Fractures of the fifth metatarsal; diagnosis and treatment

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A B S T R A C T

Of all foot fractures the fifth metatarsal fracture is the most common. A complete clinical and radiological assessment is required to select the best treatment option. Nondisplaced tuberosity avulsion fractures can be treated non-operatively. Surgical treatment is indicated when the fracture is displaced more than 2 mm or when more than 30% of the cubometatarsal joint is involved. Non or minimally displaced shaft fractures can be treated non-operatively. If the dislocation is more than 3–4 mm or the angulation is more than 10°, percutaneous K-wires, plate or screw fixation is indicated. The Jones fracture is known for prolonged healing time and non-union. The indication for surgical treatment of Jones’ fractures depends on activity level and Torg classification: type I fractures are treated non-operatively. Type II fractures can be treated non-operatively or operatively, depending on patient activity level. Type III fractures have more complications and should be treated operatively. Several operation techniques have been described.

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Introduction

Metatarsal fractures are injuries of the foot frequently seen in emergency departments. Classifications of these fractures are based upon anatomical region, patient history and radiological findings.5,23,33,46,47 Depending on these classifications and patient activity level, treatment can be conservative or operative.4,18,32,36,50 Most types of fractures of the fifth metatarsal have a favourable prognosis and can be treated conservatively.1 However the Jones fracture is known for prolonged healing time and even non-union.16,19,26,42 Several operation techniques have been described in the treatment of fractures of the fifth metatarsal. 11,24,31,38

The purpose of this review is to assess the optimal diagnosis and treatment strategy for the different types of fifth metatarsal fractures.
Methods

The search was performed with the help of a clinical librarian. We searched the Cochrane, Embase and Medline databases. The reference list of each referred article was screened for other relevant publications.

We used the following search terms: fifth metatarsal, metatarsal fractures, Jones fracture, non-operative treatment, operative treatment, internal fixation.

Results

Epidemiology and trauma mechanism

Fractures of the fifth metatarsal are the most common of metatarsal fractures in children over 5 years of age and adults. Approximately 45–70% of all metatarsal fractures involve the fifth metatarsal.12,24,30,41 Certain groups seem to be at risk: age distribution peaks in the second to fifth decades of life, mostly involving young men in organized sports.6,19,30,47 The majority of the metatarsal fractures sustained from sport are from soccer (73%), with the fifth metatarsal being the most commonly fractured.40 In motorcycle accidents metatarsal fractures are the most common injuries. In the elderly, women seem to be more affected.10,15

Most fractures are caused by a fall from standing height or an ankle twist with the forefoot fixed.30 In the latter, avulsion fractures of the base of the fifth metatarsal are caused by pull of the lateral cord of the plantar aponeurosis.37 Action of the peroneus brevis tendon causes further dislocation and torsional strain of the fracture.45 Jones fractures are transverse fractures on between the proximal diaphysis and metaphysis. They usually result from a vertical or mediolateral force on the base of the metatarsal of the plantar flexed foot, while the patient's weight is placed laterally from the foot.16,19 Stress fractures occur by chronic overloading and are most common in young athletes.15

Diagnosis

An acute fracture of the fifth metatarsal causes typical fracture symptoms. Patients complain about their inability to walk or bear weight after trauma. The lateral side of the foot is swollen, may develop ecchymosis and is painful on palpation. Axial compression provokes pain. In most emergency departments the Ottawa ankle rules are implemented.44 According to these clinical decision rules the clinical assessment of every acute ankle injury should include palpation of both malleoli, navicular bone and base of the fifth metatarsal. If the Ottawa ankle rules are positive for tenderness at the fifth metatarsal radiographs of the foot should be performed. This includes three standard views: the antero-posterior (AP), lateral and oblique view. However, some avulsion fractures at the tip of the tuberosity may not be recognised in these standard views. In the study of Pao et al. up to 23% of the avulsion fractures were not seen on standard foot radiographs. They therefore suggest that an additional AP view of the ankle including the base of the proximal fifth metatarsal should be obtained if clinical findings are suggestive of a fracture.29

A stress fracture is caused by a sudden increase in activity, extensive sports practice or chronic repetitive forces. Initially, patients only complain about pain during activity (prodromal phase). If the stress fracture progresses under ongoing activity, progressive pain and swelling occur and the fracture will have “typical fracture symptoms” as described above. Differentiation between acute and stress fractures is based on patient history, since radiological appearances can be very similar. However, in the prodromal phase stress fractures are rarely visible on radiographs. They appear as well-defined linear lucencies or fluffy periosteal reactions after 2–6 weeks. The periosteal reaction is variable and is occasionally florid. In the early phase magnetic resonance imaging (MRI) or a technetium bone scan can be helpful for confirmation. However in most cases patient history, physical assessment and

Fig. 1. Tuberosity avulsion fracture.
radiography will lead to the right diagnosis and other expensive investigations will not be cost effective.11

Classification

From anatomical point of view the fifth metatarsal can be divided in a basal (proximal), midshaft, subcapital en capital part (Fig. 6). The AO classification of fractures differentiates between extra- (type A) and intra-articular fractures (type B) and fracture dislocations (type C and D) with different subgroups.

