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Predictors of reduction loss in tibial plateau fracture surgery: Focusing on posterior coronal fractures

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ABSTRACT

Introduction: Some studies have reported that fracture pattern was associated with reduction loss after surgery. The purpose of this study was to evaluate various factors that can influence reduction loss, including fracture patterns in unicondylar and bicondylar tibial plateau fractures.

Materials and methods: A total of 138 tibial plateau fractures that underwent open reduction and internal fixation using plates were retrospectively reviewed. The OTA/AO classification, fracture pattern, degree of comminution, and existence of reduction loss were evaluated based on simple radiographs and computed tomography. Patient information, including age, gender, and occupation, were acquired through chart reviews. The effect of each variable on reduction loss was evaluated through multiple logistic regression analysis.

Results: Of 138 knees, reduction loss was observed in 40 knees (29.0%). Reduction loss was found in 11 (20.4%) of the type B knees (54 knees) and 29 (34.5%) of the type C knees (84 knees), according to the OTA/AO classification. The multiple logistic regression analysis for all cases revealed that the existence of comminution and coronal fracture influenced the occurrence of reduction loss, with odds ratios of 9.148 and 4.823, respectively ($P < 0.001$ and $P = 0.001$, respectively). In type B and type C, according to the OTA/AO classification, the existence of comminution and coronal fracture had causal relationships with the occurrence of reduction loss. The odds ratios of comminution and coronal fracture for reduction loss for type B were 9.114 and 9.117, respectively ($P = 0.019$ and $P = 0.031$, respectively), and the odds ratios for type C were 8.490 and 4.782, respectively ($P = 0.001$ and 0.009, respectively).

Conclusions: When a tibial plateau fracture has a coronal fracture, if it is difficult to fix its fragments rigidly with medial or lateral plate fixation; therefore, buttress plating or direct fixation of fragments through the posteromedial, posterolateral, or posterior approach should be considered.

Introduction

Some studies have reported the clinical results of operative management for tibial plateau fracture [1–4]. Ali et al. [1] have reported that failure occurred in 31% of tibial plateau fracture surgeries and that in older patients (older than 60 years of age), premature weight bearing, preoperative displacement, fracture fragmentation, and severe osteoporosis were associated with reduction loss.

Some studies have reported that fracture pattern was also associated with reduction loss after surgery. In a study of factors related to reduction loss in bicondylar tibial plateau fractures, Weaver et al. [5] have reported that posteromedial coronal fracture was associated with a high rate of reduction loss. Other studies that have addressed the existence of posteromedial fragment in bicondylar tibial plateau fracture have reported incidences of 29–59% [6,7].

Research about the correlation between fracture pattern and reduction loss is clinically important because the approach or fixation method can vary, depending on the fracture pattern. However, in the aforementioned studies, the research subject was limited to posteromedial fragments in bicondylar tibial plateau fractures. Posterolateral coronal fractures can occur in bicondylar fractures, and posteromedial or posterolateral fractures can also occur in unicondylar fractures. Although, Weaver et al. [5] have reported on the relationship between fracture pattern and

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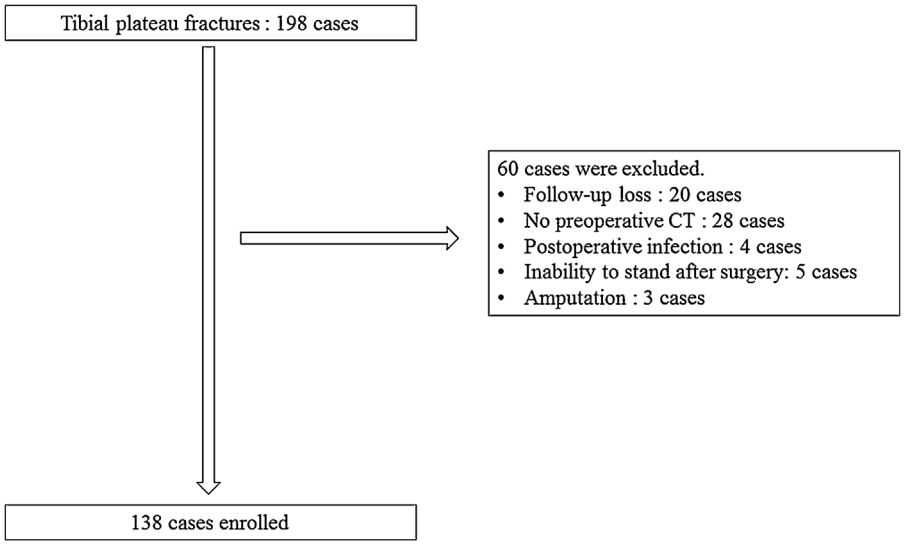

