Arthroscopically assisted treatment for Schatzker type I-V tibial plateau fractures

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Objective: To report the clinical outcome of arthroscopically assisted treatment for tibial plateau fractures.

Methods: A total of 39 patients with tibial plateau fractures were treated by arthroscopic fixation from February 2002 to December 2005, including 11 patients with bony avulsion of the anterior cruciate ligament and 19 with meniscal injury. There were 4 cases of type I fracture, 12 type II, 9 type III, 12 type IV and 2 type V according to Schatzker criteria. Firstly, the combined injuries were treated. Then the plateau fractures with the displacement over 3 mm or more were reduced and fixed. Finally, the internal fixation was observed by X-ray equipment. Postoperative management was early motion and delayed weight bearing.

Results: All the fractures healed in 3 or 4 months. All patients were followed up for 1 to 5 years after operation. No case had severe complications, such as poor wound healing, infection, osteofascial compartment syndrome and osteoarthritis. According to the Rasmussen scoring system, 36 cases obtained excellent or good results and the other 3 cases had moderate clinical results. The average score was 26 ± 3.

Conclusions: As an adjuvant treatment of intraarticular fractures such as tibial plateau fracture, arthroscopy has many advantages. It can treat associated intraarticular soft tissue components, visualize the chondral surface reduction, lavage the hematoma and smaller loose fragments, decrease soft tissue dissection, reduce the risk of scarring and promote rapid recovery.

Key words: Tibial plateau fracture; Arthroscopy; Treatment; Surgical technique

Fractures of the tibial plateau are serious intraarticular injuries and constitute approximately 1% of all fractures. These severe injuries may result in premature arthritis, ligamentous injury, and lifelong pain and disability.\(^1\)\(^-\)^\(^3\) Arthroscopic reduction with internal fixation (ARIF) has long been recognized as a treatment option for tibial plateau fractures. From February 2002 to December 2005, 39 patients with tibial plateau fractures were treated by arthroscopic fixation in our hospital.

METHODS

Patients

We recruited 39 patients who had received arthroscopically assisted reduction for closed tibial plateau fractures in our department from February 2002 to December 2005. There were 28 men and 11 women, including 21 patients with injuries on the left knee and 18 on the right knee. The mean age at operation was 35.9 years ± 11.2 years (range: 17-58 years) and the mean follow-up period was 2.8 years ± 1.5 years (range: 1-5 years). Nineteen cases were traffic accident injuries, 11 falling injuries and 9 injured in sports accidents. There were 4 cases of type I fracture, 12 type II, 9 type III, 12 type IV and 2 type V according to Schatzker criteria. The indications for operative fixation included any varus instability of the medial tibial plateau fracture found in full extension, lateral plateau fractures with a varus or valgus instability > 10 degrees, and an articular step-off > 3 mm or a condylar widening > 5 mm.

Symptoms and examinations

Preoperative evaluations included detailed physical examinations of soft tissue swelling, the sensorimotor function of limbs and vascular status during pulsations over dorsalis pedis and posterior tibialis arteries. All patients underwent anteroposterior and lateral plain radiography and CT scanning in both knees. Surgery was delayed and a calcaneus traction was emplaced until the swelling in leg subsided. A formal arthroscopically assisted reconstruction was performed with minimal stripping and dissection, so that definite stabilization
could be accomplished safely.

**Surgical technique**

Patients were in supine position on the operating table, where they were given general endotracheal anesthesia. A complete knee evaluation under anesthesia was performed before surgery. A pneumatic tourniquet was placed on the thigh. The anterolateral and anteromedial portals were used for the insertion of arthroscope and other instruments. Fluid extravasation did not require special treatment because the inflow was achieved by gravity. The arthroscopic inspection of the joint permitted evacuation of the hematoma and loose particles at the initial procedure. Then the capsuloligamentous structures were then probed and the associated intra-articular lesions were evaluated.

Schatzker Type I fracture usually represents the simplest and most amenable to arthroscopic fixation. The arthroscopy had potential benefits in hematoma evacuation, removal of smaller chondral fragments, and direct visualization. If sagittal plane rotational displacement exists, the addition of an anterior to posterior Steinman pin may be useful as a joy stick for assisting reduction. Alternately, the 2 parallelled guide pins typically used for large cannulated screw fixation can be inserted into the subchondral bone of fracture fragment for manipulating the fragment before moving forward across the fracture site and into medial metaphyseal bone. In normal bone, these 2 screws were placed approximately 1 cm beneath the joint surface, which is the adequate fixation.

