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CASE REPORT

Pediatric Tillaux Ankle Fracture with Concomitant Adult-type Supination External Rotation Fracture Pattern: A Rare Injury

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ABSTRACT

The juvenile Tillaux fracture is a transitional ankle fracture that occurs in the adolescent population. The juvenile Tillaux fracture is an avulsion injury of the distal tibia's anterolateral epiphysis as the result of excessive external rotation. The purpose of this article is to present a pediatric ankle fracture that is best described as a supination-external rotation type IV ankle injury with an associated Tillaux fragment. This fracture pattern represents a unique variant to classically described pediatric ankle fractures.

Keywords: Adolescent ankle fracture, Juvenile Tillaux fracture, Transitional ankle fracture.

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INTRODUCTION

Transition fractures of the ankle occur in patients whose distal tibial physis is undergoing physiologic epiphysiodesis. Classically, two transitional fracture patterns of the ankle are discussed: The triplane fracture and the juvenile Tillaux fracture. These fracture patterns are observed in patients between the ages of 12 and 15, and typically occur during an 18-month period of time as ossification progresses across the growth plate.[1-4] The juvenile Tillaux fracture results from an avulsion injury when a taught anterior inferior tibiofibular ligament (AITFL) displaces the nonossified anterolateral distal tibia epiphysis. The triplane ankle fracture is defined by having a coronal fracture line through the posterior tibial metaphysis, in addition to both sagittal and transverse fracture lines through the distal tibial physis.[4]

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The Tillaux fracture was first described in 1822 by Sir Astley Cooper and Paul Tillaux.[5] In general, this fracture pattern can be thought of as a pediatric injury; however, the injury has been described in adults.[6-10] In an adult patient, the avulsed fragment is generally triangular in appearance, whereas in children the avulsed fragment is quadrangular in appearance.[11]

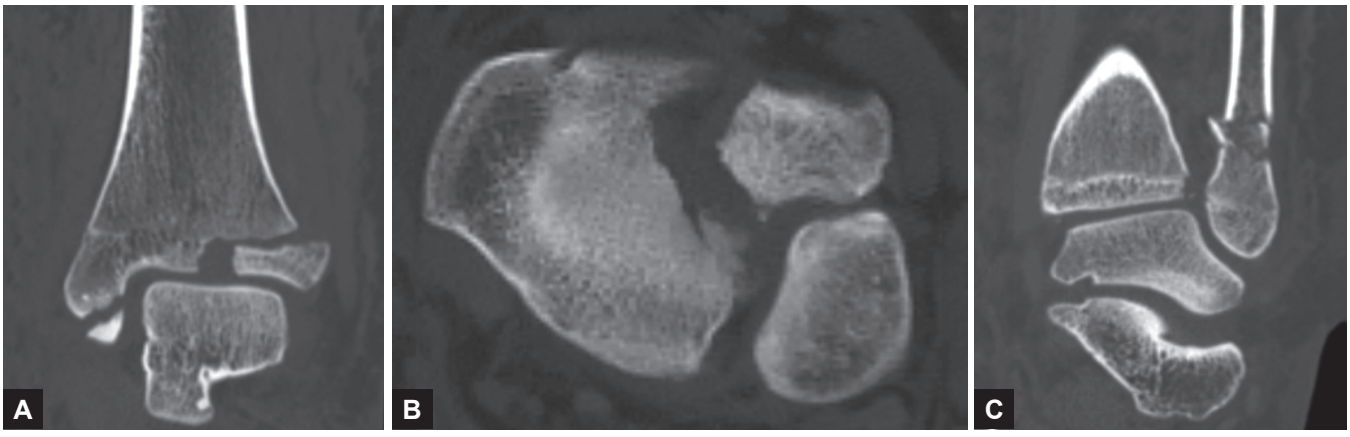
The triplane ankle fracture, first described in 1970 by Marmor, occurs at the interface between the ossified and nonossified regions of the distal tibial growth plate.[4] In 1983, Rang[12] described triplane fractures as "fractures [that] run in three planes, but beyond this there is uncertainty." Proof toward the "uncertainty" or complexity that is inherent to triplane fractures can be seen by the numerous fracture patterns that all meet the criteria to be termed triplane fractures. Although not stated specifically in the literature, one could predict that the dynamic ossification of the physis from medial to lateral and the force of injury will influence the fracture pattern.

