

Comparison of outcome of ARIF and ORIF in the treatment of tibial plateau fractures

Zhen Wang^{1,2} · Zhibing Tang² · Chaoqun Liu² · Jinlian Liu² · Yaozeng Xu¹

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Abstract

Purpose The purpose of this study is to explore whether arthroscopically assisted reduction and internal fixation (ARIF) is superior to traditional open reduction and internal fixation (ORIF) in the treatment of tibial plateau fractures.

Methods Fifty-seven patients with tibial plateau fractures (Schatzker type I–IV) treated by ARIF or ORIF from 2010 to 2013 were included in this retrospective study. All patients received pre-operative radiographs and CT scans. The patients were divided into two groups (ARIF or ORIF). All had a minimum follow-up of 24 months and an average follow-up of 44.4 months. The clinical and radiographic outcomes were evaluated according to the Rasmussen and KSS scores.

Results There was no significant difference in KSS score or Rasmussen clinical score between the two groups. The average Rasmussen radiographic score was 14.1 (SD 2.4, range 10–18), for the ARIF group and 14.9 (SD 2.3, range 10–18) for the ORIF group ($p < 0.05$). Meniscal lesions were found in 12 knees in group ARIF.

Conclusions Both ARIF and ORIF yielded satisfactory clinical results for the treatment of Schatzker I–IV tibial plateau fractures. ARIF led to better radiological results than ORIF. Concomitant intra-articular soft tissue lesions are common and can be addressed during ARIF.

Level of evidence III.

Keywords Tibial plateau fracture · Arthroscopy · Knee · Internal fixation

Introduction

Tibial plateau fractures are usually caused by high-energy trauma in young adults or by milder injuries in elderly individuals with osteoporosis. They represent approximately 1 % [3, 6–8, 22] of all fractures. The goals of treatment are anatomical reduction, rigid internal fixation, early mobilization, and minimizing complications. Arthroscopically assisted reduction and internal fixation (ARIF) was initially described by Caspari et al. [4] and Jennings [18] and thought to be best indicated for Schatzker type I–III fractures. Later, a number of studies [9, 11, 12, 14, 19, 21, 25] also demonstrated satisfactory short-term functional and radiological results.

It is unclear whether ARIF offers more advantages when compared to conventional open reduction and internal fixation (ORIF). The purpose of this retrospective study is to explore whether ARIF is superior to ORIF in treating tibial plateau fractures (Schatzker types I–IV). More complex or higher-energy injury patterns (Schatzker type V or VI) were not included in this study [2, 23] because of technical fears of considerably increased operation time, incidence of infection and compartment syndrome. To our knowledge, this is the first study to compare the therapeutic

✉ Yaozeng Xu
bigzhen0512@163.com

Zhen Wang
qiushui21@163.com

Zhibing Tang
526010990@qq.com

¹ Department of Orthopedic Surgery, The 1st Affiliated Hospital of Soochow University, Suzhou 215000, Jiangsu, China

² Department of Orthopaedics, Suzhou Kowloon Hospital Shanghai Jiao Tong University School of Medicine, Suzhou 215006, Jiangsu, China

outcomes of ARIF versus ORIF in Schatzker I–IV tibial plateau fractures. The result of this study may help future surgeons make better decision when faced with these types of fracture.

Materials and methods

A total of 69 consecutive patients with Schatzker type I–IV tibial plateau fractures treated either by ARIF or ORIF at the traumatology department of our hospital were retrospectively reviewed from 2010 to 2013. Open fractures, type V–VI fractures, those requiring open conversion, and patients with follow-up of less than two years were excluded.

Fifty-seven of the 69 patients fulfilled these criteria and were included. There were 36 males and 21 females with a mean age of 46 years (range 24–65 years). There were 26 patients treated with ARIF, and 31 treated with ORIF. All patients were injured either in accidental falls or traffic accidents. All patients underwent standard knee radiographic examination and computed tomography scanning with three-dimensional reconstruction for pre-operative planning. Fracture configuration, impaction, and the extent of comminution were recorded. Twenty patients were managed by emergency surgery. Thirty-seven patients had delayed surgery at 10.2 (SD 2.1) days to allow for soft tissue recovery with temporary trans-calcaneal skeletal traction or external fixation. The mean follow-up period was 44.4 months (SD 11.8, range 24–64 months).

