An Overview of Tibial plateau fractures Management

Seleem Hamed Almosalamy 1, Mohsen Mohamed Abdo Mar'ei 1, Ahmed Mostafa El Naggar 1, Ayhaab Abuzayd Salim Mohammed 2
1 Department of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt
2 M.B.B. Ch, Faculty of Medicine – Zawia University

Corresponding Author: Ayhaab Abuzayd Salim Mohammed
Email: ehababozeed1987@gmail.com

Abstract

Background: Tibial plateau fractures are one of the commonest intra-articular fractures resulting from indirect coronal or direct axial compressive forces. Fractures of tibial plateau constitute 1% of all fractures and 8% of fractures in the elderly. Tibial plateau fractures may be accompanied by meniscal and ligamentous injuries to the knee too. In the surgical treatment of split depression fractures (Schatzker type II) of the lateral tibial plateau (which constitute more than 25% of all tibial plateau fractures) the goal is reduction of the articular surface and stable fixation. The subchondral defect in the metaphysis is usually grafted with bone from the iliac crest to support the elevated articular surface.

Keywords: Tibial plateau fractures

Surgical and applied anatomy of tibial plateau

The tibial plateau represents the entire proximal end of the tibia and is composed of medial and lateral weight bearing articular surfaces. The 2 articular surfaces are asymmetric both in size and concavity as well as relative density and strength. (1). The medial tibial plateau is the larger of the two, is concave in both planes, is covered with hyaline cartilage and carries about 60% of the knee ‘s load and consequently has increased subchondral bone and a stronger, denser plateau when compared with the lateral. The lateral plateau is smaller, weaker, convex in both sagittal and coronal planes, and is also covered with hyaline cartilage. Due to this relative weakness combined with the natural valgus carry angle of the lower extremity, fractures of the lateral tibial plateau are more common. (2)

A fibrocartilaginous meniscus covers both plateaus. The coronary ligaments serve to attach the menisci to the plateaus and the intermeniscal ligament serves to connect the menisci anteriorly. Oftentimes, this ligament is incised and elevated to afford direct visualization of the articular surfaces. (1).

There are many bony prominences serve as attachment sites for tendonous structures and are located in close proximity of the tibial plateau:

- The tibial spines are between the plateaus. The medial and lateral tibial spines serve as attachment points for the anterior and posterior cruciate ligaments as well as the menisci.
- The tibial tubercle is found anterolaterally about 3 cm below the articular surface. This site serves as a point of attachment for the patellar tendon.

Further lateral on the proximal tibia is Gerdy's tubercle where the iliotibial band inserts. (Figure 1)
The proximal tibia and fibula form an articulation covered with hyaline cartilage. The medial (tibial) collateral ligament inserts into the medial proximal tibia and along with the lateral (fibular) collateral ligaments protect against varus and valgus instability, while anterior and posterior cruciate ligaments afford anterior-posterior stability. (Figure 2) (4).

There are some anatomic structures should be considered during approaching the tibial plateau. On the medial side the medial plateau has a broad area of insertion for both the deep and superficial medial collateral ligament, the semimembranosus attaches to a ridge at the posteromedial corner of the medial
plateau just below the joint line, the pes anserinus located anteriorly and distally, close to the tibial tubercle (figure 3) (5).

The posterior aspect of the tibial plateau serves as the insertion site for both the posterior cruciate ligament and the posterior oblique ligament. These structures should be identified and protected when approaching the tibial plateau. The anterior compartment musculature attaches to the proximal lateral tibia and should be carefully elevated when approaching the lateral tibial plateau (figure 4) (1).
Neurovascular structures are at risk with proximal tibia fractures. The common peroneal nerve courses around the neck of the fibula distal to the proximal tibia-fibula joint before it divides into its superficial and deep branches. It is at risk with severe displacement following high-energy fractures of the proximal tibia (figure 5). (2)

The trifurcation of the popliteal artery into the anterior tibial, posterior tibial, and peroneal arteries occurs posteromedially in the proximal tibia. Vascular injuries to these structures are common following knee dislocation, but can occur in high-energy fractures of the proximal tibia as well. If clinical examination indicates diminished distal pulses, further workup with ankle-brachial indices, Dopplers or an angiogram is warranted, and should be the impetus for vascular consultation. Furthermore, knee flexion during surgery will move these vascular structures farther from the posterior aspect of the plateau (figure 6) (2).
Fracture management

