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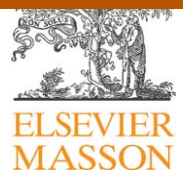

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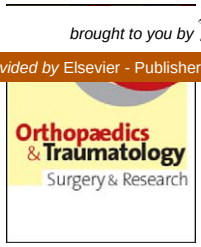

ORIGINAL ARTICLE

Percutaneous fixation of tibial plateau fractures under arthroscopy: A medium term perspective

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KEYWORDS
Fracture;
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Summary
Introduction: Arthroscopically assisted percutaneous internal fixation has found its place in the treatment of Schatzker I—III tibial plateau fractures, with good short-term results reported. The objective of this study was to observe the progression of osteoarthritis at the medium term through clinical and radiological assessment.
Patients and methods: Twenty-seven patients were treated with arthroscopy-assisted percutaneous fixation for stage I—III Schatzker tibial plateau fractures.
Results: Twenty-one patients were reviewed with a mean follow-up of 59.5 months (range, 24—138 months); satisfaction was good except for return to sports activity. The mean IKS score was 85.2 for the knee score and 91 for function. The mean Lysholm score was 86 points, with a mean Tegner activity score of 4. A mean score of 25.5 and 8 points was found for the clinical and radiological Rasmussen scores, respectively; 47.6% of the patients presented early osteoarthritis on radiological evaluation.
Discussion: The medium-term functional results were comparable to the short-term results. The patients were satisfied except for return to sports activity. Age at surgery appears as a prognostic factor for osteoarthritis.
Conclusion: Arthroscopic internal fixation remains the technical reference for Schatzker I—III tibial plateau fractures despite the appearance of osteoarthritis, which remains less extensive than in open surgery.
Level of evidence: Level IV. Retrospective study.

Introduction

Tibial plateau fractures account for 1% of all fractures, and their management remains difficult. These are joint frac-

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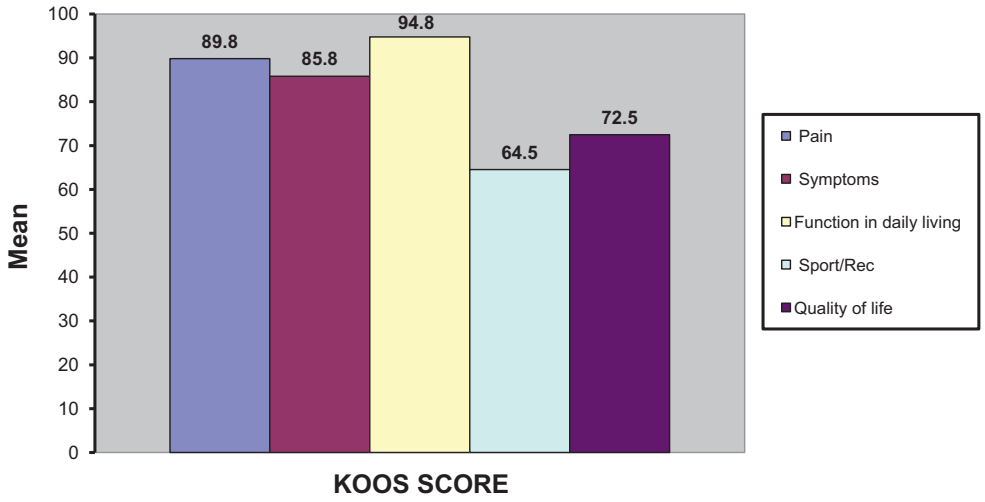

Figure 1 Patient satisfaction according to the KOOS score.

tures requiring reduction that is as anatomic as possible and stable fixation allowing early rehabilitation so as to obtain the best functional results possible [1,2]. Poorly adapted treatment can result in sequelae with a significant social impact.

The arthroscopically assisted percutaneous fixation technique, initially described by Caspari et al. [3] and Jennings [4], has been best adapted to type I—III fractures in the Schatzker classification [3,5]. It has the theoretical advantages of being minimally invasive, with less morbidity than open reduction internal fixation notably in terms of devascularization [6], verifying fracture reduction, and evaluating both the associated lesions and their treatment.

