The Knee xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

The Knee

A biomechanical evaluation of different fixation strategies for posterolateral fragments in tibial plateau fractures and introduction of the 'magic screw'

Hui Sun, Qi-Fang He, Bin-Bin Zhang, Yi Zhu, Wei Zhang *, Yi-Min Chai *

Department of Orthopaedic Surgery, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, Shanghai, China

ARTICLE INFO

Article history:
Received 8 August 2017
Received in revised form 28 February 2018
Accepted 26 March 2018
Available online xxxx

Keywords:
Biomechanical study
Fixation
Posterior
Tibial plateau fracture

ABSTRACT

Background: Posterior plate fixation is biomechanically the strongest fixation method for posterolateral column fracture (PLCF) of the tibial plateau; however, there are inherent deficiencies and risks of a posterior approach. Thus, the 'magic screw' was proposed to enhance fixation stability of the lateral rafting plate used for PLCF. The purpose of this study was to re-examine and compare the stability of different fixation methods for PLCF.
Methods: Synthetic tibiae models were used to simulate posterolateral split fractures. The fracture models were randomly assigned into three groups: Group A, fixed with posterolateral buttress plates; Group B, with lateral locking compression plates (LCP); and Group C fixed with lateral LCPs and one 'magic screw'. Gradually increased axial compressive loads were applied to each specimen.
Results: There was a mean subsidence hierarchy of the posterolateral fragment at different load levels: Group A had the least subsidence, followed by Group C, and Group B had the most. There were no significant differences in the mean loads at different displacements between Group A and Group C. Group A had the highest axial stiffness. Additionally, there was a significant difference in axial stiffness between Group B and Group C.
Conclusion: Biomechanical stability of the combined fixation of the posteriorly positioned lateral rafting plate with the 'magic screw' was much closer to that of posterior plate fixation for split-type PLCF. The necessity of posterior fixation through a posterior approach may be reduced for selected patients.
© 2018 Elsevier B.V. All rights reserved.

1. Introduction

There have been times in the past when a posterolateral column fracture (PLCF) of the tibial plateau was considered a relatively uncommon injury, accounting for seven to 10% of tibial plateau fractures [1–3]. However, a recent morphological study has shown an incidence rate of PLCF in bicondylar tibial plateau fractures as 44.32% [4]. Based on another investigation, except for Schatzker type III fractures, PLCF can be observed in each type of Schatzker fracture, and the incidence of PLCF may account for 54.3% of all posterior fractures [5]. These epidemiologic data indicate that PLCF is more common than previously thought [6]. Thus, the treatment of PLCF might play a significant role in the overall effectiveness of tibial plateau fracture management.

* Corresponding authors at: Department of Orthopaedic Surgery, Shanghai Jiao Tong University Affiliated Sixth People's Hospital, 600 YiShan Road, Shanghai 200233, China.
E-mail addresses: orthozhangwei@163.com, (W. Zhang), ymchai@sjtu.edu.cn. (Y.-M. Chai).

https://doi.org/10.1016/j.knee.2018.03.015
0968-0160/© 2018 Elsevier B.V. All rights reserved.

Please cite this article as: Sun H, et al, A biomechanical evaluation of different fixation strategies for posterolateral fragments in tibial plateau fractures and introduction of the 'magic screw', Knee (2018), https://doi.org/10.1016/j.knee.2018.03.015

ARTICLE IN PRESS

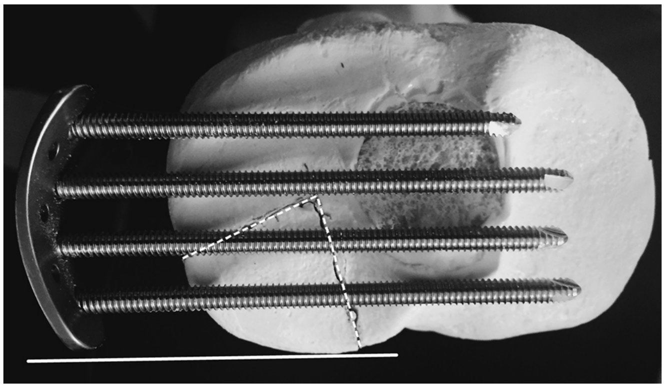

Figure 1. The Synbone model with the lateral plate positioned as posteriorly as possible. The posterior rim of the transverse arm of the lateral plate was aligned with the posterior edge of lateral plateau (solid line). The posterolateral fragment or articular surface involved (dotted line) could be supported by one or two, at the most, rafting screws.