Complex bicondylar fractures of the tibial plateau remain a challenge to even the most experienced surgeons. The anatomy of the tibial plateau, combined with high energy trauma, produce complicated injury patterns with involvement of metaphyseal and articular comminution and frequently with loss of integrity of the soft-tissue envelope. The severity of soft tissue injury and the degree of bone comminution reflects the energy transmitted to the bone and incline to unfortunate prognosis (9).

All kinds of stabilization, from non-operative treatment to modern staged and combined management with temporary external fixators, prior to conventional or angular stable plating, fine-wire devices or even arthroscopically assisted procedures and nailing for selected cases have been recommended in the literature for complex tibial plateau fractures (10).

Adequate fixation and early motion are important for a good prognosis and satisfying postoperative functioning. Targets of definitive treatment should be from one hand restoration of the articular surface and from the other hand the restoration of tibial length and alignment, by rebuilding metaphyseo-diaphyseal comminution. The basic principles for all articular fractures imply rigid fixation for the articular block and indirect reduction with relative stability for the metaphysic foundation of the knee joint (10).

1. Temporary External Fixation

Casts, splints, traction, and braces are some options for initial damage control treatment for severe cases, nevertheless, the optimal temporizing treatment is spanning external fixation. (11-12)

Staged management with standardized protocol is evaluated by Egol, reporting low rate of wound infections (5%) and relative low rates of complications, with a possible downside of residual knee stiffness. Spanning external fixators reduce fracture fragments via ligamentotaxis, along with providing pain relief and a stable environment for soft tissue healing, as well as early mobilization of the patient. Antero-lateral pin positioning for the femur has been found to combine convenience when lying in bed, along with minimal quadriceps muscle damage, and is suggested even at the expense of a somewhat less stable biomechanical construct, whereas tibial half-pins should be placed in accordance with future incisions and plate positioning (11).

Figure (6): Spanning external fixator (13)
2. Open Reduction and Internal Fixation (ORIF)
Evidence for Approach Dual plating of both medial and lateral compartments with buttressing conventional plates through a single midline incision, can achieve rigid anatomic fixation for the articular components and has been considered the gold standard of treatment for managing bicondylar tibial fractures, since the initial recommendation by Schatzker back in 1979. (14) However, subsequent high rates of soft-tissue complications and nonunion reported in the literature, involving wound dissociation and deep infection up to 88%, gave birth to an ongoing debate concerning surgical approach and different implant constructs in an attempt for a biomechanically adequate but more "biological" osteosynthesis. (15)
Over the next years, several authors adopted the double incision technique (postero-medial / antero-lateral) for dual plating, reporting lower wound complication rate and less adverse effects. Barei et al. in his 2004 study of 83 complex bicondylar tibial fractures treated with dual plating using 2 separate incisions, reported an 8.4% of deep infection while for Jiang et al. in 2008 (84 patients) and Zhang et al. in 2012 (79 patients) the percentages were 4.7% and 3.8% respectively showing a distinct decrease in infection rates to the previously reported with single incision procedures. (16, 17)
Apart from approach-related technique improvements, the introduction of angular-stable plates including Less Invasive Stabilization System (18) and locking compression plates (LCPs) along with MIPO technique, offered the potential for a low implant-profile fixation able to provide adequate stability in a severely comminuted or osteoporotic environment.