The purpose of this case report is to present an interesting fracture pattern that does not fit into a current ankle fracture classification. The ankle fracture is an adult type IV supination-external rotation (SER) injury with a concomitant juvenile Tillaux fracture fragment.

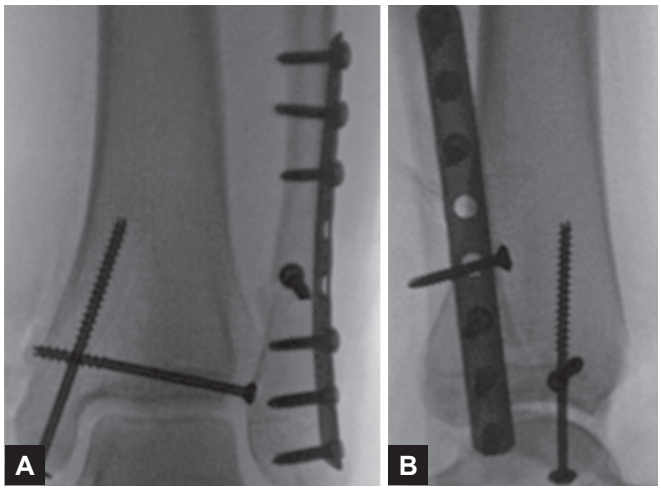
CASE REPORT

A 15-year-old otherwise healthy male presented to the pediatric orthopaedic clinic with a left ankle fracture caused by a zip-lining accident. Computed tomographic imaging revealed the fracture pattern as seen in Figures 1A to C. The fracture consisted of an oblique fibular fracture at the level of the syndesmosis, an avulsion fracture of the medial malleolus, and an intraarticular Salter–Harris type 3 avulsion fracture of the anterolateral distal tibial epiphysis.

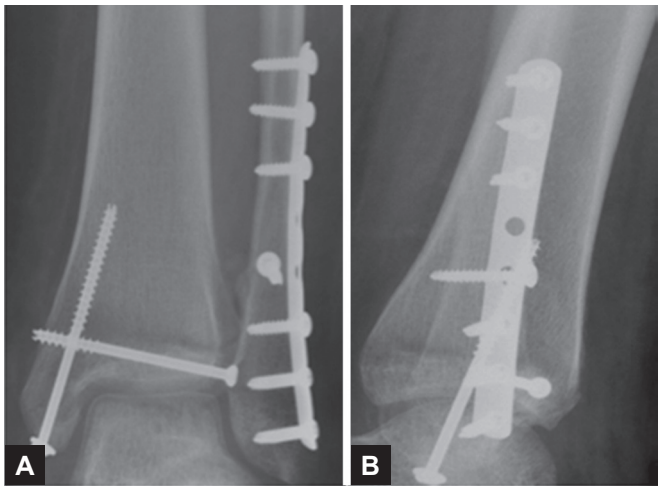
The fracture was treated like an adult-type injury as the patient was approaching skeletal maturity. Absolute stability was obtained utilizing an open reduction and internal fixation technique. The fibular fracture was stabilized using a lag screw and neutralization plate. The Tillaux fragment was fixed using a cannulated screw. A second cannulated screw and washer were used to fix the



Figs 1A to C: Computed tomographic imaging demonstrating fracture pattern 10 days following injury: (A) coronal view showing juvenile Tillaux fragment and medial malleolus fracture, (B) axial view demonstrating Tillaux fragment, and (C) coronal view demonstrating fibular fracture pattern



Figs 2A and B: Intraoperative fluoroscopy images demonstrating: (A) Mortise view of the ankle, (B) lateral view of the ankle



Figs 3A and B: Postoperative plain films obtained at a 4-week follow-up appointment demonstrating interval healing of fracture on: (A) Mortise ankle view, (B) lateral ankle view

medial malleolar fracture. Figures 2 and 3 demonstrate intraoperative and postoperative films of the surgery respectively.

