Original Article

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Comparison of Different Surgical Incision Choices and Their Effects on Surgical Treatment Outcome in Tibial Plateau Fractures

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Abstract

Aim: Our hypothesis was that the treatment results would be superior to those of other methods in the patient group treated with a single anterior midline approach. The aim of this study was to assess the clinical and radiological results of surgical methods used to treat tibial plateau fractures.

Methods: This retrospective study included 60 patients who underwent tibial plateau fracture surgery between 2019 and 2021. The Schatzker fracture classification was used to analyze and compare the association between surgical incisions and clinical and radiological outcomes in terms of complication rate.

Results: The study included 60 patients (35 males and 25 females). The mean age of the patients was 44.8 years. The lateral incision is almost always preferred for Schatzker type 1-2-3 fractures, whereas the midline incision is used extensively for type 4-5-6 fractures. Better clinical and radiologic results were observed in Schatzker type 1 and 3 fractures. There were no significant differences in complications between anterior midline single-incision and double-incision surgeries.

Conclusion: Tibial plateau fractures require anatomical joint reduction and rigid fixation of fracture fragments. A single anterior midline incision for bicondylar plateau fractures can be safely utilized, although larger patient series studies are needed.

Keywords: Tibial plateau fractures, surgical approach, midline incision

Introduction

Tibial plateau fractures account for 5-8% of lower limb fractures and 1% of all adult fractures and frequently necessitate surgical intervention (1). High-energy trauma is the main cause of these fractures, which can significantly impair knee stability and function (2,3). The surgical treatment plan for tibial plateau fractures may vary depending on the type and location of the fracture and the general health status of the patient (4). Advances in surgical techniques and fixation methods have improved the treatment of tibial plateau fractures (5).

In tibial plateau fractures, the anatomical location of the fracture, fragmentation status, and soft tissue damage are the most important parameters affecting the results of surgical treatment (6). Therefore, patient-specific surgical approaches are used for treating patients with tibial plateau fractures (7). Many studies in the literature compare approaches to surgical treatment of tibial plateau fractures (8,9). However, clinical studies involving a single anterior incision, particularly for bicondylar fractures, are limited.

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This study aimed to evaluate the clinical and radiological results of all surgical approaches used in the surgical treatment of tibial plateau fractures, including the single anterior midline approach. Our hypothesis was that the treatment results would be superior to those of other methods in the patient group treated with a single anterior midline approach.

Methods

Compliance with Ethical Standards

This study was conducted in accordance with the Declaration of Helsinki, revised in 2013, and approved by the Clinical Research Ethics Committee of University of Health Sciences Turkey, Istanbul Haseki Training and Research Hospital (decision no.: 2023-276, date: 27.12.2023).

Study Design

Sixty patients who underwent surgery for a tibial plateau fracture between 2019 and 2021 were included in the study (Figure 1).

The Inclusion Criteria were

- Patients treated surgically for a tibia plateau fracture.
- Patients with adequate clinical and radiological data at postoperative follow-up visits.

The Exclusion Criteria were as Follows:

- Open fractures.
- Those with concomitant vascular nerve damage.
- Patients without sufficient follow-up data.
- Conservatively treated patients.
- Pathological fractures.

Age, sex, fracture side, fracture type, surgical treatment approach, time from fracture to surgery, follow-up, duration of surgery, Rasmussen score, visual analogue scale (VAS), range of motion, postoperative pivot shift, and Lachman test results were analyzed (10,11). Radiologically, fracture union time, femorotibial angle, posterior tibial slope, and medial plateau diaphyseal angle were analyzed.

Statistical Analysis

SPSS 20.0 for Windows was used for statistical analysis. Because the numerical variables did not meet the normal distribution condition, comparisons of the independent groups were made using the Kruskal-Wallis test. The data were tested for normality using the Kolmogorov-Smirnov test. The ratios of categorical variables between the groups were tested by chi-square analysis. The statistical alpha significance level was set at $p<0.05$.

Results

A total of 60 patients, 35 (58.33%) males and 25 (41.66%) females, were included in the study. The mean age of the participants was 44.81±12.64 (19-89). The comparison of patients grouped using the Schatzker classification according to age, gender, and surgical incision selection is summarized in Table 1. Although the patients grouped according to the Schatzker classification were similar in terms of age and gender, there was a significant difference between the groups in terms of side effects. The lateral incision is almost always preferred for Schatzker type 1-2-3 fractures, whereas the midline incision is used extensively for type 4-5-6 fractures.

