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Minimally Invasive Surgery of Tibial Plateau Fractures Reduces Incision-Healing Complications of Open Reduction and Internal Fixation

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Abstract

Background: Recently, minimally invasive surgical (MIS) techniques have become more common in orthopedics and traumatology practice. MIS techniques may also reduce complications in the treatment of tibial plateau fractures (TPFs).
Objectives: The aim of this study was to compare the radiological and functional outcomes of TPF, treated by MIS techniques and the conventional approach (open reduction and internal fixation).
Methods: The patients were divided into two groups, receiving either MIS (group A) or conventional treatment (group B). Each group consisted of 20 patients. The mean age of patients was 46.8 ± 2.85 years in group A and 50.3 ± 2.41 years in group B. Incision-healing complications were classified based on severity. Functional outcomes were evaluated using the Lysholm scale in the first year.
Results: Complete healing without incision-healing complications was reported in all patients from group A, whereas nine incision-healing complications were found in group B ($P < 0.001$). The mean Lysholm scores of patients in group A and group B were 81.8 ± 1.72 and 76.3 ± 2.27, respectively ($P = 0.06$). Also, the mean fracture union time in group A and group B was 9.55 ± 0.46 and 10.25 ± 0.71, respectively ($P = 0.41$).
Conclusions: Widespread use of MIS can be promoted in order to reduce incision-healing complications in TPF. However, further prospective studies with a larger sample size are needed to confirm our results.

Keywords: Minimally Invasive Surgical Procedures, Fracture, Complications

1. Background

Tibial plateau fractures (TPFs) account for approximately 1% of all fractures (1). There is a higher incidence of TPF in males below 50 years compared to females, whereas after this age, the incidence increases in females and decreases in males. The highest frequency has been reported in the age range of 40 - 60 years in both genders (2). Nondisplaced TPF can be treated conservatively, whereas displaced fractures are conventionally treated with open reduction and internal fixation (ORIF) (1, 3, 4).

While various complications may occur in the operative treatment of TPF, the primary morbidities generally involve soft-tissue complications (5). In recent years, minimally invasive surgical (MIS) techniques have become more common in orthopedics and traumatology practice (6-8). These techniques may also reduce complications in the treatment of TPF. To the best of our knowledge, no controlled study has been performed to compare the outcomes of MIS techniques with conventional ORIF in the treatment of TPF.

2. Objectives

The aim of this study was to compare the radiological and functional outcomes of TPF, treated with MIS techniques and ORIF.

3. Methods

In this retrospective study, TPF patients treated with ORIF between January 2014 and June 2016 were included. The patients' clinical and demographic data were extracted from the hospital records. All patients evaluated in this study had displaced TPF (Figure 1). The Schatzker classification system was used for classification of TPF (9). The

inclusion criteria were as follows: 1) ORIF with plate-screw fixation for TPF treatment; 2) age above 18 years; and 3) minimum follow-up of one year. The patients were excluded from the study if they had open fractures.

The patients were divided into two groups according to the date marked for the change of treatment approach in our clinic. Therefore, it was not possible to have a matched distribution of Schatzker classification subtypes. Since February 2015, when wound healing problems, associated with the conventional approach, were obvious to the treatment team, the strategy changed to MIS techniques (Figures 2 and 3); before this change, all patients were being treated with the conventional approach. Finally, the patients were divided into two groups: MIS (group A) and conventional approach (group B).

All operations were performed in the supine position with the use of a pneumatic tourniquet. For group A (MIS), a medial and/or lateral skin incision of approximately 4 - 6 cm was made. Fracture reduction and bone grafting, if necessary, were performed. Then, the anatomic plate was advanced to the tibial shaft and mini-incisions were made to insert the distal screws. In group B (ORIF), a medial and/or lateral skin incision of approximately 10 - 12 cm was made. Fracture reduction, bone grafting (if necessary), anatomic plate application, and insertion of distal screws were carried out in the same manner. In both groups, reduction and fixation were examined using plane radiographs. Following drain placement in the wound, the soft tissue and skin were closed layer by layer.

