Int J Clin Exp Med 2017;10(12):16694-16698
www.ijcem.com /ISSN:1940-5901/IJCEM0065705

Original Article

Arthroscopic-assisted internal fixation versus limited incision combined internal fixation in the treatment of complex tibial plateau fractures

Ximing Yang[1], Lin Wang[2], Zhi Liu[1]

[1]*The First Department of Traumatology, Tengzhou Central People's Hospital, Tengzhou City, Shandong Province, China;* [2]*Department of Operation Room, Tengzhou Central People's Hospital, Tengzhou City, Shandong Province, China*

Received September 16, 2017; Accepted October 24, 2017; Epub December 15, 2017; Published December 30, 2017

Abstract: Objective: To compare the efficacy of arthroscopic-assisted internal fixation and limited incision combined with internal fixation for complex tibial plateau fractures. Methods: A total of 76 patients with complex tibial plateau fracture (including Schatzker I, II and III) were enrolled in this study. The patients were divided into the control group (38 cases) and the observation group (38 cases) randomly. Patients in the observation group accepted arthroscopic-assisted internal fixation, and patients in the control group were treated with limited incision and internal fixation. The operation parameters, postoperative recovery, complications and clinical efficacy between groups were compared. Results: Compared with the control group, the indicators including the operation time (159.81±15.39 vs. 86.24±9.26 min, P=0.021), bleeding volume (88.17±15.53 vs. 137.09±18.43 ml, P=0.011), postoperative weight-bearing time (45.64±5.21 vs. 19.56±2.87 days, P=0.035), hospitalization time (16.71±4.27 vs. 19.56±2.87 days, P=0.019), knee joint flexion and extension (127.31±8.21 vs. 115.21±7.68 degree, P=0.022), HSS score (84.95±4.34 vs. 115.21±7.68 points, P=0.032), healing time (3.42±0.41 vs. 5.68±0.81 months, P=0.028), complications rate (2.63% vs. 13.16%, P=0.017) and effective rate (94.74% vs. 81.58%, P=0.025) in the observation group were all significantly better (all $P < 0.05$). But there was no significant difference between the two groups regarding to anatomic reduction rate (97.37% vs. 94.74%, P=2.167). Conclusion: Arthroscopic-assisted internal fixation presented a better performance in the treatment of complex tibial plateau fractures in comparison with limited incision and internal fixation.

Keywords: Arthroscopic assisted internal fixation, limited incision and internal fixation, complex tibial plateau fracture, clinical efficacy

Introduction

Tibial plateau fracture is a common type of fracture. With the increasing accidental injuries and traffic accidents in recent years, the incidence of complex tibial plateau fractures has gradually increased [1, 2]. In addition, it is a typical intra-articular fracture, often accompanied with cruciate ligament, meniscus or synovium injury, which can easily lead to knee joint stiffness, knee instability and traumatic arthritis and other complications due to delayed or improper treatment [3, 4]. Recently, with the development of minimally invasive technique and arthroscopic techniques, arthroscopic-assisted internal fixation has progressed fundamentally in the treatment of complex tibial plateau fracture [5, 6]. However, the clinical efficacy and the safety haven't been well studied [7, 8].

In this study, we aimed to analyze the clinical efficacy of arthroscopic-assisted internal fixation by comparison with limited incision combined with internal fixation in the treatment of complex tibial plateau fracture.

Materials and methods

Patient enrollment

A total of 76 patients with complex tibial plateau fractures were enrolled, who were treated at our hospital from January 2015 to June 2016. This study was approved by Ethics Committee, and the signed consent was obtained from all the patients.

Inclusion criteria: Patients aged above 18 years old; patients with primary surgery; patients with complex tibial plateau fractures diagnosed by CT and MRI before surgery; patients with Schatzker I~III; patients without surgical contraindications.

Exclusion criteria: Patients with serious heart or brain diseases; patients with contraindication of arthroscopic surgery; patients with severe dysfunction in liver and kidney; patients with severe mental illness; pregnant women; patients with tumor; and patients with previous tibial plateau surgical history.

Intervention

The patients were randomly divided into the observation group (n=38) and the control group (n=38).

Patients in the observation group received arthroscopic-assisted internal fixation with the standard anterolateral or direct anterolateral approach. Briefly, after arthroscopic examination, the free bone and cartilage debris were washed and removed, then a 5~7 cm incision was performed at the inside or outside of the knee to expose the end of the fracture without cutting the switch capsule. The notching and poking reduction was conducted from the fracture gap and confirmed by endoscopy. After reduction, the temporary fixation was made with 2~3 Kirschner wires under the cartilage surface. Finally, the articular surface defects were repaired with allograft bone. For patients with meniscal injuries, correction or removal of the meniscus combined with the repair of damaged posterior and anterior cruciate ligament was conducted, and a drainage tube was placed in the joint cavity before the end of the operation.

