injuries are less common than Type II injuries, though more published information exists regarding the so-called "complex" Type I dislocations. This is likely due to the predominantly irreducible nature of Type I injuries which usually require open reduction. Of the 43 cases of first metatarsophalangeal joint dislocations described in the recent English literature, there are 22 Type I,^{3,5,8,9,10,11,15,17,20,22} 4 Type II-A,^{3,6,20} 7 Type II-B,^{1,2,4,6,7,12,19,26} 6 Type II-C,^{14,16,18,20,28} and 4 Type III^{3,21,23,24} injuries. We present the fifth case of a Jahss Type III injury in this paper. Among those reports describing the cause of injury, 22 cases were due to moving vehicle accidents^{1,3,4,5,6,8,9,10,11,12,15,17,18,19,21,21,22,23,25} and 9 cases occurred as the result of a fall at work or home.^{2,7,14,16,20,22,24,26,28,29} The cases caused by falls usually were due to a hallux fixed on an immobile object during the fall itself, resulting in hyperextension of the metatarsophalangeal joint. 26 of the 43 cases required either early or late surgical repair.^{1,2,3,4,5,6,8,9,10,11,12,15,16,18,21,22,26,28,29} 15 of the 26 surgical cases describe the incisional approach utilized, including 5 plantar,^{1,3,11,16,22} 5 medial^{1,5,18,21,28,29} and 5 dorsal^{5,8,9,10,22} incisions. 4 of the 26 papers described chondral or osteochondral defects within the first metatarsophalangeal joint.^{8,11,12,18} 18 cases exhibited concurrent ipsilateral metatarsal and/or tarsal injuries.^{1,2,4,10,11,12,14,17,19,20,21,22} Most published articles recommend surgical intervention for irreducible injuries, and conservative treatment for those injuries with a disrupted sesamoid complex and/or plantar plate which are generally amenable to closed reduction.

Of the 4 Type III injuries reported in the literature, 2 were treated by closed reduction^{23,24} and 2 required early (1) or late (1) surgical repair.^{3,21} One case had concurrent fractures of the second and third metatarsal heads and/or necks. All cases reported satisfactory results on follow-up evaluation. Our case presents a Type III injury in which immediate surgical repair was performed.

CASE DESCRIPTION

QJ is a healthy 19 year old male with no significant past medical, surgical or social history who sustained a right foot injury upon falling a moderate distance off a ladder. He was not able to recall the mechanism of injury, but believes he landed first on the ball of his right foot. He noted immediate pain and inability to bear weight on the affected foot, and was brought to the Presbyterian Medical Center Emergency Department where he was referred to the Podiatric Surgery service for evaluation and treatment.

Physical examination revealed a right foot with obvious dorsal dislocation of the first metatarsophalangeal joint without blanching of the plantar skin (Figure 1). The neu-

rovascular status of the foot was intact and normal, and no open lesions of the integumentary system were found. Focal edema centered about the first metatarsophalangeal joint. The patient refused palpable examination of the joint due to significant pain. Standard radiographs of the right foot were obtained and revealed complete dorsal dislocation of the first metatarsophalangeal joint without evidence of local or adjacent fractures (Figures 2, 3). Notably, the sesamoid complex remained plantar to the first metatarsal head, though retracted proximally to the level of the metatarsal neck. The diagnosis of a Jahss Type III injury was made, and the patient was informed as to both conservative (closed) and surgical (open) reduction options with their associated risks and benefits. The patient elected to undergo open reduction with surgical repair to more predictably assure full return to

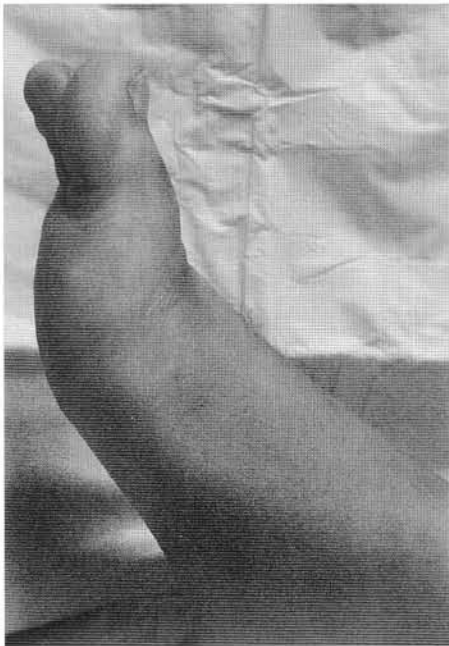


Figure 1.