Since most fractures are located at the proximal part and prognosis and treatment are different depending of the type of proximal fracture, this has been a point of interest in literature. Most classification systems therefore focus on proximal metatarsal fractures only.

Sir Robert Jones was the first to describe a specific fracture of the fifth metatarsal. In 1902 he described a fracture at ‘the proximal 3/4 segment of the shaft distal to the styloid by indirect violence of his own foot and that of four other patients.16 This so-called Jones’ fracture was later defined as a transverse fracture at the metaphyseal/diaphyseal junction without distal extension beyond the fourth to fifth intermetatarsal articulation.22,43 This type of fracture has been recognised for its delayed union, non-union and difficulties in treatment.2,5,19,45

This healing problem was later explained by a watershed in blood supply at that junction.39,42 In order to avoid the confusing term Jones’ fracture and to distinguish between other fracture types with a variable healing tendency, proximal metatarsal fractures were classified.

Dameron, Lawrence and Quill divided proximal fractures in three anatomic subgroups: tuberosity avulsion fractures in zone 1 (Figs. 1 and 7), fractures at the metaphyseal/diaphyseal junction (Jones fracture) in zone 2 (Figs. 2 and 7) and proximal diaphyseal stress fractures in zone 3 (Figs. 3 and 7).5,22,33

The distinction between Jones and proximal diaphyseal fractures is often difficult because of their close anatomic proximity. A recent study determined that differentiation between Jones and proximal diaphyseal fractures is not necessary because regardless of treatment type the clinical outcomes were not different between the two fracture locations.3 The Stewart classification of fifth metatarsal fractures 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 (Fig. 8).43

Torg developed a classification for fractures of the base distal to the tuberosity (former Jones’ fracture and proximal diaphysis fracture), which is based on radiological appearances and healing potential. According to this classification there are three types of fracture, requiring adjusted management strategies. Type I fractures are characterized by a narrow fracture line and absence of intramedullary sclerosis (Fig. 2), type II by a widening of the fracture line and evidence of intramedullary sclerosis (Fig. 3) and type III by complete obliteration of the medullary canal by sclerotic bone (Fig. 4).23,46,47

The Torg classification is widely used. This classification implies what has become the standard treatment strategy for Jones and
proximal diaphysis fractures. Therefore we use the Torg classification for Jones’ fractures.

**Treatment options and outcomes**

**Nondisplaced tuberosity avulsion fractures**

Treatment of all nondisplaced or minimal displaced tuberosity avulsion fractures is conservative with weight bearing as tolerated. Dameron described a study of 100 fractures involving the tuberosity treated with elastic wrapping or partial weight bearing with crutches if needed. All but one had healed clinically at 3 weeks. Other studies have comparable results in the treatment of nondisplaced avulsion fractures. Overall, the prognosis of conservative treatment of avulsion fractures is good, but recovery can take up to 6 months or longer. Treatment options are a hard soled shoe, plaster cast or Jones or elastic dressing. Zenios and Wiener found significant better results and earlier return to work in treatment with an elastic wrapping compared to short leg cast. Vorlat et al. found poor functional outcome in non-weight bearing treatment and therefore suggested to minimize this. We advise to treat all non or minimal displaced tuberosity avulsion fractures with an elastic wrapping and weight bearing as tolerated for a period of 3 weeks.

**Displaced tuberosity avulsion fractures**

Displacement (>2 mm) or comminution of fractures of the tuberosity should be reduced. Fracture reduction and fixation should also be considered in fractures that involve more than 30% of the cubometatarsal joint. This can be obtained by open reduction and internal fixation (by using tension band wiring or small fragment screws) or closed with percutaneous pinning. Most of these osteosyntheses only allow partial weight bearing. As a consequence postoperative treatment should provide additional protection by casting and partial weight bearing for the time of bone healing.
Nondisplaced shaft and neck fractures

Nondisplaced shaft and neck fractures can be treated with an elastic dressing, posterior splint, a short leg walking cast or a hard plastic cast shoe with weight bearing if tolerated with crutches. If there is more than 3–4 mm displacement or angulation of more than 10° in dorsal or plantar direction the fracture should be reduced. This can be measured on standard foot radiographs. To maintain the reduction when conservative follow-up treatment is not sufficient, surgical treatment by open reduction and internal fixation (by using a plate or small fragment screws) or closed reduction with percutaneous K-wiring is recommended. Hereafter postoperative treatment should provide additional protection by casting and partial weight bearing. O’Malley et al. performed a study in 35 ballet dancers who sustained a distal shaft fracture. Treatment was conservative in 31 patients, two were treated with percutaneous K-wiring and two with open reduction and internal fixation. All patients were able to return to professional performance without limitation or pain.

