

RESEARCH ARTICLE

Outcomes of Tibial Plateau Fracture Surgical Fixation: a Comparative Study between Younger and Older Age Groups

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Received: 30 October 2020

Accepted: 07 July 2021

Abstract

Background: Tibial plateau fractures account for approximately 8% of the fractures of the elderly. Low bone quality that is more common in the elderly is one of the major challenges in fixing fractures and may be a barrier to achieving satisfactory outcomes after a surgical fracture treatment. Accordingly, surgical fixation of tibial plateau fractures was controversial in the elderly. This study aimed to investigate and compare the clinical outcomes of surgical fixation in patients over and under 60 years of age.

Methods: This study was conducted as a retrospective cohort study of data that were prospectively collected. In total, 48 patients who underwent surgery with open reduction and internal fixation before August 2019 were recruited and followed up at least one year after surgery. Demographic characteristics, the range of motion of the knees, visual analog scale (VAS) score of pain intensity, and the Oxford Knee Score (OKS) were obtained in this study. Furthermore, Short Form-36 (SF-36) questionnaire was used to evaluate patient satisfaction.

Results: In total, 19 and 29 patients were over and under 60 years of age, respectively. According to Schatzker's classification, the most common type of fracture was type VI. The range of motion in the knees did not differ significantly between the two groups ($P>0.05$). Moreover, OKS and the VAS of pain intensity were not significantly different in both groups ($P>0.05$). In addition, SF-36 scores were not significantly different between elderly patients and the age-matched general population. However, younger patients had lower scores in the physical function and vitality scales of SF-36, compared to the age-matched general population.

Conclusion: Based on the results of the present study, it can be stated that increasing age did not affect the surgical outcomes of patients with tibial plateau fractures.

Level of evidence: III

Keywords: Clinical outcome, Elderly patient, Tibial plateau fracture

Introduction

Tibial plateau fractures account for 1% of all fractures and 8% of fractures in the elderly. Such fractures occur in young people due to high-energy traumas, and in older people, following a lower energy trauma (1). These fractures are challenges for orthopedic surgeons since they are not always associated with excellent outcomes (2, 3). Fixation of tibial plateau fractures is performed by surgery to restore the tibial joint surface, stabilize the knee joint, and restore the limb alignment (4). Knee

instability and failure to restore limb alignment lead to poor long-term clinical outcomes (2, 5, 6). Most surgeons prefer surgery for fractures with knee instability, displacement, or excessive joint depressions to achieve better therapeutic results (4). Some studies on the open reduction and internal fixation (ORIF) technique of tibial plateau fractures in elderly patients have reported poor outcomes (7, 8). The need for total knee arthroplasty (TKA) after ORIF has been reported from 0% to 21.9% for tibial plateau fracture in different studies (9-15).

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Wasserstein et al. reported a 7.3% conversion rate to TKA after a 10-year-follow-up. They also showed an association between older age and the necessity of secondary TKA in their patients (15). It also should be considered that secondary TKA was associated with poorer outcomes, compared to primary TKA in some studies. In addition, performing primary TKA instead of ORIF in patients with tibial plateau fracture showed faster weight-bearing, lower rates of revision surgery, and fewer complications. Therefore, some authors suggest that the best treatment strategy in the elderly is primary TKA (16-19). However, other studies have reported that the clinical outcome of ORIF in elderly patients could be excellent (9, 20, 21). Hsu et al. reported that good or excellent outcomes in surgical fixation in elderly patients could be as high as 90% (22). Although TKA in older patients with tibial plateau fracture has been associated with good results, controversy exists, and ORIF may also be associated with satisfactory results in older patients. The available literature concerning the outcome of ORIF in the elderly is still scarce and inconsistent. This study aimed to examine and compare recovery level and patient satisfaction after ORIF in patients over 60 and younger patients.

Materials and Methods

Patients

This retrospective study was conducted based on the analysis of prospectively collected data. A total of 48 patients were enrolled between March 2015 and August 2019 in this retrospective cohort. Postoperative outcomes were assessed and compared between patients over and under 60 years of age. All patients with Schatzker's I to VI tibial plateau fractures who underwent surgery in our institution were considered for inclusion. On the other hand, the patients with a history of neuromuscular, vascular, or other abnormalities of lower extremities (i.e., contralateral knee injury) were excluded from the study. In addition, patients with degenerative joint disorder or osteoarthritis on the triple knee compartments were removed from the study based on their radiological findings. The study protocol was approved by our institutional review board (Ethical code: IR.AJAUMS.REC.1398.161), and informed consent was obtained from all patients to participate in the study.