Surgical technique

All patients were operated in the supine position after general or spinal anaesthesia. An examination under anaesthesia was performed before surgery. A pneumatic tourniquet was used for most patients who underwent ARIF. Fluid inflow was directed by gravity instead of an arthroscopic pump, to avoid extravasation and compartment syndrome. Following the evacuation of the haemarthrosis and any loose particles, the joint was systematically inspected for capsular, ligamentous, cartilage and meniscal injuries. Anterior cruciate ligament avulsion injuries were reattached using absorbable sutures, and associated meniscal tears were mended using standard techniques. Lateral collateral ligament (LCL) and medial collateral ligament (MCL) lesions were primarily repaired or reconstructed if the joint remained unstable after fracture fixation (Fig. 1).

Impactions were elevated and reduced from below with a bone impactor introduced through the metaphyseal fracture line or through a small cortical window. Anatomical

reduction of the articular surface was ascertained arthroscopically. Internal fixation was performed using standard techniques consisting of buttress plate and raft screws. Excessively large bone defects were filled with autogenous bone graft or bone substitutes.

Associated lesions in ARIF are shown in Table 1. There were 12 cases with meniscal lesions, including two medial meniscus tear, and 10 lateral meniscus tear. Three menisci were repaired and nine partially resected. One patient was diagnosed with a combined anterior cruciate ligament and medial collateral ligament rupture. Five patients with anterior cruciate ligament (ACL) avulsions had repair by suture reattachment, one other patient ACL tear received secondary reconstruction of the ligament. Six cases of medial collateral ligament ruptures were sutured, and two were treated with external fixation. One lateral collateral ligament avulsion was fixed by screw with a washer.

For the ORIF group, the medial or lateral sub-meniscal approach was used. The lateral coronary ligament or the deep medial joint capsule parallel to the articular surface was incised along with minimal unnecessary soft tissue dissection. The meniscus was tagged with sutures and retracted proximally. Articular surface reduction was assessed under direct vision and fluoroscopy. The reduction method is the same as the ARIF group.

Post-operative rehabilitation

All patients were treated with a standardized post-operative rehabilitation protocol. Continuous passive motion mobilization was prescribed at the first post-operative day at up to 90 flexion. Active and passive range of motion exercises were progressively stepped up within the initial 6–8 weeks. Partial weight bearing was allowed after 8 weeks and full weight bearing after 12 weeks.

Therapeutic outcome evaluation

Anteroposterior (AP) and lateral radiographs were taken on the first post-operative day. Posteriorly inclined radiographs were taken at 8 weeks, 12 weeks, 6 months, 1 year and 2 years post-operatively. At the final follow-up, long-leg standing AP radiographs were taken to assess the overall limb alignment. Independent knee assessments were carried out according to the KSS (Knee Society Score) [17], and Rasmussen's clinical and radiological scores [24]. Each radiograph was evaluated by three observers in blinded fashion. The three observers also classified fracture type and measured clinical scores for the 57 patients. The KSS score, Rasmussen's clinical and radiographic score were compared separately between ARIF and ORIF groups.