An above-the-knee plaster cast was applied to the operated extremity for one week after surgery. Active range of motion exercises were encouraged at the end of first postoperative week. The patients were allowed full weight-bearing after radiologically confirmed bone union. Fracture union was assessed radiologically with respect to the appearance of bony bridging between fracture fragments in both anteroposterior and lateral views (Figure 1).

The patients' follow-up visits were scheduled every two weeks for the first month and then every month until the third month; after the third month, the follow-up intervals changed to every three months. Incision-healing complications were classified based on severity (Table 1) (10). Functional outcomes were evaluated using the Lysholm scale at the end of the first year (11).

3.1. Statistical Method

Statistical analysis was performed using SPSS version 22.0 for Windows. Descriptive statistics were presented as mean, standard deviation, and minimum/maximum values for numerical variables (age, duration of union, and scores) and as number and percentage for categorical variables (Schatzker grade, exposure, side, and gender). Mann-Whitney U test was used to evaluate significant associations between variables. Correlations were evaluated using Spearman's correlation coefficient test. $P < 0.05$ was considered statistically significant.

Table 1. Definitions of Incision-Healing Complications

Stage		
1	None	Complete healing without incision complications
2	Minor without additional treatment	Suture, granuloma, suture abscess, and skin-edge necrosis without any need for intervention
3	Minor with additional treatment	Additional office visits, in-office debridement, local wound care, and oral/topical antibiotics
4	Major	Formal operative intervention for any incision complication

4. Results

Each group consisted of 20 patients. The mean age of patients was 46.8 ± 2.85 years in group A and 50.3 ± 2.41 years in group B (P = 0.35). The patients' demographic and clinical characteristics are listed in Table 2. No significant difference was observed between the clinical and demographic characteristics of the two groups.

In group A, complete healing without incision complications was reported in all cases. In group B, nine incision-healing complications were observed ($P < 0.001$); the incision-healing complications are presented in Table 2. Optimal bone healing was achieved in all TPF patients in both groups. The Lysholm scores and fracture union time were not significantly different between the groups (P = 0.06 and P = 0.41, respectively).

5. Discussion

Recently, MIS techniques have become popular because of their advantages. MIS techniques particularly reduce complications in the treatment of different fractures and have major impacts on the outcomes (6-8). The results of this study demonstrated that MIS techniques applied for internal fixation of TPF can provide similar results to the conventional approach in terms of functional scores and fracture union over one year of follow-up. However, MIS techniques were found to be superior, especially in terms of incision-healing problems.

Nondisplaced TPF can be treated conservatively, whereas surgery is usually indicated for displaced fractures (1, 3, 4). The treatment goal for TPF is anatomic

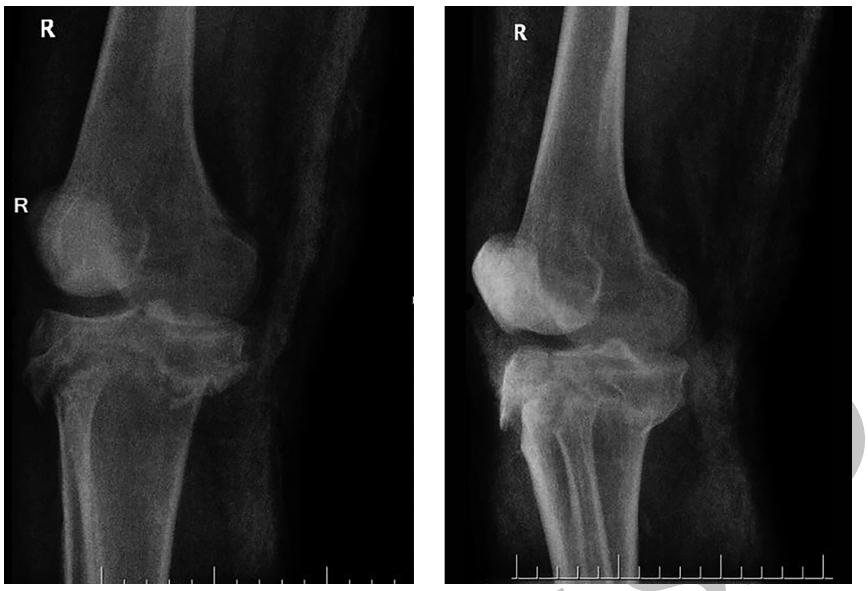

Figure 1. A 62-year-old male patient treated with an MIS technique. A Schatzker type-V right TPF was observed in the preoperative radiographs (A and B); postoperative radiographs of the same patient 12 months after surgery (C and D).

