Peer Review File

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Reviewer Comments

1.The reviewer's comment: Throughout the document I found several grammatical mistakes and errors in the structuring of the sentences. I would highly recommend sending the manuscript to a native English speaker for correction. When going through this manuscript I had to read sentences multiple times in order to understand what was meant. Addressing these errors could highly benefit both the reader-friendliness and the understanding of the manuscript.

The authors' Answer: We feel sorry for the grammatical mistakes and errors in the manuscript, to correct the sentence, two native English speakers of the AJE give the help to revise the language and we upload the language certification.

Changes in the text: The changes have been marked by using the "Track Changes" function of word processing program.

2. The reviewer's comment: By stating that you developed a new 3D CT technology you are implying that you created a new algorithm/software or another new technology. This statement is false in my opinion. You developed a new method to simulate the injury pattern by using features within an existing 3D technology, namely the Mimics software.

2. The authors' Answer: Thank you for your advice to correct the word misusage, the word "technique" may lead to an incorrect understanding. The "3D CT technology" has been revised as "3D simulation method" in the revised manuscript.

Changes in the text: We have modified our text as advised (see Page 3, line 46; Page 5, line 148; Page 13, line 467; Page 14, line 483; Page 18, line 607; and Page 19, line 625).

3.The reviewer's comment: The findings of this study are based on the assumption that the repositioning process of the tibia is performed accurately. However in my opinion it is quite user-dependent how the tibia is repositioned. By moving an object in 3D, you easily introduce variation between different observers. This aspect is however not properly addressed within this manuscript.

3.The authors' Answer: Thank you for your advice. In this study, the injury pattern simulation is based on the articular surfaces match between the tibial plateau and femoral condyle. The tibial repositioning process seems subjective and user-dependent; however, to achieve the optimal injury pattern, the process is accurate, non-arbitrary and subject to certain rules. All the process of matching is operated by orthopaedists experienced in the management of tibial plateau fractures and knowledgeable with knee biomechanics, and kinematics. To achieve the optimal match, the orthopaedic surgeon needs to adjust the tibial position repeatedly at all views. With the Mimics software, the surgeon can adjust the tibial position in 2D windows to match the contour lines between tibial and femur in axial, coronal, and sagittal planes. During the process of matching, the tibial model motion in the three planes is coordinated linkage. Such as the 10 degrees motion in the sagittal plane may result in a synchronous movement 3 degrees in coronal and 5 degrees in the axial plane. So the optimal match position in both 3D and 2D views is unique and less user-dependent, the variation between different observers is limited.

Changes in the text: This aspect is added in the method section (see Page 8 line 278-285) and discussion section (see Page 14 line 476-482).

4.The reviewer's comment: Recently an article was published by Xie et al. in the JBJS which did a similar analysis between the injury force mechanism and the fracture morphology. Yet in your manuscript you do not mention this article. In the introduction you state that: "Until now, however, the injury pattern of the actual complex fractures can only be reconstructed by means of imagination and speculation, which requires extensive experience" (Line 94 – 96). This implies that there has not been any other method to address this problem, which is false since Xie et al. also developed a method for this. I would recommend to address this article in your manuscript. What makes your method different from theirs? How do your findings relate to theirs?

(Xie, Xuetao, et al. "Comparative analysis of Mechanism-Associated 3-dimensional tibial plateau fracture patterns." JBJS 102.5 (2020): 410-418.)

4. The authors' Answer: Thank you for your advice. We have modified our text as advised (see Page 6, line 178-179) and cited Xies article as reference 33 in page 13, line 460. We also compared the research methods between Xie and us.

Changes in the text: We have modified our text as advised in the introduction section (see Page 6, line 178-179) and in discussion section (Page 13, line 461-468)

Methods:

The reviewer's comment: The methodology is clear in general. Yet, it could benefit from a bit more detail in some parts. Especially since a new method is introduced in

this manuscript, it would be nice if the reader can repeat the method himself after reading the manuscript.

The authors' Answer: We described more details of the methodology in the method section. We believe the readers can repeat the simulation process and analysis following the method described in the revised manuscript.

5.The reviewer's comment: line 112: Please specify when CT images are of insufficient quality.

5.The authors' Answer: The "insufficient-quality CT images" are defined as "axial CT images with a slice thickness less than 3 mm, or CT scan did not involve intact femoral condyles".

Changes in the text: We have modified our text as advised (see Page 7, line 245-246)

6.The reviewer's comment: Please specify the segmentation process. What HU treshold did you use for the segmentation process? How did you separate the femur from the tibia? Did you use any smoothing filter? What did you do with the fibula?

6.The authors' Answer: The segmentation process is described with more details.

Changes in the text: We added some details in the method section (see Page 7, line 250-261).

7.The reviewer's comment: Line 119: "were flipped horizontally" . This is unclear for the reader. Please state how you performed the mirror process.

