Functional results of percutaneous fixation of displaced tibial plateau fractures assisted by arthroscopy

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Background

Tibial plateau fractures are a common injury that require anatomic reduction to obtain the best functional results. Assisted arthroscopy seems to be more satisfactory in reducing the risks of open reduction and internal fixation.

Aim of the study

This study evaluated the functional results of percutaneous fixation of displaced tibial plateau fractures assisted by arthroscopy.

Patients and methods

The study was carried out between July 2012 and June 2013 in Suez Canal University Hospitals. This was a prospective study and 20 patients were included, 16 men and four women, mean age 40 years (range 21–72 years) at the time of surgery. Patients with closed tibial plateau fractures type I–IV according to the Schatzker classification were included in the study with step-off of the articular surface more than 3 mm and condylar widening more than 5 mm. All patients underwent preoperative and postoperative clinical and radiological assessment, and the outcomes were scored by the Rasmussen system.

Results

The results of the current study showed a significant difference between preoperative and postoperative Rasmussen scores. For the postoperative Rasmussen score, the median clinical score at the 1-year follow-up was 28 (range 22–30) and the median radiological score was 9 (range 6–10). According to clinical and radiological assessments, we found that 95% of the patients had satisfactory results. All fractures were united and no permanent complications developed.

Conclusion

Percutaneous fixation of displaced tibial plateau fractures with assisted arthroscopy is a safe and effective procedure with excellent results and early mobilization.

Keywords:
arthroscopy, percutaneous fixation, tibial plateau fracture

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Introduction

Tibial plateau fractures account for 1% of all fractures. These fractures require anatomic reduction as soon possible to obtain the best functional results [1,2]. Fractures of the tibial plateau result from direct axial compression after a fall or motor vehicle accidents [3]. Many classifications on the basis of the degree and type of displacement have been applied and the one used the most is Schatzker's classification [4]. Nondisplaced or minimally displaced fractures are treated by conservative measures. Displaced fractures, if not managed in the proper manner on an anatomical and functional basis, will lead to harmful late complications for the patients. The most common indications for surgical treatment are for impacted articular fragments that cannot be dislodged by traction alone and articular depression more than 2 mm and unstable joints [5]. Studies on the use of arthroscopy in the surgical treatment of displaced medial and lateral tibial plateau fractures have increased since 1980, but are not advised for bicondylar fractures, which require more soft tissue dissection [6]. Most studies encourage the use of arthroscopy for better anatomic reduction and less soft tissue dissection, with better functional results expected[7,8]. The arthroscopically assisted percutaneous fixation technique has been best adapted to type I–III fractures in the Schatzker classification [9]. The benefits of this technique are saving the soft tissues, adjusting fracture reduction, and good evaluation of any associated lesions [10].

For more complex tibial plateau fractures, Schatzker types V and VI, arthroscopy will enable evaluation of articular fracture reduction without the need for extensive arthrotomy. In these fractures, arthroscopy must be combined with rigid fixation by a plate or an external device [11]. The current study focuses on the functional results of percutaneous fixation by cannulated cancellous screws of displaced tibial plateau fractures.

Patients and methods

Study sample

According to the standard ethics drawn by the Suez Canal University Ethical Committee for human researches, a prospective study was carried out on 20 patients attending the Suez Canal University Hospitals between July 2012 and June 2013. After the purpose and procedures of this study were explained to the patients, their verbal informed consent was obtained and full assessment of history was performed for each patient with a recent displaced fracture tibial plateau with a follow-up for 1 year. There were 16 men and four women, mean age 40 years (range 21–72 years) at the time of surgery.

The fractures were classified according to the Schatzker classification [4]. Type I–IV Schatzker closed tibial plateau fractures were included in this study with step-off of the articular surface more than 3 mm and condylar widening more than 5 mm. Types V and VI were excluded because they require open reduction and extensive soft tissue exposure. Also, open fractures were excluded from the study because they require debridement of soft tissues and late rehabilitation.

