Injury, Int. J. Care Injured xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Injury

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

Correlation of parameters on preoperative CT images with intra-articular soft-tissue injuries in acute tibial plateau fractures: A review of 132 patients receiving ARIF

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ARTICLE INFO

Keywords:
Tibial plateau fracture
CT
Arthroscopy
Meniscus tear
ACL avulsion

ABSTRACT

Introduction: Tibial plateau fractures often occur in conjunction with soft-tissue injuries of knees. The hypothesis of this study is that parameters of CT imaging can predict intra-articular soft-tissue injuries.
Patients and methods: Patients who underwent arthroscopically assisted reduction and internal fixation (ARIF) for acute tibial plateau fractures performed by a single orthopedic surgeon between 2005 and 2015 were included in this retrospective study. Patients with concomitant ipsilateral femoral fractures, who had received revision surgery or who had undergone index surgery more than 30 days from the event were excluded. We measured lateral plateau depression and widening, medial plateau depression and displacement, and column involvement observed on preoperative CT scans. Intra-articular soft-tissue injuries were diagnosed based on findings from knee arthroscopy. The correlation of imaging parameters with soft-tissue injuries was analyzed by the area under a receiver operating characteristic (AUROC) curve and multivariate logistic regression.
Results: One-hundred and thirty-two patients were enrolled in the study. The average age was 45.7 ± 13.1 years (range: 18–75 years). Lateral tibial plateau depressions >11 mm were significantly associated with increased risk of lateral meniscus tears ($p = 0.001$). However, there was no significant threshold of lateral tibial plateau widening that could be used to predict lateral meniscus tear. Greater risk of anterior cruciate ligament (ACL) avulsion fracture was observed in younger patients, patients with high-energy-pattern tibial plateau fractures, patients with fractures involving anteromedial or posterolateral columns, and patients with medial tibial plateau displacement >3 mm ($p < 0.05$).
Conclusion: Measuring lateral tibial plateau depression and column involvement on preoperative CT scans can help predict a higher risk of lateral meniscus tear and ACL avulsion fracture respectively in patients with acute tibial plateau fractures.

Introduction

Intra-articular soft-tissue injuries associated with tibial plateau fractures are common [1–6]. These include meniscus tears, cruciate ligament tears, and cruciate ligament avulsion fractures. When intra-articular soft-tissue injury is identified, acute repair along with appropriate fracture reduction and fixation can lead to a good outcome [7,8]. If meniscus tears or cruciate ligament injuries are left untreated, the contact stress of the knee will increase [9] and the stability of the knee will be compromised [10–13], which can lead to progression of osteoarthritis [14,15].

Preoperative CT scans for tibial plateau fractures have been widely used. Compared to plain radiographic films, CT imaging can offer much more detail about the pattern of fracture and thus can improve surgical planning [16]. However, the intra-articular soft-tissue conditions can hardly be identified on CT scans. Although MRI was regarded as a tool for diagnosis of internal derangements of the knee, longer scan time and higher cost limit the MRI use in the setting of acute tibial plateau fractures. In addition, MRI was more accurate in diagnosing ACL injuries than meniscus injuries [17–19].

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http://dx.doi.org/10.1016/j.injury.2017.01.043
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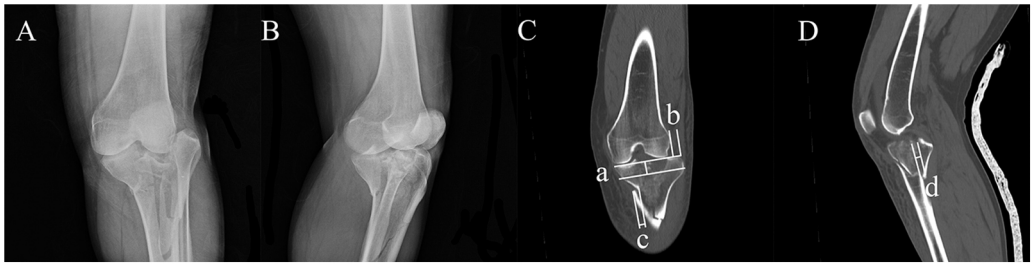

Fig. 1. A 54 year-old male sustained left tibial plateau fracture in a traffic accident. (A) anterior-posterior view of the plain film (B) lateral view of the plain film (C) coronal view of the CT scan (D) sagittal view of the CT scan; a = lateral tibial plateau depression; b = lateral tibial plateau widening; c = medial tibial plateau displacement in coronal plane; d = medial tibial plateau displacement in sagittal plane; no medial tibial plateau depression in this case.

Reports in the literature show that greater articular depression and widening of the lateral tibial plateau are associated with a higher incidence of soft-tissue injuries in patients with lateral tibial plateau fractures [20–22]. Although intra-articular soft-tissue injuries of the knee occur in both medial and lateral tibial plateau fractures [1–4], those studies did not include tibial plateau fractures involving the medial compartment.

