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LETTER TO THE EDITOR

Four-quadrant/column classification of tibial plateau fractures

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Dear Editor,

Posterior tibial plateau fractures have been a hot topic in orthopaedic traumatology during the past two decades, since Lobenhoffer et al. [1, 2] and Carlson [3, 4] reported posteromedial and posterolateral approaches (with or without fibular neck osteotomy) to expose and fixate the posterior bicondylar fractures separately. Soon after, posteromedial split fractures or complicated posteromedial fractures with posterolateral extended variant were also presented in the literature [5, 6]. These posteromedial fractures and variants are considered as Schaztker Type-IV patterns, usually caused by relatively high violence such as motorcycle traffic accident, fall from height, and mountain skiing.

A three-column classification system, first proposed by Luo et al. [7] in 2010, divided the tibial plateau into medial, lateral, and posterior columns. The classification system was then revised and updated [8, 9]. The three-column system describes posterior bi-condylar fracture patterns very well.

However, isolated posterolateral tibial plateau fractures are a unique injury pattern [10–16], which has been reported mainly in China during the past ten years because of the widespread use of lower-speed (<20 km/h) scooters in daily life. This kind of electrical bicycle is personal communication tool driven by a storage battery. On riding an electric bicycle, the person is sitting with his/her knee relaxed in a 90° position. When the bicycle falls onto one side, an axial compression load with valgus force is applied to the posterior tibial plateau with the knee in flexed position, which is prone to result in posterolateral fracture of the lateral plateau.

To better describe these unique posterolateral tibial plateau fractures, we classified the proximal tibial plateau into four quadrants (articular surface), differing from the cortical column (metaphyseal condyle). The concept of bicondylar four-quadrant classification was first proposed in a Letter to the Editor in 2011 [17], which was a comment regarding the selection of surgical approaches in isolated and combined patterns of posterolateral fractures. It was then introduced in three original articles published in 2012 and 2014 [18–20]. With improved understanding, the current updated classification includes four articular quadrants, two intercondylar spines, and one anterior tibial tuberosity (Fig. 1).

In our opinion, tibial plateau fractures must involve an articular fragment (AO/OTA 41, type B & C), but not necessarily a rupture of the cortex containment. So Schaztker type-III fractures (central depression in lateral plateau) can be classified as anterolateral quadrant (IIIa), posterolateral quadrant (IIIp), or lateral two quadrants (III-ap). Alternatively, these central articular depression fracture patterns are classified as no column fractures (called zero column fracture), because no cortex in circumference is ruptured. It is puzzle that a column fracture classification has no column involvement.

Generally speaking, an articular quadrant fracture usually has a corresponding column rupture of its cortex containment. But there are some kinds of specific exemptions. For example, the true Schaztker type-III fractures, and some sub-groups of Schatzker type-IV fractures that the articular fracture line is located in the lateral plateau, and the cortex fracture is located in the medial metaphysic, with no articular involvement in the medial plateau [19].

An integrated system combining articular surface quadrant and cortical containment column will provide a full description of the fracture characteristics, but it seems too complicated to use clinically.

We think it is reasonable to differentiate the posterior tibial plateau into two parts: posteromedial and posterolateral, rather than depicting them as a whole. The reasons include:

1. Both posteromedial and posterolateral quadrant fractures can occur individually or combined as a whole. They can also occur as an isolated pattern or combined patterns with other quadrant or quadrants (two, three, and four

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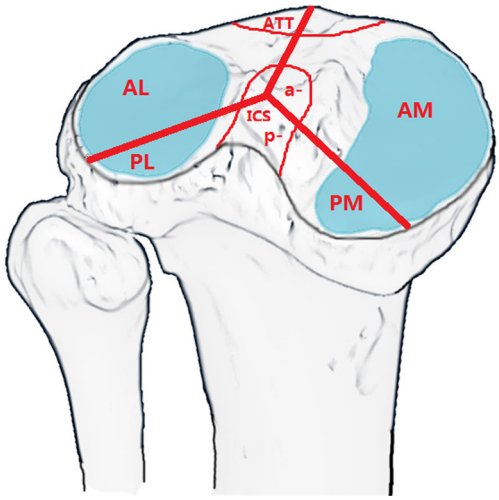

Fig. 1 The current four-quadrant tibial plateau classification involves four articular surfaces, two intercondylar spines (ACL and PCL insertion), and one anterior tibial tuberosity (patella tendon attachment). *AM* anteromedial quadrant, *PM* posteromedial quadrant, *AL* anterolateral quadrant, *PL* posterolateral quadrant, *a-ICS* ACL attachment, *p-ICS* PCL attachment, *ATT* anterior tibial tuberosity

quadrants). In fact, the four-quadrant concept was born originally with the recognition of isolated posterolateral tibial plateau fractures [11].

2. Posteromedial quadrant fractures and posterior bicondylar fractures (two posterior quadrants) can be exposed through a posteromedial or posteromedial L-shaped approach [7]. However, posterolateral quadrant fractures can be additionally exposed by a large number of surgical routes, such as modified anterolateral, posterolateral, or osteotomy approaches (such as fibular neck, lateral femoral epicondyle). Most of these approaches have been described in the last 10 years [21].
3. Posteromedial quadrant fractures are usually split-type, without articular depression or comminution. The split length of cortex is usually greater than 5 cm, with a V-shaped or L-shaped inferior cortical spike. By exact reposition of the distal cortical spike under direct visualization, proximal anatomic reduction of the articular surface can be assumed, and heavy plate fixation with antiglide-buttress mode should be applied.
4. Posterolateral quadrant fractures are usually comminuted or split-depressed type. The split length of cortex is usually less than 3 cm, and the depressed depth of articular surface is usually about 10 mm in isolated fracture pattern. The articular reduction needs arthrotomy with direct visualization, and filling with bone-grafting substitute to support the elevated fragments. Posterolateral quadrant fractures can be fixed by a variety of methods, including posterolateral buttress plating, lateral supra-fibula-head raft plating, horizontal belt plating, rim plating, and even hoop plating [21–23].

To summarize the abovementioned reasons, there are many differences between posteromedial and posterolateral plateaus in fracture mechanism, fracture morphology, operative approaches, and fracture reduction technique and fixation fashion. Hence, from the surgical point of view, posterolateral tibial plateau fractures should be considered as a fourth-quadrant/column fractures. Operative surgeons should consider and balance the pros and cons of different approaches and fixations to achieve the best results for the patients.

The computed tomography (CT)-based axial and three-dimensional three-column classification and four-quadrant classification both strengthen the evidence of frequent involvement of the posterior tibial plateau fractures, and put emphasis on the posterior coronal fragments, which is indeed an important prognostic factor in tibial plateau treatment.

Fracture classification is served as a common language among surgeons to characterize as far as certain general and specific features, to guide treatment, and to predict outcomes. The fracture classification is an evolving system, and should be revised with updated progress and data accumulation. Despite differing views, constructive dialog of international orthopedic trauma surgeons will promote the achievement of an optimized rationale to various patterns of tibial plateau fractures involving the posterolateral quadrant [24–30].

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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