Patients in the control group received the traditional incision and internal fixation to treat the proximal tibia with the anteromedial inverted I incision. Under direct vision, fracture reduction was performed by compression, traction, and drawing. After the restoration of the articular surface, the Kirschner wires were used for fixation. The reduction condition was confirmed under X-ray. After reduction, the patients' autologous iliac bone was implanted into the defected site and fixed by cancellous bone screw. For patients with meniscus injuries, correction or removal of the meniscus combined with the repair of damaged posterior and anterior cruciate ligament was conducted.

After surgery, all the patients received routine treatment, including postoperative antibiotics, elastic bandage of limb and knee, raise of the limb, cold compress of knee joint for 24 h, exercise of quadriceps contraction on the bed 1 day after the surgery. And the drainage tube was removed 3 days after the surgery, then, the functional exercise was carried out based on the stability of internal fixation and the condition of fracture reduction, and gradually to take partial weight-bearing exercise until the full weight-bearing exercise was available. And the follow-up was conducted for all the patients by outpatient visit and telephone.

Outcome measures

The parameters of operation were recorded, including operation time, bleeding volume, hospitalization time, postoperative weight-bearing time, anatomical reduction rate, fracture healing time. Postoperative recovery profiles (including knee joint flexion and extension, and knee function HSS score 6 months after operation), clinical efficacy and the complications were recorded in both groups.

Anatomical reduction criteria: articular surface collapse < 2.0 mm [9]. HSS scoring criteria: excellent, 85~100; good, 70~84; average, 60~69; bad, 0~59 [10]. The effective rate (clinical efficacy) was defined as the total percentage of excellent and good cases in HSS scoring.

Statistical analysis

SPSS 22.0 was used for statistical analysis. The measurement data was presented as $\bar{x} \pm$ sd, and independent t test was used for comparison between two groups. The categorical data was presented as the incidence or percentage, and the chi square test was used for the comparison between two groups. $P < 0.05$ was considered statistically significant.

Results

General information

As shown in **Table 1**, there was no statistically differences between the two groups with respect to the clinical characteristics, including

Table 1. Clinical characteristics

Clinical characteristics	Observation group (n=38)	Control group (n=38)	t/X^2	P
Mean age (year)	43.44±6.18	42.78±5.76	1.371	0.399
Gender (male/female)	21/17	22/16	0.054	0.817
Period from injury to hospitalization (d)	6.34±0.35	6.68±0.48	0.866	0.681
Cause of injury (n/%)			0.266	0.967
Traffic injury	16/42.1	15/39.5		
Sports injury	11/28.9	13/34.2		
Crushing injury	8/21.1	7/18.4		
Crashing injury	3/7.9	3/7.9		
Schatzker classification (n/%)			0.751	0.687
I	2/5.3	3/7.9		
II	25/85.8	27/71.0		
III	11/28.9	8/21.1		
Concomitant injury (n/%)			0.583	0.747
Posterior cruciate ligament injury	3/7.9	2/5.3		
Anterior cruciate ligament injury	7/18.4	9/23.7		
Meniscus injury	14/36.8	12/31.6		

Table 2. The operation conditions

Group	Operation time (min)	Bleeding volume (ml)	Hospitalization time (day)	Weight-bearing time (day)	Healing time (m)	Anatomic reduction rate (%)
Observation group	159.81±15.39	88.17±15.53	16.71±4.27	45.64±5.21	3.42±0.41	37(97.37)
Control group	86.24±9.26	137.09±18.43	19.56±2.87	56.98±8.23	5.68±0.81	36(94.74)
t/X^2	3.191	11.257	9.037	9.521	10.562	1.527
P	0.021	0.011	0.035	0.028	0.019	2.167

Table 3. The condition of postoperative functional recovery

Group	Knee flexion and extension (degree)	HSS scores
Observation group	127.31±8.21	84.95±4.34
Control group	115.21±7.68	76.12±5.25
t	9.328	10.017
P	0.032	0.022

age, gender, period from injury to hospitalization, cause of injury, Schatzker classification and concomitant injury (all P>0.05).

