Author’s response to reviews

Title: The Risk of Violating the Posterior Malleolar Fracture When Nailing the Ipsilateral Concomitant Spiral Distal Tibial Fracture

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Author’s response to reviews:

Dear Editor, Dear reviewers

Thank you for your letter dated November 09. We were pleased to know that our work was rated as potentially acceptable for publication in Journal, subject to adequate revision. We thank the reviewers for the time and effort that they have put into reviewing the previous version of the manuscript. Their suggestions have enabled us to improve our work. Based on the instructions provided in your letter, we uploaded the file of the revised manuscript. Accordingly, we have uploaded a copy of the original manuscript with all the changes highlighted by using the track changes mode in Microsoft Word.

Appended to this letter is our point-by-point response to the comments raised by the reviewers. The comments are reproduced and our responses are given directly afterward in a different color (red).

We would like also to thank you for allowing us to resubmit a revised copy of the manuscript.

We hope that the revised manuscript is accepted for publication in the Journal of Mountain Science.

Sincerely,

Xiang Li

Reviewer 1 :
Comments to the Author

1. Review of the manuscript “The Risk of Violating Posterior Malleolar Fracture When Nailing the Ipsilateral Concomitant Spiral Distal Tibial Fracture”

The authors present a computational study evaluating the risk of displacing non or minimally displaced posterior malleolar (PM) fractures associated with spiral distal tibia fractures. The study is based on the presumption that distal interlocking bolts from the intramedullary nail are the sole reason for PM fracture displacement. This premise disregards the fact that nail placement in and of itself may displace the PM fracture, especially in good bone.

We thank the reviewer for the very interesting comment. In fact, the possibility of secondary displacement of the posterior malleolar fragment (PMF) caused by the intramedullary nail itself has been taken into the consideration. In the background introduction, the role played by the nail itself has been described as follows “Although the multiple distal locking option of the latest nail design greatly improves the holding strength of the short distal tibia segment and is compatible with a soft envelope, there is always a major concern about secondary displacement of an initial non-displaced PMF, especially those involving a substantial articular surface area, when inserting an IM nail or distal AP locking screws.” (Lines 68 to 73 of page 4 from the manuscript). To quantify the possibility of nail tip relating PMF displacement, we measured the minimal distance from vIM nail tip to the fragment. It conducted as follows “2.3.4 The distance from the nail tip to the PMF (DNP): On the axial plane, the minimal distance from tip of the nail to the PMF was measured (Figure 1D). When there was no violation from the nail tip to the PMF, the distance was defined as positive. When the nail tip violated the PMF, the measurement was defined as negative.” (Lines 175 to 179 of page 8 and 9 from the manuscript). Although in the following section the meaning of the DNP results was further discussed, the measurement was not sufficiently listed in the Result section.

Regarding the suggestion, the completion of the Result section has been described as follows: “The DNP was 4.29 mm [range, 1.5-8.54 mm] and all the measurements were positive, which indicated no PMF penetration from the vIM nail tip. Among the three AP locking screws, the S13 entailed the highest probability of PMF violation, followed by the S15 and S37.” (Lines 220 to 223 of page 10 and 11 from the manuscript). Based on the measurement, the conclusion as follows “Therefore, the nail itself would not greatly exacerbate the posterior malleolar fracture displacement when the nail tip depth was properly determined.” (Lines 312 to 314 of page 15 from the manuscript) was supported with solid evidences.

2. Next, assuming that the bolts themselves were the reason for fracture displacement, simple clamp application during drilling and bolt insertion would prevent fracture displacement, negating the use of any measurement from the study. Also, if nail placement does not displace the fracture, leaving the PM fracture alone and placing two medial to lateral interlocking bolts would also leave the PM fragment undisturbed.

We really appreciate reviewer’s opinion that simple clamp application and bolt insertion before locking screw insertion might eliminate the possibility of secondary PMF displacement. In the
Background section we had list the shortcomings of preliminary PMF fixation as follows “The suggestion of indiscriminate PMF fixation with cannulated screws before nailing was made without sufficient supporting evidence and is not an effective solution [6]. This protocol might irritate the adjacent tendon (especially the hallux flexor longus from the posteroanterior screw) and ligaments, cause percutaneous nerve entrapment [7], exaggerate excessive patient radiation exposure and incur extra financial cost.” (Lines 73 to 78 of page 4 from the manuscript).

