

Case report

Combined arthroscopic and radioscopic management of tibial plateau fractures: report of 18 clinical cases

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Abstract. Tibial plateau fractures are complex lesions capable of causing severe consequences if not appropriately treated. They are often the result of a high-energy trauma and, not rarely, are associated with significant soft-tissue and intra-articular injuries. Different therapeutic options can be managed in the treatment of these lesions. Minimally invasive surgery offers several advantages compared to other surgical techniques and allows, with less additional soft tissue damages, good reduction and stable fixation of the fracture. In this study we assessed the results of the combined arthroscopic and radioscopic assisted reduction and internal fixation of tibial plateau fractures in 18 patients affected by Schatzker type I, II, III, IV fractures. According to Hohl's and Rasmussen's grading system, 16 out of 18 patients scored a satisfactory result. We experienced no complications due to arthroscopy.

Key words: tibial plateau fractures, arthroscopic reduction, minimally invasive surgery, split and depressed fractures

Introduction

Tibial plateau fractures have always been a challenge for orthopaedic surgeons. These fractures may be difficult to manage and, although these lesions are relatively rare representing approximately 1% of all fractures (1, 2), the consequences of an inadequate treatment can be serious. There have been in the past, there are now and there will be in the future controversies regarding the best method of treatment. Several choices have been considered in the treatment of these fracture and numerous satisfactory results have been reported using both non-surgical and surgical methods (3, 4). In any case, the goals of treatment are restoration of normal alignment, joint congruity, joint stabilization and, ultimately, the prevention of degenerative osteoarthritis. A precise reduction and a stable fixation of the fracture fragments, obtained through out a good visualization of the articular surface with minimal dissection, can help to achieve these goals and allows early mobilization and a faster recovery.

Proximal tibial fractures are often the consequence of a high-energy trauma and present a wide spectrum of bone and soft tissue injury patterns and, not rarely, are associated with intra-articular lesions. Minimally invasive surgical techniques have gained popularity over the recent years and try to prevent additional surgical trauma to the knee joint by using a minimally invasive approach. These surgical techniques fall in between the management of unstable tibial plateau fractures by plaster cast immobilization (higher risks of stiffness and deep venous thrombosis) and the traditional form of open reduction and internal fixation (higher incidence of soft tissue problems) (5). The combined arthroscopic and radioscopic surgical treatment, initially used in the 1970s as a diagnostic tool (6, 7) and later as a standardized method of treatment, minimizes the additional surgical trauma, reducing additional insult to the soft tissues, and encounters several advantages compared with other techniques (1, 2, 8-15).

These advantages include: better visualization of the articular surfaces, better reduction of the fracture, better anatomical restoration of the joint surface, the possibility to assess and treat the associated intra-articular ligamentous and meniscal injuries, the possibility, through joint lavage, to remove loose fragments, the possibility to achieve stable fixation with the least amount of soft-tissues dissection, low risk of complications and low morbidity, the possibility of converting to arthrotomy if necessary and shorter hospital stay with faster recovery of joint motion.

The purpose of this study is to evaluate retrospectively the functional and radiographic results and the value of the combined arthroscopic and radioscopic treatment of tibial plateau fractures.

Materials and methods

Between January 1997 and December 2003 we performed the combined arthroscopic and radioscopic assisted treatment in 19 patients with tibial plateau fractures. We reviewed clinical records and radiographic findings of 18 out of the 19 patients with a minimal follow-up of at least 12 months (range 12 months-6 years and 9 months). There were 13 men and 5 women, mean age at injury 36 years old (range 15-61). One patient refused to participate in the study. Ten cases were injuries following traffic accidents, 5 cases followed a falling and three fractures were following skiing accidents. According to Schatzker's classification (16), 4 type I (or isolated split lateral fracture), 6 type II (or split-depression lateral fracture), 6 type III (or isolated depression lateral fracture) and 2 type IV fractures (or medial fracture) were assessed. Using the AO classification (17), 4 B1.1, 2 B1.3, 8 B2.2 and 4B3.1 type fractures were considered. The indication for surgical fixation included any varus instability of the medial tibial plateau fracture found in full extension, lateral plateau fractures having a varus or valgus instability greater than 10°, and an articular displacement >3mm or a condylar widening >5mm. Preoperative assessment included detailed physical examination and anteroposterior and lateral plain radiograph. Computed tomography (CT) scanning was performed only in the last 9 patients.

