ARTHROSCOPICALLY ASSISTED REDUCTION AND INTERNAL FIXATION OF TIBIAL PLATEAU FRACTURES : REPORT OF TWENTY CASES

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The purpose of this study was to evaluate the results of arthroscopically assisted reduction and internal fixation of tibial plateau fractures. We report on 20 patients with 20 fractures with a mean follow-up time of 39 months (27-64 months). All fractures were evaluated according to the Schatzker classification. Under arthroscopic guidance, the fractures were reduced and associated intra-articular lesions were addressed appropriately. For split fractures a limited lateral approach, or the joystick technique, was used. Depression fractures were reduced with the aid of an anterior cruciate ligament (ACL) tibial guide. Postoperatively, immediate mobilisation and continuous passive motion was encouraged. A hinged brace provided stability and the patients were not allowed to bear weight for at least six weeks. According to the Rasmussen grading system, 18 out of 20 patients scored an excellent (15 patients), or a good (3 patients) result. One patient had a fair result. The only poor result we noted was caused by the fact that we were unable to reduce the fracture arthroscopically and had to perform an arthrotomy. We experienced no complications due to the arthroscopic procedure.

Keywords : arthroscopy ; tibial plateau fracture.
Mots-clés : arthroscopie ; fracture du plateau tibial.

INTRODUCTION

Results of the treatment of tibial plateau fractures are mainly determined by the accuracy of reduction, alignment of the fracture (4, 7, 17, 23, 31, 33), and the presence of associated lesions (11, 17, 31). Preoperatively, plain radiographs and CT. scans are used to evaluate displacement of the fracture. During reduction, evaluation of the articulating surface of the tibia is essential. This may be accomplished by arthroscopy (16, 26, 27, 29, 30, 32, 36) alone or in combination with fluoroscopy (3, 6, 8, 10, 12-14, 18, 19, 21, 22, 34) and/or arthrotomy (10).

Arthroscopy allows diagnosis and treatment of associated intra-articular lesions, thorough lavage and removal of loose fragments (3, 6, 10, 14, 16, 18-20, 30, 32, 36). More importantly, it provides an excellent view of the articulating surface of the tibia and allows accurate reduction and rigid fixation, without extensive surgical exposure (3, 6, 10, 14, 15, 20, 30, 32, 36). Other advantages of an arthroscopically assisted procedure include the low risk of complications (10, 15, 21), low morbidity (6, 15, 30) and the possibility of converting to arthrotomy if necessary (10). A shorter hospital stay has also been reported (12).

Although a number of studies have been published using arthroscopy as an aid in the treatment of tibial plateau fractures (3, 6, 8-10, 12-14, 16, 18-22, 25-27, 29, 30, 32, 34-36) only two reports (20, 34) have a longer follow-up period than this study.

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Table I. — Detailed overview of patient characteristics, types of lesions and results

Case	Age	M/F	Mechanism of trauma	Schatzker type	Associated lesions	Treatment of associated lesions	Follow-up (months)	Rasmussen score
1	33	M	Soccer injury	I	–	–	32	30
2	38	M	Fall of wall on leg	I	Partial ACL rupture, patella fracture	–	44	30
3	55	M	RTA	I	Lateral meniscus lesion	Partial meniscectomy	23	27
4	59	F	Fall	I	ACL rupture	–	34	27
5	55	M	RTA	I	Fibula fracture, MCL grade 3, ACL rupture	–	43	28
6	51	M	Fall	I	Lateral meniscus lesion	Partial meniscectomy	43	27
7	41	M	Fall	I	–	–	30	30
8	48	M	Fall	II	Lateral meniscus lesion	Partial meniscectomy	41	28
9	78	F	Distortion	II	–	–	27	24
10	45	M	RTA	II	–	–	30	28
11	77	F	RTA	II	Medial meniscus lesion	Partial meniscectomy	47	Failed
12	65	F	Fall	II	–	–	24	20
13	18	F	RTA	II	–	–	42	28
14	31	M	Skiing	II	–	–	64	30
15	54	M	RTA	II	Lateral meniscus lesion	Partial meniscectomy	62	28
16	48	F	Distortion	II	–	–	44	30
17	48	F	Skiing	II	Lateral meniscus lesion	Meniscus suture	30	30
18	42	M	RTA	IV	–	–	47	25
19	36	M	Soccer injury	IV	–	–	49	30
20	66	F	Fall	V	Lateral meniscus lesion	Partial meniscectomy	28	19

The purpose of this study was to evaluate the results with arthroscopically assisted operative treatment of tibial plateau fractures after a medium-term follow-up.

