

## Peer Review File

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### Reviewer A

**Comment 1:** Despite the simple aim of the research, the authors describe the research results in a complex manner. This can be confusing for the reader of the article. The individual results in particular, depending on the knee flexion, seem to be presented vaguely.

**Response 1:** We are very sorry that we did not state our results briefly. Our main objective was to study the effects of PCL on tibiofemoral joint pressure (TFP). We introduced two other variables: the tibial insert thickness and knee flexion angle. The explanations were as follows: we analyzed the effects of PCL retention, PCL release, and PCL resection on TFP under knee pressure balance. The pressure balance can be obtained by adjusting the thickness of gasket and releasing soft tissue of the knee joints. To avoid the influence of soft tissue release on the test results, we tried not to release the soft tissue other than PCL. Therefore, we gradually changed the thickness with a 1mm gap to seek the pressure balance. Furthermore, we introduced the tibia insert thickness to finish the comparison between the effects of PCL resection on the medial tibiofemoral joint pressure (MTFP) and the effects of tibial insert thinning on MTFP. Moreover, the stiffness of soft tissue of the knee joints differed during knee flexion, resulting in the different tibiofemoral pressure to varying degrees of knee flexion. Therefore, the results we presented with the changes of knee flexion angles and the tibial insert thickness.

Given your valuable comments, we have rewritten the results section, and the language has been polished by "ATM Editing service." (*see Page2-3, line 37-44; Page 9-12, Line176-220*). We divided the results into four parts. The first part was the characteristics of the cadaveric specimens. The second part was the agreement analysis of the pressure-sensing tibial insert (*see Page10, Line180-183*). The third part was the results of the effects of PCL release and resection on TFP (*see Page10-11, Line184-206*). The final part was the comparison between the effects of the PCL resection on MTFP and the effects of the tibial insert thinning on MTFP (*see Page 12, line 207-220*).

**Comment 2:** Moreover, special attention should be paid to incorrectly conduct statistics and their use. The authors only use the ANOVA test, comparing the individual knee bends as groups. When using electronic measuring devices, one should focus on linear analyzes such as correlations, agreements, etc. The entire section of the statistics must be changed, and thus the way of presenting the results.

**Response 2:** We are very sorry for not clearly stating the reliability of the pressure-sensing tibial insert. As mentioned above, we have added the agreement analysis of this device in the results section (*see Page9, Line167-169*). We used the intraclass correlation coefficient to perform the agreement analysis. The results demonstrated that the device showed excellent consistency in measuring joint pressure under different PCL treatments and different thicknesses of the tibial insert.

We have modified our text as advised (*see Page 10, line180-183*).

**Comment 3:** Furthermore, the measuring devices used were not tested for measuring error! And other parameters such as resolution, sensitivity, specificity, repeatability, etc. have not been tested. Moreover, the description of the measuring devices is insufficient.

**Response 3:** We are sorry that we didn't make it clear in this section. The device was an angle measurement tool, a component of the i-Join knee replacement navigation system. This device uses a 3-axis accelerometer (programmable FSR  $\pm 2$  g,  $\pm 4$  g,  $\pm 8$  g,  $\pm 16$  g) and a 3-axis gyroscope ( $\pm 1\%$  sensitivity error and  $\pm 4$  mdps /  $\sqrt{\text{Hz}}$  noise) for data collection. The angle measurement error is  $\pm 1^\circ$ .

We have modified our text as advised (*see Page 6, Line 102-108*)

To make readers better understand the pressure measuring device, we have replaced the “smart tibia insert” with “pressure-sensing tibial insert” (*see Page 6, line 109*). The pressure sensor is a 6-channel, 24-bit delta-sigma ADC that achieves exceptional performance while consuming very low power. Six pressure-sensing points were separately embedded in the medial and lateral sides of the tibial insert depending on tibiofemoral pressure distribution. These pressure-sensing points were able to record pressure at different points, directions, and angles with good sensitivity. Based on the data obtained from the sensors, the MTFP and LTFP were calculated using a specific algorithm. A third-party testing center used a push-pull force gauge to calibrate the pressure-sensing tibial insert. The measurement error of this device was  $\pm 10$  N.

Furthermore, we used the intraclass correlation coefficient to perform the agreement analysis. The results demonstrated that the device showed excellent consistency in measuring joint pressure under different PCL treatments and different thicknesses of the tibial insert.

We have modified our text as advised (*see Page6, line109-119; Page10, line 180-183*).

**Comment 4:** The discussion largely describes the TKA gap, which is indirectly but ambiguously related to the overriding aim of the study. The authors of the discussion should focus on measuring tibiofemoral joint pressure.