Percutaneous reduction and osteosynthesis of the fracture were performed under radioscopic and arthroscopic control only in type I, II, III and IV fractures according to Schatzker's classification. For more complex bicondylar fractures (type V and VI fractures) we preferred on open reduction and ostesynthesis.

During surgery the patients were placed in the supine position and a pneumatic tourniquet was applied; all patients were given spinal anaesthesia. A complete clinical evaluation of the knee was performed under anaesthesia and a radioscopic evaluation was done before arthroscopy. The anterolateral and anteromedial portals were used for the insertion of the arthroscope and working instruments permitted, at the beginning of the procedure, the inspection of the space joint, haematoma and loose particle evacuation and the diagnosis of concomitant ligament and meniscal lesions. The inflow was supero-medial and was achieved by gravity. After this initial assessment a skin incision, with minimal exposure and avoiding arthrotomy, was performed on the side of the fracture. In depressed fractures of the medial or lateral tibial plateau, under arthroscopic and radioscopic view, we elevated the depressed fragment with a curved impactor placed in the center of the fragment through a tibial metaphyseal window. If needed, through the metaphyseal window, it is possible to fill the bone gap with human or synthetic bone grafts (Fig. 1). In split fractures we obtained reduction using closed manipulation or external clamp associated with percutaneous pinning by the joy-stick technique (Fig. 2). In these types of fractures the fixation was usually achieved with cancellous screws. In two cases we needed additional plate and screw fixation.

The associated intra-articular injuries were treated in the appropriate sequence after fracture fixation. The meniscal tears were immediately treated. Six out of 18 patients showed associated intra-articular lesion. We observed rupture of the lateral meniscus in 4 patients. All these meniscal tears were partially resected and none were totally removed. We observed

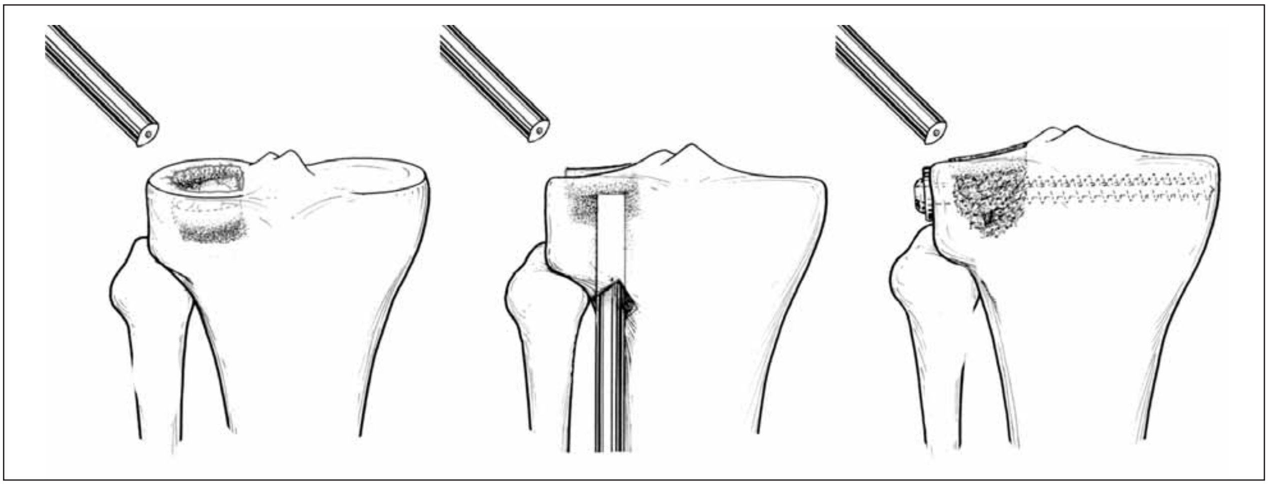

Figure 1. Depressed fracture of the lateral tibial plateau; indirect arthroscopically assisted reduction through a tibial metaphyseal window with an impactor under arthroscopic vision and fixation with screws.