Schatzker Type II fracture is often amenable to ARIF with the additional complexity of joint surface elevation, involving more than one osteochondral fragment. The arthroscopic approach obviates the need for detachment of the anterior portion of lateral meniscus. Fractures with milder degree of depression in the range of 3 mm to 10 mm have less comminution and can be arthroscopically addressed more easily. Initial reduction of the cortical split will reestablish the correct articular height of the plateau’s rim, but the visualization may require meniscal retraction. Over-reduction of the lateral cortical wall may create tibial condylar narrowing blocking reduction of the central plateau fragments. Placement of the bone reduction clamp lower in the metaphyseal region can prevent it. The depressed central plateau is accessed through either medial or lateral cortical windows in order to derotate and elevate the major fragments, maintain enough supporting subchondral bone for fixation and retain a congruous surface. Whether to choose the medial or lateral cortical window is controversial. The medial side represents uninjured bone with easy subcutaneous access. The lateral side can generally be accessed through the fracture site if compression is released from the bone reduction clamp. The basic sequence involves initially placing a guide wire up through metaphyseal bone to the apex of the fragment using a guide. An anterior cruciate ligament tibial guide usually works well if its profile is not too high. Once the position is checked fluoroscopically and arthroscopically, the cortical window is created with a reamer at 15 to 20 mm above subchondral bone. A bone tamp, placed through the cortical window underneath the depressed fragment, is used to elevate the fragment under direct visualization. Once the congruity of joint surface is restored, reduction is maintained using smooth Steinman pins through subchondral bone, placing permanent fixation distally, or using guide pins for cannulated screws that act as final fixation. Choice of fixation device depends on bone quality and degree of comminution. Two large 6.5- or 7.3-mm cannulated screws work well for simple fractures. However, several small-diameter screws are preferable in more comminuted fractures as a “raft” to support the articular surface. Bone graft from multiple sources (synthetic, autograft, and allograft) have been proved to be applicable.

Schatzker Type III fracture is caused by lateral plateau central depression. The surgical technique is similar to that of type II fractures in many aspects, including guide wire placement, fracture access via reamer, elevation with tamp, temporary fixation percutaneously, bone grafting, and final fixation with cannulated screws.

Schatzker Type IV fracture refers to medial plateau fracture, which is generally thought to be associated with higher energy injury due to the stronger subchondral bone of the medial plateau. Simple splits are relatively easy to reduce arthroscopically. The depressed fractures can be managed with techniques similar to lateral fractures. After reduction of any coronal split component of the medial tibial plateau, it is final fixation of the fracture with cannulated screws in the coronal plane, followed by fixation in the sagittal plane.
Schatzker Type V fracture is bicondylar. In these more complex high-energy fractures, arthroscopic indications are expanded. The risk of fluid extravasation and compartment syndrome, even in ORIF, is increased. The arthroscope is effective in treating meniscal injury diagnosed by preoperative MRI or it can assist in articular reduction. Especially, the arthroscopy is superior in treating severely injured surrounding soft tissue. Extensive incisions or dual incisions may be avoided with theoretically low complication rate. Actually, most of these fractures are not amenable to arthroscopic treatment. The arthroscope may be used to treat larger articular fragments either through the fracture splits or using a cortical window with limited incisions. With the development of locked plate, a fixed-angle periarticular construction can be achieved unilaterally. However, the use of locked screws should be cautious.

Postoperative management

One primary goal of internal fixation is to provide adequate fracture stability to allow immediate unrestricted range of motion to promote cartilage health and prevent arthrofibrosis of the knee. It is suggested to begin the prophylaxis of deep venous thrombosis on admission to the hospital with foot compression devices and low molecular weight heparin 24 hours after surgery. Continuous passive range-of-motion (ROM) machines are used postoperatively along with toe touch weight bearing in a hinged knee brace. Progression of weight bearing does not generally start 8 weeks after surgery. The patients can begin muscle isometric exercise and electrical stimulation if the condition allows.

