

# Common Errors Related to the Tillaux Fracture

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## Editorial

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### ABSTRACT

Ankle injuries are very common in children and adolescents. The clinical localization of pain to the ligaments or over the distal tibial or fibular physis should be carefully evaluated. In children with an apparently sprained ankle disproportionately severe or prolonged symptoms may be due to a missed bone injury. The most commonly missed distal tibia physeal fracture in older children and adolescents is the Tillaux fracture. Radiography remains the imaging standard for the diagnosis of a Tillaux fracture. However, occasionally these injuries are quite subtle or even impossible to detect on plain radiographs. A wide variety of potential errors and pitfalls has been encountered in the description, evaluation, diagnosis and management of the Tillaux fracture in the world literature. A review of the related literature as well as two cases, misdiagnosed as ankle sprains, which represent patients of different physeal maturity and classification type, is presented in this editorial. In the former, the lesion was a Salter-Harris type III injury in a child with a completely open distal tibial physis. In the latter, the injury was a Salter-Harris type IV injury. In both cases the fracture was overlooked due to the superimposition of the fibula on the plain radiographs, although in the second patient that could also be due to a more prominent bone lesion of the distal tibial metaphysis.

## EDITORIAL

The distal (inferior) articular surface of the tibia is also called *plafond* because of its vaulted shape. Sir Astley Cooper, in 1822, was the first to describe a fracture of the lateral *plafond* of the tibia. Paul Jules Tillaux, in 1876, performed experiments on cadavers and found that stress could lead to avulsion injuries of the lateral *plafond* of the tibia. His drawing of the lesion, including not only the anterior but also the posterior aspect of the lateral tibial *plafond*, was found and presented after his death by Chaput, who demonstrated the fracture on radiographs in 1899. The avulsion injury of the anterolateral part of the distal tibial epiphysis was finally named after Tillaux, although his work was not in any way related to a new traumatic clinical entity. The lesion is also occasionally reported as Tillaux-Chaput fracture [1-5].

The nomenclature of the distal tibial tubercles is also occasionally confused. The Chaput tubercle is the insertion site of the anterior tibiofibular ligament at the anterolateral aspect of the distal tibia, the Volkmann tubercle is the site of insertion of the posterior tibiofibular ligament at the posterolateral aspect of the distal tibia, while the Wagstaffe tubercle is the insertion site of the anterior tibiofibular ligament at the anterior aspect of the distal fibula. Subsequently, the Tillaux or Tillaux-Chaput fracture is an avulsion fracture at the tibial insertion of the anterior tibiofibular ligament, the Volkmann triangle fracture refers to an avulsion bone lesion at the tibial insertion of the posterior tibiofibular ligament (it should not be confused with a fracture of the posterior malleolus), and the Le Fort-Wagstaffe fracture refers to an avulsion bone injury at the fibular insertion of the anterior tibiofibular ligament [6,7].

A medical misnomer that is frequently associated with Tillaux fracture is the term *juvenile*. The fracture is not a traumatic entity of childhood, since it is not seen in younger children with a completely open physeal plate of the distal tibia. It involves only older children and adolescents. Tillaux and triplane injuries have been labeled 'transitional' fractures because they occur during the transition from an immature to a skeletally mature ankle. In adolescents, the distal tibial growth plate begins to close in its midportion and fusion later progresses medially. Medial closure occurs at approximately 13-14 years of age, while lateral closure begins at 14.5-16 years of age. Subsequently, for a period of 12 to 18 months, the lateral physis remains unfused, rendering it particularly vulnerable to injury. Triplane, unlike Tillaux, fractures have occasionally been detected in older children with completely open distal tibial physis. Tension on the anterior tibiofibular ligament from an abduction-external rotation injury of the ankle, may

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be complicated by a fracture at the junction of the fused and unfused growth plate. Tillaux fracture is usually a Salter-Harris type III injury that is associated with this peculiar type of physeal closure. In the older child the fracture line occurs more laterally due to the increased area of the closed physis. This definition has also proved not to be correct, since a Tillaux fracture may also be diagnosed in older children with a completely open distal tibial physis (**Figure 1**). Tillaux fracture has rarely been reported in adults, since the anteroinferior tibiofibular ligament is more likely to rupture than to avulse a bone fragment in adults [5,8-11].

The term Tillaux fracture is also not descriptive, since it does not differentiate between Salter-Harris type III and type IV injuries. In adults, the fracture line usually crosses the physeal scar avulsing a triangular fragment. In adolescents, the fragment is quadrangular and does not involve the metaphysis. Exceptions to these rules have also been documented, such as adolescents with a triangular epiphyseal fragment (**Figure 1**) or patients with a metaphyseal piece of bone attached to the avulsed epiphyseal fragment (**Figure 2**). Regarding to terminology, the most precise description of the Tillaux fracture would be fracture of the anterior tubercle of the distal tibia [5].



