Fractures of the Proximal Fifth Metatarsal
Keeping Up with the Joneses

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Abstract
Fractures of the proximal fifth metatarsal are among the most common fractures of the foot. History, physical examination, and subsequent radiographic work-up can help with the diagnosis of such a fracture. Many fractures of the proximal fifth metatarsal can have an associated prodrome, thereby establishing a level of chronicity to the problem. Identification of the location of the fracture plane within the proximal fifth metatarsal can have prognostic implications in regards to fracture union rate and guide treatment options, due to the particular vascular anatomy of the region. Additional findings on physical exam, such as heel varus, can also impact prognosis and treatment options. Treatments can range from nonoperative to operative modalities, and time to weightbearing can vary. Within the realm of operative treatment, identification of certain parameters can aid in successful reduction and fixation of the fracture and thus impact healing. Careful consideration of the patient’s particular constellation of social and professional needs, clinical and radiographic parameters, and acceptance of different options can help guide treatment recommendations in the individual patient.

Fractures of the proximal fifth metatarsal are the most common fracture seen in the foot.1 Anecdotally once felt to be a rare occurrence, these injuries were initially described in 1902 by Sir Robert Jones in a series of six cases including one in his own foot. Prior to his description of sustaining the injury through “indirect violence,” it was widely accepted that the predominant mechanism by which a proximal fifth metatarsal fracture could be sustained was by direct load on the region of fracture.2 Epidemiological studies in populations greater than 5 years of age have demonstrated that the twisting of the foot or fall from standing height to be by far most common mechanism of injury.1,3,4 Age distribution peaks were noted in the third and sixth decades of life, with a shift from younger males becoming injured in sports like soccer to elderly females.1,5,6

It has been estimated that 1 in 10,000 people sustain an injury to the foot or ankle daily, with an estimated 5 million radiographic series ordered annually in Canada and the United States.7,8 The differential diagnosis of a proximal fifth metatarsal injury may include midfoot and ankle sprains, plantar fascial ruptures, ruptures of the peroneal tendons, and fractures of other midfoot and hindfoot bones. To delineate those injuries which require further radiological investigation, the Ottawa Foot Rules were devised as an extension of the Ottawa Ankle Rules for the purpose of reducing unnecessary radiographs in the diagnosis of midfoot injuries. The criteria for the Ottawa Foot Rules are displayed in Table 1. A radiographic workup is indicated if the patient has pain in the midfoot zone and any one of the following: bone tenderness at the base of the fifth metatarsal, bone tenderness at the navicular, and an inability to bear weight both immediately and in the ER for four steps. They have been found to be up to 100% sensitive and 79% specific for the identification of proximal fifth metatarsal fractures.8-11

Additionally, by history this complaint may be acute, chronic, or acute-on-chronic involving a prodrome of pain with sudden worsening after a particular injury. Careful history taking may provide clues to a possible underlying etiology for the fracture sustained, which in combination with radiographic findings may influence the treatment rendered.12,13
A subset of proximal fifth metatarsal fractures have been identified for their potential to develop into a delayed or nonunion, while others proceed on to heal uneventfully with little to no intervention. A number of classification schemes describing proximal fifth metatarsal fractures have been devised over the years to help physicians determine prognosis and treatment, in what has been determined to be distinctly different fracture injuries.

In 1960, Stewart described a classification scheme based on the fracture location and morphology (Table 2). Stewart’s classification differentiated between type I, extra-articular fracture between the metatarsal base and diaphysis; type II, intra-articular fracture of the metatarsal base; type III, avulsion fracture of the base; type IV, comminuted fracture with intra-articular extension; and type V, partial avulsion of the metatarsal base with or without a fracture.

Subsequent series described and classified proximal fifth metatarsal fractures based on differences in outcome in relation to anatomic location. Dameron in 1976 noted that patients with fractures through the fifth metatarsal tuberosity tended to have an uneventful healing course, whereas those with fractures distal to the insertion of the peroneus brevis were more prone to prolonged symptoms and delayed union. Later contributions to the literature have described anatomic classifications of proximal fifth metatarsal fracture into 3 zones: zone 1, tuberosity avulsion; zone 2, metaphyseal-diaphyseal junction; and zone 3, proximal diaphyseal stress fracture (Table 2). Currently, it is commonly accepted that fractures in zone 2 are true “Jones fractures” (Fig. 1) and fractures in zone 1 are “pseudo-Jones fractures” (Fig. 2). In a review of

### Table 1

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<th>Ottawa Foot Rules–Determine the Need for Radiographic Evaluation of the Foot</th>
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<tr>
<td>Pain in the region of the midfoot and one of the following:</td>
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### Classification Schemes through History