Procedure

All patients underwent anterolateral incision in the proximal tibia with submeniscal arthrotomy for lateral injuries and posteromedial incision for medial injuries or a combination of both surgical incisions. Soft tissue flaps were used for patients only if necessary. Bone defects were filled with cancellous allografts. The appropriate plate (either pre-contoured or non-contoured plates) was selected depending on the type of fracture and the quality of the patient's bone. Schatzker's II, III, and IV fractures and minimally displaced sagittally oriented large medial condyle fragments in Schatzker's VI were fixed with a uni plate device. A double-plate device was used for type V and VI fractures according to the indications. Patients with Schatzker's I fractures were treated with screw fixation. The screws were directed

toward the posterolateral and posteromedial wall of the bone according to the fracture pattern. After surgery, active and passive movements were started for the patients as soon as possible. Patients were advised not to put weight on the operated knee for the first three months after surgery and then started gradual weight-bearing activities.

Follow-up

After discharge, patients were followed up periodically for examination. Patient satisfaction, quality of life and pain severity in resting, as well as weight-bearing conditions were assessed using Oxford Knee Score (OKS), Short Form-36 (SF-36), and Visual Analog Score questionnaires, respectively. OKS and SF-36 have been translated to Persian, and their accepted validity and reliability were reported in previous studies (23, 24). Moreover, data on the range of motion of both knees were recorded. A comparison was performed between the injured knee and the contralateral healthy knee in terms of the range of motion and pain score.

Statistics

The obtained data were analyzed in SPSS software (version 16.0). Qualitative variables were reported as frequency and percentage. Furthermore, the quantitative variables were reported as mean±SD. Qualitative and quantitative variables were compared using the Chi-square test and independent t-test, respectively. One-sample t-test was also used to compare the results of SF-36 of the patients with the general population based on the reports in the same country (24, 25). For non-parametric variables, the Mann-Whitney test was applied, and a p-value less than 0.05 was considered statistically significant.

Results

A total of 61 patients underwent ORIF during the study period, and 48 cases met the inclusion criteria for final analysis. Among 13 excluded patients, two patients passed away, one case underwent TKA three years after surgical fixation at the age of 68, three individuals had multiple fractures, and seven subjects were lost from follow-up. Furthermore, a complication occurred in 4 (10%) patients. Surgical site infection occurred in one patient who required intravenous antimicrobial treatment and debridement. One patient with postoperative compartment syndrome was treated with fasciotomy, and two patients at the ages of 47 and 65 years had a failure of fixation due to varus deformity after four and six weeks from the ORIF surgery. They underwent a secondary procedure for the revision of the fixation. Implant removal due to subcutaneous irritation was performed in three cases all younger than 60 years old.

The patients' mean age at the time of injury was obtained at 51.8±14.4 years (age range: 21-78 years) and the mean follow-up was 31.6±14.0 months (range:13-58). Study participants were divided into two groups of older than 60 years (n=19) and younger than 60 years (n=29). Gender and body mass index (BMI) were comparable in both groups [Table 1]. The frequency of different types of fracture based on Schatzker's classification has been compared between different age groups in [Table 2].

Table 1. Demographic information

Variable		all patient (48)	Age 60>	Age 60<	p-value
Gender	Male	28 (58.3%)	19 (65.5%)	9 (47.4%)	0.212*
	Female	20 (41.7%)	10 (34.5%)	10 (52.6%)	
BMI		25.87 ± 4.12	25.25 ± 3.92	26.80 ± 4.34	0.218†

* Chi-square test

† independent t-test

Table 2. Schatzker classification

Schatzker class	< 60	> 60	Total
I	3 (10.3 %)	3 (15.8 %)	6 (12.5 %)
II	5 (17.2 %)	3 (15.8 %)	8 (16.7 %)
III	6 (20.7 %)	2 (10.5 %)	8 (16.7 %)
IV	3 (10.3 %)	4 (21.1 %)	7 (14.6 %)
V	4 (13.8 %)	3 (15.8 %)	7 (14.6 %)
VI	8 (27.6 %)	4 (21.1 %)	12 (25.0 %)

Overall, type VI was the most common type of fracture among patients. The range of motion in the operated and healthy joints was similar in both age groups [Table 3]. The mean differences in the range of motion between healthy and operated knees were 15.51±14.03 and 15.78±10.70 in patients younger and older than 60 years, respectively; however, the difference was not statistically significant. The difference in pain severity was also calculated between healthy and operated knees in both weight-bearing and resting conditions applying VAS [Table 4]. OKS and VAS tests were similar in both groups. In addition, the difference between healthy and operated knees in terms of pain score was similar in both groups. Compared with the general population, the younger patients had lower scores in the physical function and vitality scales [Table 5]. However, the results of SF-36 in the elderly showed no statistical differences in any area of the survey, compared to the age-matched general population [Table 6].

