Second Place Award

Immediate versus delayed operative treatment of low-energy tibial plateau fractures

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ABSTRACT

Background:

Current management of tibial plateau fractures requires careful soft-tissue management. Often a staged approach with temporary external fixation followed by delayed internal fixation is recommended. While proven in high-energy injuries, its relevance in treating low-energy fractures has not been investigated. The goal of the current study was to assess the short-term complication rates in low-energy tibial plateau fractures treated early (< 48 hr). As a secondary aim, we investigated whether surgical approach would affect rates of wound complications.

Methods:

This is a retrospective analysis of patients treated operatively for low-energy tibial plateau fractures at a level-1 urban trauma center between January 1, 2000 and January 1, 2010. Schatzker type 1-3 fractures were considered "low-energy," despite stated mechanism. Statistical analysis was performed using chi-square and Fischer's exact tests.

Results:

We analyzed 49 patients. From these, 29 received early (< 48 hr) definitive surgery, while 20 had surgery delayed (> 48 hr). The early treatment group had an infection rate of 3.4% and total complication rate of 20.6%. The delayed treatment group had an infection rate of 5.0% and total complication rate of 25%. There was no significant difference with respect to superficial infection ($P=1.0$), deep infection ($P=0.48$), or total complications ($P=0.74$). Additionally, infection rates did not differ between surgical approaches ($P=1.0, 1.0$).

Conclusions:

Early surgical fixation (< 48 hr) of low-energy tibial plateau fractures can be performed safely. Additionally, a midline approach did not increase soft-tissue complications and could be utilized in a patient with a prior midline incision, or one who will soon require a knee arthroplasty.

Key Words

trauma, fracture, tibial plateau, early treatment, surgical approach

INTRODUCTION

The treatment of tibial plateau fractures has evolved dramatically over the last 20 yr, with greater emphasis placed on protecting the soft-tissue envelope. Newer practices employing temporizing external fixation followed by delayed open reduction and internal fixation have significantly reduced historically high rates of soft tissue related complications. While this strategy has become the standard of care for high-energy tibial plateau fractures, there is a paucity of literature to guide management in the optimal timing of surgical fixation for low-energy tibial plateau fractures.

In part, this may be due to a lack of a clear definition as to what constitutes a low-energy injury. Attempts have been made to correlate mechanism as well as classification system to energy imparted into an injury; however, there is significant variability when employing these methods. Regardless, acute operative intervention (within 48 hr) allows for easier reduction and offers earlier patient mobilization, range of motion, and likely recovery. Identifying a subset of patients who could tolerate early intervention, such as those sustaining low-energy trauma, could be of significant benefit to that group.

The goal of the current study was to determine whether early surgical intervention resulted in acceptable short-term complication rates for low-energy tibial plateau fractures. As a secondary aim, we investigated whether surgical approach would affect rates of wound complications. We hypothesized that early time to surgery (less than 48 hr) and surgical approach would result in acceptable complication rates in this low-energy fracture group.

MATERIALS AND METHODS

This is a retrospective analysis of patients who were treated operatively for "low-energy" tibial plateau fractures. Prior to initiation of the study, approval was obtained from the institutional review board. The study was conducted at a level-1 urban trauma center. We identified 228 patients by a database search of ICD-9 codes pertaining to proximal tibial fractures from January 1, 2000 to January 1, 2010. Of these, we excluded patients who ultimately did not receive surgery

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at our institution, those with pathologic fractures, injuries that were miscoded, and patients who did not reach at least 3 mo of postoperative follow-up.

Patient baseline characteristics and history were obtained from the chart. Specifically, we recorded injury mechanism, Tscherne classification, compartment syndrome, open versus closed fracture, treatment plan, time to final treatment, incision location, and postoperative complications or return to the operating room within 30 days of the index surgery. Finally, radiographs were reviewed by trained orthopedic surgery personnel (a board-certified orthopedic surgeon and a chief resident in orthopedic surgery) to classify the fracture according to Schatzker.¹

All fractures classified as Schatzker 1-3 patterns were considered low energy, regardless of mechanism. Surgical exposures were next classified as single anterior midline, single lateral, or dual incisions. Statistical analysis using chi-square and Fischer's exact tests was performed to determine differences in the groups with regards to surgical timing and approach.

Surgical Technique

All procedures were performed with the patient under a general anesthetic. Reduction was verified with image-intensifier assistance in most cases. In four patients, the reduction was verified arthroscopically. Timing of surgery was left to the discretion of the operating surgeon who also determined placement of the incision (i.e. lateral or midline). The most common incisions were midline and lateral. After reduction of the joint surface, the metaphyseal void was filled with either allograft or synthetic material. Fractures were fixed with a lateral plate, or in cases with minimal joint depression, percutaneous screws were used. Patients were kept non-weightbearing after surgery and progressed as fracture healing allowed. All patients had regular follow-up. Patients with less than 3 mo follow-up were excluded.

RESULTS

On initial review, 228 patients were identified via ICD-9 codes. After removal of patients meeting exclusion criteria, 117 patients with tibial plateau fractures remained. After determining the Schatzker classification of each fracture, 49 patients were considered low-energy (types 1-3) and were used for final analysis. From these, 29 received definitive surgery within 48 hr of presentation, while 20 had surgery delayed beyond that increment. No difference was noted within the baseline characteristics between the two groups (Table 1).

Early Treatment Group

Twenty-nine patients received surgery within 48 hr of presentation. Eighteen patients were treated within 24 hr of presentation to the emergency department, and 11 were treated between 24 and 48 hr. The rate of infection for this group was 3.4%, with one patient developing a deep infection that required a return to the operating room 6 days postoperatively. Otherwise, all wounds healed without soft-tissue related complications.