Operation profiles

The operation time, bleeding volume, hospitalization time, postoperative weight-bearing time, anatomic reduction rate and healing time are shown in **Table 2**. The operation time of the observation group was significantly longer than that of the control group (P=0.021). The bleeding volume, postoperative weight-bearing time, fracture healing time and hospitalization time in the observation group were significantly less than those of the control group (P=0.011, P=0.035, P=0.028 and P=0.019). However, there was no significant difference between the two groups in the anatomic reduction rate (P=2.167).

Condition of postoperative functional recovery

All the patients were followed up for 10~16 months, with an average of 12.35±1.65 months. As shown in **Table 3**, 6 months after the operation, the HSS scores of knee flexion and extension and knee function in the observation group were better than those in the control group (P=0.032, P=0.022).

Complications

As shown in **Table 4**, the incidence of complications was 13.16% in the control group. There

Table 4. Complications

Group	Infection (n/%)	Postoperative pain (n/%)	Joint stiffness (n/%)	Traumatic osteoarthritis of knee joint (n/%)	Overall incidence of complication (%)
Observation group	1/2.6	0/0	0/0	0/0	2.63
Control group	1/2.6	2/5.2	1/2.6	1/2.6	13.16

Table 5. Clinical efficacy

Group	Excellent (n/%)	Good (n/%)	Average (n/%)	Bad (n/%)	Effective rate (%)
Observation group	23/60.5	13/34.2	1/2.6	1/2.6	94.74
Control group	15/39.5	16/42.1	6/15.8	1/2.6	81.58

was only one patient with infection in the observation group, yielding a complication rate of 2.63%. Statistical analysis showed that the complication rate in the observation group was lower than that of the control group (X^2=10.567, P=0.017).

Clinical efficacy

As shown in **Table 5**, the effective rate was 94.74% in the observation group, which was significantly higher than that of the control group (81.58%), (X^2=10.214, P=0.025).

Discussion

In the tradition treatment of complex tibial plateau fracture, it is needed to check the meniscus and articular structure through the incision of knee joint capsule, and to open the gap under the meniscus to observe and restore the articular surface fracture in the treatment of complex tibial plateau fractures by using limited incision and internal fixation, which not only can destroy the normal anatomy and stability of the internal structures of the joint, but also can cause severe trauma, postoperative incision pain, joint swelling, severe adhesion, and delay union even nonunion, and slow functional recovery [11-14]. However, the arthroscopic-assisted internal fixation can directly observe the knee meniscus injury in the treatment of complex tibial plateau fracture. Meanwhile, modified meniscus angioplasty or resection is applied for patients with cruciate ligament injury as the cruciate ligament is sutured directly. and the reconstruction of articular cartilage was performed to repair the articular cartilage damage in patients, which can not only avoid knee joint capsule incision, but also avoid further damage to the meniscus [15, 16]. In addition, arthroscopic- assisted internal fixation can also alleviate the soft tissue dissection, protect blood supply around the fracture site, reduce postoperative joint stiffness, and reduce the incidence of traumatic knee joint osteoarthritis [17, 18].

In the current study, it could be found that the weight-bearing time, healing time, knee function, HSS score, clinical efficacy, complication rate in the observation group were all better than those in the control group. The results above indicated that the efficacy of limited incision and internal fixation was limited in the treatment of complex tibial plateau fracture, which could prolong the period of postoperative healing and function recovery, and increase the incidence of complications in comparison with arthroscopic-assisted internal fixation. This might be due to the minimal joint space and less trauma under arthroscopic-assisted internal fixation in the treatment of complex tibial plateau fractures, which could promote the postoperative recovery of patients, and shorten the fracture healing time. Additionally, arthroscopic-assisted internal fixation could achieve limited peeling of soft tissue around the fracture, and reduction under direct vision, which could increase the stability of fracture site, provide the basis for early functional exercise, and promote the rehabilitation of patients. The results of this study were consistent with those reported previously [5, 19, 20].

To conclude, the arthroscopic-assisted internal fixation was effective and safe in the treatment of complex tibial plateau fractures with small trauma, less bleeding, quick recovery and less complication compared to the limited incision and internal fixation. Nevertheless, there were some limitations in this single-center study, such as the small sample size and the short-term follow-up, which might cause

some statistical bias on the results. Therefore, in the further study, we need to optimize the study design, expand the sample size, and extend the follow-up period to obtain a better understanding of the clinical efficacy and safety on arthroscopic-assisted internal fixation in the treatment of complex tibial plateau fractures.

Disclosure of conflict of interest

None.

Address correspondence to: Zhi Liu, The First Department of Traumatology, Tengzhou Central People's Hospital, No.181 Xingtan Road, Tengzhou 277500, Shandong Province, China. Tel: +86-0632-5533023; E-mail: liuzhi170907@163.com

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