Original article

Arthroscopic-assisted reduction and fixation of proximal tibial fractures: personal surgical technique

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Abstract. *Purpose:* The purpose of this study was to describe the authors' arthroscopic-assisted reduction and fixation (ARIF) technique in the treatment of type Schatzker I-III tibial plateau fractures, with the use of instruments commonly used in anterior cruciate ligament reconstruction, evaluating clinical and radiological outcomes on four patients at short-term follow-up. *Methods:* A retrospective analysis was performed in our Institution considering 4 patients who underwent ARIF procedure between 2018 and 2020 at minimum 3 months of follow-up. All patients were evaluated clinically (Rasmussen Score, VAS and Crosby-Insall Grading) and radiographically (after surgery and at 6 weeks). *Results:* Mean follow-up was 9 months (range 6-12 months). Rasmussen score and VAS were respectively 26 (Excellent) and 1 at the last follow-up. According to the Crosby-Insall Grading System, all patients reported excellent results. At final control the mean range of motion in the injured knee was 125°(range 100°-140°). Mean hospitalization was 2 days (range 1-4 days). No adverse events were reported. *Conclusions:* ARIF is a reliable technique for tibial plateau fracture (Schatzker I-III). The technique described is very cheap and reproducible in any hospital. This procedure allows to well understand the pattern of fracture and to obtain an anatomical reduction with a great tissue sparing and a faster recovery of knee function. (www.actabiomedica.it)

Keywords: tibial plateau fractures, treatment, arthroscopy, surgery, artrhoscopic-assisted

Introduction

Tibial plateau fractures are quite rare, representing about 1,2% of all fractures, (1) but can evolve in severe joint function limitations if not correctly treated. The Schatzker classification is the most used and tibial plateau fractures are divided into six categories considering the involved compartment and articular depression. (2)

Tibial plateau fractures affect typically two specific groups: younger people as a consequence of a high-energy trauma or elderly patients in low-energy fractures secondary to osteoporosis or metabolic diseases.

The goal in the treatment of these fractures is absolute stability, restoring the articular surface, preserving local blood supply, and soft tissues as much as possible. Historically surgical treatments include external fixation, open reduction and internal fixation (ORIF) with plate and screws and percutaneous osteosynthesis with cannulated screws (3); recently arthroscopic-assisted reduction and internal fixation (ARIF) has gained a prominent place especially in type II-III fractures (4).

This technique has many potential advantages, considering that proximal tibia fractures are associated with soft tissue injury in 71% of the cases, menisci in 57%, anterior cruciate ligament (ACL) in 25%, posterior cruciate ligament in 5% and collateral ligaments in 3% (5). Many different ARIF techniques have been proposed recently, requiring in some cases specific instrumentation or complex surgical strategies.

This study aims to describe the authors' ARIF technique in the treatment of type I-III tibial plateau fractures, with the use of instruments commonly used in anterior cruciate ligament reconstruction, evaluating clinical and radiological outcomes on four patients at short-term follow-up.

Surgical technique

Accurate pre-operative planning is performed to evaluate the fracture pattern and the best choice of treatment. In authors' practice, anteroposterior and lateral radiographs of the knee are completed by a CT scan (fig. 1)

The patients' positioning is similar to the one used by authors for ACL reconstruction: patient supine, tourniquet at the tight, possibility to fix the knee on the bed at 90 degrees of flexion, free of reaching a complete range of motion. The contralateral leg is

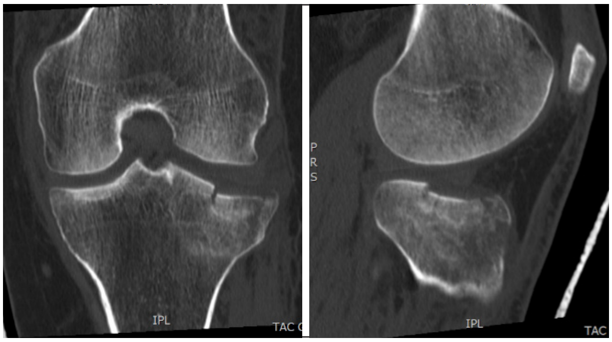

Figure 1. Pre-operative CT scan showing a Schatzker type III fracture

positioned about 10 cm lower than the affected one to facilitate lateral x-ray projections with the c-arm. Standard portals (superomedial, anteromedial, and anterolateral) are used, the pressure pump should not be set higher than 50 mm Hg to avoid fluid effusion and the risk of compartment syndrome.