One patient developed a deep vein thrombosis and required therapeutic anticoagulation. Another patient

TABLE 1. Demographic data		
	Early treatment (n = 29)	Delayed treatment (n = 20)
Age (mean years)	43	41.5
Sex (M/F)	21/8	13/7
Schatzker 1	2	2
Schatzker 2	20	11
Schatzker 3	7	7
Midline incision	15	8
Anterolateral incision	14	12

developed weakness in the extensor hallucis longus. One patient developed reflex sympathetic dystrophy in the operative extremity approximately 3 mo after surgery. Two patients underwent later implant removal for painful hardware, one at 9 mo and the other at 3 yr postoperatively. The overall complication rate for this group was 20.6%.

Delayed Treatment Group

Twenty patients underwent surgery greater than 48 hr after presentation. The average time to definitive treatment was 6.9 days from time of presentation. One patient was treated with an external fixator and one with a traction pin before definitive treatment. The infection rate in this group was comparable at 5%. One patient developed a superficial infection 1 wk postoperatively that resolved with oral antibiotics. There were no deep infections, nor were there any wound or soft-tissue complications.

One patient expired 5 days postoperatively secondary to worsening adult respiratory distress syndrome (ARDS). One patient developed lateral foot numbness, which had not resolved 5 mo postoperatively at that patient's last follow-up. One patient developed a 10-degree extensor lag, but ambulated well, without assistive devices. One patient required implant removal 5 yr postoperatively. Overall complication rate in this group was 25%.

Comparison of early and delayed treatment groups with respect to deep or superficial infection rate showed no statistical difference ($P = 1.0$ and 0.48). Similarly, no difference was seen between the groups with respect to complication rates ($P = 0.74$). Subgroup analysis comparing infection and complication rates within the early and late infection groups with respect to surgical approach did not show a significant difference ($P = 1.0$ and 1.0).

DISCUSSION

Treatment of tibial plateau fractures has significantly evolved. Early results of closed treatment were promising and ranged from closed reduction and casting to traction or functional bracing.²⁻⁶ Methods of internal fixation improved, and open reduction internal fixation became more common. Initial comparisons of closed and open treatment showed similar results.⁷⁻⁹ Open reduction and internal fixation has become well accepted for displaced fractures, and indications have expanded.^{1,10-13} Others, however, have noted the high complication rates with open reduction

and internal fixation, especially infection rates.^{12,14–16} These infection rates often were attributed to extensive soft-tissue stripping.^{14,17} The application of staged protocols, calling for temporary spanning external fixation to allow resolution of soft-tissue injury before definitive fixation dramatically reduced infection rates.^{18,19} Although no specific guidelines exist, most authors recommend that the surgeon perform a thorough evaluation of the soft tissues in all tibial plateau injuries and decide if the limb can tolerate a further surgical insult. If not, a staged protocol employing provisional stabilization with a knee-spanning external fixator is recommended to maintain length and alignment, as well as facilitate soft-tissue healing.^{20,21}

Much of the literature has focused on treatment of high-energy injuries. Simpler fracture patterns often have less severe soft-tissue injury²² and may benefit from an alternative treatment strategy that does not necessitate temporizing with an external fixation. We found no statistical difference in the overall complication rate or infection rate between lateral plateau fractures (Schatzker type 1-3) treated before 48 hr and those treated later, regardless of mechanism of injury. This suggests that these injuries can be treated immediately. This can allow for easier fracture reduction, as well as fewer visits to the operating room, earlier mobilization, and possibly earlier recovery. In addition, costs to the patient and the healthcare system can potentially be reduced by utilizing a single surgery.

We included injuries based on fracture pattern alone, not mechanism of injury. Many patients included in our study sustained “high-energy” injuries based on mechanism. Our results support using the Schatzker classification in determining not only mode, but also timing of fixation. Because our classification of low-energy injuries is based on a well-accepted and generalizable classification system, our results can be more easily generalized to different practice settings.

Early reports on open reduction and internal fixation of tibial plateau fractures noted high rates of infection. Moore *et al.*¹² reported a 23% infection rate when dual plating was performed through a “y” incision, and Young and Barrack¹⁵ reported an 88% infection rate through a single midline incision. Both reports comment on the extensive soft-tissue stripping required in these approaches. Emphasis on meticulous soft-tissue handling and the development of minimally invasive techniques have decreased infection rates.^{23–25} Current literature cites infection rates between 2% to 13%, with rates tending to increase along with Schatzker type.²⁶ A recent report out of Korea followed 10 patients treated with dual plating of a high-energy plateau fracture through a midline incision. They reported zero infections and only one instance of delayed wound healing that resolved without a return to the operating room.²⁷ These reports show the safety of an anterior approach in high-energy injuries where soft tissues are more often a concern. Similarly, our results show that a midline incision is a reasonable option when approaching the lateral side for lower energy injuries. This can be beneficial in patients who may soon require knee arthroplasty or in patients who have had prior knee surgery through a midline incision. This becomes increasingly important with an aging population.

Our sample size is notably small. We had low rates of infection and complications, making determination of true

nondifference less reliable. However, our results do support low complication and infection rates in a cohort of patients treated with early definitive fixation.

Treatment of tibial plateau fractures remains controversial. Standard staged protocols developed to treat high-energy tibial plateau fractures may not be necessary for treatment of low-energy tibial plateau fractures. Many of these fractures may be safely operated on within the first 48 hr without a significant increase in infection or complication rates. Additionally, a midline approach may be a consideration in a patient with a prior midline incision or potential need for a knee arthroplasty in the future.

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