When the clinical and radiological results of the patients grouped according to the Schatzker classification were compared, there was a significant difference between the groups in terms of radiological union time, VAS score, special surgery hospital knee rating scale, Rasmussen score, flexion knee joint and knee joint score, and complication rate. Analysis of the time between fracture and surgery

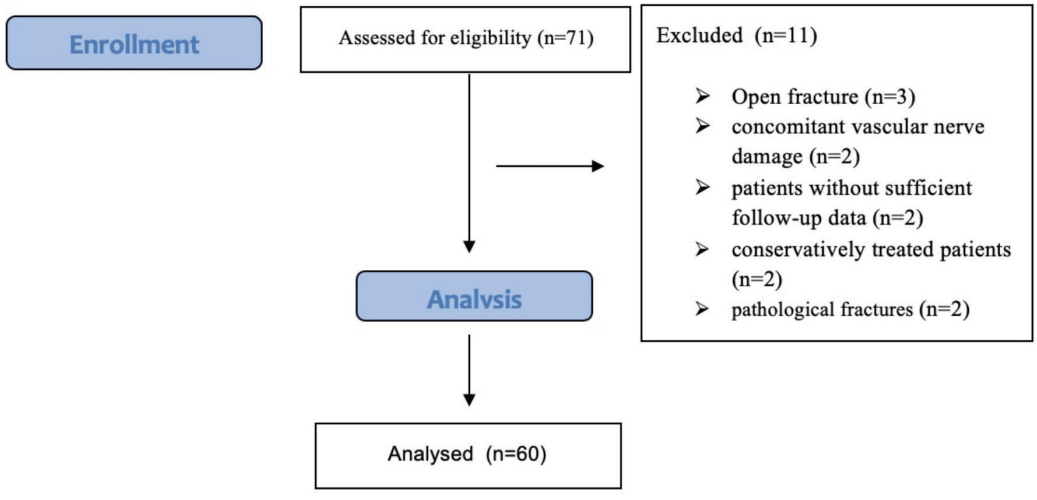

Figure 1. Consort flow diagram

showed that the more complex the fracture, the longer the time. Better clinical and radiologic results were observed in Schatzker type 1 and 3 fractures (Table 2).

When the clinical and radiological results of the patients grouped according to surgical incision selection were compared, a statistically significant difference was observed between the groups in terms of Rasmussen score, Hospital for Special Surgery knee rating scale, and radiological union time (Table 3).

Discussion

Patients who underwent different surgical approaches for tibial plateau fractures were evaluated in our study. When patients were assessed on the basis of the Schatzker classification, it was found that type 5 and 6 fractures were associated with longer preoperative waiting times, longer union times, and worse clinical and radiologic outcomes, as expected. Although type 4 fractures were less complex, comparable outcomes were noted with type 5 and 6 fractures. After surgical treatment of lateral plateau fractures, no complications were observed in our patients, whereas higher complication rates were found in fractures with medial plateau involvement.

The lateral approach is undoubtedly the most accepted method for treating isolated lateral plateau fractures and has been shown to achieve satisfactory results (12). It is possible to achieve improved results with the assistance of arthroscopy. Significant improvement has been reported with arthroscopic-assisted percutaneous fixation (13). Although the common approach involves lateral and medial double incisions, it has been reported that the same success can be achieved with a single anterior incision in fractures involving the medial and lateral columns of the tibial plateau (14,15). Anterior midline incisions were performed on 11 patients who had affected lateral and medial columns of the tibia. Five patients underwent surgery with a lateral and medial double incision, three patients underwent surgery with a medial and posterior incision, and one patient underwent surgery with a lateral and posterior incision. There was a significant difference in the postoperative radiological and clinical results of patients who underwent different incision options. However, considering the selection of different incisions according to the type of fracture, this situation was considered quite natural. The most critical concern of orthopedic surgeons regarding the anterior midline incision is that the fracture cannot be adequately controlled and skin necrosis may occur. However, our study shows that adequate reductions can be achieved with comparable complication rates using this method. No infection or skin necrosis was observed with the double and single midline incisions. Guild et al. (14) compared single and double midline incision techniques in tibial bicondylar plateau fractures. They found no significant difference in revision and infection rates. Similar findings were reported in a comparative study involving hyperextension injuries in the bicondylar plateau of the tibia (16). In addition to achieving comparable clinical and radiological results, our study highlights that the use of a single anterior midline incision reduces surgical time by approximately half. Although we did not observe

