LCP in the treatment of the proximal tibial fractures in 2006

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Low and high-energy tibial plateau fractures present a spectrum of soft tissue and bony injuries that can produce permanent disabilities. Their treatment is challenged by fracture comminution, instability, displacement and extensive soft tissue injuries. New implants and surgical techniques have provided new options for the management of these fractures. The goals of treatment are restoration of joint congruity, normal limb alignment, knee stability, and a functional range of knee motion. There is a wide range in treatments for proximal tibial fractures. Surgical treatment of low-energy unicondylar tibial plateau fractures can usually be carried out at early state. In most closed high-energy tibial plateau fractures temporary knee bridging external fixation is needed to allow soft tissue recovery. Delayed definitive surgical treatment can be carried out once optimal soft tissue conditions exist (7-21 days). Locking plates may decrease the need for dual plating in certain bicondylar fracture patterns. Locking plate in the lateral side in bicondylar tibial fractures might be a stable enough fixation when medial condyle is not comminuted and there is no separate posteromedial fragment. Dual plating is needed in bicondylar tibial plateau fractures with a separate posteromedial segment, complete separation of the entire medial plateau, and medial articular comminution.

Classification

A. Proximal tibia fractures (AO classification)
Proximal tibial fractures are those that extend into the proximal metaphyseal region of the bone, and they may be either extra-articular or intra-articular.
1. Type 41A: Completely extra-articular
2. Type 41B: Intra-articular (unicondylar) fractures that have some intact portion of the metaphysis
3. Type 41C: Intra-articular (bicondylar) fractures with complete metaphyseal-diaphyseal separation

B. Tibial plateau fractures (Schatzker classification)
1. Type I: Wedge fracture of the lateral tibial plateau with no depression at the articular surface (more common in younger patients)
2. Type II: Split fracture with depression of the lateral articular surface (more common in older patients)
3. Type III: Central or peripheral depression of the lateral tibial plateau without a lateral wedge fracture
4. Type IV: Split fractures with or without depression
of the medial tibial plateau
5. Type V: Wedge fractures through both the medial and lateral tibial plateaus
6. Type VI: Bicondylar fractures with distal oblique metaphyseal/shaft fractures

Open reduction and internal fixation
The goals of treatment are restoration of joint congruity, normal limb alignment, knee stability, and a functional range of knee motion. Closed management of comminuted and dislocated fractures has proven ineffective, and is therefore not usually recommended (2). Open reduction of the fracture allows a good control of the articular surface and correction of the mechanical axis. Dual plating through a midline extensile approach has a relatively high risk of soft tissue complications as a result of medial and lateral soft tissue stripping. To minimize the rate of deep infection, limited incisions and reduction techniques for joint surface restoration have been recommended. Dual plating is better to perform through two separate incisions (anterolateral and posteromedial), which allows leaving the soft tissue attachments at the anteromedial tibial surface undisturbed.

Regular plates
All plate fixation methods today have one common element, which is the compression force between the plate and the bone (3). Regular plates work only if they can be compressed to the bone. Compression plating needs adequate bone quality, anatomical reduction, precise plate pre-shaping and sufficient blood supply. The risks with compression plates are the need for large exposures to achieve absolute stability, disturbance of blood supply by plate-bone contact and loosening of plate screws in porotic bone. The stability of a standard screw/plate fixation depends on the bone quality. In case of a porotic bone, the screw holding power is not sufficient, which leads to tilting or loosening of the screw. The pull-out force of screws in porotic bones is strongly reduced.

Locked plates
In locked compression plate (LCP), the screws are locked in the plate (3). The double lead thread from the screw head engages and automatically threads the screw into the plate hole. This locks the screw axially and provides optimal angular stability. This stability is independent of the bone quality and distance between the plate and the bone. The strength of a plate/screw construct is independent of the bone quality.

The pull-out of regular plate screw constructs happens as the result of a bending load. Under this load the screws are pulled out sequently. The resistance of locking screws under bending load is higher. The angular stability of the screws strongly increases the area of resistance. The lowest resistance to pull-out occurs when the screws are loaded in a pure axial direction. The parallel locked screw fixation fails by pulling out the cylinder with the size of the screw diameter. To increase the axial pullout strength, the locked diverging or converging screws should be used (metaphyseal area). The pull-out force can so be multiplied.