The recent literature on arthroscopic treatment of these fractures reports good short-term functional and radiological results [3,5,7,8]. However, few studies have assessed the radiological and functional outcome of these potentially arthrogenic joint fractures.

The objective of this study was to observe the medium-term osteoarthritic progression of tibial plateau fractures treated with arthroscopically assisted percutaneous fixation through a clinical and radiological assessment.

Patients and methods

The series

This retrospective, single-center study was conducted on 27 patients operated for a recent fracture of the tibial plateau via arthroscopy, out of 200 tibial plateau fractures treated in the Limoges University Hospital (France) Orthopaedics Unit between January 1997 and July 2007.

Type I—III Schatzker closed tibial plateau fractures were included in this study. Open fractures, type IV—VI fractures, those requiring open conversion (three), and fractures with follow-up less than 2 years were excluded from the study.

There were ten females and 17 males, with a mean age of 45 years (range, 18—79 years) at the time of surgery, with a strong predominance of lateral tibial plateau involvement (22 cases).

Bone lesions were evaluated on standard AP and lateral knee x-rays taken in the emergency unit as well as on computed tomography (CT) images with systematic preoperative 2D or 3D reconstruction.

The fractures were classified according to the Schatzker classification [9] with a strong predominance of type III fractures.

During arthroscopy, we examined nine intra-articular soft tissue injuries, including two meniscal lesions, one avulsion of the inferior insertion of the anterior cruciate ligament (ACL), two tibial fractures of the intercondyloid eminence, and four femoral chondral lesions.

The mean duration of care was 1.5 days (range, 0—10 days). One-third of the patients underwent surgery the same day; only one was operated on in a semi-emergency situation at 10 days because of a delay in diagnosis.

The mean duration of hospitalization was 5 days (range, 2—14 days).

Surgical technique

All patients underwent arthroscopically assisted surgery using the technique described by Cassard et al. [1]. Type I fractures were reduced using bone-holding forceps under arthroscopic assistance. The type II and III fractures were reduced with arthroscopic assistance after raising the subsidence. Excessively large bone defects were filled with autograft material or bone substitute. In this series, 21 patients did not need a graft. In six cases, filling was carried out: two with autograft material and four with bone substitutes.

Fixation consisted in 6.5-mm screw fixation as recommended by Boisrenoult et al. [10]. We used one screw in four cases, two screws in 16 cases, three screws in six cases, and four screws in one case.

Of the nine soft tissue injuries, only four were treated: two partial meniscectomies, one reinsertion of the distal extremity of the ACL, and one fixation of the intercondylar eminence.

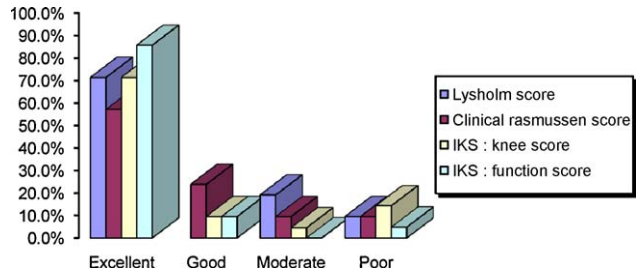

Figure 2 IKS, Lysholm, and Rasmussen clinical scores.

Intra-articular drainage was placed in all cases for 24 h.

Continuous passive motion mobilization was begun on the 1st postoperative day without going beyond 90° flexion.

Mobilities were progressively increased to normal joint amplitudes within 6—8 weeks. A nonarticulated knee splint was worn for 6 weeks with the aim of reducing pain and protecting the knee. Weightbearing was progressively resumed at 2.5 months.

Evaluation methods

The patients were reviewed seen by the same examiner with a minimum follow-up of 2 years.

The clinical assessment included the KOOS functional score [11], the International Knee Society (IKS) score [12], the Lysholm score [13], the Tegner score [14], and the Rasmussen score [15].

The radiological workup included AP and lateral knee x-rays with load, schuss view of the knee, as well as long-leg films with load of both lower limbs.

This radiographic assessment consisted in evaluating the degree of osteoarthritis using:

- the Rasmussen radiographic score [15], rated out of 10 points and distributed into four stages: excellent (9—10 points), good (7—8 points), moderate (5—6 points), and poor (< 5 points);
- the Ahlbäck classification [16].

