Tibial plateau fractures — review of current concepts in management

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Abstract

Tibial plateau fractures represent a wide spectrum of injury patterns and encompass degrees of severity that are challenging to treat by even experienced orthopaedic trauma surgeons. The principles of treatment include respect for the soft tissues, restoring the congruity of the articular surface and reduction of the anatomic alignment of the lower limb to enable early movement of the knee joint. There are various surgical fixation methods that can achieve these principles of treatment. Recognition of the particular fracture pattern is important, as this guides the surgical approach required in order to adequately stabilize the fracture.

Keywords adult; fracture; tibial plateau

Introduction

Tibial plateau fractures are intra-articular fractures of the knee that are often associated with high energy trauma, but also commonly occur in the elderly as a result of a lower energy mechanism of injury. However, despite the spectrum of possible fracture patterns, the treatment principles remain the same with the aim of restoring the congruity of the articular surface and maintaining the mechanical axis of the lower limb. The severity of the fracture and an understanding of the associated soft tissue injury and its evolution influences the timing and method of surgical reconstruction. This article reviews the relevant surgical anatomy, the classification systems, treatment options and surgical approaches that are currently available in order to try to optimize the outcome in this often difficult fracture.

Epidemiology

Tibial plateau fractures account for 1–2% of all adult fractures.[1] There is a bimodal distribution of incidence: high energy fractures occur in the younger population, often as a result of road traffic accidents or falls from height, while relatively lower energy osteoporotic fractures occur in the elderly, often sustained as the result of a simple fall. The injury is rare in children and young adults prior to physeal closure and will not be discussed in these patient groups. High energy fractures are more likely to be associated with concurrent fractures, compartment syndrome, neurological and vascular compromise.[2,3] Given the morbidity associated with this injury, it is important to carefully evaluate the fracture pattern to plan the definitive management at the appropriate time in order to avoid soft tissue complications.

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Relevant anatomy

The tibial plateau is divided into medial and lateral parts, separated by the non-articular intercondylar eminences. The medial plateau is larger and concave in the sagittal and coronal planes and has less thick articular cartilage compared to the lateral plateau. The lateral plateau is convex in the sagittal plane. The articular surface of the proximal tibia lies in 3° of varus to the mechanical axis of the tibia. As a result of these anatomical differences the lateral plateau lies higher than the medial. This is important to recognize in order to avoid screw penetration during fixation into articular cartilage during placement of supporting subchondral screws. The trabecular bone pattern on the medial aspect of the tibial plateau is denser than the lateral and this is reflected in more medial fracture patterns being associated with higher energy trauma and lateral fractures occurring more commonly in the elderly following lower energy trauma.

The normal average posterior tibial slope is approximately 9°. It is important to recognize that in some patterns of tibial plateau fracture in which a hyperextension injury has occurred the posterior tibial slope is reversed into an anterior slope and not only does the articular congruity need to be restored but also the posterior tibial slope, in order to avoid hyperextension of the knee during normal gait.

The tibial tuberosity is the site of attachment of the patella tendon and can be fractured in high energy injuries yet this is easily missed during the initial assessment. This represents disruption of the extensor mechanism of the knee and unless addressed at the time of surgical fixation can result in an extensor lag of the knee. It is also important to note that a displaced tibial tuberosity fragment can cause pressure necrosis of the skin, compromising any form of surgical treatment. Temporary external fixation with the knee in full extension can minimize this and the treating surgeon needs to be cognizant of this fracture pattern.

Classification

One of the fundamental roles of any useful fracture classification is that it should guide the surgical approach and fixation, and should be reliable. As for most fractures there is not a single classification that encompasses all fracture patterns and can enable a surgeon to identify the specific approach and fixation needed. Some knowledge of the different classification systems, and using them in combination, can enable a surgeon to make more informed decisions on treatment. The next section summarizes the pertinent classification systems and highlights where they may be useful in guiding treatment.