Discussion

In this study, the mid-term outcomes of surgical fixation of tibial plateau fractures were compared in young and old patients with both subjective and objective assessment tools. SF-36 questionnaire did not show any significant difference between the elderly patients and the elderly in the general population on any scale. However, physical function and vitality scales in the younger group of patients were lower than the general population. OKS and VAS scores were similar in both groups. Based on these results, surgical fixation may be a reasonable treatment for elderly patients; however, the best treatment strategy for old patients has remained controversial for many years.

Bone mineral density is one of the major factors that influence the success of fixation of fractures (26, 27). Several studies reported that some factors (e.g., nutritional status, physical activity level, BMI, medications, and age) influence the quality of bone (28-33). Accordingly, surgical fixation of tibial plateau fractures in elderly patients has been the subject of controversy in previous studies (6, 34).

Table 3. Range of motion

Range of motion	< 60	> 60	p-value
Operated	108.62 ± 17.26	103.68 ± 13.42	0.397*
Healthy	124.14 ± 13.23	119.47 ± 12.68	0.212*
ΔROM	15.51 ± 14.03	15.78 ± 10.70	0.625*

* Mann-Whitney test

ROM: Range of motion

Table 4. OKS and VAS

Test type		Age < 60 (mean ± SD)	Age > 60 (mean ± SD)	p-value
Oxford	Function	22.03 ± 5.08	19.47 ± 5.29	0.101*
Knee	Pain	15.28 ± 3.67	13.16 ± 4.18	0.065*
Score	Total	37.28 ± 8.23	32.58 ± 9.83	0.074*
Pain	operated knee	2.62 ± 2.71	3.84 ± 3.14	0.153*
	Weight-bearing			
Severity	operated knee	0.21 ± 0.94	0.84 ± 1.77	0.142*
(Visual	Weight-bearing			
Analogue	healthy knee			
Scale)	Resting	1.45 ± 1.70	2.11 ± 1.82	0.169*
	operated knee			
	Resting	0.10 ± 0.55	0.42 ± 1.17	0.059*
	healthy knee			
	ΔPain in			
	weight-bearing	2.41 ± 2.39	3.00 ± 1.88	0.262*
	situations			
	ΔPain in			
	resting	1.34 ± 1.42	1.68 ± 1.76	0.519*
	situations			

* Mann-Whitney test

Therefore, orthopedic surgeons may refuse to perform ORIF for tibial plateau fracture on elderly patients due to the higher frequency of low bone quality in this age group. It also appears that tibial plateau fractures are more likely to cause osteoarthritis in the elderly (35, 36).

Although there is apparently an agreement about acceptable results of surgical fixation of tibial plateau fracture in young patients, some authors reported that ORIF was not associated with satisfactory outcomes in the elderly. Ali et al. reported a radiologic failure of fixation in 79% of patients over 60 years of age versus 7% of patients under 60 years of age (7). In addition, postoperative progression to osteoarthritis has been reported to be as high as 59.5% in patients older than 55 years using radiological criteria with a mean follow-up of 2.54 years after surgical fixation (14). Moreover, another study showed that the need for TKA after surgical fixation of tibial plateau fractures increased as the patient's age increased (37). With regard to the evidence concerning the poorer outcomes of surgical fixation, some surgeons prefer primary TKA in the elderly. Furthermore, primary TKA had an acceptable outcome in some studies (38-40).

However, some recent studies debate the benefits of primary TKA for elderly people. A systematic review by Wong et al. suggested that primary TKA maybe not superior to ORIF, and the complication rate of primary TKA was unacceptably high (41).

Table 5. Comparing SF-36 results between younger patients and young general population

	The patients younger than 60 years	Young general population*	p-value
Physical function	67.93 ± 26.10	83.34	0.004†
Physical role	66.38 ± 33.59	67.26	0.889†
Bodily pain	72.03 ± 20.01	77.20	0.176†
General health	63.79 ± 16.23	64.87	0.720†
Vitality	57.93 ± 17.29	64.53	0.049†
Social function	76.14 ± 23.50	73.84	0.603†
Emotional role	72.48 ± 35.72	62.91	0.160†
Mental health	64.28 ± 20.97	65.12	0.830†

* The data has been extracted for the general population in the age range of 25-64, from a study by Montazeri *et al.*(24)