Preoperative evaluations of fracture tibial plateau were performed on standard anteroposterior and lateral knee radiography taken in the Emergency Unit as well as on computed tomography images to evaluate the fractures displacement. MRI was also performed to detect any concomitant severe soft tissue ligamentous injuries, and were excluded from the study as they would have affected the functional results.

A clinical and radiological evaluation was carried out using the modified Rasmussen clinical and radiological criteria [12]. The clinical evaluation depends on pain, walking capacity, knee extension, and range of motion, stability, and power of quadriceps muscles (Table 1). Radiological assessment depends on the evaluation of articular depression, condylar widening, varus and valgus angulation, and osteoarthritis (Table 2).

Table 1 Modified Rasmussen criteria for clinical assessment

Pain	Points
None	6
Occasional	5
Stabbing pain in certain positions	3
Constant pain after activity	1
Significant rest pain	−3
Walking capacity	
Normal walking capacity for age	6
Walking outdoors (>1 h)	5
Walking outdoors (15 min–1 h)	3
Walking outdoors (<15 min)	1
Walking indoors only	0
Wheelchair/bedridden	−3
Knee extension	
Normal	4
Lack of extension (<10°)	2
Lack of extension (>10°)	0
Lack of extension (>20°)	−2
Total range of motion	
Full	6
At least 120°	5
At least 90°	3
At least 60°	1
<60°	−3
Stability	
Normal stability in extension and 20° flexion	6
Abnormal stability in 20° flexion	4
Instability in extension (<10°)	2
Instability in extension (>10°)	0
Power of quadriceps	
Grade 5	2
Grade 3–4	1
Grade <3	2
Maximum score	30
Excellent	28–30
Good	24–27
Fair	20–23
Poor	<20

Surgical technique

Under tourniquet and C-arm control for reduction of the displaced fracture, assisted arthroscopy with lateral parapatellar portal is performed for all patients, and the portal should be 2–3 cm above the joint level to have a good view of the joint.

For split fracture lateral and medial condyle types I and IV (12 patients), any entrapped soft tissue was removed and reduction of the fragment was performed by a Kirschner-wire (K-wire) from the outside under C-arm control and maintained with a large pointed reduction forceps and arthroscopic assistance. Then, two guide wires were inserted across the fracture site and parallel to the joint line under C-arm control, and cannulated screws 7 mm with washers were inserted over the guide wires and reduction was assisted arthroscopically.

For types II and III (eight patients) tibial plateau fractures, the depressed fragment was reduced by inserting a 2 mm K-wire into its center and confirmed by the C-arm. The point of entry of the K-wire was just distal to the depressed fragment, which aids elevation of the depression. A small window in the cortex was created and a cannulated impactor was introduced over the guide wire with elevation of the depressed fragment and bone graft was used to maintain reduction in all eight patients. As described before in split fracture, 7 mm cannulated cancellous screws were inserted to fix the fracture under image control and restoration of the articular surface was checked by assisted arthroscopy.

After fixation, the knee was examined to check stability and a suction drain was placed in all cases for 1 day and the wound was covered by sterile dressing and crepe bandage. A knee brace was applied and continuous passive motion was started, with a progressive increase to full range of motion. Nonweight bearing was maintained for 6 weeks and at 10 weeks, partial weight bearing with the brace was allowed; the brace was removed at 12 weeks. Clinical and radiological evaluation was performed for scoring of the results.

Statistical analysis

Collected data were subjected to statistical analysis using the SPSS 16 program (SPSS Inc., Chicago, Illinois, USA). For the qualitative variables, a Pearson χ^2-test was carried out and the significance level retained was P value less than 0.05.

Results

The mean duration of hospital stay was 4 days (range 2–10 days). During arthroscopy, we examined five patients with meniscal tear; three patients had a lateral meniscal tear and partial meniscectomy was performed, and two patients had a medial meniscal tear, one with a bucket handle, and meniscal repair was performed; for the second patient, partial meniscectomy was performed.

Percutaneous fixation under C-arm control using two cancellous screws with washers was performed in all patients, except in two patients (type IV); three cancellous screws were used to add stability.

The clinical assessment preoperatively and postoperatively at 1 year according to the Rasmussen score showed highly significant results as the total median score was -7 preoperatively and 28 postoperatively, with excellent results (Table 3).