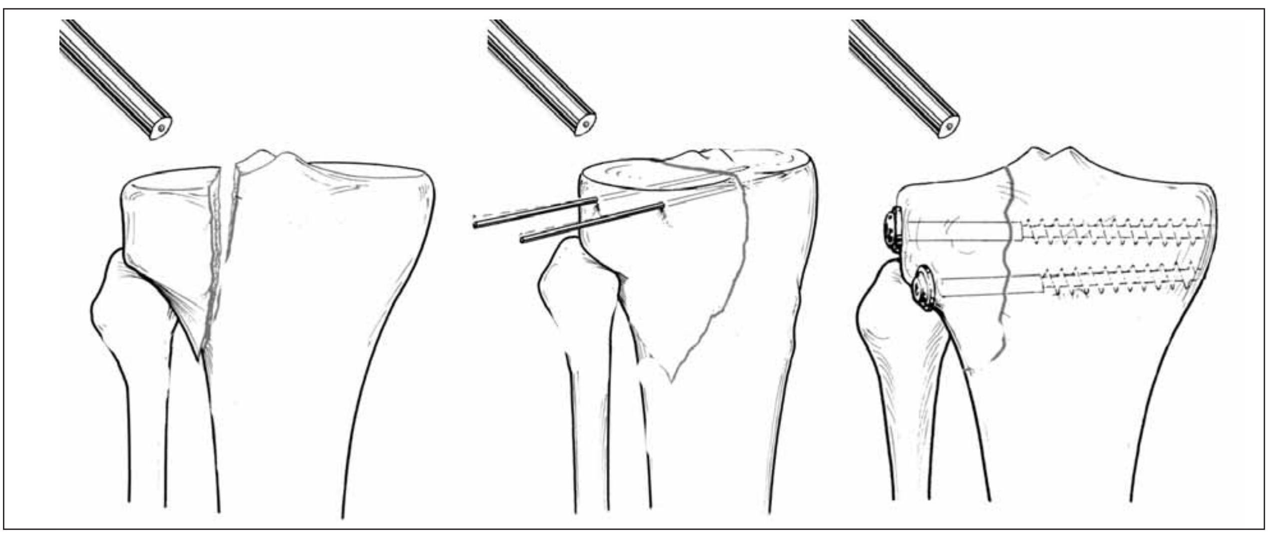

Figure 2. Split fracture of the lateral tibial plateau; indirect arthroscopically assisted reduction with percutaneous pinning through the joy-stick technique under arthroscopic vision and fixation with screws.

one partial case of anterior cruciate ligament (ACL) rupture, one partial posterior cruciate ligament (PCL) rupture, one isolated medial collateral ligament (LLI) rupture and one combined ACL and LLI lesion. None of the treated patients with associated partial rupture of the cruciate ligament needed a secondary ligament reconstruction. LLI injuries healed with postoperative immobilization. Autologous iliac spine bone grafting was carried out in two lateral depressed fractures.

Initially, post-operative treatment started with 4 weeks of immobilization in plaster, followed by four weeks of physiotherapy without weight bearing using continuous passive and active motion. In the last cases this period of immobilization was shorter. Weight bearing was allowed after a mean time of 2 months and in each case it was delayed until radiological evidence of healing of the fracture was observed.

All the recruited patients were clinically and radiologically assessed (weight bearing bipedal long-leg projection and latero-lateral projection) using Hohl's (18) and Rasmussen's (19) scoring system. The osteoarthritis changes were evaluated through the width of joint space narrowing according to the scale of Ahlback (20). The patients were also asked to indicate whether they were subjectively satisfied with this surgical management.

Results

According to Hohl's (18) clinical and radiographic scoring system 7 patients were assessed as excellent, 8 good, 2 fair and 1 poor.

According to Rasmussen's clinical scoring system (19) 8 patients were assessed as excellent, 7 good, 2 fair and 1 poor.