In this study, we retrospectively evaluated preoperative CT scans and arthroscopic findings in patients with acute tibial plateau fractures, in the hopes of finding ways to predict intra-articular soft-tissue injuries in these patients. The hypothesis was that both the degree of displacement and column involvement seen on preoperative CT scans could be used to predict intra-articular soft-tissue injuries associated with tibial plateau fractures. The study was approved by the local institutional review board.

Patients and methods

We retrospectively enrolled patients who had received arthroscopy-assisted reduction with internal fixation (ARIF) surgery for tibial plateau fractures between January 2005 and June 2015. All surgeries had been performed by a single surgeon at our institute. Patients with concomitant ipsilateral femoral fractures, who did not have preoperative CT scans, or who underwent index surgery delayed for more than 30 days, or those with revisions for tibial plateau fractures were excluded from the study.

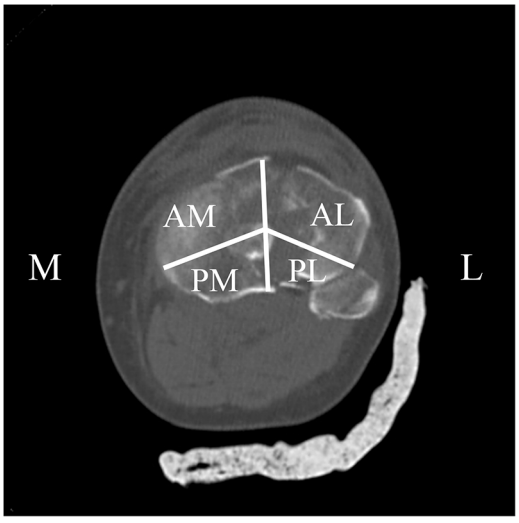

Fig. 2. Transverse view of the CT scan. The tibial plateau fracture involved the anterolateral column, anteromedial column and posterolateral column. AL anterolateral column, AM anteromerial column, PL posterolateral column, PM posteromedial column, L lateral, M medial.

Two authors evaluated the preoperative CT scans. Both authors were blinded to the results of physical examination and surgical findings during image measurement. The mean values of fracture displacement measured by the two authors were used in the analysis. Schatzker classifications of tibial plateau [23] were applied and recorded based on evaluation of the preoperative CT scans. Lateral or medial joint-line depression was measured as the distance between the non-injured joint line to the maximal articular depression point on coronal or sagittal CT images. To evaluate lateral tibial plateau widening, two lines perpendicular to the joint line were drawn on the coronal view. These lines were tangential to the lateral femoral epicondyle and the most lateral point of the lateral tibial plateau, respectively. The distance between the two parallel lines was then measured, and defined as the amount of lateral widening. Instead of measuring the degree of medial widening, we measured the greatest amount of displacement of the medial tibial plateau fragment from the proximal tibia on coronal or sagittal views (Fig. 1). The reason for this was that the relative position of medial tibial plateau and medial femoral condyle was usually retained by the medial collateral ligament.

In addition, we evaluated the fracture involvement based on the "three-column classification" on the transverse view of the CT scans [24] (Fig. 2). According to the concept of three-column, the tibial plateau was divided into medial, lateral and posterior columns. The posterior column was further divided into postero-lateral and posteromedial columns. Pure articular depression without a fracture line across the column was defined as lack of column involvement.

Each patient's sex and age, the interval from the accident to the index surgery, and surgical findings were recorded by another author. Surgical findings were based on results from the knee arthroscopic examination, which included the status of the meniscus tear, cruciate ligament tear, or cruciate ligament avulsion fracture (Fig. 3).

Numerical data were presented as means ± standard deviation (SD), while categorical data were expressed as absolute frequencies and percentages. The association of soft-tissue injuries and the

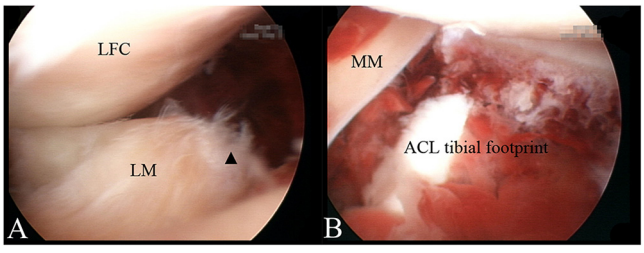

Fig. 3. Left knee arthroscopic examination of the same patient revealed peripheral tear (arrowhead) of lateral meniscus (A) and ACL avulsion fracture from the tibial footprint (B). LFC lateral femoral condyle, LM lateral meniscus, MM medial meniscus.

Please cite this article in press as: H.-C. Tang, et al., Correlation of parameters on preoperative CT images with intra-articular soft-tissue injuries in acute tibial plateau fractures: A review of 132 patients receiving ARIF, Injury (2017), http://dx.doi.org/10.1016/j.injury.2017.01.043