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Reinforcement strategy for lateral rafting plate fixation in posterolateral column fractures of the tibial plateau: The magic screw technique

Hui Sun[a,1], Yi Zhu[a,1], Qi-Fang He[a], Lin-Yuan Shu[b], Wei Zhang[a,*], Yi-Min Chai[a]

[a] Department of Orthopaedic Surgery, Shanghai Jiao Tong University, Affiliated Sixth People's Hospital, 600 YiShan Road, Shanghai, 200233, China
[b] Department of Emergency, Shanghai Jiao Tong University, Affiliated Sixth People's Hospital, 600 YiShan Road, Shanghai, 200233, China

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Background: A posterolateral column fracture of the tibial plateau (PLCF) is not uncommon, especially lateral and bicondylar tibial plateau fractures. Currently, there is no consensus on the methods of surgical treatment for PLCF, including the surgical approach or the fixation strategy. Though various posterior approaches have been explored and can allow posterior buttress plate fixation, the necessity of a posterior approach with fixation for PLCFs is increasingly questioned. Meanwhile, there is no literature to analyse the morphological features of PLCFs. None of the available surgical techniques can solve all of the problems of PLCFs.
Methods: From February 2016 to June 2016, an inconsecutive series of 16 patients who suffered Schatzker type II tibial plateau fractures involving the posterolateral column were selected based on an analysis of the morphological characteristics of PLCFs. The patients were all treated by lateral rafting plate fixation with magic screw implantation through the extended lateral approach.
Results: According to PLCF morphology, 4 patients had mild slope-type depression fractures (MSDF) of the articular surface, and the other 12 patients had block-type splitting fractures (BSF). After a 12-month follow-up period, there were no complications related to the fixation technique and no significant changes in limb alignment. At the final follow-up, the average range of motion (ROM) of the affected knees was 2.3°–125°, and the average HSS score was 94.2.
Conclusions: The selected patients who suffered Schatzker type II fractures involving the posterolateral column could be successfully treated via lateral rafting plate fixation with the magic screw technique. For PLCF treatment, magic screw fixation is a valuable technique that may reduce the utilization of posterior approaches and posterior fixations.

1. Introduction

A tibial plateau fracture is an intra-articular fracture that always involves various degrees of splitting, depression and displacement, which may influence the stability and movement of the knee joint [1]. The treatment of complex tibial plateau fractures remains a challenge in many respects [2]. Historically, the Schatzker and AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) classifications, both of which are based on the two-dimensional radiographic assessment of fracture patterns, have been widely used to guide treatment. With the development of computed tomograph (CT) and image reconstruction techniques, tibial plateau fractures can be more appropriately evaluated from multi-planar and multi–angle perspectives. Until 2010, three-column classification (TCC) based on CT imaging was proposed to improve the assessment of tibial plateau fractures [3]. In this classification system, the tibial plateau is divided into three columns with prominent morphological characteristics and different biomechanical functions, including the lateral, medial and posterior columns, as seen on CT axial plane images and three-dimensional (3-D) reconstructions. The morbidity of posterior tibial plateau fractures is not low according to an epidemiological study [4]. The concept of the posterior column of the tibial plateau has been gradually accepted by surgeons all over the world [5–8]. Recently, the TCC system was updated based on assessments of

* Corresponding author.
E-mail addresses: sunshine20002000@126.com (H. Sun), tzjzzy@163.com (Y. Zhu), heqifang1982@126.com (Q.-F. He), phoenix_lin2013@163.com (L.-Y. Shu), orthozhangwei@163.com (W. Zhang), chaiyimin@outlook.com (Y.-M. Chai).
[1] These authors contributed equally to this work.

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fracture morphology and injury mechanism to guide surgical treatment effectively [2].

According to the TCC system, the posterior column of the tibial plateau is divided into two sub-columns, the posteromedial and posterolateral sub-columns. Several scholars thought that PLCFs were relatively uncommon, accounting for 7%-10% of all tibial plateau fractures [9–11]. However, based on our investigation, except for Schatzker type III fractures, PLCFs can be observed in each type of Schatzker fracture, and the incidence of PLCFs may account for 54.3% of all posterior fractures [4]. Clinical practice has shown that this type fracture is more problematic and disabling and can cause significant, chronic post-traumatic instability of the knee [11,12]. Due to the morphological features of the posterior aspect of the proximal tibia [13] and the anatomical complexity of the posterolateral corner of the knee [14], the surgical strategy for PLCFs is complicated, requiring the constant development of surgical approaches and fixation methods. However, no final conclusion or guideline has been proposed. In the past decade, many surgeons have developed numerous approaches and have conducted various anatomical research studies [14–16], case series reports, and clinical comparison studies [17]. Through in-depth studies, the risks and deficiencies of the posterior approach have been gradually realized, especially the damage to normal structures. Several scholars have proposed various anterolateral or lateral approaches to manage posterolateral fractures. According to our experience, posterolateral fractures can be reduced using the anterolateral or lateral approaches and fixed by a posteriorly positioned lateral plate, but on the plate the number of screws that can support and maintain posterolateral articular fragments is limited. Therefore, we attempted to reinforce the holding power and the stability of posterolateral fractures by adding an extra screw outside the lateral rafting plate, and styled that as “magic screw”. Therefore, a clinical study with a small simple size was conducted, and short-term follow-up outcomes were evaluated.