MATERIALS AND METHODS

We report on 20 consecutive fractures in 20 patients, (table I) with a mean age of 49 years (18 to 78 years). There were 12 men and 8 women with a mean follow-up time of 39 months (27 to 64 months). Four fractures were the result of sporting accidents (two skiing and two soccer injuries) and seven of a road traffic accident (R.T.A.) ; six fractures were the result of a fall from a height and two fractures followed a knee distortion. In one case a fallen brick wall was the cause of the fracture.

Preoperatively, all patients were assessed clinically and with plain radiographs and CT scanning. Fractures were evaluated using the Schatzker classification (table II), (fig. 1), (6, 13, 14, 21, 27, 30, 32, 33). One patient had a concomitant fibula fracture and another one had a fracture of the patella.

Surgical technique : All patients were placed in the supine position, with the affected leg in a knee holder, suspended over the end of the table. A mid-thigh tourniquet was applied. The image intensifier and screen were situated on the contralateral side of the patient. We used the classic parapatellar, lateral and medial, arthroscopic portals. All the arthroscopic procedures were carried out with a continuous flow of physiological saline under gravity pressure. After thorough irrigation of the knee, the extent and displacement of the fracture fragments in the joint and possible associated intra-articular lesions were evaluated under direct arthroscopic view.

Bony injuries were treated according to the fracture type : for split fractures, either a limited lateral approach or the joystick principle to tilt the fracture percutaneously (34) was used. Depression fractures were reduced with the aid of the ACL tibial reconstruction guide by drilling towards the deepest point of the fracture and then overdrilling with an 8- millimetre cannulated drill. Through this cortical window, the depressed fragment was elevated with the use of a blunt bone punch. Human allograft bone was used to support the elevated fragment.

In all cases two cancellous bone screws (fig. 2) were used to fix the fracture.

In our series, 6 lateral and 1 medial meniscus lesions, 3 anterior cruciate ligament ruptures and one complete

Fig. 1. — Preoperative xray showing a Schatzker type II tibial plateau fracture. Arthroscopic view showed approximately 3 mm displacement of the fracture fragments.

Table II. — Schatzker classification of tibia plateau fractures (33)

I	Pure cleavage
II	Cleavage and depression
III	Pure central depression
IV	Medial condyle
V	Bicondylar
VI	Meta- / diaphyseal

medial collateral ligament tear were identified. One meniscus lesion was sutured and 6 partial meniscectomies were performed. The postoperative management was the same for all patients : immediate mobilisation was encouraged and continuous passive motion was applied (3, 6, 10, 12-14, 16, 19-22, 26, 32, 34), while a hinged brace provided stability (8, 10, 12-14, 19, 27, 32). The patients were not allowed to bear weight for six to eight weeks (6, 8, 12-14, 16, 19, 20, 22, 27). All

Fig. 2. — Postoperative xray showing a reduced and internally fixed Schatzker type II tibial plateau fracture fixed by means of two cancellous screws.

patients were followed for an average of 39 months (27 to 64 months). All fractures had radiographically healed at the time of evaluation at the final follow-up.

The Rasmussen scoring system (table III), (13, 21, 26, 31, 32) was used to evaluate the results. This functional grading system evaluates the knee joint where subjective complaints and clinical signs are taken into account with a possible total score of 30 points. The following five categories (pain, walking capacity, extension, total range of motion and stability) are scored. A maximum of six points is attributed in each category.

A score ranging from 30 to 27 points rates as an excellent result, 26 to 20 points as a good result. A fair result ranges from 19 to 10 points and a poor result is a score of less than 10 points.

Table III. — Grading system according to Rasmussen (31)

Criteria	Score
Pain	0-6
Walking capacity	0-6
Extension	2-6
Range of motion	0-6
Stability	2-6

Total	Grade
27-30	Excellent
20-26	Good
10-19	Fair
<10	Poor

RESULTS

All seven patients with a Schatzker type I fracture had an excellent result, irrespective of the associated lesions. Six out of nine patients with a Schatzker type II fracture, had an excellent result and two had a good result. In one case it was impossible to get a satisfactory reduction during the arthroscopic procedure due to the comminuted nature of the fracture and conversion to an open procedure was necessary in order to achieve an anatomical reduction. Although this patient was clinically rated as having an excellent outcome, we view this case as a failure of the arthroscopic procedure. The patient with a Schatzker type III fracture scored an excellent result. One excellent and one good result were achieved in the patients with a Schatzker type IV fracture. The one patient with a Schatzker type V fracture scored a fair result.

We experienced no complications due to the arthroscopic procedure. There was one case of peroneal nerve neurapraxia postoperatively, which resolved spontaneously. In our series, 50% of the patients had an associated intra-articular lesion. There was no correlation with the clinical outcome. Out of 20 patients, 18 scored an excellent (15 patients), or a good (3 patients) result. One patient scored a fair result. In one case we had to convert to an open procedure, this case was scored as a poor result for the arthroscopic procedure.