First of all, fracture hematoma is evacuated and a full diagnostic inspection of all compartments is performed to evaluate associated lesions and to confirm the fracture pattern, avoiding to stress the knee in valgus with the risk of fracture compression. Then the fracture is reduced using a probe and a k-wire (2 mm) is inserted starting from the anteromedial surface of the proximal tibia to the middle of the largest displaced fragment using an ACL tibial guide (Acufex Protract, Mansfield, MA) with the knee flexed of about 50°.
A medial tibial corticotomy is performed with the 10 mm atraumatic cannulated reamer, commonly used in ACL reconstruction, using the k-wire as a guide (fig.2 a). The cannulated reamer is introduced to reach about 2 mm below the subchondral bone, and the correct positioning is confirmed by fluoroscopic control.
The reamer is left in place and used for elevating the fragment, using a small hammer, until the restoration of the joint surface, with the arthroscopy camera checking the restoration of the correct articular surface. In authors' experience normally no graft or cement is needed to fill the depression. Final control of fragment reduction is performed using fluoroscopy and two k-wires are placed from the lateral side parallel to the joint surface (fig.2 b). The fracture is finally stabilized with two cannulated cancellous screws (7.3mm) with a washer (fig.3). Placement and progression of screws are controlled under fluoroscopy.

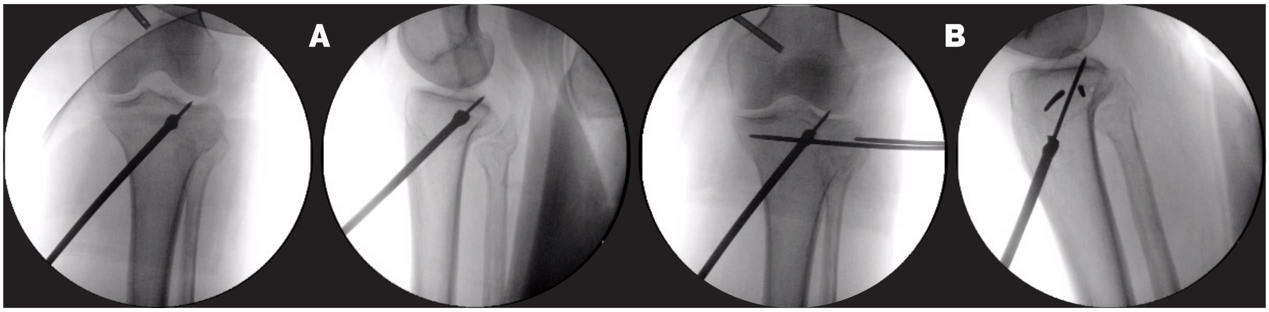

Figure 2. Fluoroscopic controls during surgical procedure: atraumatic cannulated reamer on a guide k-wire to elevate the fragment (a); two k-wires from lateral to medial side to stabilize the fracture (b).

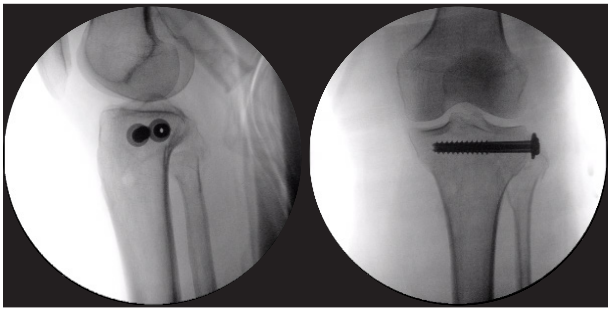

Figure 3. Final fluoroscopic control to check the correct position of the screws, inserted with washers.

A knee brace locked at 20 degrees is maintained for 2 weeks, then the brace is unlocked permitting full extension and flexion improvement of 15 degrees every week.

Thromboembolic prophylaxis is usually started from the first access in the emergency room as an internal hospital protocol and continued till the recovery of partial weight-bearing.

During the not-weight-bearing period patients follow an isometric reinforcement program for quadriceps muscle and hamstrings stretching.

Full weight-bearing is allowed after clinical and radiological healing, usually not before 10-12 weeks after surgery.

Material and Methods

A search was carried out on the hospital database in August 2020 identifying patients who underwent ARIF procedure between May 2018 and May 2020. Inclusion criteria were: 1) Schatzker fracture type I-III; 2) pre-operative CT scan. Exclusion criteria were: 1) Schatzker fracture type IV-VI; 2) Open, comminuted and bifocal fractures ; 3) Polytrauma patients. Four patients were identified and retrospectively analyzed at minimum of 3 months of follow-up using the Rasmussen score, Visual Analog Score (VAS) and Crosby-Insall satisfaction scoring system. Furthermore, the postoperative range of motion (ROM) was measured with a manual goniometer by two independent examiners. Usually, standard radiographs (anteroposterior and lateral) after surgery and at 6 weeks of follow-up were performed. The study protocol was approved by the Local Scientific Board and all patients signed informed consent to participate in the study.

Results

The patients were 3 females and 1 male. The patient's age at the time of the surgery ranged from 33 to 56 with an average of 46 years old. According to Schatzker's classification, there were 2 type II and 2 type III fractures. Only a partial ACL tear was reported during the procedure. No menisci and/or cartilage lesions were recorded. The mean follow-up was 9 months (range 6-12 months). The average BMI at the time of surgery was 25 (range 23-27). Rasmussen score and VAS were respectively 26 (Excellent) and 1 at the last follow-up. Concerning the Crosby-Insall satisfaction system, all the patients reported excellent results. The mean ROM in the injured knee was 125° (range 100°-140°) compared with the ROM of 130° (range 120°-140°) in the healthy knee. One peroneal nerve neuropathy occurred, probably due to brace compression the day after surgery. No cases of septic arthritis, non-union, compartmental syndrome and screws failure were recorded.