According to Rasmussen's radiographic scoring system (19) 5 patients were assessed as excellent, 7 good, 4 fair and 2 poor. These data suggest a mild discrepancy between clinical and radiographic results. One patient (female, 59 yrs, Schatzker III type fracture) with a severe post-menopausal osteoporosis showed poor results in all scoring systems. She had an inadequate fixation without bone grafting and an unacceptable post-operative joint depression. One month after the arthroscopic procedure she underwent surgery again with adequate reduction and stable plate and screw fixation associated with autologous bone grafting.

A second patient (female, 55 yrs, Schatzker type II fracture) with a condition of mild post-menopausal osteoporosis was rated fair in Holm's and clinical Rasmussen's scoring system and poor in radiographic Rasmussen's scoring system. She showed a joint depression exceeding 5 mm in the x-Ray films performed after weight bearing. The last follow-up (X-ray views) pointed out a moderate degree of osteoarthritis with incomplete knee range of motion (ROM) and pain during walking.

According to Ahlback's (20) scoring system, 1 patient showed a moderate degree of osteoarthritis with a joint narrowing >50% and 4 patients showed a mild degree of osteoarthritis with a joint space narrowing <50%.

All the patients except 1 showed excellent to good ROM.

Fourteen of the reviewed patients were subjectively very satisfied with the treatment (Figs. 3, 4); three patients mildly satisfied and one (the one who was reoperated) was unsatisfied.

No patient suffered from severe and invalidating complications such as deep infection, compartment syndrome or deep venous thrombosis. We experienced no complications directly associated with arthroscopy. In the 2 patients in which we performed autologous bone grafting no donor-site morbidity was observed.

Discussion

Tibial plateau fractures have always been a challenge for orthopaedic surgeons. The goal of treatment is to restore anatomical reduction and to give a stable fixation to the fracture fragments in order to begin early mobilization.

This is further facilitated if soft tissue damage can be kept to a minimal degree.

Open reduction and internal fixation have a high incidence of soft tissue problems while plaster cast immobilization produces higher joint stiffness and deep venous thrombosis rate (5).

Minimally invasive surgery techniques, such as indirect arthroscopically assisted reduction, have gained popularity over the recent years and have been associated with good results (8-15). Fowble (21) compared arthroscopic treatment to open reduction and internal fixation. He reported better results in terms of hospital stay, time to full weight bearing and anatomical reduction of the joint surface in patients who underwent arthroscopic treatment. Ohdera (8) in a similar study concluded that there were no significant differences between both treatments in terms of duration of surgery, postoperative flexion and clinical results. On the other hand, he demonstrated an easier and faster postoperative rehabilitation and the possibility to diagnose and treat any associated joint pathology. In the 1970s arthroscopy was first used as a diagnostic