Besides those disadvantages, one paper, named “The treatment options for posterior malleolar fractures in tibial spiral fractures.” published in 2017, suggested that PMF fixation failed to improve functional outcomes in tibial combined with PMF fractures especially when the fragment size is not significant. So we would add a brief description as follows “Guo’s study also suggested that PMF fixation failed to improve functional outcomes when there was a moderate size PMF combined with a tibial spiral fracture [8]. As the treatment benefit should be balanced against the potential complications and costs, we believe it is wise to tailor the operation protocol for every case.” (Lines 78 to 82 of page 4 from the manuscript)

We also agree with reviewer’s opinion that compared to nail tip and distal anteroposterior locking screws, medial to lateral interlocking screws (or bolts) is unlikely to cause secondary PMF displacement.

3. Finally, every nail design is different, with interlocking bolts in different trajectories so again, assuming that the bolts are the only reason for fracture displacement, the measurements that the authors make are only applicable to this specific nail design.

We agree with the reviewer’s suggestion that our vIM nail does not cover all types of authentic tibial nail. Actually, it is impractical to make the virtual model represent all nail design. There are two reasons we choose those two types of tibial nail as prototype. The first is that TRIGEN META-NAIL (Smith & Nephew Inc., Massachusetts, USA) and expert TN (Depuy Synthes Inc., Zuchwil, Switzerland) are two most widely used tibial intramedullary nail. They are both characterized by allowing a number of extremely-distal-located locking screws to be used to reduce the incidence of malalignment and loss of fixation of distal metaphyseal fractures. To our best knowledge, they may have the most distal anteroposterior locking screw design. The second reason is that in our hospital only TRIGEN META-NAIL was available. So this point should be further discussed as follows “Third, our vIM nail does not cover all types of authentic tibial nails. Actually, it is impractical to make the virtual model represent all nail designs. To the best of our knowledge, the two prototypes are among the most widely used tibial intramedullary nails and both are characterized by an extremely distally located locking screw design. Therefore, we believe this virtual model has certain representativeness.” (Lines 362 to 367 of page 17 from the manuscript).

To make the Conclusion more reasonable, the revision is as follows “In this paper, the potency of Bartoníček’s classification in directing the treatment of a PMF combined with a distal tibial spiral fracture was confirmed. We further found three key factors underpinning the risk of PMF secondary displacement: (1) the height of the PMF, (2) the space relationship between the nail tip and the distal tibial physeal scar and (3) the position of the distal anteroposterior locking screw in
the tibial intramedullary nail. Among all the factors, the HP and the physeal scar were consistent variants and out of the surgeon’s control. Identification of them could help the treating surgeon eliminate the risk of PMF secondary displacement by using a simple mathematical calculation. Other than preliminary PMF fixation, the surgeon could either draw the tibial nail (with a distal locking screw arrangement similar to the vIM nail) back a little to maintain a safe distance between the nail tip and the physeal scar, or change to another tibial nail with a more proximal tibial anteroposterior locking screw design.” (Lines 369 to 381 of page 17 and 18 manuscript)

Reviewer 2:

Comments to the Author

Review of the manuscript “The Risk of Violating Posterior Malleolar Fracture When Nailing the Ipsilateral Concomitant Spiral Distal Tibial Fracture”

This is a very well done study about tibial shaft fractures that have concomitant undisplaced posterior malleolar fractures involving the ankle joint. The authors have hypothesized that a need for stabilizing the malleolus fracture prior to rodding exists when the posterior malleolus is long. They have done this through virtual space relationship studies between the tibial rod implant and the PMF using 3-D models of 55 cases. They then explored their hypothesis using intra-operative radiographs during 35 nail treated cases. The conclusion has now been established that undisplaced fractures of the PMF with a height of 31.2 mm of that structure required stabilization before nail fixation to avoid secondary displacement from distal locking screw insertion.

1. The hardest thing to read in this article happens to be the most important: The Abstract. It is suggested that this be rewritten with simpler language that is actually contained within the body of the manuscript. It should begin with a hypothesis that trauma surgeons handling spiral fractures of the tibia with concomitant posterior undisplaced malleolar fractures can use assessment of the size of the PMF to determine the need for stabilizing that structure first before rodding the tibia. Then they need to clearly state step one and step two as to how they prove their case, first with analysis of CT scans and then prospectively with intra-operative cases. The inclusion of details like "...screw 13, screw 15 and screw 37" should be eliminated because they are very confusing and are not part of the rest of the manuscript.