The radiological evaluation, including anteroposterior and lateral views of the knee joint, was performed preoperatively, immediately postoperatively, and every 6 months. All fractures united with an average time of 10 weeks (range 8–14 weeks). There was a significant difference between the radiological results preoperatively and postoperatively as the range of fracture depression preoperatively was 6–18 mm, and at the 1-year follow-up, the range of fracture depression was 0–2 mm. There was a highly significant difference between preoperative and postoperative results as the total median score was 2 preoperatively and 9 postoperatively, with excellent results (Table 4).

Table 2 Modified Rasmussen criteria for radiological assessment

Articular depression	Points
None	3
<5 mm	2
6–10 mm	1
>10 mm	0
Condylar widening	
None	3
<5 mm	2
6–10 mm	1
>10 mm	0
Varus/valgus angulation	
None	3
<10°	2
10–20°	1
>20°	0
Osteoarthritis	
None/no progress	1
Progression by 1 grade	0
Progression by >1 grade	−1
Maximum score	
Excellent	9–10
Good	7–8
Fair	5–6
Poor	<5

Table 3 Preoperative and postoperative modified Rasmussen score for clinical criteria

Criteria	Preoperative MRS	Postoperative MRS
Pain	Median: −3Range: −3 to 1	Median: 5Range: 5–6
Walking capacity	Median: −3Range: −3 to 0	Median: 5Range: 5–6
Knee extension	Median: 2Range: 0–2	Median: 4Range: 2–4
Total range of motion	Median: −3Range: −3 to 1	Median: 6Range: 5–6
Stability	Median: 2Range: 0–4	Median: 6Range: 4–6
Power of quadriceps	Median: −2Range: −2 to 1	Median: 2Range: 1–2
Total score	Median: -7Range: −11 to 9	Median: 28Range: 22–30

MRS, modified Rasmussen score.

Table 4 Preoperative and postoperative modified Rasmussen score for radiological criteria

Criteria	Preoperative MRS	Postoperative MRS
Articular depression	Median: 0Range: 0–1	Median: 3Range: 2–3
Condylar widening	Median: 1Range: 0–2	Median: 2Range: 2–3
Varus/valgus angulation	Median: 1Range: 0–2	Median: 3Range: 2–3
Osteoarthritis	Median: 0Range: −1 to 1	Median: 1Range: 0–1
Total score	Median: 2Range: −1 to 6	Median: 9Range: 6–10

MRS, modified Rasmussen score.

Figure 1 shows a patient with a depression fracture of the lateral tibial plateau (Schatzker type III). Reduction was performed with insertion of an iliac bone graft under C-arm control and arthroscopy, and the fracture was fixed by two cancellous screws.

Two patients had superficial infections; they were managed by frequent dressing and showed improvement. No screw loosening or deep infection was observed on follow-up, and no patients developed late complications.

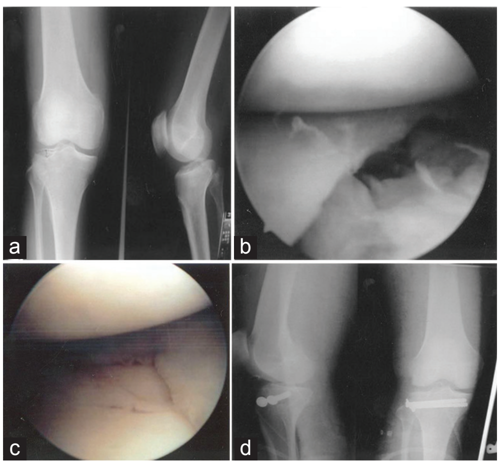
Discussion

The major aims of treatment of tibial plateau fractures are to reduce the articular surfaces, achieve stable fixation and early motion, and to manage all soft tissue lesions [13]. Therefore, successful results depend on the quality of reduction, ligament stability, preservation of soft tissue envelope, with good evaluation of the articular surface, and minimal dissection [14].