RESULTS

Totally, we treated 25 cases of closed tibial plateau fractures, including the lateral plateau fractures (4 Schatzker type I, 12 type II, and 9 type III), 12 medial Schatzker type IV and 2 bicondylar Schatzker type V. Among them, 11 patients were treated in the bony avulsion of the anterior cruciate ligament and 19 with the meniscal injury. Five menisci were sutured, fourteen were partially resected and none was totally removed. The average interval from injury to operation was 7.1 days (range: 5-10 days). According to the Rasmussen scoring system,13 excellent scores were obtained in 26 patients, good in 10, and fair in 3 (2 type III and 1 type V). Generally speaking, 36 patients (92.3%) obtained satisfactory results and the mean score was 26±3. Thirty-five (90%) patients had no pain while walking, 3 (7%) reported mild pain, and one (3%) had moderate pain. All patients had excellent to good ROM results. At final follow-up, ROM was 1.6 to 130 degree on average (range: 0-5 degree to 90-140 degree). Thirty-four (87%) patients returned to normal work and thirty (77%) patients recovered to their previous activity level, including sports. Among the reviewed patients, 33 were very satisfied with the treatment, 6 were mildly satisfied and none was dissatisfied. All 39 fractures united. The average time of bone union was 12 weeks (range: 11-14 weeks). No severe osteoarthritis with complete loss of space or bone destruction was observed. No patient suffered from devastating complications such as infection, compartment syndrome, or deep venous thrombosis in final follow-up.

Typical case report

A 43-year-old female was injured on her left knee during a traffic accident. Plain radiographs revealed a split depression and medial tibial plateau fracture. Three-dimensional reconstruction of CT scan confirmed the fracture pattern. Diagnostic arthroscopy showed a partial anterior cruciate ligament avulsion in addition to the documented medial tibial plateau fracture. The fracture was reduced by subchondral elevation and bone grafting. Internal fixation of the fracture was performed using transverse AO screws. The postoperative rehabilitation program consisted of nonweightbearing ambulation and extension splinting for 6 weeks. Continuous passive motion and early active ROM exercises were initiated. Three months after surgery, the patient had no pain and regained full knee ROM. The fracture was healed. After one-year follow up, transverse screws were removed. The prognosis was excellent and the patient was content with the treatment (Figs. 1-6).

DISCUSSION

Potential advantages

It is reported that ARIF has the potential advantages in following indications: better visualization of joint surface reduction, lavage and removal of hematoma and small loose fracture fragments, treatment of concomitant soft tissue injuries to ligaments meniscus, limited soft tissue dissection with no need to peripherally detach the meniscus to gain visualization and postoperative recovery including decreased pain, shorter hospital stay and recovery of knee ROM. Fowble et al.7 found
that all 12 ARIF patients remained anatomic reduction versus only 6 of 11 in the ORIF group. Kiefer et al. reported a series of 31 fractures, among which 25 showed anatomic reduction within 25 months on average. Van Glabbeek et al. were unable to arthroscopically reduce only 1 of 20 split/depression fractures. Ohdera et al. reported that 16 of 19 type II and III fractures were anatomically reduced via ARIF. Gill et al. were able to correct articular depression of mean 7.7 to 0.8 mm in 25 patients.
**Indications**

Indications for surgical management of tibial plateau fractures have been inconsistent with limits of acceptable articular displacement ranging from 2 to 10 mm. Residual tilt of the tibial plateau and varus or valgus malalignment have been associated with higher risk of arthrosis. Biomechanical studies on articular stepoff show that a 6-mm stepoff of the lateral plateau produces 7.6 degree of increased valgus and a 208% increase in contact pressure. Honkonen evaluated the outcomes in 131 tibial plateau fractures and recommended surgical management for more than 5 degree of valgus malalignment, articular stepoff over 3 mm and condylar widening over 5 mm. In fact, multiple factors may contribute to long-term outcome. The surgeon should give special concern to fracture type, presence of laxity, location of articular displacement (central vs. submeniscal), associated soft tissue injuries and patient’s data such as age, activity level, and comorbidity. Inherent in our philosophy of treating intraarticular fractures, particularly in weight-bearing joints, is the goal of anatomical stable fixation of the joint surface for early functional rehabilitation. Visualization of the knee joint via arthroscopy has led to its broader application to fracture management.

The arthroscopic articular reduction of tibial plateau fractures is technically demanding but useful in accurate articular reduction. It also allows the application of minimal invasive techniques and has the theoretical benefit of expedited rehabilitation. The application of arthroscopy also permits early diagnosis of intra-articular pathology with the ability to address these injuries at the same operative setting. ARIF in the treatment of selected tibial plateau fractures allows achievement of anatomic reduction and stable internal fixation with less morbidity than ORIF. Moreover, it is superior in visualization of the entire joint.

**REFERENCES**


(Received December 17, 2007)

Edited by LIU Jun-lan