

## CASE REPORT

# Unusual stress fractures of the proximal phalanx of the great toe: a report of two cases

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Stress fractures of the toes are rare. Most reported fractures of the proximal phalanx of the great toe have been associated with halux valgus deformity. Two cases are presented that illustrate several unique features of this rare injury which have not been reported before. One of the cases went on to non-union, requiring bone grafting and internal fixation.

Whereas stress fractures of the foot are common, fractures of the toes are rare. A computerised search using the key words "stress fracture" and "toe" yielded four specific references, three for the great toe and one for the second toe. Yokoe and Mannoji in 1986 published a case series in the great toe of a sprinter, a Kendo player (Japanese fencer), and a 21 year old rugby player with this injury.<sup>1</sup> Similarly, Shiraishi and colleagues in 1993 reported three cases of this injury in a long distance runner, a volleyball player, and a soccer player.<sup>2</sup> Matsusue and colleagues in 1992 reported this injury in a shot putter.<sup>3</sup> Pitsis and colleagues in 2003 reported a stress fracture in the proximal phalanx of the second toe in a basketball player.<sup>4</sup> Notably, with the exception of one case,<sup>1</sup> these stress fractures have only been reported among adolescent athletes. Most reported fractures in the great toe were associated with halux valgus deformity.

We present two cases that illustrate several unique features of this rare injury which have not been reported before. Importantly, one of the cases went on to non-union, requiring bone grafting and internal fixation.

### CASE REPORT 1

A 41 year old nulliparous non-professional female triathlete presented with pain in the left great toe after progressive moderate increased training load over a 12 week period leading into a triathlon. This included 20 km of running a week. A mild ache was felt two weeks before competition. After completing the 65 km cycle and 500 m swim of the triathlon uneventfully, the athlete experienced moderately severe pain during the first 500 m of the 4.5 km run. On completion of the race, she could not fully weight bear because of severe pain. She denied a specific history of trauma.

She gave a history of multiple stress fractures, including the left fibula in June 1997, the left calcaneus in October 1998, and the right fibula in April 2000, suggestive of a low threshold for stress fractures. She has no notable personal or family history.

A dual energy x ray absorptiometry scan in November 1998 revealed osteopenia. At the time of the scan, the patient had been amenorrhoeic for 14 months. After treatment with alendronate (Fosamax), hormone replacement therapy (Ogen 1.25 mg and Provera 2.5 mg), and calcium, follow

up scans in July 2000 and May 2001 were normal (table 1). The patient continues to use hormone replacement therapy and reports normal menstruation.

Initial clinical examination revealed point tenderness over the medial base of the proximal phalanx of the left great toe. There was no associated hallux valgus or swelling. Orthoses worn for the past 15 years to correct bilateral hyperpronation of the feet were in good condition.

A clinical diagnosis of a stress fracture of the medial base of the proximal phalanx of the left great toe was made. A radiograph confirmed an undisplaced fracture involving approximately one quarter of the articular surface (fig 1A).

Excellent clinical and radiological union was achieved with six weeks of non-weight-bearing rest using crutches. Radiographs documented evidence of progressive radiological union four, eight, and 32 weeks after the injury (fig 1). A graduated return to activity was achieved over a further six weeks. A 2nd to 5th metatarsal bar orthosis was used for eight weeks to off load stress from the great toe. At follow up 32 weeks after the injury, the patient had returned to previous levels of swimming and cycling without complication, but decided not to continue running because of the risk of further stress fractures.

### CASE REPORT 2

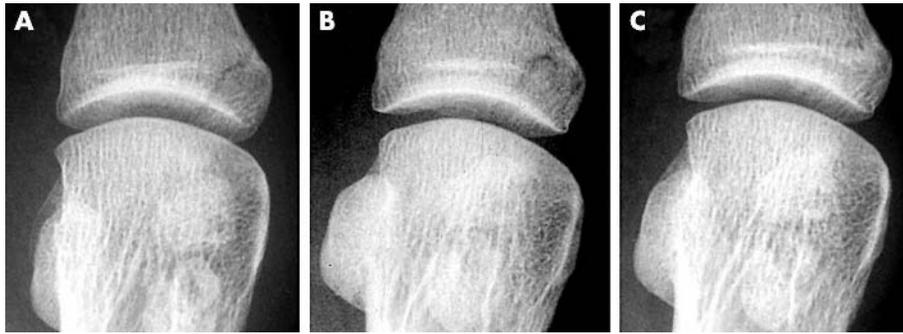
A 17 year old elite female gymnast presented with a two year history of increasing pain in the left great toe. She denied a specific history of trauma. Her training regimen consisted of two hours a day, five days a week. Pain had initially started after training but had gradually become continuous and disabling, such that she could no longer run. It was worse during the push off phase of walking.

Physical examination showed hallux valgus of the great toe. There was mild swelling and pain localised to the medial aspect of the left first metatarsophalangeal joint. Plain radiography performed one year before presentation to our clinic revealed an oblique fracture of the medial aspect of the proximal phalanx of the left great toe (fig 2).