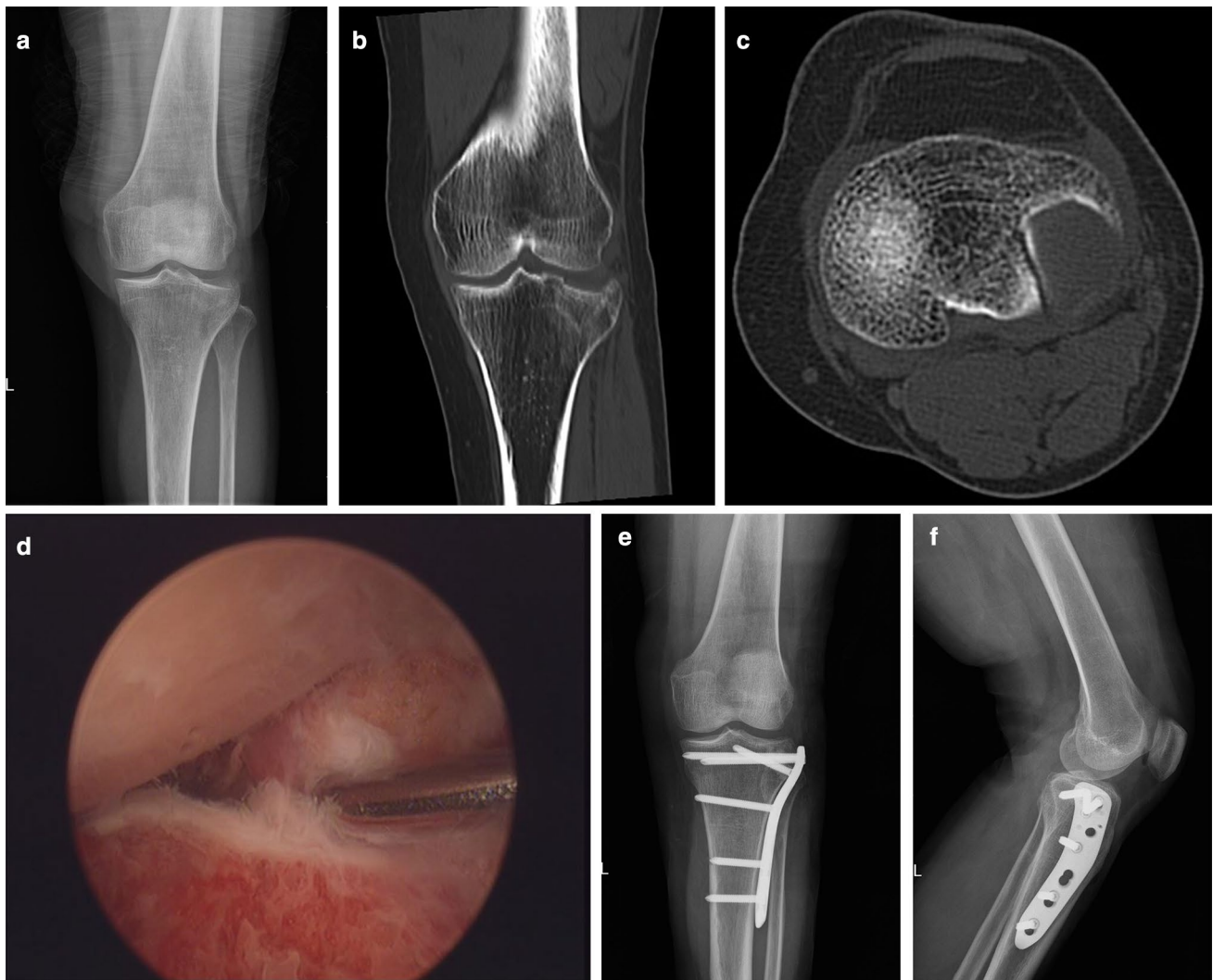


Fig. 1 A 61-year-old female patient, traffic accident injury, Schatzker type III fracture of left tibial plateau. **a** Pre-operation radiograph. **b, c** CT-scan pre-operation. **d** Arthroscopic view of the articular surface before reduction. **e, f** Post-operation radiographs, achieved anatomical reduction

Ethics approval

Prior approval to conduct this study had been obtained from the local human research ethics committee (2010-005-C7). This study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Statistical analysis

Statistical analyses were performed with the SPSS version 18.0 statistical software package (SPSS Inc. Chicago, Illinois). Continuous variables were recorded as mean \pm SD. The KSS score, Rasmussen clinical score and Rasmussen radiological score in the two groups were compared using the independent sample *t* test, and $p < 0.05$ was considered statistically significant.

Results

Fifty-seven patients were clinically and radiographically reviewed with a mean follow-up of 44.4 months (SD 11.8). There were no complications directly associated with arthroscopic procedures in the ARIF group. No patients in either group had post-operative compartment syndrome or deep vein. One patient in the ORIF group had a superficial infection managed successfully by antibiotic treatment without surgery. One case of knee stiffness was observed in the ORIF group, later requiring manipulation under general anaesthesia after 6 months which resulted in an ultimate range of motion of -10° to 100° . In all 57 patients, the implants were removed at a mean period of 16.6 months post-operatively (range 12–20 months) and no mechanical failures were observed. No patients

Table 1 Patient's data, treatment and associated lesions

Classification	Schatzker I <i>n</i> = 9		Schatzker II <i>n</i> = 28		Schatzker III <i>n</i> = 12		Schatzker IV <i>n</i> = 8	
	ARIF	ORIF	ARIF	ORIF	ARIF	ORIF	ARIF	ORIF
Patient	4	5	13	15	5	7	4	4
Age	42.8	47.8	43.8	47.4	44.2	46.3	47	51.3
Gender								
Male	3	2	7	7	1	3	3	2
Female	1	3	6	8	4	4	1	2
Treatment								
Screws	1	1	2	1	3	4		
Plate	3	4	5	5	2	2	2	1
Screws + plate			6	9		1	2	3
Associated lesions								
Meniscus	1		7		2		2	
ACL			3		1		1	
PCL								
MCL			3	3	1	1		
LCL								1