**Response 4:** We appreciate your valuable comments. The explanations for joint space mentioned in the discussion part are as follows. Our research aimed to analyze the effects of three conditions of the PCL on the TFP of the knee joints—this pressure derived from the soft tissue tension. Thus, the effects of PCL on soft tissue tension can be regarded as the indirect purpose of our study. Soft tissue is distributed in three dimensions on the articular surface, and its position changes with the flexion of the knee joint. Therefore, it is impossible to directly measure soft tissue tension of the knee joint. Previous studies have to use the indirect indicators to reflect the soft tissue tension, such as the expansion of joint space height by a constant distraction force or the joint pressure under a certain joint space height. Pressure sensor has only been used in TKA for a few years. Previous studies mostly used the changes of joint space height to reflect the impact of PCL resection on the soft tissue tension. The changes of joint space height was also an indirect reflection of the soft tissue tension, which was not inconsistent with our study purpose.

## Specific comments

1. 25, 32, 36, etc. - throughout is unclear. I suggest during.  
Response: We have modified our text as advised. (*see Page 2, line 28,36,40*)
2. 29-32 - The sentence is not out of context. I recommend using verbs.  
Response: We have modified our text as advised. (*see Page 2, line 31-36*)
3. 34 - 36 - it should be mentioned that there is an effect, but statistically not significant. You should avoid using "did not affect" or failed to affect because You didn't measure the lack of effect  
35 - "failed" - should be "did not"  
34, 36 - please provide exact p values  
33 - 40 - Whole result section is unclear, should be completely revised.  
Response: We are sorry that we didn't state this part clearly and appreciate your valuable suggestions. We have rewritten this result section as advised (*see Page 2, line37-44*). And we added the exact *p* values as advised (see *Page 2, line 38, 40, 41*).
4. 43 - if it was higher than 2mm thickness, it was also higher than 1mm thickness - it seems obvious. Please consider.  
Response: I very much agree with your suggestions, and we have modified our text as advised. (*see Page 3, line 47*)
5. 65 - change vital  
Response: We are very sorry for our incorrect writing and have replaced the word "vital" with "very important" (*see Page 4, line 65*)
6. 66 - CR-TKA - a new acronym  
Response: We have added the description before the "CR-TKA". (*see Page4, line 66-67*)
7. 67 - native kinematics – unclear  
Response: We tried to use "native" to express physiological kinematics. To avoid misunderstanding, we have deleted the word "native" (*see Page 4, line 68*)
8. 68 - eg -> such as  
Response: Thank you very much for your suggestions. We have modified our text as advised (*see Page 4, line 68*)
9. 69 - help to resume? Unclear  
Response: We are very sorry for our incorrect writing and have replaced "help to resume" with "help restore". (*see Page4, line70*)
10. 76 - result repeated? please change  
Response: We have rewritten this according to your valuable suggestion (*See Page 4, line76-77*)
11. 78 - eg.: "by various elements such as"... etc.. or and  
Response: Thank you very much for your suggestions. We have modified our text as advised. (*see Page4, line 80*)
12. 79 - surgeons?  
Response: As advised, we have replaced the word "operators" with "surgeons". (*see Page4, line 80*)

13. 83 - Furthermore, whether please change  
Response: We are sorry for not stating this clearly and have rewritten this part according to the Reviewer's suggestion (*see Page 3-4, line83-85*)
14. 83 - 84 – unclear  
Response: We are sorry for not stating this clearly. Joint pressure was determined by the soft tissue tension related to the thickness of the tibia insert. It was a difficult choice between ligament resection and tibia insert thinning when dealing with high joint pressure in the CR-TKA. Therefore, we analyzed the effects of the PCL resection and tibia insert thinning on joint pressure.  
*we have modified our text as advised (see Page 4-5, line 83-87)*
15. 85 - smart insert? - unacceptable.  
Response: We are sorry for not stating this clearly. For a concise understanding of the device, we have replaced the “smart tibia trial insert” with the “pressure-sensing tibial insert” (*see Page5, line88*)
16. 85 - you can measure how it is objective  
Response: We are sorry for not stating this clearly. The word “objective” comes from the evaluation method of knee balance. Knee balance in traditional TKA surgery was evaluated by the experience and feeling of surgeons, which was considered a subjective evaluation method. The pressure-sensing tibia insert can directly evaluate knee balance by joint pressure, which was considered an objective evaluation method. Furthermore, this device can accurately measure joint pressure. First, a third-party testing center has used a push-pull force gauge to calibrate the device's medial and lateral pressure. Results showed that the measurement error was  $\pm 10$  N. Moreover, we have also added the agreement analysis of this device (*see Page10, line180-183*), and the results demonstrated that the device showed excellent consistency in measuring joint pressure under different PCL treatments and different thicknesses of tibial insert (*see Page10, line189-190*)
17. 87 - the insert cannot "compare"  
Response: We have rewritten this according to the Reviewer's suggestion (*see Page5, line90-92*)
18. 85 - 89 - please change  
Response: We have rewritten this according to the Reviewer's suggestion (*see Page 5, line88-92*)
19. 98 - navigation - what kind of navigation GPS? accelerometer? gyroscope? magnetometer? please provide resolution, measurement error, and validation data according to the sensor.  
Response: We are very sorry that we didn't clarify this section. The device is an angle measurement tool, a component of the i-Join knee replacement navigation system. We have replaced the “navigation tool” with “goniometer” in *Page 6, line102-106*. This device uses a 3-axis accelerometer (programmable FSR  $\pm 2g, \pm 4g, \pm 8g, \pm 16g$ ) and a 3-axis gyroscope ( $\pm 1\%$  sensitivity error and  $\pm 4$  Mbps/ $\sqrt{\text{Hz}}$  noise) for data collection. The angle measurement error of this device is  $\pm 1^\circ$ .  
*We have modified our text as advised (see Page 6, line 102-108)*
20. 102 - this whole section should be expanded. reliability, repeatability, resolution,