Figure 2. The postoperative incision view in a 62-year-old male patient treated with an MIS technique for Schatzker type-V right TPF (A); clinical assessment of the same patient in the final follow-up session (B and C).

Figure 3. Incision-healing complication of a 55-year-old male patient treated with the conventional approach. He was treated with in-office debridement, local wound care, and oral antibiotics.

reduction and stable fixation to allow early joint rehabilitation. Although ORIF allows anatomic reduction and stable fixation, the surgical approach has been reported to cause a higher rate of complications, including incision-healing problems and infection (12, 13). Following surgical treatment of TPF, incision-healing problems are common and devastating complications, which may lead to deep infections. Careful timing of surgery, extraperiosteal dissection, and limited dissection of comminuted bone fragments are likely to decrease complications (14).

Many authors have recommended arthroscopy-assisted techniques and external fixator applications (3, 15-18). Each of these techniques has its limitations, such as need for special equipments and experience. In a case report by Li et al. a Schatzker type-VI TPF was successfully treated with an MIS technique (19). Moreover, treatment of depressed, displaced, or unstable TPF via open conventional techniques provided satisfactory results (20, 21).

In the current study, the outcomes of MIS techniques were compared to the conventional approach in TPF patients, who were treated by ORIF with plate-screw application; our results are consistent with the literature. On the other hand, the complication rate in the MIS group was very low, compared to the literature (12, 13, 20-22). Weimann et al. described a minimally invasive reconstruction technique of lateral TPF and compared it with the conventional osteosynthesis technique. The results indi-

Table 2. The Demographic and Clinical Characteristics of TPF Patients

Variables	Group A (MIS) (n = 20)	Group B (Conventional) (n = 20)
Gender		
Male	16	13
Female	4	7
Age, y	46.8 ± 2.85	50.3 ± 2.41
Range	19 - 75	31 - 66
Side		
Right	9	9
Left	11	11
Comorbidity		
DM	2	1
HT	6	5
None	12	14
Schatzker classification[a]		
Type 1	5 (25)	3 (15)
Type 2	6 (30)	5 (25)
Type 3	4 (20)	3 (15)
Type 4	3 (15)	4 (20)
Type 5	1 (5)	3 (15)
Type 6	1 (5)	2 (10)
Skin incisions[a]		
Medial	3 (15)	4 (20)
Lateral	14 (70)	11 (55)
Double	3 (15)	5 (25)
Classification of incision-healing complications[a]		
Stage 1	20 (100)	11 (55)
Stage 2	0 (0)	7 (35)
Stage 3	0 (0)	2 (10)
Stage 4	0 (0)	0 (0)
Total incision complications		
Stage 2 + 3 + 4	0	9
Lysholm score	81.8 ± 1.72	76.3 ± 2.27
Range	62 - 90	60 - 90
Fracture union time, mo	9.55 ± 0.46	10.25 ± 0.71
Range	8 - 15	5 - 18

Abbreviations: DM, diabetes mellitus; HT, hypertension; MIS, minimally invasive surgery; TPF, tibial plateau fractures.
[a]Values are expressed as No. (%).

cated that the minimally invasive reconstruction and conventional techniques had similar biomechanical properties (23).

In the review of literature, no previous report was found to include a control group for ORIF in TPF treatment with MIS techniques. To the best of our knowledge, this is the first clinical study on this subject. However, there are some limitations in our study, primarily the retrospective design and limited number of samples. The patients were separated into two groups according to the date marked for the change of treatment approach in our clinic; therefore, it was not possible to have a matched distribution of Schatzker classification subtypes. In addition, Schatzker type-V and type-VI TPFs are associated with extensive soft tissue damage, leading to higher complication rates as reported in the literature (24-26); this could be considered another limitation of our study.

Based on our observations, MIS techniques can be recommended to promote their widespread use in reducing incision-healing problems. In the light of these results, the superiority of MIS to ORIF techniques can be suggested in the treatment of TPF. However, further prospective studies are needed with a larger sample size.

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