Schatzker classification

Schatzker described this classification in 1979 and it is still in common use[4] (Figure 1). The advantages of this classification

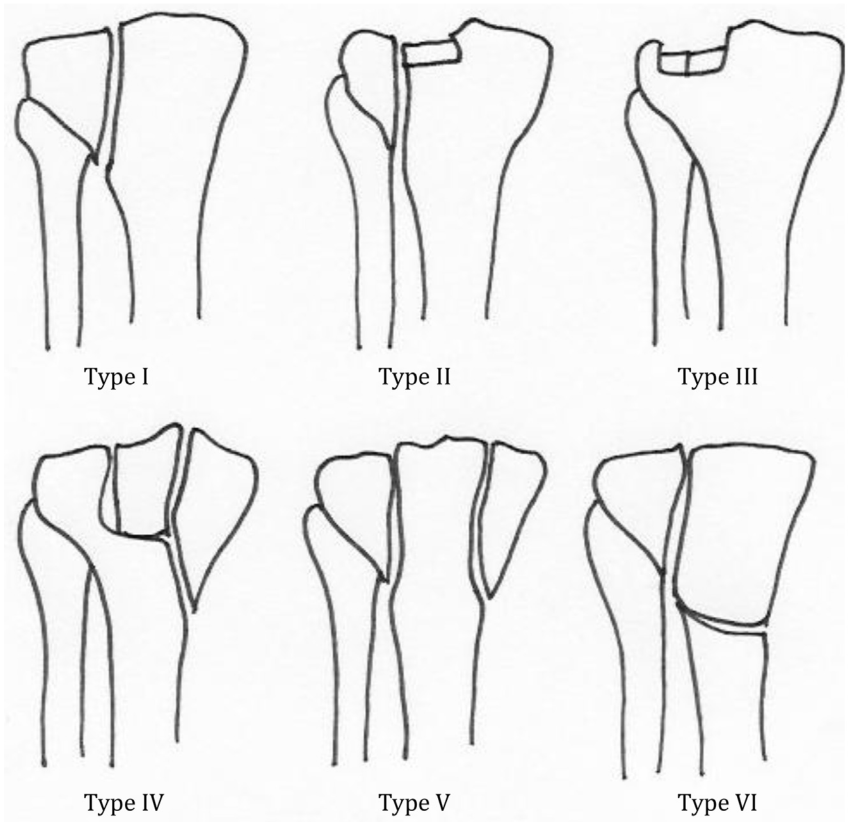

Figure 1 Schatzker classification.

system are that it is simple, reliable and offers guidance for treatment. Schatzker (types I—III) are unicondylar fractures of the lateral plateau and are often lower energy injuries, while types IV—VI represent higher energy injury patterns. Schatzker (types V and VI) are bicondylar fractures.

The **Schatzker type I** fracture is a pure split in the sagittal plane, not associated with joint depression and tends to occur in younger patients with denser bone. Lateral meniscal pathology (peripheral tear) can prevent reduction of this fracture pattern as it becomes incarcerated in the fracture.

The **Schatzker type II** fracture is a split depression and is either associated with higher energy injury patterns in younger bone or is secondary to poor bone quality and is a common fracture pattern in the elderly. The mechanism of injury is similar to a type I injury with a valgus and axial load to the knee.

The **Schatzker type III** fracture is a very rare pattern of injury and is a pure depression fracture, classed as a fragility fracture in the elderly, and is a result of bone crushing rather than splitting. It is likely that most fracture patterns presumed to be type III are type II fractures with an occult split fracture not visible on plain radiographs. A review of the MRI scans of 103 patients with tibial plateau fractures found no cases of type III fractures but an associated extension of the fracture line in lateral depression fractures technically making these fracture patterns type II.[5]

Schatzker type IV fractures are higher energy injuries and are akin to a variant of knee fracture—dislocation. The fracture involves the medial tibial plateau and can be regarded as more of a shear fracture, often with the fracture line exiting proximally either on the lateral tibial plateau or at the level of the intercondylar eminences. The fracture is usually unstable and requires surgical stabilization. These fractures have a significantly higher rate of associated neurovascular and cruciate ligament injury than other patterns of fracture. There is also a risk of compartment syndrome with this injury pattern.

Schatzker type V injuries involve both the medial and lateral plateaux, often with preservation of the intercondylar eminence and cruciate ligament attachment. The pattern is often an 'inverted Y' fracture and rarely associated with knee dislocation. This is often caused by a pure axial load with the knee in full extension.

Schatzker type VI injuries involve fractures of both the medial and lateral tibial plateaux but there is metaphyseal—diaphyseal dissociation. The high energy mechanism of injury that causes this fracture pattern will often cause multifragmentary fractures that extend into the diaphysis of the tibia. Often one or both tibial plateaux are highly comminuted and tibial tuberosity involvement is also often present. The soft tissue injury with this pattern is significant.

AO/OTA

The AO/OTA classification, published in 1996, has been shown to have good interobserver agreement and is commonly used in scientific publications (Figure 2). Type A fractures are extra-articular and type A1 fractures represent avulsion injuries (A1.1 — fibula avulsion, A1.2 — tibial tubercle avulsion and A1.3 — intercondylar eminence avulsion).