† One-Sample t-test

Table 6. Comparing SF-36 results between elderly patients and age-matched general population

	The patients older than 60 years	Elderly general population*	p-value
Physical function	57.89 ± 23.76	51.75	0.275†
Physical role	48.42 ± 32.23	47.58	0.841†
Bodily pain	55.47 ± 25.72	55.78	0.959†
General health	56.32 ± 20.19	47.85	0.084†
Vitality	53.16 ± 17.33	51.31	0.648†
Social function	67.37 ± 19.94	59.55	0.105†
Emotional role	54.68 ± 39.58	51.54	0.733†
Mental health	53.26 ± 22.15	55.42	0.676†

* The data has been extracted from a meta-analysis study by Doosti-Irani *et al.*(25)

† One-Sample t-test

Timmers *et al* Reported that the mean age of patients who required secondary TKA after tibial plateau fixation was comparable to those who did not require TKA (15). In addition, performing ORIF in old patients had a reasonable outcome in some studies (42-44).

In the current study, clinical outcome after surgical fixation was comparable between elderly and young patients. To the best of our knowledge, this is the first study that compares the operated knee with the contralateral healthy knee to specify the impact of injury and surgery on the joint. The differences in pain and range of motion between healthy and injured knees were similar in both age groups. Altogether, based on the result of the present study, surgical fixation in the elderly may be an appropriate option with a satisfactory outcome. In line with our findings, several studies showed the feasibility and efficacy of this approach.

In a study on 42 patients with a mean age of 42 years (age range: 16-70 years) and a mean follow-up of 2.7 years, Lachiewicz *et al.* showed excellent results in more than 80% of patients who underwent ORIF. They also showed that clinical outcome was not related to age (45). Similarly, Rademaker *et al.* revealed excellent radiographic outcomes in ORIF irrespective of age (42). Studies with longer-term follow-up also showed satisfactory outcomes in older patients (42-44). It should also be considered that clinical outcome (i.e., functional decline) is more important in elderly patients. Outcome assessment based

on more stringent criteria (i.e., anatomical reduction) does not seem to be necessary for the elderly (46) though the satisfactory outcome has also been reported using radiographic criteria (20, 22).

Stevens *et al.* using the SF-36 questionnaire showed a significant decline in the quality of life in patients older than 40 years after ORIF, whereas patients younger than 40 years did not indicate the worse quality of life score, compared to the general population, which was contrary to our results. However, based on the Western Ontario and McMaster Universities Osteoarthritis Index questionnaire, Stevens *et al.* did not show compromised outcomes and quality of life in patients older than 40 years (8). In the present study, using the SF-36 questionnaire, similar scores were observed between patients older than 60 who underwent ORIF, compared to the general elderly population. There is a need to note that because of the unavailability of the results of the SF-36 in the general population younger than 60 years in the same country, our younger patients were compared with the general population in the age range of 25-64 years, which might limit the interpretation of the results.

The need for secondary TKA could be considered an index to evaluate the outcome of surgical fixation. However, TKA has a serious impact on the outcome, and it was preferred to use it as an exclusion criterion. In the present study, it was found that one patient (2%) had TKA after three years of ORIF. The rates of conversion to TKA have been reported between 0% and 7.9% in the previous studies (9, 13, 14, 20). A study with 8426 subjects reported that 5.3% and 7.3% of patients who had ORIF for tibial plateau fracture had TKA at 5 and 10 years, respectively (37). The lower conversion rate to TKA in the present study could be justified to the shorter follow-up duration of the study.

Prior degenerative joint disease (DJD) obviously influences the clinical outcome of surgical fixation in patients with joint injuries. Accordingly, it was decided to exclude the patients with primary osteoarthritis in order to examine the pure role of age on the clinical outcome. Based on the result of this study, the outcome of surgical fixation in older patients who had not prior DJD could be reasonable. The main limitation of the present study is related to the retrospective nature of the study. Tibial fractures may be associated with meniscus injuries which may impact the outcome of the surgery. Furthermore, the associated meniscus injuries were not assessed in this study. In addition, usage of some medication could impact bone quality and the healing process of fractures, which were not investigated. Therefore, prospective studies with more strict inclusion and exclusion criteria may better evaluate the efficacy of ORIF in the elderly population.

Conclusions

Based on the results of the present study, the clinical outcome of surgical fixation for tibial plateau fractures in elderly patients seems to be similar to that of the younger age group. Therefore, this study supports the continuing usage of standard ORIF to manage tibial plateau fractures in older patients.

Conflict of interests: The authors declare that there are no competing interests.

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