Discussion

The most important finding of this study was the reproducibility and safety of ARIF for lateral tibial plateau using common instrumentation used in ACL reconstruction. The intra-operative arthroscopic evaluation of fracture reduction evidenced a good alignment of bone fragment, with the restoration of the articular surface. Clinical and objective scores at the final follow-up were good with a quite full recovery of range of motion without pain or discomfort.

Arthroscopy permits accurate evaluation, anatomical reduction and tissue-sparing. A significant advantage is the possibility of performing a profuse lavage of the joint allowing evaluation and repair of any associated lesion (cartilage or menisci). Furthermore, arthroscopy is correlated to a faster hospitalization and rehabilitation protocol (4): in our experience, the mean hospitalization was 2 days (range 1-4 days) and rehabilitation was faster than other procedures.

In Literature there are several comparisons between ARIF and ORIF technique and no study has shown a real superiority of a technique (4).

Different techniques have been described to elevate the decalage. Rossi and colleagues (6) developed custom-made instrumentation with 4 basic elements: 2 cutting guides, a hollow trephine cutter with a saw-toothed tip, and a bone plunger; using this device they obtain a good restore of the articular surface without the need for bone grafts. The advantage of the technique proposed in this article, instead, is the potential implementation of this technique without special instruments, using a standard ACL set-up.

Burdin (7), conversely, inserted one or two K-wires into the fractured plateau using them as a joystick to elevate the fragment and to correct rotations in Schatzkers type I-II; in Schatzkers type III with isolated depression, he used a spatula or a cannulated curved osteotome after creating an anterior cortical window with a reamer.

According to Hartigan and colleagues (8), the best choice to elevate the fracture fragment was to use a bone tamp. In the proposed technique it was used the cannulated reamer itself to push up (hammering on the cutter handle) the depressed area with double - arthroscopic and radiological - check; it seems easier and cheaper because there is no need for specific devices. The disadvantage of using the reamer itself is the risk of breaking the osteochondral fragment (especially if it is small) (9), even if in our experience such complication has not been reported.

Many authors prefer to fill the depression with grafts and several studies have addressed this topic (10). Some authors (11) use a 1- to 2-cm-long bone graft harvested from iliac bone and they gently drive through the tunnel with a dilatator. Berkes and colleagues (12) used a structural allograft, reporting subsidence < 2mm at a minimum 6-month radiographic follow-up. Iundusi et al. (13) developed an injectable biphasic hydroxyapatite and calcium sulfate ceramic material with radiological and clinical satisfactory outcomes at an average 44 months follow-up. Some other surgeons, instead, prefer not to fill the defect and they take autograft from the tibial metaphysis opposite the fracture and compacting the cancellous bone with a special device (6). For many authors is better to fill the depression especially if it is greater than 6 mm or in patients over 55 years due to poor quality of cancellous bone (7). In our case series, there was no need for bone graft because the cancellous bone was compacted advancing the cannulated reamer. This was possible thanks to the little subsidence of reported fractures.

The learning curve of the arthroscopic technique depends especially on the surgeon's experience and pattern fracture. In our case series, all procedures were carried out by the same fully trained surgeon, accustomed to performing shoulder and knee arthroscopies.

ARIF technique is not adapted to all types of fractures: in Schatzker IV, V and VI types, this approach should not be performed due to hard fragments reduction and high risk of the compartmental syndrome. In these cases is preferable an open reduction and plating.

The follow-up of our study is too short to evaluate the development rate of osteoarthritis after this procedure. However in literature symptomatic osteoarthritis after arthroscopic treatment of tibial plateau fractures was reported to be more than 12% of the cases (14).

In a very recent study (15) clinical and radiological outcomes were evaluated on 25 patients treated with ARIF with an average follow-up time of 14 months: the mean clinical Rasmussen score resulted in 26 (range, 24-30) and the average time for bone consolidation in Schatzker type I was 9.1 weeks, in type II was 10.2 weeks, and in type III it was 9.4 weeks.

According to our data, the results were similar to the high satisfaction of patients although the number of patients is much lower.

In this study there are some limitations: the short-term follow-up with a little group of patients without a control group; furthermore, all procedures were performed by the same surgeon. A mid to long-term follow-up would be useful to better understand the real effectiveness of the technique proposed in the study.

Conclusions

ARIF is a reproducible and reliable technique for tibial plateau fracture (Schatzker I-III). The technique described is very cheap and reproducible in any hospital since there is no need for special instruments or bone grafting. This procedure allows to well understand the pattern of fracture and to obtain an anatomical reduction with great tissue sparing and a faster recovery of knee function. Moreover, it permits to treat in the same time any chondral or meniscal tears.

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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