Jones' fracture—non-operative treatment

The nondisplaced Jones’ fracture, the transverse fracture between metaphysis and diaphysis is known for prolonged healing time, mal- and non-unions. This is due to a watershed in blood supply. In addition, the fifth metatarsal has the widest range of motion of all metatarsals. When fractured at the junction between meta- and diaphysis the fixed base and loose shaft provide little fracture stability. Torg et al. proposed what has become the standard treatment strategy for Jones and proximal diaphysis fractures. They described 46 patients who were treated either conservatively or operatively, depending on their Torg classification. Type I (acute) was initially managed by non-weight bearing in a short leg cast. Of the 25 fractures 6 eventually required operative treatment. Type II (delayed union) was managed conservatively or with surgery. Of the 12 patients in this group, 10 were treated with weight bearing and short leg cast, one refused treatment and one was operated primarily. Of the 10 initially conservative treated patients three eventually required operation. Surgery was performed by curettage and drilling of the fracture site and inlay of an autograft. All nine patients with type III (non-union) fractures were managed surgically. One patient who disregarded the postoperative non-weight bearing protocol did not heal. All 46 patients eventually were asymptomatic and returned to full activities. Torg et al. recommended conservative treatment without weight bearing for Type I fractures for a period of 3–12 weeks. Type II fractures may eventually heal with conservative treatment, but an active athlete will benefit surgical treatment, as will type III fractures. Most studies subscribe these recommendations. Other studies advocate more aggressive treatment of Jones fractures in order to avoid prolonged immobilization. Portland et al. had excellent results with a 100% union rate using immediate screw fixation in 22 patients. Quill observed that one in three conservatively treated fractures refractured and therefore recommended early surgical treatment. In a recent study by Mologne et al. 37 patients with Jones fractures were randomised to 8 weeks non-weight bearing casting or early intramedullary screw fixation. Operative treatment significantly reduced both time to clinical union and return to sports with nearly 50%. Josefsson on the other hand described good results in the conservative treatment of 40 patients with a Jones fracture. After a follow-up of 17 years (11–26), 33 of the fractures had healed primarily, evidence of refracturing or delayed unions was found in seven patients and there were no non-unions. All but one of the patients were free of symptoms. Konkel et al. treated 64 patients conservatively and found high satisfaction rates and low costs.
Jones’ fracture—operative treatment

Several operation techniques have been described. Intramedullary screw fixation with or without grafting is a common operation technique in the treatment of fifth metatarsal fractures. Porter et al. described 100% union, high satisfaction rates and no refractures after using (4.5 mm cannulated) screw fixation in athletes. Other studies had equally good results with intramedullary screw fixation.6,8,19,23,32 Reese et al. suggested to use the largest screw possible and that screws less than 4 mm in diameter should be used with caution.35 Some surgeons use autografts for the fracture site, especially if there is considerable intramedullary sclerosis.23,24,46 Larson et al. performed an analysis of failure. Return to full activity before complete radiological union was predictive of failure. Screw diameter or usage of a graft was not predictive.35 Glasgow et al. concluded that using other than 4.5 mm malleolar screws for internal fixation correlated with failure. In bone graft procedures undersized corticocancellous grafts and incomplete reaming of the medullary canal correlated with failure. In addition, for both procedures early return to vigorous physical activity was believed to be associated with delayed union and refractures.6 Tension band wiring was described by Sarimo et al. (Fig. 5). They concluded that this technique was reliable and a safe alternative. They have treated 27 patients with good results of whom two were initially unsuccessfully treated with intramedullary screw fixation.38 The optimal surgical treatment has not been determined but should be an internal fixation device that can resist the torsion, tension and bending. Intramedullary devices that have some form of locking system might be a solution (Figs. 6–8).48

Conclusion

Nondisplaced tuberosity avulsion fractures can be treated conservatively. Surgical treatment is indicated when the fracture is displaced more than 2 mm or when there is more than 30% of the cubometatarsal joint involved. Nondisplaced or minimally displaced shaft fractures can be treated conservatively. However, when the dislocation is more than 3–4 mm or the angulation is more than 10°, percutaneous K-wiring, plate or small fragment screw fixation is indicated. The Jones fracture, located at the junction between the proximal diaphysis and metaphysis, is known for prolonged healing time and even non-union. The indication for operative treatment depends on activity level and Torg classification: type I fractures are managed non-operative. Type II fractures can be managed non-operative or operative, depending on activity level. Type III fractures have more complications and should be operated.

Authors’ contributions

Both authors have been involved in the review of literature and development of this article. Both authors read and corrected draft versions of the manuscript and approved the final manuscript.

Conflicts of interest

There are no conflicts of interest.

References