Her initial treatment elsewhere consisted of three weeks of non-weight-bearing rest using crutches. She was started on a graded training programme at the end of this period and

**Table 1** Dual energy x ray absorptiometry scan results for female triathlete with pain in left great toe

	Nov 1998	July 2000	May 2000
Lumbar age matched (Z) score	-1.4	-1.1	-0.6
Lumbar young adult (T) score	-1.8	-1.2	-1.1
Proximal femur age matched (Z) score	-1.0	-0.8	-0.4
Proximal femur young adult (T) score	-1.4	-1.0	-0.9



**Figure 1** Case 1: lucent fracture line visible in the medial aspect of the proximal phalanx of the left great toe. (A) Radiograph at diagnosis. (B) Radiograph four weeks after diagnosis. (C) Radiograph 32 weeks after diagnosis displaying complete radiological union.

immediately experienced continuous pain, requiring cessation of all sporting activity. Subsequent radiographs showed a non-union of the fracture of the medial aspect of the proximal phalanx of the left great toe. The patient was then referred for an opinion to the surgical author (MRS) for elective surgical intervention.

Surgical excision of the non-union was performed with a cancellous bone graft to the non-union site and internal fixation with two Leibinger 2.3 mm screws (Stryker, Kalamazoo, Michigan, USA) using a medial approach. There were no postoperative complications, and the patient was discharged non-weight-bearing for six weeks. She started partial weight bearing in a Camwalker boot (Aircast, Summit, New Jersey, USA) for a further six weeks at the end of this period. Subsequent plain radiography, three months after surgery showed good incorporation of the bone graft. She was symptom-free and gradually resumed training to previous levels without incident.

## DISCUSSION

The pathophysiology of this stress fracture involves weight bearing activities inducing vertical ground reaction forces several times that of body weight. This results in large repetitive shear forces on the base of the proximal phalanx

from the windlass action of the plantar aponeurosis and muscle action, in addition to axial compressive forces.<sup>5</sup>

Hallux valgus is a postulated associated biomechanical predisposing factor to this injury. The abducted first metatarsal displaces the point of insertion of the extensor hallucis longus (dorsal base of the distal phalanx) and adductor hallucis (lateral base of the proximal phalanx) further away from the axis of the foot (second metatarsal). The resultant increased tensile forces and bowstring effect of these two muscles acting on the great toe causes adduction forces on the proximal and distal phalanges. The resulting tensile strain on the medial collateral ligament and the medial head of the flexor hallucis brevis may predispose to an avulsion type stress fracture of the medial base of the proximal phalanx of the great toe.<sup>1-3 6 7</sup>

It is expected that this type of stress fracture would heal with conservative treatment of four to six weeks of non-weight-bearing rest, as it did with case 1. A graduated return to activity over a further four to six weeks is usually required. Biomechanical factors need to be addressed appropriately. The patient in case 2 had inadequate initial conservative treatment and subsequently developed non-union of the fracture requiring operative treatment. To our knowledge, this is the first reported operative intervention in a non-union of a fracture of the proximal phalanx of the great toe, although non-union was reported in one of the earlier cases.<sup>2</sup>

There are a number of unusual features about case 1. This patient's age was not consistent with the previously documented incidence in adolescence. The injury occurred with relatively low levels of stress, possibly related to osteopenia, as reflected in the low bone mineral density readings. In addition, there was no associated hallux valgus. Case 2 showed nearly all the characteristics described in the earlier series of patients.

Stress fractures are more common in female athletes with menstrual disturbance.<sup>8</sup> Hormone replacement therapy with Ogen 1.25 mg and Provera 2.5 mg may be effective in reducing the negative effects of menstrual disturbances on bone mineral density.<sup>9</sup> The addition of calcium in patients who exercise may also promote increased bone mineralisation.<sup>10</sup> Alendronate (Fosamax) may be used for treatment in osteoporosis.

Evidence of clinical union occurred before radiological union four weeks after the injury in the first case. This supports the current understanding of the temporal relation of clinical and radiological union. Thus clinical status of the fracture is of paramount importance when assessing progress of union of the fracture. Radiological investigations can document fracture position and evidence of union after four weeks or earlier non-union.

There have now been nine reported cases of this type of stress fracture. Of these, seven were in adolescent athletes,



**Figure 2** Case 2: lucent fracture line visible similar to case 1 at diagnosis (baseline) with computed tomography scan insert. Radiological union with good incorporation of bone graft three months after surgery (follow up).

### What is already known on this topic

- Predominant in adolescent athletes
- Hallux valgus is a biomechanical predisposing factor
- Uncommon injury, therefore little information available on epidemiology, risk factors, etc

### What this study adds

- There may be a spectrum of presentation for this injury with less common, more unusual features: older athletes, lower stress loads with possible underlying osteopenia, and absence of hallux valgus as a biomechanical predisposing factor. Therefore awareness of the unusual presentations of this injury is required to make a diagnosis and institute appropriate treatment
- Conservative treatment may fail, particularly if inadequate initially, and operative treatment may be required

suggesting a tendency for this stress fracture to occur in this age group, with as many cases having an associated hallux valgus as a biomechanical predisposing factor. As hallux valgus is more common with advancing age, we would expect the incidence of this injury to likewise increase with age. The epiphyseal growth plate at the base of the proximal phalanx of the great toe fuses, on average, by about 18 years of age. We hypothesise that the adolescent athlete may be more susceptible to this injury in the presence of hallux valgus because an unfused or recently fused epiphyseal growth plate at the base of the proximal phalanx may be a weaker area in the bone. In addition, younger athletes may expose themselves to higher levels of stress because of greater exercise volume and intensity. This indicates the need for

increased awareness of this injury in adolescent athletes presenting with pain in the region of the first metatarsophalangeal joint.

### CONCLUSIONS

Two rare cases of an unusual stress fracture of the proximal phalanx of the great toe are presented. One fracture responded to conservative treatment, but the other progressed to non-union, requiring surgical intervention. The diagnosis should be considered in the differential diagnosis of patients who present with pain in the region of the first metatarsophalangeal joint, particularly in the adolescent age group.

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