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Dear Professor Lian-Sheng Ma and Reviewers

We thank the Editor for the decision about our manuscript entitled “Selection of internal fixation of femoral intertrochanteric fractures using a finite element method”, submitted for consideration of publication in the World Journal of Clinical Cases.

We are grateful to the Editor and Reviewers for the sound and constructive comments. By assessing these remarks, questions, and suggestions (see the point by point below), we have substantially improved our manuscript. The revised part of the manuscript has been **marked in red.**

We hope the current version would fulfill your editorial requirements. Please contact me if further questions are raised.

Best wishes,

Dr. Gu

POINT-BY-POINT RESPONSES TO THE COMMENTS OF REVIEWER #1

Abstract

Comment 1: Remove the software name from the abstract.

Response: We thank the Reviewer for the comment. It was removed.

Comment 2: Describe the number of models simulated in the present study.

Response: We thank the Reviewer. We developed five models. It was clarified in the Abstract - Aim.

Comment 3: Insert more information about the meshing process and boundary conditions.

Response: Thanks for the comments. There is much content about grid division and boundary information, and it needs a large text to describe, which cannot be included in the Abstract due to the word number limit. Therefore, we fear that we cannot comply with the Reviewer's request.

Introduction

Comment 4: Correct the sentence "...the intramedullary nail system has become a new favorite in the treatment".

Response: We thank the Reviewer. The sentence was revised.

Comment 5: Avoid the use of personal pronouns in a scientific text, such as "We hope to find a biomechanical answer.

Response: We thank the Reviewer. The manuscript was revised appropriately.

Methods

Comment 6: *Describe the CAD software and the modelling process properly.*

Response: We thank the Reviewer for the comment. The present study used Mimics 17.0 software for model building, not CAD software. The CT cross-sectional image of the femur in DICOM format was introduced into the medical image processing software Mimics 17.0 (Materialise, Leuven, Belgium) for denoising. The ideal boundary threshold of the bone and soft tissue was defined, the soft tissue image around the bone was removed, and the image was selectively segmented according to the anatomical structure. All parts of the femur were aligned to fill the small gaps, make the outer contour of the femur smooth and continuous, and establish a geometric model of the femur (Figure 1). The constructed femur information was saved as an STL format file, and the reverse engineering software Geomagic Studio 2012 (3D Systems, Rock Hill, SC, USA) was used to repair and optimize the STL format file. First, the non-feature blocks and dents on the model surface were removed, and the loose model surface was smoothed to prevent the generation of non-feature high curvature and self-intersecting surfaces. Then, the smooth curved surface was used to fit the triangle surface of the model, and finally, a continuous curved surface model was generated. The femoral cortical bone and cancellous bone were distinguished by the offset function.

Comment 7: *Describe the meshing process, number of elements and nodes for each model, the element type and aspect ratio applied in the numerical model.*

Response: We thank the Reviewer for the comment. Based on your comments, we have added the content to the manuscript.

For the meshing process, the intramedullary nails, proximal spiral blades, and distal transverse locking nails were edited as a standard tetrahedral mesh with a size of 2 mm. The femoral cortical bone and femoral cancellous bone were divided into standard tetrahedral meshes with a size of 3.5 mm. The numbers of elements and nodes of the models are shown in Supplementary Table S1.

Supplementary Table S1. Numbers of elements and nodes of the models

	ITN						PFNA					
	Inside		Outside		Inside and outside		Inside defect		Outside defect		Inside and outside defect	
	Node	Element	Node	Element	Node	Element	Node	Element	Node	Element	Node	Element
Femoral Cortex-Proximal	16673	8408	18343	9180	16673	8408	16686	8399	18399	9268	16686	8399
Cancellous femur-proximal	14965 7	102716	15233 5	104342	14965 7	102716	10184 1	70776	10608 7	73643	101841	70776
Femoral Cortex-Distal	15963 5	107100	10230 2	68246	10230 2	68246	10000 9	65208	94872	62186	94872	62186
Cancellous femur-distal	11292 7	75415	10670 2	71017	10670 2	71017	99944	66092	91986	60542	91986	60542
Main nail	16054 6	102606					19556 5	130063				
Cephalospin-Lag Screw	10760 5	68846					57919	37079				
Cephalospin-Compression Screw	66137	41932										
ACINFN	10842	9317					10842	9317				

Within the range of linear elasticity, each model has not yet reached the yield strength. Therefore, the finite element type is not involved. Table 1 in the manuscript has shown aspect ratio.