Furthermore, analysis of the long-leg films with load sought to identify any axis difference between the operated knee and the contralateral knee.

Statistical analysis

Statistical analysis was done using SAS™, version 9.1.3, SAS Institute, Cary, NC, USA.

The Student *t*-test or univariate analysis was used to compare the subgroups on the quantitative variables (number of groups less than two) when normality was not rejected (Shapiro-Wilk test); if not the Mann-Whitney or Kruskal-Wallis test (number of groups greater than two) was preferred.

For the qualitative variables, a Pearson chi-square test was carried out or a Fisher exact test if the theoretical numbers were too low.

The significance level retained was $P < 0.05$.

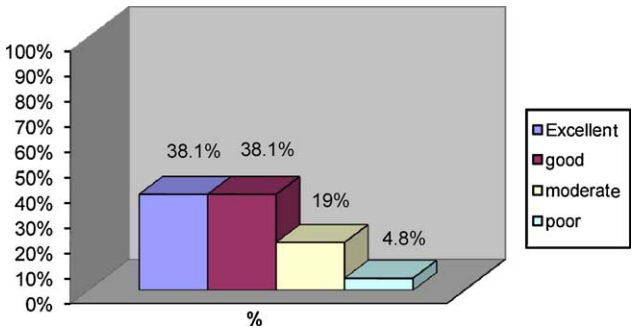

Figure 3 Rasmussen radiologic score.

Results

Twenty-one patients were clinically and radiographically reviewed, i.e., 75%, with a mean follow-up of 59.5 months (range, 24—138 months).

Of the seven patients not reviewed, two had died and five were lost to follow-up.

Complications — Revisions

We observed no immediate postoperative complication, notably in terms of infection, but, over the short term, four cases of complex regional desease, four cases of secondary compression (one at 6 weeks and three at 3 months), and two cases of knee stiffness were observed.

Two surgical revisions were necessary: one manipulation under general anesthesia at 6 months for stiffness, which allowed to obtain a −10 to 100° range of motion, and one unicompartmental prosthesis at 2 years. In 11 cases, the hardware was removed a mean 8.4 months later (range, 6—43 months).

Clinical results

The mean KOOS score was 89.8 for pain (range, 44—100), 85.8 for symptoms (range, 50—100), 94.8 for function (range, 68—100), 64.5 for sports activity (range, 0—100), and 72.5 for quality of life (range, 0—100) (Fig. 1). These scores were comparable in the groups with and without osteoarthritis.

The mean IKS knee score was 85.2 (range, 25—100) and the mean function score was 91 (range, 45—100).

The mean Lysholm score was 86 points (range, 25—100 points). The mean Tegner activity level was 4.

Finally, the mean Rasmussen clinical score was 25.5 points (range, 4—30 points) (Fig. 2).

Mean flexion was 131.3° (range, 100—140) and mean extension 1.4° (range, −10 to 0).

As for postoperative osteoarthritis (defining beginning with Albaäck grade 1), we observed the following:

- in the group with no osteoarthritis (11 cases): a mean IKS knee score of 91 points, a mean IKS function score of 95 points, a mean Lysholm score of 90.3 points, and a mean Rasmussen score of 27.8 points;

Table 1 Intermediate-term results of tibial plateau fractures.

	Scheerlinck 1998	Beaufils 1999	Rossi 2008	Our series 2011
Number of patients	52	44	57	28
Number of patients reviewed	38	44	46	21
Mean age	47	46	48	43
Mean follow-up (months)	62	69	60	59.5
Associated lesions (%)	53.8	—	39	32.1
Meniscus lesions (%)	—	—	28	7.1
ALC lesions (%)	—	—	11	3.6
Postoperative complications (%)	15.4	—	3.5	0
Mean IKS knee score	—	92	93.2	85.2
Mean IKS function score	—	96	94.8	91
Mean Rasmussen clinical score	—	—	28.2	25.5
Mean Rasmussen radiological score	—	—	—	25.5
Radiological osteoarthritis (%)	28.9	20	8.6	47.6
Axis defect (%)	15.8	—	8.7	32.1

- in the group with osteoarthritis (ten cases): a mean IKS knee score of 78.8 points, a mean IKS function score of 86.5 points, a mean Lysholm score of 81.4 points, and a mean Rasmussen score of 23 points.