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<th>Stewart</th>
<th>Dameron</th>
<th>Torg</th>
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<tr>
<td><strong>Type I</strong> - Extra-articular fracture between the metatarsal base and diaphysis</td>
<td><strong>Zone 1</strong> – Tuberosity avulsion</td>
<td><strong>Type I</strong> – Acute – Narrow fracture line with no intramedullary sclerosis</td>
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<tr>
<td><strong>Type II</strong> - Intra-articular fracture of the metatarsal base</td>
<td><strong>Zone 2</strong> – Metaphyseal – Diaphyseal junction</td>
<td><strong>Type II</strong> – Delayed Union – Widened fracture gap and intramedullary sclerosis</td>
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<tr>
<td><strong>Type III</strong> - Avulsion fracture of the base</td>
<td><strong>Zone 3</strong> – Proximal diaphyseal stress fracture</td>
<td><strong>Type III</strong> – Nonunion – Obliteration of the medullary canal</td>
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<tr>
<td><strong>Type IV</strong> - Comminuted fracture with intra-articular extension</td>
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*Figure 1 Jones fracture.*
32 Jones fractures as compared to 29 proximal diaphyseal fifth metatarsal fractures, Chuckpaiwong noted no difference in outcomes due to the location of the fracture with a similar treatment protocol. They found a higher union rate with operative treatment of meta-diaphyseal and diaphyseal fractures.18

As the eponym “Jones fracture” elicits a connotation of the possibility of delayed or nonunion, Torg reviewed qualitative radiographic parameters and union rates in his series of patients. He used this information to describe a new classification system, which delineated the degree of radiographic sclerosis on presentation to help determine the age of the fracture on presentation. He then correlated the age of the fracture with the outcome. The Torg classification (Table 2) is divided into three types: Type I (acute), which had a narrow fracture line with no IM sclerosis; Type II (delayed union), with a widened fracture gap and intramedullary sclerosis; and Type III (nonunion), which demonstrated obliteration of the medullary canal. He noted that all but 1 of 15 of his Type I patients healed in 6 to 12 weeks in a non-weightbearing cast. In contrast, Type II patients treated nonoperatively required an average of 14.8 months (range 8 to 26) to achieve union. All of the patients in the series treated operatively (all Type III and some Type II) were seen to heal in 12 to 14 weeks time.19

**Anatomy of Injury and Healing**

As early as 1902, in Jones’ original description of his namesake fracture pattern and Carp’s 1927 series of 21 cases, the surrounding anatomy about the proximal fifth metatarsal has been implicated in its predisposition to injury and problematic healing.20 The blood supply of the proximal fifth metatarsal in the meta-diaphyseal junction has been implicated as the leading factor in the development of a delayed or nonunion in Jones fractures. The meta-diaphyseal junction represents a watershed region between blood supplies coming from proximally at the tuberosity via metaphyseal arteries where the peroneus brevis inserts and distally from a nutrient artery which enters a foramen on the tibial side of the bone which tracks proximally.21,22 With a relatively limited blood supply in the region, the meta-diaphyseal region of the fifth metatarsal becomes prone to poor healing and self-repair.

The most common mechanism of injury in fifth metatarsal fractures involves a fall from standing height or an ankle twist with the forefoot fixed. In this position, a pulling force from the lateral cord of the plantar aponeurosis along with tension from the peroneus brevis tendon causes a longitudinal and torsional strain. The act of repetitive cyclic loading, especially in the setting of a young athlete or military recruit, can lead to a chronic overloading predisposing one to a stress reaction and ultimately fracture.

Gu investigated the stress loads on the metatarsals during landing in a 3-dimensional finite element model of the foot. One of the peaks in stress points was found to be the proximal fifth metatarsal. As the angle of landing was changed to increasing inversion, lateral metatarsal stress was seen to increase.24 Clinically and radiographically, Raikin noted that 18 of 21 Jones fractures treated in his series had evidence of hindfoot varus, and he concluded that fractures of the fifth metatarsal may have a predisposing chronic etiology.25

**Treatment Options**

Since the early 1900s, treatment of fractures of the proximal fifth metatarsal has varied from soft dressings or rigid shoes to casting or ultimately surgical intervention. Different treatments have been met with a wide range of results, largely dependent on fracture type and location. It, therefore, becomes of utmost importance to properly determine the fracture pattern in order to select the most appropriate treatment.