The advantages of locked compression plates are:
1. angular stability of the screws, 2. no accurate plate contouring required, 3. less damage to the periosteum, and 4. less screw loosening. The rule of anatomical reduction of intra-articular fractures remains unchanged. In contrast to the existing techniques, the LCP allows the use of locking screws to secure the fragments without the risk of fragment dislocation during the subsequent tightening of the screws. Depending on the type of tibial plateau fracture, the reconstruction of the joint surface can also be achieved with plate independent lag screws.

Timing of surgery
In most closed high-energy tibial plateau fractures temporary knee bridging external fixation is needed to allow soft tissue recovery (2,3). Delayed definitive surgical treatment can be carried out once optimal soft tissue conditions exist (7–21 days). Temporary bridging external fixation is indicated in associated dislocation of the knee, when arterial injury necessitates a repair, and in polytraumatized patients. Open fractures need emergent operative treatment. In our institution this includes debridement and stable articular surface restoration (ORIF/ExFix) and early soft tissue coverage with rotational muscle flap (gastrocnemius) or free tissue transfer (latissimus dorsi). This protocol includes definitive internal fixation at the time of initial operative treatment and good co-operation with plastic surgeons. Surgical treatment of low-energy unicondylar tibial plateau fractures can usually be carried out at early state.

Dual plating of bicondylar fractures
Locked plates may decrease the need for a secondary incision and dual plating in certain bicondylar fracture patterns (AOC1-C3). Locking plate through anterolateral approach in bicondylar tibial fractures might be
a stable enough fixation when medial condyle is not comminuted and there is no separate posteromedial fragment. Anatomic or near-anatomic restoration of the articular surface is the goal, but anatomic reduction of the metaphysis is not necessary and may increase surgical morbidity (2).

There is still a need for lateral and medial plating in the following bicondylar tibial plateau fractures: 1) coronal fractures with posteromedial segment, 2) fractures with complete separation of the entire medial plateau, and 3) fractures with medial articular comminution. In our institution combined anterolateral and posteromedial approaches have been used instead of an extensile midline approach.

Operative technique of bicondylar fractures

Usually the medial condyle is approached first, but working simultaneously through posteromedial and anterolateral incisions might help the reduction (2). The medial incision is made 1 cm posterior to the posteromedial border of the tibia. The medial collateral ligament is not detached, the gastrocnemius fascia is dissected off the posteromedial tibia and retracted posteriorly. The pes anserinus tendons are retracted anteriorly for reduction and plate fixation. A standard anterolateral incision is used. The use of lateral AO-distractor helps to achieve successful fracture reduction. Bone graft or graft substitutes are needed in most plateau fractures. New low-profile precontoured locked plates have simplified the lateral plate application. The definitive surgical treatment of concomitant ligamentous avulsion injuries and meniscal ruptures should be carried out in the same operation.

Rehabilitation

Continuous passive motion is started early as well as active exercises. The goal is full extension and 90° of flexion as soon as possible. The patient is mobilized with a hinged brace with ROM 0–90° for 6 weeks. Non-weight-bearing or partial-weight-bearing (20 kg) continues for 10–12 weeks. Active knee extension is delayed if ORIF of the tibial tubercle avulsion was required. Normal muscle strength exercises are started immediately after the operation.

Review of the literature

More than 500 studies evaluating proximal tibial fractures were identified in MEDLINE. Most studies were case-series. The literature is relatively poor with respect to providing evidence for treatments of proximal tibial fractures. Most published studies are case-series. No randomised controlled trials have been reported. This makes it difficult to establish the superiority of one treatment method over another. Less Invasive Stabilization System (LISS) has led to high rates of union and minimal complications (4-8).

Summary

The type and timing of surgical intervention must be guided by the degree of injury to the soft-tissue envelope and the patient’s physiological demands. Articular fractures demand anatomical reduction and absolute stability to enhance the healing of articular fragments and make early motion possible. LCP seems to provide a new option for the treatment of certain tibial plateau fractures (osteoporotic AO type 41B3 and AO types 41C1-C3 fractures). In most closed high-energy tibial plateau fractures temporary knee bridging external fixation is needed to allow soft tissue recovery. Delayed definitive surgical treatment can be carried out once optimal soft tissue conditions exist (7–21 days). Locking plates may decrease the need for dual plating in certain bicondylar fracture patterns; when medial condyle is not comminuted and there is no separate posteromedial fragment.

References