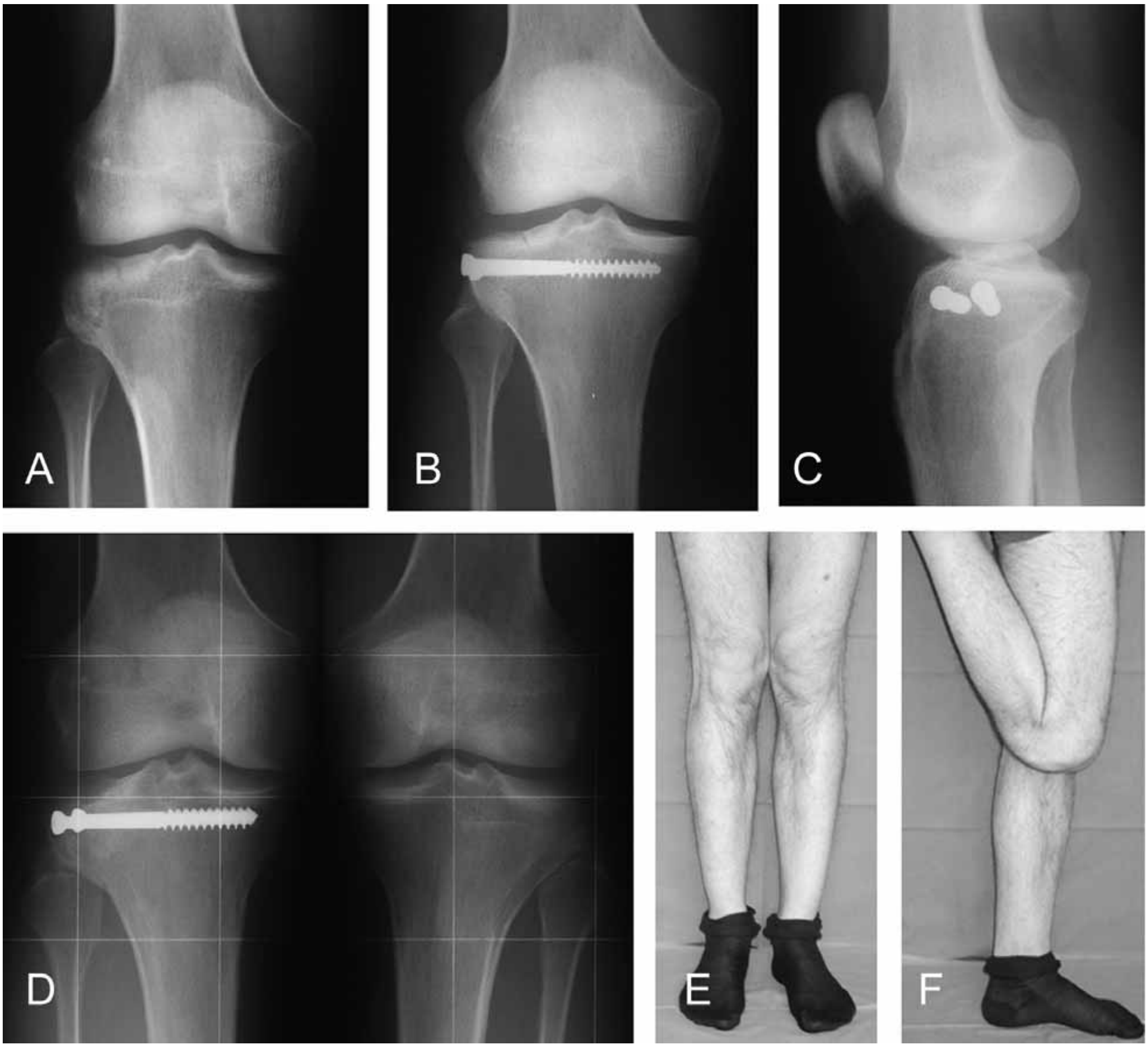

Figure 3. Schatzker type II fracture. A) preoperative X-ray; B, C) post-operative X-ray; D) X-ray after 3 years; D, F) clinical outcome.

tool (22, 23). Reiner (11) first reported 3 patients treated by arthroscopic management in 1982 and Mc Lennan (6), in the same year, reported a series of 35 cases treated in the same way. From these initial reports new arthroscopic techniques developed and the results gradually improved.

With the assistance of arthroscopy the articular surface can be seen better without meniscal detachment and intra-articular lesions can be diagnosed and eventually treated.

In our study associated intra-articular injuries were found in 33,3% of the patients. Lateral meniscal rupture was more susceptible to trauma. As demonstrated by Walker and Erkman (24), the lateral meniscus is the most important structure in the transmission of forces across the lateral compartment, but both menisci are crucial for the maintenance of a normal joint function. For this reason the treatment of associated lesions of the meniscus is important and should be repaired or partially removed if indicated. The

Figure 4. Schatzker type III fracture. A, B) preoperative X-ray; C, D) post-operative X-ray; E) X-ray after 2 years; F, G) clinical outcome.

complete meniscal removal during fracture repair resulted in a higher rate of secondary osteoarthritis (12, 25). In our patients we observed 4 lateral meninscal ruptures which were partially resected.