Fig. 1. Patient flow chart.

reduction loss in tibial plateau fractures, studies of this subject are still rare. Furthermore, because Weaver et al. [5] have defined reduction loss as 5° or greater changes in alignment, reduction loss through depression of the posterior fragment, without any alignment changes, cannot be reflected. Therefore, we thought that the correlation between the fracture pattern and reduction loss must be researched with stricter standards for reduction loss.

The purpose of this study was to evaluate various factors that can influence reduction loss, including fracture patterns in unicondylar and bicondylar tibial plateau fractures.

Materials and methods

Patients

This study was approved by the institutional review board at our institution (15-0157). Between January 2006 and June 2014, 190 patients (198 knees) at our institution underwent surgical treatment of tibial plateau fractures. The following inclusion criteria were applied: (1) patients who received open reduction and internal fixation using plates, (2) patients who were followed for one year or longer after surgery, (3) patients who underwent preoperative CT (computed tomography), and (4) patients whose follow-up weight bearing knee anteroposterior (AP) and lateral radiographs were available. The following exclusion criteria were applied: (1) patients who had no available preoperative CT, (2) patients with a history of postoperative infection, (3) patients who could not perform weight bearing even after undergoing surgery due to a traumatic spine or brain injury, and (4) patients who underwent amputation due to a severe crushing injury (Fig. 1). A total of 135 patients (138 knees) were enrolled in this study, and the sample characteristics are outlined in Table 1.

Surgical technique

The surgeries were performed by three experienced surgeons who specialized in knee surgery or trauma. Every surgery was performed after the soft tissues were stabilized. For patients who also had severe soft tissue injuries, such as tense swelling, fracture blisters or open wounds, a temporary external fixator was applied to maintain the length and alignment. After recovery of the soft tissue injury, definite plate fixation was performed.

The plates were applied as unilateral or dual plates, depending on the fracture type and soft tissue condition. In the case of unilateral plate fixation, the plates were applied using the anterolateral or anteromedial approach. Dual plate fixation was conducted through separate anterolateral and medial skin incisions, and the plates were applied to the anterolateral and medial/anteromedial parts of the proximal tibia, respectively. During reduction, an external fixator or a universal distractor was used, and the joint line was checked through the arthroscopy or submeniscal approach. All plates applied to the lateral side of tibia were locking plates. For weight bearing, partial weight bearing was allowed from the second postoperative month.

Evaluation

The OTA/AO classification [8] and fracture pattern were evaluated through preoperative simple radiographs and CT. The articular surface depression, condylar widening, and alignment of the articular surface to the anatomical axis of tibia were evaluated from the immediate postoperative and follow-up radiographs (Fig. 2) [1,5]. The existence of comminution was evaluated by the severity of fragmentation. More than three bone fragments on simple radiographs or CT were defined as comminuted fracture. The definition of reduction loss or fixation failure after tibia plateau fracture surgery is unclear. Therefore, we used a modified version of the method used by Ali et al. [1] and Weaver at al. [5]. Reduction loss was defined as a depression of the articular surface that is

Table 1
Sample characteristics.

Gender		Male (93) Female (45)
Age		51.2 (range, 17–81)
Mean follow-up (month)		30.2 (range, 12–96)
Time to surgery (days)		7.7 (range, 0–41)
OTA/AO classification		
Type B 54 (39.1%)	Type B1	21 (15.2%)
	Type B2	14 (10.1%)
	Type B3	19 (13.8%)
Type C 84 (60.9%)	Type C1	40 (29.0%)
	Type C2	18 (13.0%)
	Type C3	26 (18.8%)
Open injury	No	124 (89.9%)
	Type I	8 (5.8%)
	Type II	4 (2.9%)
	Type IIIA	1 (0.7%)
	Type IIIB	1 (0.7%)
	Type IIIC	0 (0%)
Coronal fracture	43 (31.2%)	Type B: 10/54, 18.5%
		Type C: 33/84, 39.3%