DISCUSSION

Arthroscopic procedures used in the treatment of certain types of tibial plateau fractures have good results (3, 8, 12, 13, 18-22, 26, 27, 34, 36). Although some authors believe that Schatzker type V and VI are not suitable for minimally invasive treatment (21), Buchko *et al.* and Roerdink *et al.* even advocate the use of arthroscopy assisted management in some Schatzker type VI fractures (6,32). In combination with hybrid external fixation, it may be possible to treat all Schatzker types V and VI effectively with arthroscopic assistance. Further studies will have to confirm this. Mostly Schatzker type I,II,III and IV are treated with arthroscopic guidance (6, 13, 14, 27, 30, 32). According to Koval (24) arthroscopy is most useful in a Schatzker type III fracture with central depression.

Knee arthroscopy is very helpful in the detection and treatment of associated intra-articular lesions. The reported incidence of meniscal lesions associated with tibial plateau fractures ranges from 14% to 50% (10, 12, 13, 18-20, 24, 27, 32, 35). There seems to be no apparent correlation with a specific fracture type (35). Cruciate ligament injuries are reported in between 5% and 32% of cases (10, 12, 13, 18-20, 22, 24, 27, 32). Associated soft tissue injuries are found in between 23% and 56% (2, 6, 10, 20). Overall intra-articular injuries are reported up to 53.8% (34). We found soft tissue lesions in 50% of the patients in our series. Seven patients had a meniscus lesion (35%) and three patients (15%) had an anterior cruciate ligament injury. One patient sustained a combined, complete rupture of the anterior cruciate and medial collateral ligament.

In order to obtain a good result it is crucial to have these fractures anatomically reduced and aligned (3, 4, 6, 7, 12, 13, 15-24, 26, 27, 33, 34, 36). An important indication for operative treatment of these fractures is the evaluation of the intraarticular step-off or intra-articular displacement. However, the magnitude of critical displacement in the literature ranges considerably, from 1 mm to 10 mm (4, 7, 8, 12, 14, 16, 18, 26). The extent of intra-articular depression is difficult to evaluate through standard roentgenograms and a special “tibial plateau view” permits more accurate assessment of the depression (28). Usually there tends to be an underestimation of the intraarticular displacement of the lateral plateau on a standard x-ray (28). Figure 1 shows an example of minimal displacement on plain radiograph. Arthroscopy was performed on the basis of high clinical suspicion of

a more extended intra-articular injury. This revealed a 3-mm depression of the fracture fragment. A CT-scan with three-dimensional reconstructions will give a better idea of the extent of the intra-articular displacement when compared to plain radiographs.

In order to have a quantitative appreciation of the relation between local pressure elevations and fracture reduction inaccuracy in tibial plateau fractures, Brown *et al* examined the contact stress distributions with the use of Fuji film on seven human cadaver knees (5). The authors created different intraarticular step-off lesions. Significant increase in peak local joint contact pressures was measured with a step-off greater than 1.5 mm. Therefore, we agree with Roerdink *et al*. (32) who stated that arthroscopic investigation is indicated in nearly every plateau tibial fracture. This makes it possible to debride the joint , treat associated meniscal injuries and reduce the fracture and reconstruct the articular surface even when it is minimally displaced.

Literature shows that Schatzker type I fractures are usually treated by screw fixation (6, 18, 19, 34, 40, 46), Schatzker type II fractures are mainly treated by screw fixation (6, 18, 19, 34, 40, 46) and sometimes with a buttress plate (46). Schatzker type III fractures are mostly fixed with screws (6, 18, 19) or a buttress plate (34, 46), Schatzker type IV fractures are usually managed with screws (34, 40, 46) or plates (34), Schatzker type V fractures and VI fractures are sometimes treated with screws (40) but usually in combination with a plate or external fixator (46).

In our department all Schatzker types I to IV fractures are reduced and fixed with one or two screws. In type V or VI fractures we first reconstruct the articular surface and the fragments are fixed with one or two screws. In a next step fracture stabilization is achieved with the aid of a plate or external fixator depending on the extent of the soft tissue damage. We are thus able to obtain a stable construct and allow immediate passive mobilisation and rehabilitation.

The treatment of associated meniscal lesions is important. In a study on osteoarthritis after tibial plateau fractures, 44% of 141 cases showed secondary osteoarthritis after 7.6 years of follow-up. Removal of a meniscus during the fracture repair resulted in secondary degeneration in 74%. When the menisci were intact, or repaired, only 37% showed secondary osteoarthritis (17). This is in agreement with other reports which state that meniscal lesions should be repaired if possible (6, 19, 20, 24, 34).

In a 77-year-old female we noted a torn degenerative medial meniscal lesion associated with a Schatzker type II fracture (case 11). We were unable to determine if the tear was purely degenerative, or occurred due to the traumatic insult (22).