Comment 8: Describe where the fixation support was defined in the models.

Response: We agree with the Reviewer. In the anti-rotation intramedullary nail fixation model, the anti-rotation blade of the PFNA was located at the middle and lower position of the femoral neck 1/3. The screw tip was 10 mm away from the femoral boundary, and the lateral view was in the center of the femoral neck. In order to ensure the comparability of PFNA and ITN, the axes of the cephalospinal nails of the two are kept consistent. The lateral greater tuberosity protective plate surrounded the tail of the cephalad nail, and its midline was consistent with the lateral long axis of the femur. Using the candy paper wrapping method, the upper edge of the steel wire group was along the upper part of the femoral neck, and the lower part was along the lower part of the lesser trochanter to pressurize the lesser trochanter. The two upper and lower branches crossed over the outer side of the tail of the cephalad nail to compress the greater trochanter bone. In the steel wire and steel plate combined group, the position of the steel plate was the same as the position of the steel plate group alone, the upper and lower positions of the steel wire relative to the femoral neck were the same as mentioned above, and the steel wires crossed on the outside of the steel plate.

Comment 9: *What kind of analysis was performed? Quasi-static? Describe it.*

Response: We thank the Reviewer. Since the convergence difference of the results of the finite element analysis in this study was less than 5%, it could be considered that there was a unique solution, and statistical analysis was not required.

Comment 10: *The mechanical properties should be followed by the references that have calculated these values. Please insert them in the table 1.*

Response: We thank the Reviewer for the comment. We have inserted references in Table 1. The references were

[1] Perez JV, Warwick DJ, Case CP, Bannister GC. Death after proximal femoral fracture--an autopsy study. *Injury*. 1995 May;26(4):237-40.

[2] Goosen JH, Mulder MC, Bongers KJ, Verheyen CC. High revision rate after treatment of femoral neck fractures with an optionally (un)cemented stem. *Arch Orthop Trauma Surg*. 2009 Jun;129(6):801-5.

Comment 11: *Describe the contact type between different metallic structures and between metallic structures and bone.*

Response: We thank the Reviewer. The contact properties of the bone-metal contact were set with a friction coefficient of 0.2, except for ITN tension nails and compression nails in which some threads were set to bind. The threaded area was the set binding, and non-threaded area was the contact attribute with a friction coefficient of 0.2. We have added this content to the manuscript ^[1,2].

[1] Eberle S, Gerber C, von Oldenburg G et al. A biomechanical evaluation of orthopaedic implants for hip fractures by finite element analysis and in-vitro tests. *Proc Inst Mech Eng H* 2010; 224: 1141-1152. doi: 10.1243/09544119JEIM799. PMID: 21138232.

[2] Goffin JM, Pankaj P, Simpson AH et al. Does bone compaction around the helical blade of a proximal femoral nail anti-rotation (PFNA) decrease the risk of cut-out?: A subject-

specific computational study. Bone Joint Res 2013; 2: 79-83. doi: 10.1302/2046-3758.25.2000150. PMID: 23673407.

Comment 12: *What kind of stress criteria was selected to obtain the results?*

Response: We thank the Reviewer. Bergmann et al. ^[1] showed that when standing still, standing on one leg, and going up and downstairs, the loading stress during normal walking was 100%-140% body weight (BW), 232%-369% BW, 227%-316% BW, 211%-285% BW, respectively. The average range of peak load in daily life is 50%-350% BW. In the current research, to simplify the calculations, 100% BW was used when standing normally, 200% BW for slow walking, 250% BW for fast walking, and 300% BW for walking downstairs. We have added this content to the manuscript.