Table 2 Results of clinical and radiological assessment

	Mean KSS score	Mean Rasmussen clinical score	Mean Rasmussen radiological score
ARIF Group	81.3 ± 8.3 (range 60–96)	25.8 ± 2.9 (range 18–30)	14.1 ± 2.4 (range 10–18)
ORIF Group	78.8 ± 8.2 (range 56–94)	25.5 ± 3.0 (range 18–30)	14.9 ± 2.3 (range 10–18)
<i>p</i>	n.s	n.s	<i>p</i> < 0.05

Table 3 Results of clinical and radiological assessment

	Rasmussen clinical score					Rasmussen radiological score				
	Excellent	Good	Fair	Poor	SR (%)	Excellent	Good	Fair	Poor	SR (%)
ARIF group	9	15	2	0	92.30	4	20	2	0	92.30
ORIF group	8	20	3	0	90.30	2	25	4	0	87.10

SR satisfactory results

required conversions with a total knee prosthesis. Data of the clinical and radiological results are shown in Tables 2 and 3.

Discussion

The most important finding of the present study was that ARIF of tibial plateau fractures resulted in better radiological outcomes but comparable clinical results versus ORIF. There was no significant difference in KSS and Rasmussen clinical scores between the two groups. In the ARIF group, patients tolerated early mobilization well, but the advantages were not as good as we expected.

ARIF in the treatment of tibial plateau fractures was first introduced by Caspari et al. [4] and Jennings [18] in the 1980s and later popularized by others [11, 13, 25, 26]. Caspard et al. [5] described 26 patients with Schatzker types I–IV fractures treated arthroscopically and concluded that the results were comparable or better than ORIF. Chan et al. [9] reported satisfactory (good and excellent rate of 96 %) results of 54 ARIF cases at 2–10 years' follow-up when the Rasmussen system score was used. Lee et al. [20] offered second-look arthroscopies in a cohort of patients with united fractures and concluded that despite good clinical and radiological results, the actual condition of the articular cartilage varied significantly. Chen et al. [10] summarized three retrospective comparative studies which

explored the clinical outcomes of patients who underwent ARIF for tibial plateau fractures. All three authors favoured ARIF, although there was insufficient clinical evidence and a lack of long-term follow-up to document the incidence of secondary arthritis.

According to the Rasmussen radiological results, the ARIF group was better than ORIF group since arthroscopy allowed for better visualization of deeper locations, magnification and possibly more accurate fracture reduction. The used gravity for fluid inflow arthroscopy was safe as none of our patients experienced severe fluid extravasation in the calf.

A major advantage of ARIF is the ability to diagnose and address concurrent injuries of the meniscus, cartilage and ligaments. As these lesions are found to be quite common in our study, routine ARIF may reduce the need for secondary surgery arising from missed lesions. In fact, a number of recently published studies on ARIF also described a high incidence of such lesions that are likely underestimated by previous studies. Abdel-Hamid et al. [1] reported the rate of intra-articular soft tissue injuries associated with tibial plateau fractures to be 71 %. Honkonen [15] identified an 8 % rate of ligament injuries and a 50 % rate of meniscal lesions in a study of 76 cases of tibial plateau fracture and suggested that treatment of meniscal tears and suturing of ligaments could improve the ultimate results by preventing instability and osteoarthritis. Hung et al. [16] arthroscopically evaluated 31 tibial plateau fractures and revealed an incidence of 38 % for ACL injuries, 19 % for collateral ligament injuries, and 31 % for lateral meniscus injuries.

In our study, no significant difference in clinical outcome was found between the ARIF group and the ORIF group. Although arthroscopy increased the operation time, there was no consequent increase in complications such as compartment syndrome or infection. The small number of cases and short follow-up period are some of the shortcomings of this study. Other limitations of this study include its retrospective nature, the lack of post-operative CT or arthroscopic assessment. Confounding variations in comminution and severity that exists within fracture patterns (from I to IV) are also unaccounted. It would be of interest to review our patients at a longer follow-up period so as to assess their incidence and progression of secondary osteoarthritis.

Conclusions

Both ARIF and ORIF led to satisfactory clinical results for the treatment of Schatzker types I–IV tibial plateau fractures. ARIF is a good choice since it gave better radiological results than ORIF. Moreover, ARIF offers a unique diagnostic advantage for intra-articular lesions.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Funding There is no funding source.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent For this type of study formal consent is not required.

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