As a part of the articular surface of the tibial plateau, the posterolateral column contributes to load-bearing when knee flexion >90°. Underestimation or failure to identify this fracture at first injury inevitably leads to improper treatment and serious dysfunctional consequences [4,6,7]. Due to the morphological features of the posterior aspect of the proximal tibia [8], and anatomical complexity of the posterolateral corner of the knee [9], surgical strategies for PLCF are complicated. In the past decade, many surgeons have attempted and explored various posterior approaches to manage and implant posterior buttress plates for PLCF [2,3,7,9–28]. Although the results of these different surgical approaches with posterior plating fixation have been satisfactory thus far, through in-depth studies the risks and deficiencies of the posterior approach are being gradually realized [29], especially iatrogenic injuries to normal structures.

It is unlikely that there is only one treatment method for any kind of disease, and non-posterior treatment is worth attempting for PLCF [30–40]. According to experience, PLCF can be reduced using the anterolateral or lateral approaches, and fixed by a posteriorly positioned lateral plate; however, the number of screws on the plate that can support and maintain posterolateral articular fragment is limited (as shown in Figure 1). If the lateral plateau main depression area is located anteriorly, then the lateral rafting plate should be implanted anteriorly.

Currently, PLCF fixation strength may be insufficient. Thus, the current center attempted to reinforce the holding power and stability of PLCF by adding an extra screw outside the lateral rafting plate, and named it the 'magic screw' [29]. Although it has been confirmed that posterolateral buttress plate fixation is biomechanically the strongest method for the split type of PLCF, and this result has great guiding significance for treatment options [41], a previous study also showed defects and limitations. Taking the recent clinical practices into account, it is believed that it is necessary to re-verify the biomechanical stability of the existing fixation methods for PLCF, and explore the biomechanical property and application value of the 'magic screw', especially the synergistic effect with the lateral plate.

2. Materials and methods

2.1. Group

Twenty-four left, synthetic, adult-sized tibiae models (Synbone, type 1350. Synbone AG, Malans, Switzerland) were used for biomechanical testing. Each model was made of a rigid foam cortical shell with cancellous material within the proximal and distal ends of the model. Synthetic tibiae were used to minimize variability between specimens and to provide a consistent specimen size. The models were obtained from one manufacturing batch to ensure the same material property and geometry. All the models were randomly assigned into three groups, and fixed with three different internal fixation patterns.

Each of the 24 specimens was randomly assigned to one of the following three fixation methods. A posterolateral buttress plate was used in Group A: a 3.5-mm six-hole metaphysical locking plate (Synthes GMBH, Zuchwil, Switzerland) used as the posterolateral buttress plate was contoured and implanted obliquely from the proximal lateral aspect of the posterior tibia to the distal medial aspect of the tibia (Figure 2A–D). A lateral, 3.5-mm, L-shaped proximal tibia locking compression plate (LCP)

Figure 2. Mock-ups of different fixation methods in intact synbones.A–D, Group A: the posterior buttress plate fixation. A 3.5-mm, six-hole locking compression plate (LCP) metaphyseal plate implanted in the posterolateral position of the proximal tibia (implanted obliquely from the proximal lateral to the distal medial). A. Antero-posterior (AP) view of the model; B. Lateral view; C. AP view of radiograph; D. Lateral view of X-ray. In C and D, the fibula was removed.E–H, Group C: the lateral rafting plate and a 'magic screw'. A 3.5-mm, L-shaped LCP implanted in the lateral position of the proximal tibia. A 'magic screw' was obliquely implanted from anterior-inferior-medial to the posterior-superior-lateral direction. E. AP view of the model; F. Lateral view. In E and F, the entrance point of the 'magic screw' could be seen five to 10 cm distal to the medial plateau and at the midpoint of the anterior and posterior borders of the medial aspect of the tibia. G. AP view of radiograph; H. Lateral view of X-ray.

Please cite this article as: Sun H, et al, A biomechanical evaluation of different fixation strategies for posterolateral fragments in tibial plateau fractures and introduction of the 'magic screw', Knee (2018), https://doi.org/10.1016/j.knee.2018.03.015

Download English Version:

https://daneshyari.com/en/article/8801503

Download Persian Version:

https://daneshyari.com/article/8801503

Daneshyari.com