Table 1. Comparison of patients grouped using the Schatzker classification according to age, gender and surgical incision selection

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	p-value
Age	38.67±4.04	42.91±12.48	40.67±14.05	47.17±7.44	50.89±17.78	45.06±12.02	0.951*
Gender							
Male	0 (0%)	15 (68%)	3 (100%)	5 (83%)	5 (56%)	7 (41%)	0.054**
Female	3 (100%)	7 (32%)	0 (0%)	1 (17%)	4 (44%)	10 (59%)	
Side							
Right	3 (100%)	3 (14%)	1 (33%)	2 (33%)	5 (56%)	3 (18%)	0.014**
Left	0 (0%)	19 (86%)	2 (67%)	4 (67%)	4 (44%)	14 (82%)	
Surgical technique							
Lateral incision	3 (100%)	20 (91%)	3 (100%)	0 (0%)	0 (0%)	6 (35%)	0.001**
Medial incision	0 (0%)	0 (0%)	0 (0%)	3 (50%)	0 (0%)	2 (12%)	
Midline incision	0 (0%)	2 (9%)	0 (0%)	3 (50%)	1 (11%)	5 (29%)	
Posterior incision	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (33%)	0 (0%)	
Lateral + medial	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (33%)	2 (12%)	
Medial + posterior	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (11%)	2 (12%)	
Lateral + posterior	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (11%)	0 (0%)	

*Kruskal-Wallis-H test
**Pearson's chi-square test

Table 2. Comparison of clinical and radiological results of patients grouped using the Schatzker classification							
	Type 1	**Type 2**	**Type 3**	**Type 4**	**Type 5**	**Type 6**	**p-value**
Mean time from injury to surgery days	2±0	4.73±2.07	4.33±0.58	6.17±4.62	3.56±2.3	8.94±8.61	0.591*
Mean follow up months	31±0	16.86±9.52	12.67±9.87	22.5±12.41	15±9.14	22±14.9	0.188*
Mean operative time min	120±0	160.23±41.24	75±39.69	215±108.03	238.89±177.94	157.06±50	0.188*
Time to clinical union months	4±0	4.5±1.7	2.67±1.15	5.33±1.75	4.11±1.76	5.65±2.83	0.162*
Time to radiological union weeks	6±0	7.18±1.3	4.67±2.89	8±1.1	5.67±1.87	8.24±3.19	0.022*
Mean VAS	0±0	3.27±2.27	0±0	3.67±1.21	2.56±1.42	4.12±1.87	0.001*
Femoral tibial angle	2±0	5.77±4.6	5±1	6±4.05	3.89±2.37	3.88±2.26	0.306*
Posterior slope angle	75±0	82.5±3.92	81.67±1.53	81.17±4.12	82.33±2.87	82.06±3.83	0.053*
Hospital for special surgery knee rating scale	98±0	80.18±14.09	100±0	75.83±9.06	75.67±16.81	73.71±12.46	0.007*
Rasmussen score	44±0	38.73±4.96	47.33±1.15	34.5±3.45	39.33±7.04	36.76±6.18	0.012*
Flexion knee joint	160±0	131.14±15.65	150±0	107.5±27.7	121.67±20.77	123.24±17.41	0.001*
A extension knee joint	0±0	-2.27±2.73	0±0	-5.83±7.36	-2.56±2.51	-1.82±2.32	0.076*
Pivot shift test							
+	0 (0%)	4 (18%)	0 (0%)	2 (33%)	1 (11%)	1 (6%)	0.507**
-	3 (100%)	18 (82%)	3 (100%)	4 (67%)	8 (89%)	16 (94%)	
Lachman test							
+	0 (0%)	8 (36%)	0 (0%)	2 (33%)	1 (11%)	3 (18%)	0.379**
-	3 (100%)	14 (64%)	3 (100%)	4 (67%)	8 (89%)	14 (82%)	
Complication							
None	3 (100%)	22 (100%)	3 (100%)	3 (50%)	5 (56%)	11 (65%)	0.01**
Skin necrosis	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Malunion	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Non union	0 (0%)	0 (0%)	0 (0%)	1 (17%)	0 (0%)	0 (0%)	
Infection	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (18%)	
Traumatic arthritis	0 (0%)	0 (0%)	0 (0%)	2 (33%)	4 (44%)	3 (18%)	
*Kruskal-Wallis-H test **Pearson's chi-square test							

any infection after a single midline incision in our study, infection rates ranged between 5-88% in other studies with larger patient series (1,17,18). Although a higher rate of soft tissue abrasion may increase the likelihood of infection, a shorter surgical time may balance this disadvantage. In a study analyzing the correlation between surgical duration and infection rates following open reduction and fixation of tibial plateau fractures, a significant relationship between surgical duration and infection occurrence was demonstrated (19). In this context, it is conceivable that the surgical infection rates of anterior single incisions may be lower or the same as those of double incisions.