Figure 2.



Figure 3.

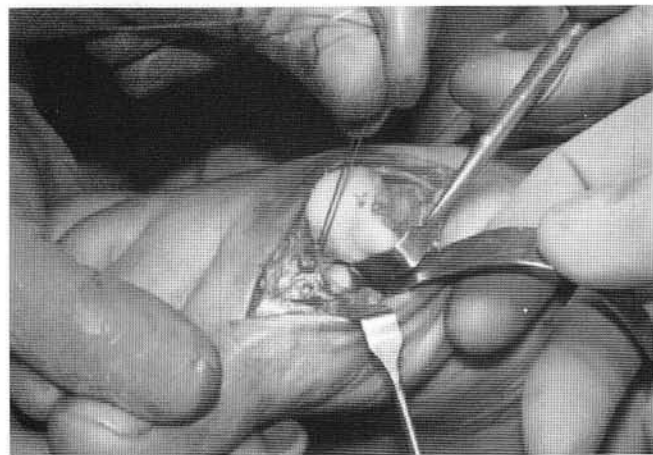


Figure 4.

physical activities and normal range of motion. No attempt at closed reduction was performed in the Emergency Department as the neurovascular status to the hallux was stable and open reduction was planned for that day.

After signing a consent for surgery, the patient was taken to the operating room where he was placed under monitored sedation and local anesthetic was infiltrated about the first ray. The right lower extremity was prepped and draped in the usual sterile fashion and a well-padded sterile tourniquet was placed about the ankle for hemostasis. The hallux was easily reduced by gentle distal distraction and slight pressure applied to the dorsal base of the first proximal phalanx. Next a 6 cm dorsomedial incision was performed and dissection was carried down in layers until the first metatarsophalangeal joint was fully exposed upon distal and plantar retraction of the hallux. The medial and lateral collateral ligaments were found to be intact, as were the intersesamoidal ligament and proximal attachments of the medial and lateral conjoined tendons to their respective sesamoids. Complete rupture of the medial and lateral sesamophalangeal ligaments were visualized with their respective stumps still attached to the plantar base of the proximal phalanx. A moderately sized osteochondral defect of the first metatarsal head was visualized within, and superior to, the medial sagittal groove (Figure 4). This was correlated with direct shearing force from the medial aspect of the first proximal phalanx as it dislocated dorsally over the metatarsal head. The loose cartilagenous flap was located within the joint at the time of capsulotomy and removed from the wound, and the exposed subchondral bone was drilled with a

0.062" k-wire for fibrocartilagenous filling of the defect.

Next the ruptured stumps of the medial and lateral sesamophalangeal ligaments were located both distal to the medial and lateral sesamoids as well as the plantar base of the proximal phalanx. A 2-0 polyester suture on a small needle was passed through the medial and lateral structures respectively and then hand-tied for reapproximation of the ligament ends and realignment of the sesamoid apparatus beneath the metatarsal head (Figure 4). The flexor hallucis longus tendon was avoided and seen to glide appropriately on hallux range of motion. Additionally, application of moderate force to the plantar central base of the hallux failed to re-dislocate the right with the repair as described. The wound was then irrigated and then closed in layers with absorbable suture. A sterile surgical dressing was applied maintaining the hallux in slight plantar flexion to decrease tension on the repaired ligaments. The patient was placed in a well-padded short leg cast and discharged from the short procedure unit the same day with instructions on remaining strictly non-weightbearing to the right lower extremity. Post-operative radiographs were obtained to ensure proper position and alignment of the joint and sesamoid apparatus (Figures 5, 6).

On the first post-operative visit 5 days after the procedure, the cast was clean, dry and intact and the neurovascular structures remained intact as evaluated at the exposed digital region of the short leg cast. The patient related no pain and had no difficulties remaining non-weightbearing to the right lower extremity. He returned 1 week later for cast and bandage removal and was found to have a healed surgical incision with minimal



Figure 5.