measurement error, etc. Is it angle sensitive? Is g-force sensitive?

Response: We are sorry for not stating this section clearly, and we have revised this section according to your valuable suggestions.

This pressure-sensing tibial insert integrates a pressure sensor with a tibial insert. The pressure sensor is a 6-channel, 24-bit delta-sigma ADC that achieves exceptional performance while consuming very low power. Six pressure-sensing points were separately embedded in the medial and lateral sides of the tibial insert depending on tibiofemoral pressure distribution. These pressure-sensing points were able to record pressure at different points, directions, and angles with good sensitivity. Based on the data obtained from the sensors, the MTFP and LTFP were calculated using a specific algorithm .

A third-party testing center used a push-pull force gauge to calibrate the pressure-sensing tibial insert. The measurement error of this device was  $\pm 10$  N.

Furthermore, we have added the agreement analysis of this device. The results demonstrated that this device had excellent consistency in measuring joint pressure under different PCL treatments and different thicknesses of the tibial insert.

We have modified our text as advised (*see Page 10, line180-183; Page 6, line 109-119*)

21. 109 - operation = surgery

Response: We have replaced the word “operation” with “surgery” as advised (*see Page7, line122*)

22. 112 - measured? please explain

Response: We are very sorry for the misunderstanding caused by the improper description. Following this sentence, the content (*Page7, line 126-132*) is a detailed introduction to the "measured resection technique". First, the knee joint was exposed by the standard medial parapatellar approach. Then the distal femur was cut at valgus 6 degrees to the femoral anatomical axis, and PCL along with the tibial attachment site was preserved with an osteotome before the tibial osteotomy. Finally, the proximal tibia was cut perpendicular to the tibial anatomical axis with 3 degrees posterior inclination according to the manufacturer's instructions.

23. 124 - why only a 20deg gap? if you use such a digital sensor, you can provide more liner results

Response: We appreciated your suggestions very much, and this was what we intended to do in the pre-test. But we must admit that there were objective difficulties. When we performed this analysis with a 10deg gap in the pre-test, the whole process took so long that the soft tissue was no longer suitable for analysis at the end of the test. In our country, the fresh-frozen cadaver specimens are very scarce and valuable. Therefore, we tried our best to make full use of these valuable specimens. Refer to previous research, we set angle intervals to 20 degrees [1].

24. 125 - it's not a navigation tool - it is rather eg. angle measurement tool

Response: We are sorry for not stating this clearly. As you advised, this was actually an angle measurement tool. We have replaced “navigation tool” with “goniometer” as advised (*see Page 7, line 138-139*).

25. 127 - from?

Response: We have modified our text as advised (*see Page 8, line 141*).

26. 128 - lbs should be converted to SI units

Response: We have modified our text according to your suggestions (*see Page 8, line 142-144*)

27. 131 - you should release 100, 50, and 0%

Response: Thank you for your comments. In our study, PCL was preserved (0% release), partially released (50% release), and then completely resected (100% release) sequentially to do the test, which was consistent with your suggestions.

28. 132 – during

Response: We have modified our text as advised (*see Page 8, line 147*)

29. 139 - unclear

139 - 148 - whole section unclear. The explanation should be simplified

Response: We are sorry for not stating this section clearly and have rewritten this section as advised.

