Management of Medial Plateau Fracture of The knee Joint
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Abstract:
Medial tibial plateau fracture, a splint depression component with associated comminution of the medial condyle of the proximal tibial end, is 10% of all tibial plateau fractures, which do not occur frequently. These fractures are typically caused by high energy trauma, but they can also occur due low energy trauma (e.g. slip and fall). Its symptoms include pain, swelling and limited ROM. Radiographs, which help in diagnosis also help surgeons plan proper intervention. Physiotherapy is a key part in the management, however, this depends on the patient and cause of fracture. Initial presentation will be oedema, pain, loss of ROM, strength and function. Post-operatively, early ROM and mobility is important. In the later stages strength, proprioception and restoring normal function are paramount.

Key words: Medial tibial plateau fracture, Tibial plateau fractures, physiotherapy.

I. INTRODUCTION

Medial tibial plateau fracture is a split, or depression component with associated comminution, of the medial condyle of the proximal tibial end. It is one of the various types of fractures involving the tibial plateau, representing 10% of all tibial plateau fractures. It is usually the result of a high energy injury and involves a varus force with axial loading at the knee. Considered dangerous due to high risk of damage to the neurovascular structures and may include distraction injuries to lateral collateral ligament, fibular dislocation/fracture, posterolateral corner. It carries a worse prognosis. Fractures of the proximal articular surface of the tibia are uncommon injuries, consisting approximately 1% of all bone fractures. The tibial plateau is one of the most critical load-bearing areas in the human body and its fractures are complex injuries of the knee joint. First described as car bumper or fender fractures, tibial plateau fractures are a diverse group of fractures that represent a wide spectrum of severity which ranges from simple injuries to complex fracture patterns. Pain, swelling, inability to move the knee or bear weight are clinical presentations seen and also there may be damage to surrounding structures like the ligaments and neurovascular structures. The mechanism of trauma may be caused by low energy or high energy fractures. Low energy fractures are commonly seen in older females due to osteoporotic bone changes and are typically depressed fractures. High energy fractures are commonly the result of motor vehicle accidents (VMA), falls or sports related injuries. These causes constitute the majority of tibial plateau fractures in young individuals. The Fractures are caused by a varus (inwardly angulating) or valgus (outwardly angulating) force combined with axial loading or weight bearing on knee either by a car or by a fall from a height. The knee anatomy also provides insight into predicting why certain fracture patterns occur more often than others. The medial plateau is larger and significantly stronger than the lateral plateau. Also, there is a natural valgus or outward angulation alignment to the limb which coupled with the often valgus or outwardly angulating force on impact will injure the lateral side. This explains how 60% of plateau fractures involve the lateral plateau, 15% medial plateau, 25% bicondylar lesions. Partial or complete ligamentous ruptures occur in 15-45%, meniscal lesions in about 5-37% of all tibial plateau fractures. X-rays will typically confirm the signs and symptoms presented, however a CT scan is done when some fractures may not be seen on plain X-rays and then Magnetic Resonance images (MRI) are the diagnostic modality of choice when meniscal, ligamentous and soft tissue injuries are suspected. CT angiography is considered when there is arterial injury. Various classification for tibial plateau fracture have been formed to help differentiate these complex fracture patterns, however the Schatzker classification is the mostly used. It divides tibial plateau fractures into six types.

| Schatzker I | lateral tibial plateau fracture without depression |
| Schatzker II | lateral tibial plateau fracture with depression |
| Schatzker III | compression fracture of the lateral (IIIA) or central (IIIB) tibial plateau |
| Schatzker IV | medial tibial plateau fracture |
| Schatzker V | bicondylartibial plateau fracture |
| Schatzker VI | tibial plateau fracture with diaphyseal discontinuity |
The goal of management is, for optimal outcome, to achieve proper fracture reduction, alignment and maintenance throughout fracture healing\textsuperscript{11} post-op and then physiotherapy rehabilitation to reduce patient’s stay in the hospital.