DISCUSSION

The fracture pattern in our patient is consistent with SER type IV injury as described by Lauge–Hansen with the unique aspect of having an associated juvenile Tillaux fracture element in the lateral, immature bone.[13] The ossified, medial portion of the distal tibia acted like mature bone. The lateral, nonossified portion of the distal tibia acted like immature bone. This dual phenomenon can occur when the distal tibial physis is actively ossifying. In a case report published in the German literature, the term "mature transitional fracture" is used to describe a fracture that has elements of both adult and adolescent fracture patterns.[14]

Adolescents represent a unique population of patients in regard to fracture management. The exact age range of adolescents is hard to classify, but generally females age 8 to 14 and males age 10 to 16 may be considered adolescents.[15] Adolescents are unique in that they are transitioning from more elastic and skeletally immature bone to skeletally mature bone.[16] During the adolescent phase of bone development, the bone physes are in the active process of ossifying, resulting in predictable physeal fracture patterns at the junction of the fused and nonfused growth plates.[4] The distal tibial physis requires 18 months to ossify, and closes in the well-described pattern of fusing centrally first, at Kump's bump, then anteromedially, followed by posteromedially, and finally laterally.[1] The ossification pattern results in the lateral aspect of the distal tibia to be more prone to fracture than the medial aspect, which produces the juvenile Tillaux and triplane fractures.

External rotation injuries are a common mechanism for ankle fractures.[17] Supination-external rotation injuries at the ankle produce characteristic fracture patterns depending on if the distal tibial physis is

ossified, nonossified, or in the process of ossifying. In the skeletally mature patient, SER injuries initially stress the lateral stabilizing structures, and failure occurs in the following order; the AITFL, the fibula, the posterior inferior tibiofibular ligament (PITFL), and finally at the medial malleolus or deltoid ligament.[18] In the skeletally immature patient, SER injuries typically result in a Salter–Harris type 2 fracture pattern with spiral fractures of the distal tibia and fibula as described by Dias and Tachdjian.[19] Finally, in the adolescent patient, or a patient whose distal tibial physis is in the process of ossifying, an external rotational injury may result in one of two unique fracture patterns, the triplane fracture or the juvenile Tillaux fracture.[1-4] A general rule for predicting fracture patterns is that the weakest structure will fail first. In immature bone, the physis is generally weaker than the ligamentous structures resulting in physeal injury. In mature bone, the weaker ligamentous structures typically fail prior to the mature bone.

In our patient, the mechanism of injury likely proceeded in the following order: Initially, the externally rotating talus caused the lateral malleolus to displace posteriorly stressing the AITFL. The nonossified lateral aspect of the physis failed, resulting in the Salter–Harris type 3 fracture pattern, or juvenile Tillaux fracture, seen on anteriorposterior imaging of the ankle. As the talus continued to rotate externally, further stress to the lateral structures resulted in the fibula fracture. With continued external rotation of the talus, the PITFL failed. Lastly, the lateral displacement of the talus with external rotation stressed the deltoid ligament resulting in the avulsion fracture of the medial malleolus.

CONCLUSION

Ankle fractures are common injuries accounting for 15% of all physeal injuries in pediatric patients, and have an incidence of 174 cases per 100,000 individuals in adult patients.[19,20] Despite the rarity of the discussed ankle fracture pattern, a case report describing a bimalleolar ankle fracture with a nondisplaced Tillaux fragment has been described.[21] Our patient's fracture pattern, in combination with other reports of adult-like fracture patterns in adolescent patients, supports the physician's need to be able to recognize and treat these fracture patterns. An understanding of potential ankle fracture patterns allows for a more thorough understanding on how to manage these injuries both with the initial reduction and in the operating room. This report provides a description of a fracture variant on the classically described Tillaux fracture, or more recently termed "the mature transitional fracture."[14]

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