Knee joints that were balanced with PCL retention and a 10-mm tibial insert were included in the following analysis. MTFP with PCL retention and a 12-mm tibial insert was set as the baseline. The changes of insert thickness from 12- mm to 11- mm and from 12-mm to 10-mm was respectively called 1-mm and 2-mm thinning of tibial insert. We compared the effects on MTFP of PCL resection without tibial insert thickness reduction and PCL retention with a 1- or 2-mm thinning of the tibial insert during knee flexion.

We have modified our text as advised (*see Page 9, lines 154-160*).

30. 153 - Inadequate statistics. one-way ANOVA cannot be a single test. Correlation should be calculated. The agreement should be considered. Errors should be calculated. Are data normally distributed? If not they should be expressed in median+/- IQR (!!!!!!!). p should be expressed as an exact value. This whole section must be revised and different statistical data calculated.

Response: We thank you very much for your valuable comments.

1) For the one-way ANOVA, we have modified results as advised (*see Page 10-11, lines 184-206*).

2) The Shapiro-Wilk test analyzed the normality of these continuous variables, and the data were normally distributed. We have modified our text as advised (*see Page 9, line 167, Page 10, line 185*)

3) In this study, joint pressure was measured three times. We have added the agreement analysis by the intraclass correlation coefficient. And the device shows excellent consistency in measuring joint pressure under different PCL treatments and different thicknesses of the tibial insert. We have modified our text as advised (*see Page 9, line 168-169; Page 10, line 180-183*).

4) A third-party testing center used a push-pull force gauge to calibrate the pressure-sensing tibial insert. The results showed that the measurement error was  $\pm 10\text{N}$ . We have modified our text as advised (*see Page 6, line 118-119*)

31. 172 - little - please change

Response: We have rewritten this section as advised (*see Page 9, line 189-190*)

32. 175 - how it was calculated? please avoid such a conclusion in the results paragraph

Response: Thank you very much for your valuable comments. We have deleted this inappropriate conclusion.

33. 198 - flexion gap measurement was not the exact aim of this study - why it was used in discussion

Response:

Thank you very much for your valuable comments. The explanations for joint space mentioned in the discussion part are as follows. Our research aimed to analyze the effects of three conditions of the PCL on the TFP of the knee joints—this pressure derived from the soft tissue tension. Thus, the effects of PCL on soft tissue tension can be regarded as the indirect purpose of our study. Soft tissue is distributed in three dimensions on the articular surface, and its position changes with the flexion of the knee joint. Therefore, it is impossible to directly measure soft tissue tension of the knee joint. Previous studies have to use the indirect indicators to reflect the soft tissue tension, such as the expansion of joint space height by a constant distraction force or the joint pressure under a certain joint space height. Pressure sensor has only been used in TKA for a few years. Previous studies mostly used the changes of joint space height to reflect the impact of PCL resection on the soft tissue tension. The changes of joint space height was also an indirect reflection of the soft tissue tension, which was not inconsistent with our study purpose.

#### **Reviewer B**

Thank you for your valuable study. This study evaluates the effect of PCL on the CR-TKA. The effect of PCL on the gap was dominant after 90-degree knee flexion, but the thickness of the insert was dominant for early flexion. According to the role of PCL, these results were theoretically acceptable. However, there were some concerns about the methodology.

**Comment 1:** Line 115 - Usually, for the CR-TKA, the tibial slope was selected higher than 3 degrees. Why did you perform the CR-TKA with 3 degrees of the tibial slope?

**Response 1:** Thank you very much for your comments. In our study, the tibia plateau osteotomy was performed according to the manufacturer's instructions. The total tibia plateau slope was 6 degrees, of which 3 degrees were the slope of the tibia insert.

**Comment 2:** For the partially resected PCL, what fiber did you resect? There might be differences if the different fiber was resected.

**Response 2:** We are sorry for not stating this clearly. In our study, the anterolateral bundle of PCL was resected, then the total PCL was resected to do the test. We have modified our text as advised (*see Page 8, line 145*)

**Comment 3:** As you stated, the condition of PCL would affect the pressure after TKA. Although the included specimen did not have severe OA, regarding the age of the specimen, this would be a major limitation.

**Response 3:** Thank you very much for your valuable comments. But we must admit

that there were objective difficulties in obtaining the optimal specimens for the research because frozen fresh cadaver specimens were scarce in China. Nevertheless, we will do further research to verify this conclusion with optimal specimens.

1. Matthews, J., et al., *Flexion-extension gap in cruciate-retaining versus posterior-stabilized total knee arthroplasty: a cadaveric study*. J Orthop Res, 2014. **32**(5): p. 627-32.