II. EPIDEMIOLOGY/ MECHANISM OF INJURY

The mechanism of trauma may be caused by low energy or high energy fractures. High energy fractures are commonly the result of motor vehicle accidents, falls or sports related injuries\textsuperscript{2}. These causes constitute the majority of tibial plateau fractures in young individuals. The fractures are caused by a varus (inwardly angulating) or valgus (outwardly angulating) force combined with axial loading or weight bearing on knee either by a car or by a fall from a height\textsuperscript{2}. The medial plateau is larger and significantly stronger than the lateral plateau. Also, there is a natural valgus or outward angulation alignment to the limb which coupled with the often valgus or outwardly angulating force on impact will injure the lateral side. This explains how 60% of plateau fractures involve the lateral plateau, 15% medial plateau, 25% bicondylar lesions. Partial or complete ligamentous ruptures occur in 15-45%, meniscal lesions in about 5-37% of all tibial plateau fractures\textsuperscript{7}.

Else, Larsen et al\textsuperscript{12}, in their epidemiological study on tibial plateau fractures reported that generally younger and middle-aged men tend to have fractures as a result of high-energy trauma, whereas older women have low-energy fractures. They further said that distribution of high-energy trauma between men and women was equal in younger age groups. After the age of 30 years, however, high-energy fractures were still common in men, whereas in women, the incidence of these fractures decreased throughout life. This finding may be related to the mechanism of injury, which showed that women are primarily injured during bicycling, walking, indoor activities, and falls from a height\textsuperscript{13}.

In contrast, men are injured primarily as a result of accidents involving motorcycles and other motorized vehicles and as a result of falls from a height. Further, men had a higher frequency of multiple traumatic injuries compared with women. The reason for the increase in the frequency of low-energy trauma with older age and female sex may be related to the increasing prevalence of osteoporotic\textsuperscript{13, 14}. Tibial plateau fracture represents 1% of all fractures and 8% fractures in the elderly\textsuperscript{3}, however, peak age is 30-40 years old in men and 60-70 in women. Approximately half of the people who sustain a tibial plateau fracture are aged over 50 years old.

III. SIGNS AND SYMPTOMS

Patients with tibial plateau fracture will present with knee effusion and swelling of soft tissues. Also the knee may be deformed due to displacement and/or fragmentation of the tibia which leads to loss of its normal structural appearance\textsuperscript{15}. There is also haemarthrosis, which is blood in the joint. Others includes vascular (i.e. arteries, veins) and neurological (i.e. nerves such as peroneal and tibial) involvement due to close proximity of these structures to the tibial plateau.

IV. DIFFERENTIAL DIAGNOSIS

Other fractures and soft tissue injuries of the knee joint like patellar fracture, segund and reverse segund fractures, anterior cruciate ligament compromise and menisc tear. Tibial plateau fractures are common intra-articular injury for which CT-scans are routinely used for pre-operative planning to rule out other pathology.

V. DIAGNOSIS

Diagnosis is typically suspected based on symptoms and confirmed with X-rays and a CT scan when some fractures may not be seen on plain X-rays\textsuperscript{7}. However, radiographs like X-rays are imperative; computed tomography scans (CT scans) are not always necessary but are sometimes critical for evaluating degree of fracture and determining a treatment plan that would not be possible with plain radiographs\textsuperscript{1}. Magnetic Resonance images (MRI) are the diagnostic modality of choice when meniscal, ligamentous and soft tissue injuries are suspecte\textsuperscript{9, 10}. CT angiography should be considered if there is alteration of the distal pulses or concern about arterial injury.

i. Classification of tibial plateau fractures

Classifications were created to assess the degree of injury, formulate treatment plan and predict prognosis\textsuperscript{9}. Multiple classifications of tibial plateau fractures have been develop, Examples include AO/OTA or the Muller OA\textsuperscript{16, 17}. Although the Orthopaedic Trauma Association uses the AO/OTA fracture classification system owing to its applicability to many extremities, the classification described by Schatzker et al.\textsuperscript{18} remains a relatively simple and familiar system for the tibial plateau. However, its inconsistent and somewhat limited interobserver reliability is a shortcoming. But despite these shortcomings the Schatzker system has many advantages, including its familiarity, ease of use, and generally good reliability. Its major shortcomings come into play where complex, high-energy fracture patterns are concerned, and when 3-D imaging tools are required\textsuperscript{19}.