Radiological results

Osteoarthritis was found in ten patients (47.6%): stage 1 in eight cases, stage 2 in one case, and stage 3 in one case. Four secondary displacement sequelae were observed, all involving the lateral tibial plateau.

The mean Rasmussen radiological score was eight points (range, 4—10 points) (Fig. 3); it was 9.4 points in the group with no osteoarthritis and 6.6 points in the osteoarthritis group.

Long-leg films showed a mean axis defect, compared to the healthy side, of 0.8° (range, 0—6°). It varied between 0.6° (range, 0—4°) in the non-osteoarthritis group and 1° (range, 0—6°) in cases of narrowed joint space. A valgus deviation (range, 2—6°) compared to the healthy side was observed in seven patients, all after fracture of the lateral plateau. A 2° varus deviation compared to the healthy side was noted in two patients.

Prognostic factors

The patients undergoing surgery before the age of 60 presented higher functional scores at review. The univariate tests showed that older age at surgery ($P = 0.030$) is a negative prognostic factor influencing the appearance of osteoarthritis.

The patients showing osteoarthritis on the x-rays presented less favorable results, without this being statistically significant because of a lack of statistical power ($P = 0.072$).

Patient satisfaction in terms of the KOOS score was comparable between the knees with and without osteoarthritis. Only the KOOS sports activity score did not follow this trend, since it was lower (53.5 versus 74.55) in the group with osteoarthritis, but not statistically significantly ($P = 0.084$) because of insufficient statistical power.

Other factors showed a trend toward developing osteoarthritis such as fracture location in the lateral compartment ($P = 0.09$) or complications at 3 and 6 months ($P = 0.182$), but these results were not statistically significant for lack of statistical power. All the cases of osteoarthritis were observed with fracture of the lateral compartment.

Discussion

The main long-term consequence of tibial plateau fractures is the appearance of osteoarthritis. These fractures require reduction of the joint surfaces that is as anatomical as possible, restoration of the axis, as well as stable fixation for early passive and active mobilization to ensure good results.

The different series reported in the literature are difficult to compare given the heterogeneity of the functional assessments used. In the present study, we chose to use several international evaluation systems (the KOOS, IKS, Lysholm, Tegner, and Rasmussen scores) for comparison with the greatest number of series in the literature.

At the medium term, the functional results are satisfactory and comparable with other series. In a series of 26 patients, Cassard et al. [1] reported a mean IKS knee and function score of 94.1 and 94.7, respectively. More recently in a series of 46 patients with a follow-up of 5 years, Rossi et al. [17] reported a mean IKS knee and function scores of 93.2 and 94.8 and a mean Rasmussen clinical score of 28.2 (Table 1).

As shown by Cassard et al. [1], the functional results do not degrade with time. Gill et al. [18] found a mean Rasmussen score of 27.5 in 29 patients. Mazoue et al. [19] had a mean Lysholm score of 80.9 points. Finally, Roerdink et al. [8], Asik et al. [7], Levy et al. [20], and Kayali et al. [21] reported excellent and good results for the Rasmussen score: 80%, 89%, 100%, and 90%, respectively (Table 2).

One of the advantages of our study is having used the KOOS score, a subjective satisfaction score that evaluates the patient's expectations, which no other study has used to date. The present results aiming at evaluating pain, symptoms, function, and quality of life were good or excellent. On the other hand, for sports function, the result was mediocre with a mean score of 64.5 points out of 100.

Table 2 Short-term results of tibial plateau fractures.