In contrast with Buchko (2) we believe that the immediate ACL reconstruction should not be attempted because it adds significant supplementary damage to a knee that has already been injured. We believe, in accordance with other authors (1, 8, 12, 14), that ACL reconstruction should not be performed during the arthroscopically assisted treatment of the fracture but later, and only if the patient presents an unstable knee. In our cases the two patients with ACL rupture didn't require a secondary reconstruction of this ligament.

Other important concerns with open reduction and internal fixation are the additional major surgical damage of the soft tissues and the higher rate of superficial and deep wound infection which could reach a rate of 45% (1). In the open reduction, arthrotomy with extensive soft tissue release is needed and this may lead to joint stiffness, increased pain, diminished muscular sense and potential wound complications (8). Arthroscopy allows minimal soft tissue dissection with a lower rate of these complications (8-15).

Some authors demonstrated (8, 21) a faster and more complete recovery of motion and shorter hospital stay. In our cases all the patients except 1 (the 2nd treated patient) had excellent to good ROM. We observed a slower but complete recovery of motion. This is probably due to the postoperative immobilization in plaster cast. In the last period we tried to diminish this period and to accelerate the rehabilitation program.

The arthroscopically assisted treatment could achieve a more precise restoration of the articular surface (8, 14), preventing or at least slowing down the development of degenerative joint disease. Scheerlinck (14) reported 28,9% of 38 patients showing osteoarthritis changes at a minimum follow-up of 5 years. This is less than the 64% reported by Honkonen (26) after open osteosynthesis at a minimum follow-up of 7,6 years. In our cases we observed in 1 patient a moderate degree of osteoarthritis with a joint narrowing >50% and in 4 (22,2%) patients a mild degree of osteoarthritis with a joint space narrowing < 50%. In our results we observed a discrepancy between clinical and radiographic results. Clinical results were better than x-ray results. Because of this we believe that the double Rasmussen's scoring system (19) is more complete than the Hohl's scoring system (18).

During the arthroscopic treatment of tibial plateau fractures, bone grafting can be easily performed. Although Ohdera (8) and Fowble (21) reported that the arthroscopically treated patients required less bone grafting than those treated by an open method, we believe that not rarely the reduction of a depressed fracture should be maintained with bone graft support. We used autologous bone grafting in 2 depressed fractures with good functional result without donor-site morbidity. In 1 case (poor result) we obtained an inadequate fixation without bone grafting, with an unacceptable post-operative joint depression. One month after the arthroscopic procedure, the patient underwent surgery again with adequate reduction and stable plate and screws fixation associated with autologous bone grafting. In this case a primary bone grafting would have avoided the unsatisfactory outcome.

Surgical potential disadvantages have been reported in the arthroscopically assisted treatment of tibial plateau fractures. These include prolonged surgery time in non experienced arthroscopic surgeons, which can lead to a higher rate of deep infection and deep thrombophlebitis, and a higher risk of compartment syndrome as a consequence of fluid extravasation into the soft tissues (27, 28, 29). We think that a longer learning curve with respect to the open technique is required and some experience in arthroscopy is necessary to avoid these complications. The risk of compartment syndrome can be minimized if the treatment is delayed until the subsidence of swelling and infusion pump is avoided. In our limited experience we didn't observe these complications.

In recent years the trend is to extend the indications of this technique to all types of tibial plateau fractures. At first the method was applied to selected fractures such as split depression and isolated depression. Carr (29) and Scheerlink (14) reported that unicondylar fractures tend to show better results than bicondylar fractures. On the contrary Ohdera (8) and Chan (13) reported good results also in complex and bicondylar tibial plateau fractures (Schatzker type V and VI). In our study we treated only Schatzker type I-IV fractures with good results and we think that more severely comminuted fractures require open reduction performing more sofisticated fixation; in Schatzker type V and VI fractures, because of the higher risk of compartment syndrome, the time of arthroscopy has to be rapid and should be limited to experienced arthroscopic surgeons.

Conclusions

The combined arthroscopic and radioscopic assisted reduction of tibial plateau fractures is a safe but demanding procedure. We recommend this technique in selected fracture types, such as Schatzker type I, II, III, IV fractures.

Based on this study and on the good results we obtained this technique has been shown to be highly effective and with several advantages in comparison with other methods of treatment.

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