There is a consensus that non-displaced fractures of the tuberosity of the fifth metatarsal, also known as an avulsion or “pseudo-Jones” fracture, tend to heal uneventfully within 3 to 12 weeks without operative intervention in nearly all
patients, despite level of treatment rendered. However, some patients may have some residual symptoms up to 6 months or 1 year’s time. Multiple studies, including a 12-week randomized control trial of 89 consecutive patients with fifth metatarsal tuberosity avulsion fractures, have compared treatment using a nonrigid, soft Jones’ dressing consisting of alternating layers of cast padding and elastic bandages with a rigid short leg casting. Treatment was seen to be no different in outcomes of time in treatment modality, time to radiographic healing, and functional foot score, and the Jones’ dressing had a significant 28% reduction in time to return to pre-injury levels of activity. Additionally, Vorlat found that the duration of the non-weightbearing period is the most important variable linked to final clinical outcome after an avulsion fracture of the proximal fifth metatarsal and noted poor functional outcome with non-weightbearing treatment. Other series have found good results when patients were allowed to bear weight as tolerated.

Surgical treatment of avulsion fractures has been advocated when there is greater than 2 mm of displacement at the fracture site or when the fracture extends into the cubo-metatarsal joint, though some may argue that these injuries represent more than a simple avulsion fracture based on the populations surveyed. Of note, as a consequence of operative treatment, additional protection by casting and partial weightbearing for the duration of bone healing should be provided.

Treatment of the true Jones fracture should include a period of non-weightbearing. In Torg’s series, even those fractures judged to be acute with no evidence of delayed or nonunion (“Type I”) at presentation, there was a 100% incidence of delayed or nonunion when patients were allowed to bear weight as tolerated. Sixty percent of these patients were symptomatic and went on to union after surgical intervention and a postoperative period of non-weightbearing.

Radiographic healing occurs in a medial-to-lateral direction and callus formation at the fracture site without intramedullary sclerosis can be seen by 6 to 8 weeks. For fractures that demonstrate little or no callus formation at 6 to 8 weeks, pulsed electromagnetic field therapy has been reported to be an effective alternative to surgery for the management of delayed union and nonunion of the proximal fifth metatarsal, with a mean time to healing of 3 months (range 2 to 4 months).

Aside from radiographic and clinic evidence of a delayed or nonunion event, considerations for the treatment of a Jones fracture with surgical intervention may include regard for the patient population, whether they are a high-performance athlete, military recruit, or simply an informed patient who prefers surgery to the risk of nonunion with nonsurgical treatment. For these patients, reliability of treatment and time to healing may be of utmost importance. In a randomized controlled trial of 37 military recruits, Mologne found 95% union rate with early fixation versus 66% union with casting, with earlier radiographic healing (6.9 vs. 14.5 weeks) and return to sport (7.9 vs. 15.6 wks). The only failure of operative fixation was attributed to the possibility that weightbearing was re-started prior to the fracture being fully healed. That patient went on to union after repeat fixation with bone-grafting. Other series also note high rates of union with operative fixation within a similar timeframe.

Operative contraindications may include patient factors, such as vascular compromise, local infection, or medical instability. However, a patient with well controlled diabetes is not necessarily a contraindication to surgery. Yue and Marcus reported success with open reduction and internal fixation of Jones fracture with bone grafting in patients with diabetes. They also noted that delayed open reduction and internal fixation with bone grafting after a trial of casting does not limit healing potential in these patients.

**Surgical Fixation through the Ages**

Historically, operative treatment of the Jones fracture has included crossed K-wire fixation, tension band constructs, and intramedullary devices. K-wire and tension band constructs are more poorly tolerated and tend to require hardware removal. Additionally, intramedullary screws have been shown to have statistically significant fixation strength improvement over tension banding for avulsion fractures in both polystyrene foam models and fresh, nonpreserved frozen cadaveric samples. Intramedullary devices have, thus, become the mainstay of surgical treatment of Jones fractures.

Intramedullary fixation devices may include locked intramedullary nails or intramedullary screws. In a retrospective study comparing an intramedullary nailing system locked with wires versus tension band constructs, IMNs were noted to be faster, with a smaller approach, theoretically biomechanically stronger, and had improved radiographic results. However, there was a slightly higher rate of irritation from the interlocking wires (56% vs. 51%), and hardware was removed in 68% of patients. There have been no comparisons to intramedullary screws.