Bicondylar tibial plateau fractures, similar to other intra-articular fractures, require rigid fixation. In high-energy fractures, the surgeon's primary goal is to achieve rigid fixation while minimizing soft tissue problems. The anterior midline method with full-thickness incisions allows rigid fixation without compromising the blood supply to the skin. According to a recent study, single and double incisions have the same risk of wound complications; however, double incisions allow greater joint restoration (1). However, in this study, anatomical joint reduction in bicondylar fractures was accomplished with a single anterior incision, and there was no reduction loss during follow-up with rigid fixation. The gold standard in tibial plateau fractures is to protect the soft tissue, ensure joint reduction, and obtain adequate stability (2). For all these purposes, an anterior midline single incision is an important option that should be considered in bicondylar tibial plateau fractures.

Study Limitations

The limitations of our study are that the patient population is limited, more specific groups cannot be created according to fracture types and surgical incision

Table 3. Comparison of clinical and radiological results of patients grouped according to surgical incision selection

	Surgical approach								
	Lateral	**Medial**	**Midline**	**Posterior**	**Lateral + medial**	**Medial + posterior**	**Lateral + posterior**	**Total**	**p-value**
Rasmussen score	38.54±5.87	27±0	39±3.85	31±0	41.6±5.03	44.33±1.15	46±0	38.53±5.92	0.002*
Hospital for special surgery knee rating scale	80.86±14.24	52±0	82.73±10.86	58±0	72.6±9.66	89.33±1.15	98±0	79.12±14.49	0.002*
Mean VAS	3.34±2.36	7±0	2.18±1.33	4±0	2.6±0.89	2.33±0.58	0±0	3.12±2.13	0.053*
A extension knee joint	-2.57±3.98	0±0	-1.36±2.34	-5±0	-2±2.74	-3±0	0±0	-2.32±3.38	0.562*
Flexion knee joint	126.57±22.42	115±0	131.36±18.04	100±0	131±10.84	146.67±2.89	150±0	127.5±20.7	0.094*
Time to radiological union weeks	7.43±2.1	13±0	6.64±2.01	5±0	6±0.71	7.33±2.31	3±0	7.15±2.31	0.001*
Time to clinical union months	5.09±2.45	7±0	3.73±1.1	4±0	4.2±0.84	5.33±2.31	2±0	4.73±2.13	0.250*
Complications									
None	26 (74.3)	2 (100.0)	10 (90.9)	0 (0.0)	5 (100.0)	2 (66.7)	1 (100.0)	46 (76.7)	0.239**
Non-union	1 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	
Infection	3 (8.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.0)	
Traumatic artritis	5 (14.3)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)	1 (33.3)	0 (0.0)	9 (15.0)	
Instability	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	

*Kruskal-Wallis-H test
**Pearson's chi-square test

selection, and the study is retrospective and a single-center study. Despite these limitations, this is one of only a few trials on anterior midline incision for treating tibial plateau fractures.

Conclusion

Open reduction and internal fixation using a single anterior midline incision in the surgical treatment of bicondylar plateau fractures can be safely performed in selected patients. Because complications such as infection or skin necrosis are not observed with this surgical method, we can say that this surgical method can be safely used in selected patients; however, we still believe that studies with larger patient populations are needed.

Ethics

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki, revised in 2013, and approved by the Clinical Research Ethics Committee of University of Health Sciences Turkey, Istanbul Haseki Training and Research Hospital (decision no.: 2023-276, date: 27.12.2023).

Informed Consent: The study is retrospective and a single-center study.

Authorship Contributions

Surgical and Medical Practices: A.E., K.E., Concept: M.A., A.E., E.G., I.S., Design: M.A., A.E., I.S., Data Collection or Processing: F.G., E.G., K.E., Analysis or Interpretation: F.G., K.E., I.S., Literature Search: F.G., E.G., I.S., Writing: M.A.

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