



Avulsion fractures in the foot: telltale radiographic signs to avoid mismanagement

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ABSTRACT

Due to similar clinical presentations, avulsion fractures are frequently missed on initial exam and categorically treated as “sprain” not otherwise specified. However, delays in appropriate diagnosis and treatment can result in further injury and long-term disability. This article will review multiple foot avulsion fractures, their respective mechanisms of injury, the clinical and radiographic presentations, and the most appropriate courses of treatment.

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1. Introduction

An avulsion fracture occurs when a fragment of bone is pulled off at a tendinous or ligamentous bony insertion site, typically due to a sudden muscle contraction. The most common fracture of the foot is an avulsion injury of the tuberosity of the fifth proximal metatarsal base, which occurs at the insertion of the lateral band of the plantar aponeurosis and often heals without surgery. Another well-described avulsion injury of the foot is the calcaneal insufficiency avulsion fracture, which typically begins at the posterior calcaneal tuberosity and extends superiorly. While these two types of fractures have been described in recent literature, the various other avulsion fractures within the foot have received less attention. In deference to the multiple tendinous/ligamentous insertions within the foot, this article provides a comprehensive review of the injury mechanisms, clinical and radiographic presentations, and appropriate courses of treatment for common and rarer foot avulsion fractures.

2. Fifth metatarsal avulsion fractures

The most common fracture of the foot is a fracture of the fifth metatarsal base due to its lateral location and resultant susceptibility to external injuries (Fig. 1). A difference of millimeters in location, however, can lead to vastly different prognoses and treatment plans. Avulsion fractures of the fifth metatarsal tuberosity (also referred to as the styloid process) account for more than 90% of proximal fifth metatarsal

fractures [1], with the remainder consisting of Jones fractures and proximal diaphyseal stress fractures.

Avulsion fractures of the fifth metatarsal tuberosity are also known as “pseudo-Jones fractures” or “dancers’ fractures.” The mechanism of injury involves inversion of a plantar-flexed foot, with tension on the lateral component of the plantar aponeurosis and peroneus brevis tendon [2]. While the peroneus brevis tendon attaches to both the base and tuberosity of the fifth metatarsal, the lateral band of the plantar aponeurosis inserts into the tip of the cancellous tuberosity. These transversely oriented fractures typically involve the cubometatarsal joint without involvement of the intermetatarsal joint (which would be seen in a Jones fracture) [1].

Since tuberosity fractures occur with ankle inversion and symptoms are often mild, patients are often misdiagnosed with sprained ankles. On physical exam, tenderness is elicited at the base of the metatarsal, and swelling and ecchymosis may be seen at the site of maximal tenderness. While walking is usually possible, it is typically painful. Avulsion fractures of the base of the fifth metatarsal are best appreciated on anteroposterior (AP), lateral, and oblique weight-bearing radiographs of the foot. If, however, avulsion fractures are not seen on standard views, an additional AP view of the ankle including the base of the proximal fifth metatarsal should be obtained if clinical findings are suggestive of fracture [3]. The os peroneum may lie near the base of the fifth metatarsal, although its uniformly corticated appearance helps to distinguish it from fracture. In addition, in adolescents, a normal apophysis is present lateral to the tuberosity, which can be distinguished by its parallel orientation with the long axis of the fifth metatarsal and its smooth, well-corticated edges.

Nondisplaced or minimally displaced tuberosity avulsion fractures are treated conservatively with a hard-soled shoe or walking boot.

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Fig. 1. Oblique radiograph of the left foot demonstrates transversely oriented avulsion fracture (arrow) of the fifth metatarsal base at the insertion of the plantar aponeurosis and peroneus brevis tendon, compatible with “Pseudo-Jones” fracture.

Many studies have reported clinical healing at 3 weeks [4,5] with elastic wrapping [6,7] and weight bearing as tolerated [8]. Radiographic union is typically present within 8 weeks [9]. Fracture reduction and fixation should be considered in fractures involving more than 30% of the cubometatarsal joint [10–12], more than 2 mm of displacement, or comminution [8].

3. Cuboid avulsion fractures

Although cuboid fractures are rare, the most common forms result from either avulsion of ligamentous/capsular insertions [13] or impaction of the cuboid between the calcaneus and lateral metatarsals, termed “nutcracker fracture” (Fig. 2) [14]. Cuboid avulsion fractures occur on the plantar aspect of the cuboid at the insertion of the plantar calcaneocuboid ligament and can be associated with peroneus longus injury. Cuboid fractures occur with athletic injuries or in cases of high-velocity trauma after extreme plantar flexion and isolated sprain or dislocation of the calcaneocuboid joint. Patients with Ehlers–Danlos syndrome also have increased incidences of cuboid injury [15].

