Injury, Int. J. Care Injured 48S4 (2017) S34–S40

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Outcome evaluation of staged treatment for bicondylar tibial plateau fractures

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KEYWORDS

Tibial plateau fracture
Plate osteosynthesis
Damage control surgery
Treatment outcome

ABSTRACT

Background: The universal accepted strategy for treating high-energy tibial plateau fractures remains a topic of ongoing debate. The challenge for the practicing orthopaedic trauma surgeon is to provide anatomical articular fracture reduction, with successfully managing the complex soft-tissue injury that is commonly present at patient admission. The primary aim of the actual study was to evaluate the results of a staged protocol for the treatment of high-energy bicondylar tibial plateau fractures. The secondary aim was to describe the technique used for the definitive fixation of this complex fracture pattern.
Methods: Thirty patients with unstable high-energy closed bicondylar tibial plateau fractures (17 Schatzker V and 13 Schatzker VI) were managed. There were 24 men (80%) and six women (20%). All of them were skeletally mature with their age ranging from 19 to 67 years (mean of 33.1±3.4 years). Treatment involved a two-stage procedure with appropriate emergency care, preoperative planning, and definitive fixation. Initial treatment, named 'damage control on complex articular fracture elements', consisted on temporary bridging external fixation. Definitive treatment was delayed in a mean of 10 days (ranging from seven to 13 days) and was performed when the soft-tissue conditioning demonstrated either complete or almost complete remission of the inflammatory reaction due to the 'first hit'. Conventional implants were used in the 30 patients. All patients were evaluated clinically and radiographically.
Results: Twenty-six (86.7%) patients had a moderate level of activity, three (10%) patients had a very light level of activity, and one (3.3%) patient was unable to have any kind of work activity and is currently supported by the Brazilian Welfare. Using the visual analog scale mean pain score was 30 (ranging from 10 to 60); even the patient with the workers' compensation had no severe pain. All patients except three have no difficulty with stairs, giving way, locking, swelling, and squatting, but were unable to run. Three (10%) patients had problems with stairs and could not bend the operated knee more than 90°. One of them had a varus knee but no instability. Ninety percent of the patients were either very satisfied or somewhat satisfied with their outcome. The three dissatisfied patients suffered postoperative complications, most commonly wound infections. Four (13.4%) patients with former anatomical reduction had a residual articular step-off or diastasis of less than 3 mm after fracture healing. All patients had no or mild arthrosis at the time of the last outpatient consultation.
Conclusions: The two-staged procedure presented herein showed to be an effective strategy for managing bycondilar tibial plateau fractures. The protocol used for these complex traumatic injuries follows very well defined steps, which means acute stabilization with a linear bridging external fixation, adequate soft tissue handling, preoperative planning, and definitive surgical fixation after seven to 14 days. The model presents a more biological approach to optimizing functional outcome with an acceptable complication rate and minimal risk of loss of reduction in these high-energy tibial plateau fractures.

Introduction

Bycondilar tibial plateau fracture is one of the most therapeutic challenging traumatic injuries of the appendicular skeleton [1]. Even the more experienced orthopaedic trauma surgeons find some degree of difficulty, arising mainly due to multiplanar articular comminution, metaphyseo-diaphyseal dissociation, severe soft-tissue damage, and joint instability [1–3]. As a consequence, complications are expected in a great number of patients, with 50% being related to the soft tissues [4–6].

Current strategies have acutely focused both on the restoration of skeletal alignment and the management of soft-tissue envelope [1–3]. This should only be accomplished by temporary fracture fixation. However, due to the inherently local instability, neither

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removable knee immobilizers nor skeletal traction should be routinely used for high-energy tibial plateau fracture [2]. Several authors have proposed the use of a staged protocol for these lesions, with application of bridging external fixation [7–9]. Narayan et al. have suggested that the so-called 'travelling external fixator' allows for reduction of swelling, permits better and repeated soft-tissue inspection, helps bring the fracture into appropriate axial alignment, and facilitates imaging investigation [2]. Following this protocol, definitive surgical intervention is delayed until the diameter of the lower limb is reduced and the 'wrinkle sign' is observed [1–3,7–10].

There has been an argument concerning the ideal method of definitive fixation of unstable bicondylar tibial plateau fractures. Recommended treatment modalities vary from closed alignment and circular external fixation to open reduction and internal fixation (ORIF). In the nineties, Dendrinos et al., Gaudinez et al., and Stamer et al. have shown the application of thin wire external fixation, with good results and several advantages over the classical plating techniques [11–13]. At this time, there has been an unacceptable rate of complication associated to additional trauma caused by formal ORIF [5]. However, more recent literature has shown improvements in the implants and surgical techniques for the ORIF of these difficult fractures. Several series describe the efficacy of one or double plating of proximal tibial fractures using a minimally invasive percutaneous technique [14–18].