A medio-lateral instability greater than 10° is associated with poor clinical results if no ligament reconstruction is performed (11). However, ligamentous reconstruction is more controversial with lesser degrees of instability. Associated medial collateral ligament reconstruction was not carried out in several studies, with satisfactory outcome (6, 12, 22, 24, 34). ACL reconstruction was not (34), or was sometimes (6, 10) performed.

Ligament reconstruction has been advocated if there is residual instability after fracture reduction and fixation (32). One patient (case 5) in the presented series underwent intra-articular ACL reconstruction 12 months after surgical treatment of a Schatzker type I fracture and associated MCL and ACL ruptures. This patient achieved an excellent final clinical result after 43 months despite a 5° residual medio-lateral instability in extension.No other patients had medio-lateral instability at the final follow-up . The other two patients (cases 2, 4) with an ACL rupture were treated conservatively with a good functional end result.

Peroneal nerve injuries have been reported in the literature after arthroscopic treatment of tibial plateau fractures (3, 10, 22, 36). We encountered this complication in one case. We believe this transient peroneal nerve injury occurred due to local swelling from the fracture hematoma. Acute compartment syndromes are a possible complication associated with the arthroscopically assisted treatment of tibial plateau fractures (1, 22). We had no such problems in our series, probably due to the gravity pressure fluid technique we used, minimising fluid pressure in the joint and extravasation in the surrounding tissues.

Arthroscopically assisted reduction and fixation of tibial plateau fractures has several benefits, with little risk of complications. If the arthroscopic technique should fail, it is very easy to convert to an open procedure. This occurred in one of our patients, who ended with an excellent result.

Overall, our study shows excellent results in Schatzker types I and III, and good results in Schatzker types II and IV fractures. We used the Schatzker classification in our study with a mean follow-up of 39 months, the only other study using the same classification with approximately the same follow-up (32) dealt with patients older than 55 years. Our series consisted of a younger population (mean age : 49 years). Although the surgical technique we used to reconstruct the articular surface has already been described (6, 12, 14, 27, 29, 34), our study confirmed its usefulness resulting in good functional end results without major complications. We feel that arthroscopic assistance in reduction and fixation of tibial plateau fractures offers a safe and effective alternative to classic open treatment in Schatzker types I to IV.

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SAMENVATTING

F. VAN GLABBEEK, R. VAN RIET, N. JANSEN, J. D'ANVERS, R.NUYTS. Arthroscopisch geassisteerde osteosynthese van tibia plateau fracturen : een studie van twintig patiënten.

Het doel van deze studie is het evalueren van de resultaten van arthroscopisch geassisteerde reductie en fixatie van tibia plateau fracturen. Onze reeks bestaat uit twintig tibia plateau fracturen, welke werden ingedeeld volgens de Schatzker classificatie met een gemiddelde follow-up van 39 maanden (27-64 maanden). Onder arthroscopische visualisatie werden 50% geassocieerde intra-articulaire letsels gevonden. Postoperatief werden alle patiënten onmiddellijk onderworpen aan continue passieve mobilisatie. Gedurende een zestal weken bestond er een steunverbod en zorgde een brace voor de stabiliteit. Het Rasmussen scoringssysteem werd gebruikt voor het evalueren van de resultaten. Vijftien excellente, drie goede en één matig resultaat werden genoteerd. Slechts één patiënt scoorde een slecht resultaat. Mede gezien de comminutie van de fractuur was een arthroscopische reductie onmogelijk en werd overgegaan tot een open reductie en fixatie. Er waren geen complicaties tijdens en na de arthroscopische procedure.

RÉSUMÉ

F. VAN GLABBEEK, R. VAN RIET, N. JANSEN, J. D'ANVERS, R.NUYTS. L'ostéosynthèse des fractures du plateau tibial à foyer fermé avec assistance arthroscopique : étude de vingt cas.

Cette étude avait pour but d'évaluer les résultats de l'ostéosynthèse des fractures du plateau tibial à foyer fermé sous contrôle arthroscopique. Elle a porté sur 20 patients avec un suivi moyen de 39 mois (27-64 mois). Les fractures ont été évaluées selon la classification de Schatzker. L'arthroscopie a montré des lésions intra-articulaires associées dans 50% des cas. Dans la période post-opératoire, tous les patients ont subi une mobilisation passive continue avec interdiction d'appui et ont eu une protection par une orthèse articulée pendant 6 à 8 semaines. Les résultats ont été évalués selon la méthode de Rasmussen. Nous avons noté quinze résultats excellents, trois bons et un moyen. Un résultat a été considéré comme médiocre a cause d'un échec de réduction arthroscopique, dans une fracture comminutive, qui a nécessité une arthrotomie.