We really appreciate reviewer’s suggestion regarding the abstract. The revision is as follows “Background: For a distal tibial spiral fracture combined with a non-displaced posterior malleolar fragment (PMF), we proposed a hypothesis that the treating surgeon could assess the size of the PMF to determine the need for stabilizing that structure first before rodding the tibia. Materials and Methods: Fifty 3-D models (22 females) of combined distal tibial and posterior malleolar fractures from one trauma center were reconstructed. In each case, a virtual tibial intramedullary nail (vIM nail) with three distal anteroposterior (AP) locking screws (S13, S15 and S37, the number indicating the distance from the screw to the nail tip) were inserted into the center of the tibial canal and ended on top of the distal tibial physeal scar. Contact between the screws and the PMF was defined as causing PMF displacement. The relationship between PMF
secondary displacement and traumatic anatomic factors (the fragment area and height of the PMF) was explored. Then, the parameters were justified by analyzing intraoperative radiographs of 35 cases treated by nail with single locking screw (S15) design. Results: In the analog experiment, multiple logistic regression analysis revealed that the height of the PMF could confidently predict the risk of fragment displacement (S13: odds ratio [OR] 1.18, 95% confidence interval [CI] 1.06 - 1.32; S15: OR 1.15, 95% CI 1.05 - 1.27). Regarding the height of the PMF, the receiver operating characteristic established a cut-off value of 31.2 mm for preliminary fixation of the fragment with 88.89% sensitivity and 88.89% specificity. In the operation group the nail stopped on the top of distal tibial physeal scar, no PMF secondary displacement occurred when the PMF height was less than 31.2 mm. However, the incidence of secondary displacement was 93.33% when the height of the PMF exceeded 31.2 mm. Conclusion: When the distal tibial physeal scar was set as the limit of nail insertion depth, the height of the PMF could be used as a reliable reference predicting the risk of PMF secondary displacement caused by distal anteroposterior locking screw. Trial registration: Retrospectively registered. Key Words: Ankle Fracture; Tibial Fracture; Morphological Measurement; Intramedullary Nail.” (Lines 28 to 56 of page 2 and 3 from the manuscript)

2. While on the topic of the importance of the height of the PMF (31.2 mm) somewhere in the discussion a comment should be made about the need or lack thereof for normalizing this very precise number to the height of the patient. Is the height of a 7" tall basketball player is going to be the same as a 5" tall person?

Thank you for the consideration. Actually, the geographical feature of the PMF is not related to the patient’s height and shape. With your advices, we made a revision as follows “The threshold of the HP is a very precise number and we believe it is unnecessary to normalize this figure according to patient’s height or body build. The risk of PMF secondary displacement is mainly determined by the fragment’s own anatomic features. Furthermore, there is no evidence that height or body build could significantly alter the position of the distal tibial physeal scar. Although the length of the tibial nail is significantly influenced by the height variance among patients, the distal locking screw arrangement in a tibial nail of any size is standardized.” (Lines 335 to 342 of page 16 from the manuscript)

3. Specific Comments:

3.1. Page 6 Line 111: "… according to Bartonicek's classification scheme…” in order to provide the reader with sufficient information about esoteric references such as this and several others throughout this manuscript, you need to provide a reference describing the reason for mentioning the eponym. For instance, what is this classification scheme? What is it based on? Why did you mention it? Don't make the reader look it up.

Thank you for the suggestion, the supplement had been made as follows “This is a pathoanatomy-oriented classification based on CT examination that takes into account the size, shape and location of the fragment, stability of the tibiotalar joint and integrity of the fibular notch (Figure 1).” (Lines 114 to 117 of page 6 from the manuscript).
3.2. Page 6 Line 119: "...CINOTTI's method..." again, same comments. What are the criteria for this method? What's the point of using it?

We agree with the reviewer’s suggestion that Cinotti’s method need further introduction. The revision as follows “First, as the ideal position of the tibial nail axis is across the center of the ankle, this point and its sagittal plane projection were established on axial scan according to Cinotti’s method [10]. This method is precise [11] and easy to perform by identifying the center of the talar dome originating from the connection of 2 points located in the middle of its anterior and posterior region.” (Lines 124 to 129 of page 6 from the manuscript).

3.3. Page 12 Line 260: "...better fixation stability and minimal soft tissue dissection." Need reference for this statement.

Thank you for underlining this deficiency. This statement was revised and modified with reference as follows “Generally, IM nails with locking screws can provide sufficient fixation stability with minimal soft tissue dissection [18, 19]” (Line 272 TO 274 of page 13 from the manuscript).

3.4. Page 14 Line 305: "... Bartonicek's classification highly correlated..." this will have greater meaning if the first reference mentioned above is clarified.

Modified in the text according to the previous comment (Lines 114 to 117 of page 6 from the manuscript).