	Bobic 1993	Cassard 1999	Mazoue 1999	Gill 2001	Kieffer 2001	Roerdink 2001	Asik 2002	Pogliacomi 2005	Levy 2008	Kayali 2008	Our Series 2009
Number of patients	31	26	17	25	29	30	48	19	16	21	28
Mean age	44.4	42.3	43.6	45.2	47.4	72	39	36	44.8	41	43
Mean follow-up (months)		32.7	14.6	24	25.1	36	36	12	41	38	59.5
Meniscus lesions (%)	23	30.8	29.4	36	13.8	40	47.9	22.2	56.2	42.8	7.1
ALC lesions (%)	13	11.5	5.9	32	10.3	6.6	6.2	11.1	6.2	0	3.6
Postoperative complications (%)	6.4	7.7	17.6	0	6.9	3.3	4.2	—	0	0	0
Mean IKS knee score	—	94.1	—	—	—	—	—	—	—	—	85.2
Mean IKS function score	—	94.7	—	—	—	—	—	—	—	—	91
Mean Lysholm score	—	—	80.9	—	—	—	—	—	—	—	86
Mean Rasmussen clinical score	—	—	—	27.5	—	—	—	—	29.25	—	25.5
Mean Rasmussen radiological score	—	—	—	—		—	—	—	16.87	—	8
Radiological osteoarthritis (%)	—	26.3	21.4	—	12.9	—	63	27.8	12.5	24	47.6
Axis defect (%)	—	10.5	—	—	6.9	—	—	—	12.5	—	32.1

This result is confirmed by the mean Tegner score (4), corresponding to a return to leisure sports activity (cycling, jogging, walking). Slightly more than half of our patients (57%) had resumed sports activity within a mean 14 months.

From a radiological point of view, with a mean follow-up of 5 years, osteoarthritis lesions were found in 47.6% of the patients. Even if this percentage is much lower than the results reported by Honkonen [22] (64%) after open reduction internal fixation with a mean follow-up of 7.2 years, the present results in terms of osteoarthritis seem less favorable than those described in the literature. Scheerlinck et al. [23] found 28.9% of patients with narrowed joint space at a mean follow-up of 5 years. With a shorter 32.7-month follow-up, Cassard et al. [1] observed osteoarthritis lesions in 26.3% of the patients.

It is important to specify that 80% of the radiological cases of osteoarthritis in our series correspond to stage 1 in the Ahlbäck classification [16]; the other reports had not specified the stage of the osteoarthritis lesions.

The analysis of our results confirms that age at the time of surgery is a negative prognostic factor in terms of osteoarthritis and functional results ($P = 0.030$), as already shown by Volpin et al. [24], Honkonen [22], and more recently Cassard et al. [1]. This also seems to be true with the lateral location of the tibial plateau fracture ($P = 0.09$) without these results being significant because of a lack of statistical power. In addition, because of the low numbers of patients in the series and therefore a lack of statistical power, it was not possible to confirm the arthrogenic role played by meniscus and ligament lesions, as is widely recognized in the literature [1,22,24,25].

Those patients with osteoarthritis present lower functional scores than the group with no osteoarthritis. However, in terms of satisfaction, the scores are comparable in the patients with and without osteoarthritis except in terms of sports activity, whose score is lower in patients with knee osteoarthritis (53.5 versus 74.55) ($P = 0.084$).

The main limitation of this study is the insufficient number of patients with the result that truly statistically significant differences could not be demonstrated but rather trends, because of a lack of statistical power. In addition, it would be interesting to review patients with a longer follow-up so as to assess the progression of osteoarthritis; Volpin et al. [24] as well as Honkonen [22] observed that knee osteoarthritis appeared in the 6—8 years following injury. Finally, in reviewing this type of patient, more precise imaging such as CT would provide a better assessment of reduction defects and residual subsidence.

Conclusion

Arthroscopically assisted percutaneous fixation is the choice treatment for Schatzker type I—III tibial plateau fractures. It presents the advantages of having lower morbidity, verifying reduction, and assessing the associated lesions as well as their treatment.

In view of this study, at the medium term, the advantages of arthroscopic treatment seem to be confirmed since the clinical and functional results are satisfactory and do not deteriorate with time compared to short-term series.

However, there is a high frequency of arthroscopic procedures that showed inferior results to those published for open reduction internal fixation series. Age at surgery was confirmed as a negative factor for developing osteoarthritis. Patients with osteoarthritis present inferior functional results. However, in terms of satisfaction, the groups with and without osteoarthritis are comparable except for return to sports activity.

Conflict of interest statement

None.

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