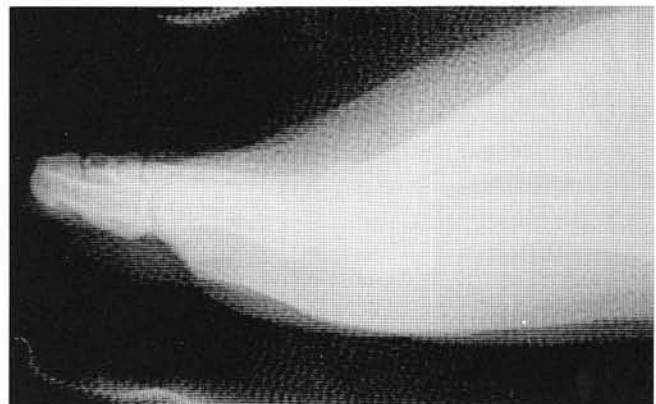


Figure 6.

edema about the first metatarsophalangeal joint. He complained of mild pain plantar to the joint on gentle passive range of motion in a dorsiflexory direction, but exhibited no subluxatory tendency on this maneuver. He was able to actively plantar flex and dorsiflex the great toe. The extremity was placed in a walking cast boot and he was instructed to bear weight to tolerance on the right foot, and instructed on active and passive range of motion exercises. At 1 month post-operatively the patient was seen on follow-up and stated he had improved to a level of no pain with good active and passive range of motion. He admitted to experimenting with ambulation in sneakers without discomfort. However, the patient related a doll house had been dropped directly over the right first metatarsophalangeal joint 2 days prior to follow-up examination, causing immediate pain and swelling. Radiographs were negative for fracture, and the first metatarsophalangeal joint and sesamoid-metatarsal joints appeared uninjured. Nonetheless, he was instructed to remain in the walking cast boot for an additional period due to the pain and swelling encountered by the recent accident. He will be re-evaluated periodically for the next year with particular attention to quality and quantity of active and passive first metatarsophalangeal joint range of motion as compared to the contralateral foot.

DISCUSSION

The majority of published literature recommends conservative treatment of reducible dorsal dislocations of the first metatarsophalangeal joint. However, several of the reducible Type II and Type III have required either early or late surgical repair. Watson, et al.²⁷ reported that surgical intervention is indicated for injuries to the first metatarsophalangeal joint when any of the following occur:

1. cartilagenous flaps/loose bodies lie within the joint,
2. a fractured or separated bipartite sesamoid is lodged within the articulation between the metatarsal head and the phalanx,
3. the sesamoid apparatus migrates proximally to the first metatarsal neck region,
4. gross instability of the joint is evident, and/or
5. persistent pain, synovitis or hallux limitus/rigidus is present.

Based on these recommendations it seems reasonable to assume all dorsal dislocations of the first metatarsophalangeal joint deserve surgical consideration, especially in younger or more active patients. Goals for the surgical management of these injuries should be to:

1. remove chondral or osteochondral flaps from the joint,
2. anatomically reapproximate disrupted soft tissue and/or osseous fragments,
3. preserve the appropriate relationship of the sesamoid apparatus to the first metatarsophalangeal joint to reduce the likelihood of developing a floating or non-purchasing hallux, and
4. allow for early active and passive range of motion to limit fibrosis of the joint.

SUMMARY

All dorsal dislocations of the first metatarsophalangeal joint should be suspicious for ipsilateral foot fractures and intra-articular pathology due to the great force required to incur the injury. Each case should be evaluated individually with an appropriate consideration of the risk versus benefit for both conservative and surgical repairs. Patient age, activity levels and desired level of physical activity after recovery are good markers for surgical versus non-surgical candidates. We have presented the case of a readily reducible first metatarsophalangeal joint dislocation in which an osteochondral defect and full rupture of sesamophalangeal ligaments were encountered. Should the dislocation have been closed reduced and treated conservatively, the likelihood of later sequelae seems to be high based on the loose chondral flap within the joint and proximal migration of the sesamoid apparatus. It is our opinion that surgical repair of this injury provided the patient with the best chance of long-term painless and proper functioning of this very important joint. We recommend surgical exploration and/or repair should be considered for all dorsal dislocation injuries of the first metatarsophalangeal joint, regardless of amenability to closed reduction.

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