**Operative Technique of Intramedullary Screws**

Intramedullary screws (Fig. 3) are currently the mainstay of treatment for operatively treated Jones fractures. The incisional approach for proximal fifth metatarsal fractures should be made proximal to the fifth metatarsal base between the peroneus brevis and longus tendons. A guidewire should be started in a high and inside position at the base of the fifth metatarsal. Intraoperative fluoroscopy is used to guide the placement of a guidewire and down the metatarsal shaft, and subsequently a screw is placed in the desired position. Care should be taken to avoid selection of an improper screw angle, which can lead to unicortical gapping at the fracture site and a prolonged time to union.

Selection of the appropriate parameters can lead to successful fixation of the fracture. In selecting a particular size screw to use, the selected screw size must allow adequate
endosteal bite of the screw threads with the screw threads passing the fracture for compression to occur. It has been noted that a better pull-out strength was achieved with a 6.5 mm screw as opposed to a 5.0 mm screw. On the other hand, maximizing screw diameter did not enhance bending stiffness, but it did increase risk of periprosthetic fracture. In terms of length, longer 5.0 mm screws are torsionally equivalent to 6.5 mm screws if they are long enough. However, the screw should not be excessively long, to prevent straightening of the naturally curved fifth metatarsal. Additionally, the use of a supplemental lateral hindfoot wedge orthotic has been advocated in the setting of hindfoot varus. In one report, 18 of 21 operative Jones fractures were noted to have some degree of hindfoot varus, versus a previous estimate of approximately 25% of the general population having hindfoot varus. In six of these patients, an event of re-fracture of screw breakage was noted without the use of a supplemental orthotic. Their study noted a 100% union rate with return to prior activity level and no recurrence of fractures, when operative Jones fractures with hindfoot varus were supplemented with an orthotic to offload the varus.

Complications
Complications of operative treatment of a proximal fifth metatarsal can include sural nerve injury, infection, re-fracture, nonunion, and potentially the need for subsequent surgical removal of hardware due to symptomatic hardware. Though clinical rates of nerve injury are not published in the literature, investigation of potential nerve injury was performed using a cadaveric study of 10 feet after undergoing placement of a cannulated screw. Exploration of the specimens revealed that the dorsolateral branch of the sural nerve was most at risk. Their results showed that the nerve was injured in one specimen; the nerve was contacted without frank injury in another; and the nerve was within 2 mm of the screw in 5 of 10 specimens and within 3 mm of the screw in 8 of 10 specimens. Studies that have included rates of re-fracture and non-union generally hypothesize that occurrences were due to the commencement of weightbearing activities too soon post-operatively. These events are relatively rare, and may also be due to an underlying varus hindfoot deformity. Lastly, no specific studies regarding removal of hardware due to symptomatology of cannulated screws have been reported.

Costs of Treatment
In an age of cost-consciousness in healthcare, one study from a private orthopaedic suburban practice noted very high satisfaction rates with treatment of proximal fifth metatarsal fractures with nonoperative measures. Their average cost for the total fracture care was $1,414.09 (range $692.50 to $2,820.50), which included physician fees, radiographs, and orthopaedic supplies. In this patient population, satisfaction with treatment was noted to be 100%, even in a patient with a delayed union of longer than 6 months. The investigators recommended nonoperative treatment of fifth metatarsal fractures for patients in whom the time to return to full activities is not critical. In comparison, no studies have estimated the cost of prolonged treatment with immobilization and weightbearing restrictions in regards to lost productivity.

Summary
The literature is full of many studies documenting the outcomes of fractures in the meta-diaphyseal and tuberosity regions of the proximal fifth metatarsal, treated in various nonoperative and operative modalities. Most series have a limited number of patients and represent Level IV evidence, though there are a handful of Level I and II studies in the literature. General consensus indicates that treatment of tuberosity avulsion fractures will be largely successful with nonoperative means with weightbearing as tolerated without immobilization. However, the true “Jones” fracture is one that is prone to nonunion without, at the minimum,
a restriction of non-weightbearing in conjunction to immobility or an operative treatment. This injury itself may represent a chronic or acute-on-chronic injury, based on clinical prodromes, radiographic findings of a stress reaction or delayed or nonunion, or the presence of a hindfoot varus in the setting of chronically loaded and stressed region of the foot. Nonoperative treatment has been shown to involve longer times to union and return to sport, though patients may still report a satisfactory result. Most surgeons would agree that operative indications include athletes needing to return to sport to sustain livelihood, nonunions, and widely displaced fractures. Given a thorough understanding of the risks, benefits, and alternatives of treatment options for their injury, an educated patient willing to undergo operative management of the fracture may also be an indication for surgery. In short, treatment of a fracture of the proximal fifth metatarsal should be based on the patient’s social situation, clinical and radiographic parameters, and willingness to undergo the treatment prescribed.

Disclosure Statement
None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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