Given the fact that soft tissues are often still inflamed, even with an apparent integral envelope, we've been choosing for the use of low profile conventional implants in an attempt to reduce the secondary local trauma, which means minimal invasion and maximal fixation. The primary aim of the present study was to evaluate the results of a staged protocol for the treatment of high-energy bicondylar tibial plateau fractures. The secondary aim was to describe the technique used for the definitive fixation of this complex fracture pattern.

Methods

Study subjects and initial management

Between January 2005 and January 2009, open reduction and internal fixation was performed in 215 patients with plateau fractures at the Orthopaedic and Trauma Department of the author's institution. One of the authors consecutively managed 43 patients with unstable high-energy closed bicondylar tibial plateau fractures, although 30 were included as study subjects. Exclusion criteria were skeletally immature patients, polytraumatized patients, open fractures, and closed fractures presenting with a compartment syndrome at admission.

Of these 30 patients, there were 24 men (80%) and six women (20%). All of them were skeletally mature with their age ranging from 19 to 67 years (mean of 33.1±3.4 years). According to the Schatzker classification, 17 (56.7%) patients sustained a Schatzker V and 13 (43.3%) a Schatzker VI. Most of the injuries were due to road traffic accident [19]. The patient characteristics are given in Table 1.

Table 1
Demographic data from the 30 patients

	Patients (n=30)
Age (years) [range]	33.1 [19–67]
Gender (male/female)	24/6
Schatzker classification	
Type V	17
Type VI	13
Cause of injury	
Pedestrian crash	11
Bicycle accident	1
Motorcycle accident	13
Car accident	5

Source: SOTPNM, 2011

At admission, special attention was paid to peripheral circulation and neurological status. Due to the high-energy mechanism related to the injury, no attempt of definitive fixation was done, but temporary bridging external fixation was performed on an urgent basis (less than 24 hours after hospital admission). Between the hospital admission and the definitive surgical procedure, knee radiographs (anteroposterior, lateral, and oblique views) and CT-scan were performed for all patients. Preoperative planning was routinely done. All patients were operated on within 14 days after trauma, based on the soft-tissue conditioning (regression of inflammation, peripheral edema, ecchymosis, and skin blistering plus 'wrinkle sign' observation).

Definitive operative procedure

The definitive procedure was performed on a radiolucent table, with the knee flexed at 30° and tourniquet ischemia. Fluoroscopy was used during the procedure as a rule. The mean time of surgery was 150 minutes (ranging from 118 to 179 minutes). Intraoperative radiographic exposure time was not evaluated. The external fixation device was cleaned, protected, and kept in place during the operation.

Operative procedure followed always the same steps. The medial component of the lesion was approached first either by a 3-cm medial or a posteromedial incision, depending on the location of the metaphyseal medial plateau vertex. The *pes anserinus* structures were protected and moved away for better exposure of the fracture site. Anatomical articular reduction was done indirectly, based on the metaphyseal edges reduction, and checked with fluoroscopy. Temporary Kirschner wire (K-wire) fixation was used to facilitate the location of the plate. The fracture was stabilized with a four-hole one-third tubular plate (Baumer®, Mogi Mirim, Brazil), with a buttressing function. No screws or small length screws were temporarily used in the epiphyseal area in order to not compromise the lateral plateau condyle reduction.

The lateral component of the fracture was then approached using a 10-cm linear incision centered on the tubercle of Gerdy. A submuscular plane of the lateral side was developed under the anterior compartment muscles. In some cases (11 of 30, 36.7%) a posterolateral dissection was required through a proximal fibula osteotomy [20]. When it was done, the common peroneal nerve was identified and protected before the bone cut. For better exposure of the fracture site, the meniscotibial ligament was incised and the lateral meniscus was detached. Direct articular reduction was done, temporarily fixed with K-wires and checked with fluoroscopy. No bone graft was used to fill the metaphyseal defect formed after subchondral fragment elevation. Instead, it was used a subchondral screw raft, with small fragment long cortical screws through a horizontally placed one-third tubular plate (as a 'big' washer) (Figure 1). Finally, either a conventional small fragment dynamic compression plate (DCP; Baumer®, Mogi Mirim, Brazil) (n=20, 66.7%) or a conventional narrow large fragment DCP (Baumer®, Mogi Mirim, Brazil) (n=10, 33.3%) was slid under the tibialis anterior muscle and fixed.

Before closure of the wounds, long epiphyseal screws were inserted through the medial plate. We tried always to position the plates in a 90-degree direction in order to facilitate the indentation of the medial and lateral screws (Figure 2). The lateral meniscus was checked for any rupture, fixed when it was present, and then reattached to the lateral tibia. Final reduction was checked with plain radiographs. The operated knee was protected with a bulky Jones dressing.

Post-operative protocol and follow-up evaluation

Intravenous antibiotics were administered for 24 hours. No pharmacological deep venous thrombosis (DVT) prophylaxis was