7.The authors' Answer: The mirror flipping process was achieved by the "mirror" function in mimics software. The right limb is flipped horizontally in the coronal plane to get a left limb model.

Changes in the text: We have modified our text as advised (see Page 7, line 261-263).

8.The reviewer's comment: Line 124: "Optimal match". What is optimal? It sounds quite subjective and depending on the observer.

8.The authors' Answer: More details about the matching process are added to describe the "optimal match" more clearly and precisely. The optimal match is subject to certain rules. The injury pattern in both 3D and 2D views is unique and less user-dependent.

Changes in the text: We have modified our text as advised (see Page 8, line 280-282).

9.The reviewer's comment: I understand you used the 3D model for the fracture mapping process instead of the CT slices. Could you specify how you chose the viewing angle? I can imagine that a difference in the viewing angle results in variation between different observers. Was this addressed?

9. The authors' Answer: The standard "top view" chosen is through the "top" function in software. The "top view" is in the axial plane which perpendicular to the medullary cavity of tibial.

Changes in the text: We have modified our text as advised (see Page 8, line 295-297).

Results:

10.The reviewer's comment: The results are well presented, understandable and are congruent with the methodologies used.

10. The authors' Answer: Thanks

11.The reviewer's comment: In the results you firstly mention the "contact areas", however it is not clear how you determined these areas. Please specify this.

11. The authors' Answer: We defined the contact areas in the tibial plateau as the projective areas of the lowest points of femoral lateral and medial condyles at the injury pattern, which identified in 3D views.

Changes in the text: We have modified our text as advised (see Page 9, line 317)

12.The reviewer's comment: The authors chose to describe the data as a mean with its standard deviation. This implies that the data is normally distributed. Yet, they chose to do a Kruskal-Wallis test, which is a test that uses the median values and assumes a non-normal distribution. This is contradictory. Please describe the data with the median and the IQR in case of non-normal distribution.

12.The authors' Answer: Thank you for your suggestion. The data of injury pattern and MFLA were non-normal distribution; we describe that with the median and the IQR in the Table 3 and text.

Changes in the text: We have modified our text as advised (see Page 9, line 325 and Table 3)

Discussion:

13.The reviewer's comment: The rotation injury pattern is an interesting finding which could indeed explain the involvement of the posterior part.

13.The authors' Answer: Glad to hear that you are interested.

14.The reviewer's comment: The authors state that their findings are important for planning the surgical strategy (line 267). Even though I find the findings of this study valuable for our understanding of (posterior) tibial plateau fractures, I do not see yet how this is going to affect the surgical strategy. Could you further elaborate on this?

14.The authors' Answer: With different injury patterns and fracture characteristics, the surgical strategy should be different. Reversing and neutralising the injury pattern while doing reduction of fracture is helpful for the fracture fixation. For example, surgeons can reduce the fracture with flexion-external rotation valgus injury pattern under extension, internal rotation, and varus position. In our preliminary research, the fracture reduction can be achieved easily with traction under the reverse injury pattern position. Different surgical approaches and fixations should be chosen differently for varying patterns of injury. The posterolateral fragment in flexion-external rotation injury pattern is depression, and a bone graft is needed to support the articular surface with a posterior surgical approach. By contrast, the split posterolateral fragment in extension injury pattern can be fixed combine with anterolateral fragment through an extended lateral approach, and a bone graft is unnecessary.

Changes in the text: We added this aspect as advised in discussion section (see Page 16, line 554-571)

15.The reviewer's comment: The authors state in their limitations that "the findings of our research were based on 3D simulations, and one may argue that the interpretation of injury patterns and fracture maps is subjective" (Line 305-307). I agree with this finding and this is in my opinion one of the major limitations of this study. Besides the subjectivity of the interpretation, also both the 3D simulation

method and the fracture mapping seems observer-dependent (See comment 3). I would recommend the authors to further elaborate on this matter.

15.The authors' Answer: For the complex construction and kinematics of the knee, the injury pattern is difficult to reproduce precisely. First, the fracture characteristics that could be simulated in cadaveric experiments are limited and are different in some aspects with the actual fractures. Second, it is difficult for patients to recall and demonstrated the injury pattern or the knee position in the three planes. Third, the injury pattern, which hypothesis from the fracture characteristics, is more subjective and needs abundant experiences. The method proposed in this study is based on the 3D simulation for the injury pattern. The tibial plateau fracture is resulted by impingement of femoral condyles, so the injury pattern can be simulated with matching the articular surfaces between tibial plateau and femoral condyles. The match process is operated by experienced orthopaedic surgeons; besides, the match is achieved both in 3D view and all 2D views (axial, sagittal, and coronal planes). The final tibial position and injury pattern is less subjective and observer-dependent.

Changes in the text: We added this aspect as advised in discussion section (see Page 18, line 602-611).