Cuboid fractures can present with varying lateral midfoot swelling and deformity. Ecchymosis over the cuboid, direct tenderness to palpation, and difficulty weight bearing raise suspicion for this injury. The cuboid is best evaluated radiographically with an oblique view to better

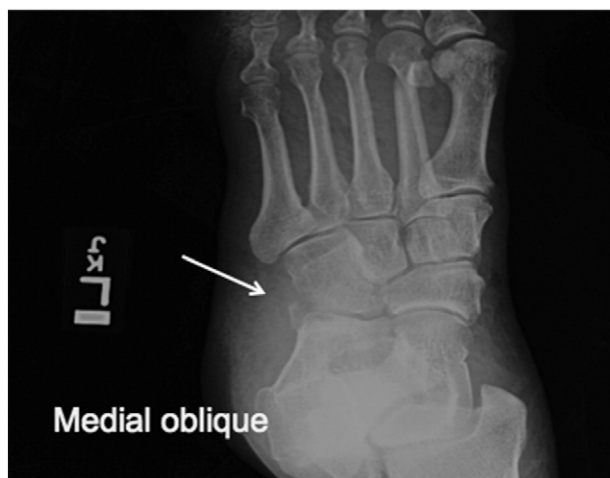


Fig. 2. Oblique radiograph of the left foot depicts cuboid avulsion fracture (arrow) at the insertion of the plantar calcaneocuboid ligament.

characterize the calcaneocuboid and metatarsocuboid articulations [16]. If a cuboid fracture is identified, weight-bearing views should be done to assess for occult ligamentous injury. Nondisplaced fractures are typically allowed to bear weight immediately in a walking boot with very good prognosis. DeLee, however, postulated that residual displacement of the articular surfaces of the cuboid could result in persistent subluxation of the midtarsal joint and consequently recommended open reduction and grafting to avoid long-term degenerative changes [16].

4. Navicular avulsion fractures

4.1. Median tuberosity navicular fractures

Medial eminence fractures are characterized by avulsion of the navicular median tuberosity at the attachment site of the posterior tibial tendon or spring ligament (calcaneonavicular) complex due to excessive eversion (Fig. 3A). These fractures often result from comminuted compression fractures of the cuboid (called “nutcracker fractures”) and involve calcaneocuboid joint capsule and calcaneonavicular ligament tears [17]. Most navicular median tuberosity fractures are minimally displaced due to the broad insertion of the posterior tibial tendon. Although they may occur alone, it is imperative to evaluate the midtarsal joint as occult fracture–subluxations across the joint have been described [18]. The mechanism of injury is typically from acute trauma consisting of pronation, external rotation, or dorsiflexion [17].

Best seen on AP and medial oblique views of the foot in equinus positioning [19], a coronal fracture line is seen with a proximally displaced median eminence secondary to tension from the posterior tibial tendon. Larger fragments may be confused with accessory ossicles, including os supranaviculare and/or os naviculare. Displacement less than 2–3 mm can be managed nonoperatively with a short leg walking cast or walking boot and progressive weight bearing over 6 weeks. Even in rare cases of nonunion, navicular median eminence fractures typically remain asymptomatic. Fragment excision and reattachment of the posterior tibial tendon may be indicated in cases of symptomatic nonunion. Patients may undergo open reduction and internal fixation with lag screw fixation in cases with more than 2–3 mm of proximal displacement, especially if posterior tibial tendon function is compromised [1,17].

4.2. Dorsal navicular fractures

Dorsal navicular avulsion fractures result from excessive plantar flexion or eversion of the midfoot, which causes avulsion of the dorsal navicular cortex by the talonavicular capsule and anterior fibers of the deltoid ligament (Fig. 3B) [1]. Radiographically, a small triangular fragment at the talonavicular joint is the best diagnostic clue [20]. Dorsal cortical avulsion fractures are generally managed conservatively with a supportive shoe, cast boot, or weight-bearing short-leg cast. In cases of major soft tissue swelling or severe pain, an avulsion fracture should be considered a more serious ligamentous injury and non-weight-bearing and immobilization for 6 weeks followed by progressive weight-bearing and rehabilitation may be indicated. If they are symptomatic, however, small nonarticular fragments may be excised, while large fragments (>25% articular surface) may be reattached with a lag screw [1].

5. Talar avulsion fractures

5.1. Posterior talar process fractures

The posterior process of the talus is composed of a lateral process and medial and lateral tubercles. The posterior process forms the undersurface of the posterior one fourth of the subtalar joint [21]. The lateral tubercle serves as the attachment site of the posterior talocalcaneal and posterior talofibular ligaments, while the medial tubercle serves as an

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