![Figure I. The Schatzker classification system of tibial plateau fractures\textsuperscript{2}](http://ijesc.org/)
A. Type I: Lateral Tibial plateau fracture without depression.
This is a wedge-shaped pure cleavage fracture and involves a vertical split of less 4mm displacement of the lateral tibial plateau \(^\text{18,20}\). It is usually the result of a low energy injury in young individuals with normal mineralization. May be caused by a valgus force combined with axial loading that leads to the lateral femoral condyle being driven into the articular surface of the tibial plateau. Represent 6% of all tibial plateau fractures \(^1\).

B. Type II: Lateral tibial plateau fracture with depression.
This is a combined cleavage and compression fracture and involves vertical split of the lateral condyle combined with depression of the adjacent load bearing part of the condyle \(^1\). Caused by a valgus force on the knee; it is a low energy injury, typically seen in individuals of the 4th decade or older with osteoporotic changes in bone and make up 25% of all tibial plateau fractures \(^1\). There is a 20% risk of distraction injuries to the medial collateral ligament. May include distraction injury to the medial collateral ligament or anterior cruciate ligament.

C. Type III: Focal depression of articular surface with no associated split.
There is a pure compression fracture of the lateral or central tibial plateau in which the articular surface of the tibial plateau is depressed and driven into the lateral tibial metaphysis by axial forces \(^1\). A low energy injury, these fractures are more frequent in the 4th and 5th decades of life and individuals with osteoporotic changes in bone and represent 36% of all tibial plateau fractures \(^1\). Can be further divided into two subtypes: IIIA Compression Fracture of the lateral tibial plateau IIIB Compression Fracture of the central tibial plateau May result in joint instability.

D. Type IV: Medial tibial plateau fracture, with or without depression; may involve tibial spines; associated soft tissue injuries.
This is a medial tibial plateau fracture with a split or depressed component \(^1\). It is usually the result of a high energy injury and involves a varus force with axial loading at the knee \(^20,21\). This class represent 10% of all Tibial plateau fractures and has the worst prognosis \(^1\); with a high risk of damage to the popliteal artery and peroneal nerve \(^22\). May include distraction injuries to lateral collateral ligament, fibular dislocation/fracture and posterolateral corner. Can also be classified into A, B and C:IVA medial plateau fracture line medial to the intercondylar spines; IVB medial plateau fracture line within the intercondylar spines and; IVC medial plateau fracture line lateral to the intercondylar spines \(^23\).

E. Type V: Bicondylartibial plateau fracture,
Consists of a split fracture of the medial and lateral tibial plateau. It is usually the result of a high energy injury with complex varus and valgus forces acting upon the tibial plateau \(^21,24,25\). May include injuries to the anterior cruciate ligament and collateral ligaments. Make up 3% of all tibial plateau fractures \(^1\).

F. Type VI: Tibial plateau fracture with diaphyseal discontinuity
Main feature of this type of fracture is a transverse subcondylar fracture with dissociation of the metaphysis from the diaphysis \(^1\). The fracture pattern of the condyles is variable and all types of fractures can occur. This is a high energy injury with a complex mechanism that includes varus and valgus forces \(^1\). Up to 33% of these fractures may be open, often with extensive soft tissue injuries and risk of compartment syndrome \(^1\). It represents 20% of all tibial plateau fractures \(^1\).

VI. MEDICAL INTERVENTION
Patients come with pain and swelling. The initial aim of treatment aims at reducing the patient’s pain to a comfortable level. NSAIDs, opioids and splint are used to manage the pain. Bracker \(^8\) also suggest that, if the bones are well aligned and the
ligaments of the knee are intact, people may be treated without surgery.

VII. SURGICAL INTERVENTION

Depends on the severity of displaced fracture surgical treatment aims to achieve anatomical reduction and stability of the fractured segments and restore the length and alignment of the structure involved, in this case the proximal tibial plateau. McNamara, Hing and Smith et.al said that open reduction and internal fixation with a variety of implants are standard approach to reduce and stabilize tibial plateau fracture. Also for less complex fracture such as Schatzker type II and III, the use of arthroscopically assisted percutaneous reduction and internal fixation methods are used involving less extensive surgical dissection but is a technically more complex procedure.