Figure (7): Less Invasive Stabilization System for fractures of the proximal tibia (19)
These bio friendly implants have been used in various combinations with conventional plates or screws to achieve proper fixation, with the hybrid lateral-LCP/medial-butress dual plating and the more daring single lateral LISS/LCP with or without lag screw fixation more widely adopted. In terms of construct stability and reduction loss, it has been proven that there is no significant difference between LCP/buttress and conventional double buttress fixation. Regarding dual plating, either hybrid or conventional, satisfying results have been reported in the literature over the last years with postoperative malreduction and nonunion rarely reported and a reduction loss rate of 4.65-13.3% in recent studies. (17)

The use of a single lateral LCP/LISS plate, fixing the lateral condyle and aiming the secure capture of the opposite condyle without medial buttressing through a single lateral incision has been producing some mixed results. Egol et al. in 2004 reported 95% union in 38 patients with complex tibial plateau fractures treated with unilateral LISS fixation, concluding in favor of the system and Ikuta et al. in 2007 reported 75%/25% excellent/good functional outcome for 12 Schatzker V and VI fractures with no complications, but only a 12-month follow-up. (21)

Barei et al. in 2008 identified a posteromedial fragment in 1/3 of the bicondylar fractures evaluated, commenting on possible implications when trying a single lateral fixation using angular-stable implants and Weaver et al. in 2012 reported significant loss of reduction and subsidence for the single plate fixation group when a medial coronal fracture line was present. (22)

Unusual morphological characteristics of the posterior coronal fracture pattern may lead to single lateral fixation implications, but also, pose difficulties in reducing through conventional 2-incision technique and has thus opted several authors to come up with different ideas. (23)

Lobenhoffer et al. in 1997, presented a posterolateral approach with fibula osteotomy with adequate exposure and satisfying results and Frosch et al. in 2010, presented a modified less traumatic version with preservation of the fibula with good results. (24)

In 2010 Luo et al. introduced the CT-based ‘‘three-column fixation ‘‘ concept using an inverted L-shaped posterior approach combined with an anterior-lateral approach to safely fix all three columns and was followed by other authors describing slight modifications based on the same concept. (25)
3. Arthroscopically-assisted Reduction and Internal Fixation (ARIF)

In an attempt to address high soft tissue related morbidity in complex tibial plateau fractures, avoiding arthrotomy and excessive dissection while maintaining adequate visualization, arthroscopically assisted reduction combined with either conventional plating or MIPO techniques has been introduced. ARIF has been widely accepted as a safe method for the treatment of Schatzker I-IV fractures also providing direct diagnosis and treatment of meniscal and ligamentous injuries and removal of loose fragments, but still remains controversial regarding V and VI injuries for several authors. (26)

Herbort et al. in a recent 2014 study of ARIF outcome on Schatzker IV equivalent fracture types, clearly identifies complex tibial plateau fractures as contraindications due to high danger of iatrogenic compartment syndrome from fluid extravasations, even though its actual occurrence is reported extremely rarely in the literature. (27)

However, there is evidence in the literature to support the safety of the method along with good results when performed by experienced surgeons. Chan et al. and Chiu et al. reported on 18 and 20 patients with Schatzker V or VI fractures respectively each showing approximately 90% (89% - 92%) good or excellent results and no complications. (28)

In a most recent systematic review by Chen et al. in 2015, the authors find this treatment option to be safe and with fewer complications regarding bicondylar fractures, whereas concerning ARIF vs. ORIF comparison the former shows lower incidence of infection but based on limited data. (29)

4. External Fixators

Fine wire external fixation, using circular or hybrid frames, gained popularity as it allows for early and adequate initial weight bearing without limitations related to skin condition and is considered the ideal method of treatment for cases where extensive dissection and internal fixation are contraindicated due to trauma of the soft tissue envelope, deficiency of bone stock, and bony comminution. (30)

Hybrid fixators like Taylor frame and Ilizarov circular fixator have been used effectively for definitive treatment of complex plateau fractures but with some concern over the associated elevation of pin tract infection risk and inadequate reduction. (30)

Moreover, external fixators must be maintained until sufficient healing has occurred, which makes patient’s acceptance and compliance difficult. In his retrospective evaluation of 15 open comminuted tibial plateau fractures treated with a circular fixator in 2007 study, Subasi et al. reported acceptable results but noted insufficient anatomical reduction and loss of reduction in comminuted posterior wall fractures in the coronal plane. (31)

To address reduction issues, several authors reported good results using a hybrid or circular frame combined with minimal open reduction and percutaneous screw fixation, femoral frame extension or even grafting, through a small skin incision in cases with severe comminution and metaphyseal osseous gap (32).
References


www.turkjphysiotherrehabil.org