Honkonen [5] recommended in his study that all fractures with step-off over 3 mm in the articular surface, a condylar widening up to 5 mm, or a lateral tilt exceeding 5° should be surgically corrected. The risks of open reduction and internal fixation of tibial plateau fractures increase the need for the use of arthroscopy-assisted surgical treatment and has gradually become more popular. Lemon and Bartlett [15] were the first to report an arthroscopic technique for the reduction of a displaced intra-articular fracture of the femoral condyle and tibial plateau.

Hung and colleagues [16–18] have recommended the use of arthroscopy for fixation of displaced tibial plateau fractures as the articular surface can be easily observed after an evacuation of hemoathrosis and any fracture debris without detaching the menisci, and the intra-articular structures can be examined thoroughly while fragments are fixed with minimal soft tissue dissection.

Figure 1



(a) Preoperative radiograph. (b) Arthroscopy showing depression fracture. (c) Postreduction under arthroscopy. (d) Fixation of fractures by two cancellous screws.

Suganuma and Akutsu [19] also reported that an arthroscopic-assisted technique is less invasive than open techniques, and reduces the period of rehabilitation. They advised arthroscopic-assisted reduction when displacement of the fractured site on radiographs is at least 5 mm or there is at least 3 mm step-off on the articular surface.

In another study, Chan *et al.* [14] recommended surgical reduction in patients with tibial plateau fractures with step-off equal to or exceeding 3 mm. This corresponds with the indications in the current study as closed tibial plateau fractures were included with step-off of the articular surface more than 3 mm and condylar widening more than 5 mm.

Fowble *et al.* [9] compared the results of the arthroscopic technique and the open method and reported more accurate reduction and rapid recovery in cases managed by the arthroscopic technique. In addition, many authors reported that the fractures treated arthroscopically healed faster with better ranges of motion and with fewer degenerative changes than patients treated with extensive surgical exposure [6,20,21]. This is in agreement with the results reported by Jensen *et al.* [22], who compared the treatment of tibial plateau fractures by assisted arthroscopy in a first group of patients and open reduction in a second group; 85% reduced anatomically in the first group in comparison with 55% in the second group, in addition to faster and smoother postoperative rehabilitation in the first group.

In a laboratory study comparing the stability and ultimate strength of three standard fixation techniques, first using three 6.5 mm cancellous lag screws with washers, second two 6.5 mm cancellous lag screws with washers and an additional antiglide 4.5 mm cortical screw with washer, and third six holes with an L-shaped buttress plate for split-type lateral tibial plateau fractures, the results showed that the use of an antiglide screw or a buttress plate did not offer an advantage over lag screw fixation alone for the treatment of split-type lateral tibial plateau fractures [23].

Many authors used arthroscopy-assisted percutaneous fixation as the treatment of choice in Schatzker types I, II, III, and IV fractures with optimal reduction and stable fixation with early mobilization, and they confirmed that cannulated screws are the most reliable method of fixation [11,24]. This is comparable with the results of Chan *et al.* [14] who reported that arthroscopic percutaneous fixation remains the standard for Schatzker type I–IV tibial plateau fractures despite the appearance of osteoarthritis, which remains less extensive than in open surgery. This is in agreement with the results in the current study on the safety and fewer complications in comparison with the use of other techniques.

Hung and colleagues [16,25–27] have reported excellent and good results of assisted arthroscopy for fixation of tibial plateau fractures ranging from 80 to 95%. Chan *et al.* [14] reported, on the basis of the Rasmussen system score, satisfactory (good to excellent) results in 96% of cases at the 2- to 10-year follow-up. In addition, Chiu *et al.* [28] reported in another series that 92% of patients showed excellent clinical and radiological results according to the Rasmussen score. This is similar to the results obtained in the current study as we achieved satisfactory clinical (good to excellent) results in 95% of patients and fair results in 5% of patients, and no poor results, and satisfactory radiological results in 95% of patients and fair results in 5% of patients, and no poor results.

Conclusion

This study confirmed that arthroscopy enables an evaluation of fractures reduction without an extensive arthrotomy incision and also enables optimal treatment of accompanying lesions. The benefits of assisted arthroscopy are optimal when stable percutaneous fixation is followed by early mobilization.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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