Figure. 3. Plain radiograph showing lateral and Antero-posterior view of the knee post-op. The radiograph shows screws used for reduction of the medial tibial plateau fracture split in place.

A. Fracture healing

Fracture in this case will be through the direct healing process, which does not commonly occur in the natural process of fracture healing. It requires a correct anatomical reduction of the fracture ends, without any gap formation, and a stable fixation. The primary goal here is achieved after open reduction and internal fixation surgery leading to direct bone healing by direct remodeling of lamellar bone, the Haversian canals and blood vessels. Usually, it takes from a few months to a few years, before complete healing is achieved.

VIII. PHYSIOTHERAPY MANAGEMENT

Physiotherapy is required to help ensure return to optimum function as quickly as possible. To achieve this, patient's goals and psychological state must be considered to reduce the risk of persistent pain following surgery. Tibial plateau fractures are notoriously difficult to manage, particularly when there is a medial or posteromedial component. The treatment for tibial plateau fractures aims to achieve anatomical reduction of the joint surface and stable osteosynthesis in order to enable early mobilization, so as to prevent complications such as joint stiffness and general postoperative complications such as deep vein thrombosis or pulmonary embolism. Protocol for rehabilitation varies from region to region and also depending on the surgeon. With phases of rehabilitation divided into 3 phases the duration for each phase vary also ranging from 0-6 weeks or 1-4 weeks or 1-8 weeks (for phase I) and so on for the other phases.

Regardless of what region or the referring surgeon the different phases are grouped into

- phase 1 non weight bearing protocols
- phase 2 partial weight bearing protocol
- phase 3 full weight bearing protocol

- Phase 1 Non-weight bearing (0-6 weeks)

Patient is recovering from the effect of surgery by using cryotherapy and elevation on the pillow to reduce inflammation and pain regaining initial knee range of motion and motor control. The goal is to gain as much range of motion (ROM) as possible, prevent the formation of adhesion and reduce muscle wastage. Also teach non-weight bearing crutch walking technique by using parallel bars before the actual crutch usage.

Means:

- supine position: gentle continuous passive movement (CPM) on the knee and then progress until 90° is achieved. Repeat daily 15 reps x 3 sets
- supine position: move ankle in circle in both direction
- supine position: patella mobilization in all directions
- supine position: putting a rolled up towel under the knee of a straight leg, try to press down on it to work the quadriceps
- supine position: straight leg raising SLR daily 10 reps x 3 sets
- sitting position: active assisted flexion exercises

- Phase 2 Partial weight bearing (7-13 weeks) Begin progressive weight bearing

Closed chain exercises
Stationary bike 5x/week
N/B Patient to continue more difficult variations of the exercises above in phase one in addition to the exercises in phase 2

- Phase 3 Full weight bearing (13- above)
  Progress to full weight bearing exercises
  Decrease dependence on crutches by taking them off gradually, one after the other
  Progress to cane
  Progress to independent walking
  N/B continue strength training of the leg muscle, improve ROM and stability

IX. CONCLUSION

Tibial plateau fractures do not occur frequently (i.e. 1% of all fracture) and medial plateau fracture, a class of tibial fracture occurs in 10% of all tibial plateau fractures. Medial tibial plateau fracture can also be classified into: A, B, C depending on where the line of fracture is found. These fractures are typically caused by high energy trauma, but they can also occur due low energy trauma (e.g. slip and fall). X-rays and CT scans can help define the type of fracture while MRI is used to determine soft tissue involvement. A collaborative management team is required for holistic management of patient with medial plateau fracture. Physiotherapy is very important and aims at preventing complications such as joint stiffness, deep vein thrombosis and pulmonary embolism, but recovery depends on the patient and cause of fracture. Initial presentation will be oedema, pain, loss of ROM, strength and function. Post-operatively, early ROM and mobility is important. In the sub-acute stages pain, oedema, and ROM must be managed but this will vary depending on surgeon guidance. In the later stages strength, proprioception and restoring normal function are paramount.

X. REFERENCES