**Figure 1.** A 10-year-old girl injured her ankle after a fall while running at school. The initial diagnosis was of a lateral ankle sprain, since a fracture line was not diagnosed on the plain radiographs (**A**). The ankle was immobilized with an elastic bandage and she walked with crutches. A new radiographic examination, 2 weeks later, due to the persistence of significant local symptoms and signs revealed a fracture of the lateral part of the distal tibial epiphysis (**B**). CT showed a triangular avulsion fracture of the lateral part of the distal tibial epiphysis without displacement (**C**). The fracture was consistent with a Salter-Harris type III lesion. The physeal plate was completely open and no projection (or hump) of the medial growth plate was evident, as it has been detected in a number of patients with completely open physeal plates suffering from triplane fractures. The fracture was immobilized in a below the knee splint and healed uneventfully.

The lesion may be easily misdiagnosed as a lateral ankle sprain when the clinical evaluation of the patient is not sufficiently careful. The diagnosis is often missed in the emergency department by those who are unfamiliar either with the pattern of distal tibial physeal closure or with this specific injury. The fibula usually prevents marked displacement of the fracture and clinical

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deformity is generally absent. Swelling is usually slight and local tenderness is detected at the anterior lateral tibial joint line [9-11].

The radiologist plays a pivot role in the diagnostic assessment. Radiological misinterpretation of the fracture may be avoided whenever the radiologist is fully aware of the clinical findings of the traumatic lesion either by examining the patient or by being informed of the physical examination findings and the potential diagnosis of a Tillaux fracture. The radiographic diagnosis is usually straightforward, but may occasionally be obscured by the superimposition of the fibula. The fracture produces a vertical or, less commonly, an oblique fracture line through the epiphysis. The lateral unfused portion of the growth plate may widen. On occasion, an avulsion fracture may occur after complete closure of the epiphyseal growth plate of the distal tibia, as in the adult type of injury. The diagnosis may also be missed on occasions that a more prominent local bone lesion is evident on the radiographs (**Figure 2**). In cases that a Tillaux injury is included in the differential diagnosis the initial conventional plain radiographs of the ankle should always include a mortise or an internal oblique view. The mortise view is essential to inspect the distal tibial epiphysis unobstructed by the fibula. Oblique views of the ankle in this age group are mandatory to enable the casualty officer in a busy emergency department to bring this fracture out of hiding and make the diagnosis in every instance. Radiographs frequently underestimate the degree of intra-articular involvement and step-off of the articular surfaces. Subsequently, computed tomography (CT) is recommended to determine the number of fragments and the extent of fracture displacement. Tomography also helps to define the fracture gap, is more economical than CT and provides the same information [12-16].



**Figure 2.** A 13-year-old girl injured her ankle after a fall from her bicycle. The initial diagnosis was of a lateral ankle sprain, since a fracture line was not diagnosed on the plain radiographs (**A**). A lytic bone lesion with sclerotic border was evident at the distal tibial metaphysis. The ankle was immobilized with an elastic bandage and she walked with crutches. A new radiographic examination, 2 weeks later, due to the persistence of significant local symptoms and signs revealed a fracture of the lateral part of the distal tibial epiphysis. CT showed a triangular avulsion fracture of the lateral part of the distal tibial epiphysis without displacement. The fracture was consistent with a Salter-Harris type IV lesion. The benign characteristics of the metaphyseal bone lesion were consistent with a cortical defect (**B**). The fracture was immobilized in a below the knee splint and healed uneventfully.

Dias and Giegerich have proposed a classification scheme in adolescents according to the mechanism of injury. Stage I injuries include the juvenile Tillaux fracture that is due to an external rotation injury of the ankle. Stage II injuries include the triplane fracture, which is caused by further external rotation. Stage III injuries, including a stage II injury associated with a fibular fracture, are caused by still further external rotation. Thereafter, several case reports have reported a wide range of stage I or II injuries associated with a fractured tibia or fibula. Therefore, it may be prudent to extend the content of stage III injuries to include all stage I or II injuries associated with a tibial or fibular fracture [17-20].

Tillaux fracture is of great importance because it involves a major weight-bearing articular surface. Therefore, anatomic or near-anatomic reduction of the joint surface is recommended. Accepting incomplete or malreduction with persistent articular incongruity may result in pain, joint stiffness, and premature degenerative arthritis. Most of these fractures occur at the end of growth, and, subsequently, altered growth is not likely to occur. Treatment protocols in the literature are not uniform for this kind of fracture, and numerous case reports can be found describing various treatment methods. The treatment procedures of this fracture are based on the displacement. Nondisplaced or minimally displaced (displacement is not exceeding 2 mm) fractures may be treated by cast immobilization, whereas most of the authors conclude that for a displacement of over 2 mm, closed or open reduction is necessary to restore articular congruity. Closed reduction is attempted by internally rotating the foot and applying direct pressure over the anterolateral tibia. If necessary, percutaneous pinning may be used for the stabilization of the closed reduction. If closed reduction is not successful, open reduction or percutaneous reduction with arthroscopic assistance may be needed. Occasionally, percutaneously inserted pins may be used to manipulate the displaced fragment into anatomical position and then advanced to fix the fragment in place. Screw fixation within the epiphysis is usually the preferred fixation method. The use of screws or threaded devices across the physis should be avoided. However, even this absolute prerequisite of

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internal fixation in patients with open physes has been questioned in adolescents with near total skeletal maturation, since growth disturbance is not likely to occur [5,9-11,21-27].

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