[1] Bergmann G, Deuretzbacher G, Heller M et al. Hip contact forces and gait patterns from routine activities. J Biomech 2001; 34: 859-871. doi: 10.1016/s0021-9290(01)00040-9. PMID: 11410170.

Results

Comment 13 : *Instead just explore the stress peaks and maximum displacements, the authors should provide the colorimetric stress maps. The qualitative view of the results will improve the interpretation and is one of the major advantages when performing a finite element analysis.*

Response: We thank the Reviewer for the comment. We have provided the colorimetric stress maps as Supplementary Figures (Figure S1- Figure S9). Still, there are too many figures to be able to include them in the main manuscript. **Only 3 related pictures have been added in the manuscript (Figure 4, 5, 6).**

Comment 14 : *How the maximum stress and maximum displacement were recorded? Describe it in the results section.*

Response: We thank the Reviewer. In the current study, the maximum stress and maximum displacement were obtained by Abaqus 6.14 (Dassault, France). We have explained in the manuscript.

Comment 15 : *In table 3, remove the unities from the table and insert them only in the table heading, such as “Maximum stress at the main nail (MPa)” and “Maximum displacement of proximal femur (mm)”.*

Response: We thank the Reviewer. Table 3 was revised as suggested.

Discussion

Comment 16 : *Discuss how easy is to individualize an interlocking plate model.*

Response: We thank the Reviewer for the suggestion. A strength of this study is that once the base model and fixation models are designed, it is easy to import the CT images from a given patient and use them to simulate the various fixations. This would allow treatment individualization.

Comment 17: *Discuss the MPa limits values to the bone tissue and its relation with the stress peaks that you calculated.*

Response: We agree with the Reviewer. For both inside and outside defects, a lot of stress will be concentrated on the main nail. In our slow walking model, the maximum stress of the PFNA and ITN groups can reach 456MPa and 445MPa, exceeding the fatigue limit of titanium. This means that even with milder rehabilitation when the fracture has not healed completely, there is a risk of fracture of the internal fixation under repeated stress stimulation. Therefore, intramedullary fixation alone allows low-intensity rehabilitation exercises such as early standing. But the healing of the patient's fracture must be evaluated before walking; otherwise, it may fracture the internal fixation. Once the bone is healed, these two maximum values should not be a problem since the nail is supported by the bone and vice-versa.

Conclusion

Comment 18: *Shorten it your conclusion section. There are redundant information already discussed and results repetition there. In this section, the authors should select the highlight information with a clear clinical significance.*

Response: We thank the Reviewer for the comment. We shortened the conclusion.

POINT-BY-POINT RESPONSES TO THE COMMENTS OF SCIENCE EDITOR:

Congratulations on submitting your revised paper. You appear to have addressed all the concerns raised in the first review and the paper reads well.

Response: We thank the Science Editor for the comments.

Comment 1: *The authors did not provide original pictures. Please provide the original figure documents. Please prepare and arrange the figures using PowerPoint to ensure that all graphs or arrows or text portions can be reprocessed by the editor.*

Response: The Reviewer is right. According to your request, we have provided a PPT file including all the original pictures, which will be uploaded together with the revised manuscript.

Comment 2: *The “Article Highlights” section is missing. Please add the “Article Highlights” section at the end of the main text.*

Response: Thank you for your comments. We have added Highlight. As follows:

- In this study, the finite element method was used to simulate the stress loading situation under the postoperative activity to a certain extent.
- When the inner and outer sides are damaged at the same time, one place should be selected for reconstruction (outer or inner side), and low-intensity rehabilitation exercises can be carried out.
- When the inner and outer sides are damaged at the same time, if the reconstruction cannot be completed, the stability of the ITN system is better.