2. Materials and methods

2.1 Patients and preoperative management

From February 2016 to June 2016, 45 consecutive patients with Schatzker type II tibial plateau fractures were surgically treated at our single level I trauma centre, including 27 cases with posterolateral column involvement. Patients with pathological, outmoded, and open fractures, neurovascular injury of the lower extremities, or osteofascial compartment syndrome were excluded. Patients with multiple injuries (injury severity scale, ISS, greater than 16) or with accompanying fractures in other body parts were also excluded. Each patient underwent preliminary management before admission, including distal bony skeletal tractions or leg braces. In the emergency phase, all the patients underwent a standard radiologic protocol of X-rays, CT scans and image reconstructions. In addition to the Schatzker classification, all fractures were also classified according to the TCC based on CT images.

Fractures of the tibial plateau include two possible components [18]: cortical separation (also referred to as split) and articular depression. According to a morphological analysis of PLCF in a full spectrum of tibial plateau fractures from the CT images, the splitting characteristics of PLCFs can be divided into two types: *block-type splitting fracture (BSF)* (as shown in Fig. 1A–C) and *slice-type splitting fracture (SSF)* (Fig. 1 H and I). A BSF of the posterolateral column is not uncommon in the lateral (Schatkzer type II) and bicondylar (Schatzker types V and VI) tibial plateaus. The splitting fragment presents as an inverted, conical-shaped block in a vertically oriented pattern and occupies nearly one-third of the surface area of the lateral tibial plateau as described by Sohn [19]. It is relatively easy to measure the morphological features of this type of fracture. SSFs mostly involve laminar breaks of the posterior cortex of the posterolateral column, which are difficult to observe and measure on CT scans images due to loose slice thickness and inconsistent accuracy of image reconstruction. There is always little or no articular surface attached to the SSF and the depressed articular surface is always located anteriorly. In addition, the depression characteristics of the articular surface of the posterolateral column can also be divided into two distinct types: *mild slope-type depression fracture (MSDF)* (as shown in Fig. 1D–F and Figs. 2 and 3) and *local sinkhole-type depression fracture (LSDF)*, or comminution (as shown in Fig. 1 G, H and I). The collapsed area of a MSDF is always large and may extend from the anterolateral quadrant to the posterolateral quadrant, which may be accompanied by a cortical splitting fracture (might also including the SSF). The degree of depression is relatively mild and is mostly caused by low-energy injuries (such as in Schatzker type II fractures). The area of an LSDF is usually limited, but the degree is deep. This fracture is always accompanied by articular comminution of the depression margin and sometimes by a cortical splitting fracture (such as in Schatzker type IV). The morphological characteristic of all PLCFs were anatomized as described above.

Each patient’s demographic information, pre-injury status, and mechanism of injury were recorded at admission. All patients underwent definitive surgical treatment only after detumescence of the local soft tissue, such as striae appearance. This study was designed as a prospective cohort study. Approval from the institution’s ethical review board was obtained prior to the initiation of the study. After thoughtful consideration and the receipt of informed consent from the patients, 16 patients who sustained Schatzker type II tibial plateau fractures were ultimately selected and surgically treated via lateral rafting plate fixation with magic screw implantation through the extended lateral approach. All of these patients were operated on by the first authors (SH and HQF) and the corresponding author (ZW).

2.2 Surgical technique

After the induction of general or spinal anaesthesia and antibiotic prophylaxis, the patients were placed in the supine position on a radiolucent table. Before the start of surgery, the bony traction devices and braces were removed.

The injured limb was maintained in a slightly flexed position at 30° with a thick pad applied under the knee joint. An extended lateral approach was used in all cases [20,21]. The distal part of the incision was positioned more anteriorly or posteriorly depending on the range of the fracture. If both columns, the lateral and posterolateral columns are involved in a Schatzker type II fracture, the distal part of the incision should be positioned more anteriorly for the management of both columns. In posterolateral single-column fractures, the incision should be posterior (Fig. 4). Superficial dissection and lateral compartment decompression were performed as usual. Deep dissection was performed along the interval between the iliotibial tract (ITT) and the biceps femoris tendon (BFT). The ITT was stripped from the anterolateral aspect of the proximal tibia and the space between the fibular collateral ligament (FCL) and the lateral plateau was disentangled. The posterolateral articular surface was exposed by arthrotomy via the submeniscal and supra-fibular-head approaches [22] (Fig. 5A). The BFT with the deeper FCL could be retracted posteriorly and as protectors for the common peroneal nerve.

To enhance the exposure and reduction of the PLCF, the knee was extended with internal rotation and inversion of the lower leg. Different reduction manoeuvres were performed for different PLCF morphologies. In BSFs, a point reduction clamp could be used in an