Author's response to reviews

Title: Improvement of walking speed and gait symmetry in older patients after hip arthroplasty: a prospective cohort study

Authors:

Walter Rapp (walter.rapp@sport.uni-freiburg.de)
Torsten Brauner (torsten.brauner@tum.de)
Linda Weber (linda.weber@tum.de)
Stefan Grau (stefan.grau@gu.se)
Thomas Horstmann (t.horstmann@medicalpark.de)

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Improvement of walking speed and gait symmetry in older patients after hip arthroplasty: a prospective cohort study

Walter Rapp, Torsten Brauner, Linda Weber, Stefan Grau and Thomas Horstmann

We would like to thank the reviewers for their excellent comments. We believe that the quality of our manuscript has improved by implementing the suggestions and comments received. Please find our response to the comments below. Comments by the reviewers are shown in quotation marks, our responses are shown below each comment in regular font and the line numbers where these changes can be found in the text are shown below.

Reviewer 1

Title: Improvement of walking speed and gait symmetry in older patients after hip arthroplasty: a prospective cohort study

Version: 1

Date: 4 March 2015

Reviewer: Joe Zeni

Minor Essential Revisions (such as missing labels on figures, or the wrong use of a term, which the author can be trusted to correct)

“• Line 32: When describing differences, what is meant? Is this compared to
control subjects, compared to the non-operated limb?"

Changes in ambulatory kinematics and kinetics include changes in stance phase, walking speed, joint moments and joint angular velocities compared to healthy subjects. We have revised this sentence accordingly.

Lines 34-37

“• Line 33: What is meant by disease severity? Radiographic severity, symptoms, duration of disease?”

Severity in these studies was assessed using clinical scores such as Kellgren-Lawrence grade. We have included this information in this sentence.

Lines 33-34

“• Line 40: The references to these other conditions seems out of place.”

Little is known about gait asymmetry in patients with osteoarthritis. However, asymmetry has been reported for these conditions. Referring to these publications forms the foundation for defining relevant parameters in this study, and hence they are important for our study. If you feel strongly about omitting these references, we would take your advice and exclude these.

“• In Figure 3, there are no indications of which changes were significant.”

We have added bars in Figure 3 indicating significant differences.

Figure 3

“• Lines 136-139: What is meant by overlap? This procedure is not clear and I recommend the authors improve the clarity of this section for readers not familiar with this procedure.”

Autocorrelation describes the correlation of a function or signal with itself at an earlier time point. We have added this information to the Methods section.

Lines 156-157

“• Line 152: Why was gender included in the model? There is no rationale in the introduction or hypotheses related to this analysis.”

As shown in the literature (Sims et al. 2009), the interplay of gait mechanics, pain, and disability differs between men and women with osteoarthritis. We have included this reference in the Introduction section and rephrased the hypothesis to reflect the fact that sex may be an important factor in this context. Please note that we have replaced “gender” by “sex” throughout the manuscript because we here refer to the biological difference between men and women.
Major Compulsory Revisions (which the author must respond to before a decision on publication can be reached)

“• Line 53: The authors state that the inertial sensors are valid for measuring symmetry in healthy subjects, but do not state whether this is a valid tool to use in a pathological population where the expected symmetry would be much lower than a healthy cohort. Have any studies validated this tool in a pathological population?”

Aminian et al. have shown that these devices are valid for assessing symmetry parameters in patients with hip or knee OA. We have included a reference to these papers.

“• Lines 68-69: Including a sample with a known pathology on the contralateral hip may skew the results. Symmetry in this subsample may be a result of decreased performance on the original side, not due to improvements in the operated side. When were the contralateral THAs performed? More information about this potentially confounding event is needed.”

Thank you for raising this important point. All patients with contralateral hip THA had received their contralateral hip THA more than 1 year prior and were pain and symptom free. The reviewer is correct with the argument that asymmetry in this subsample may be a result of decreased performance on the original side, not due to improvements in the operated side. However, such developments would rather increase than decrease discrepancies to healthy subjects. Because these patients were pain and symptom free in the opposite side, we decided to include these patients. We have included this aspect in the discussion section.

“• Lines 122-125: The description of the event calculations is not clear. The authors appear to state that the detection of the initial contact is not detectable using these sensors. I believe the authors are identifying the foot flat instant and then subtracting 50ms from this time as a surrogate of initial contact. However, this is not appropriate without substantive rationale for this procedure. This is an important consideration because quantification of symmetry is based on valid measures of gait events.”

Autocorrelation calculations do not depend on the exact definition of a specific event. We have added this information to the Methods section.
• The statistical approach and results do not match. There are no data supporting the initial ANOVA, instead the authors only appear to present data from post-hoc testing in which each time period is compared. There is no data showing main effects of time in the walking speed results section.”

Thank you for noting this oversight. We have included results of the ANOVAs before describing results of the posthoc tests.

Lines 181-222

• Similar to the preceding statement, the authors present data for the women and men between each testing time for walking speed. However, Given their statistical approach, there was no interaction effect for this analysis. Therefore, it is not appropriate to separate men and women along with time, unless that was an a priori hypothesis.”

Thank you for noting this oversight. We have included results of the ANOVAs before describing results of the posthoc tests. Sex effects were included in the hypothesis statement.

Lines 181-222, 66

• Line 161: The authors state walking speed increased, but do not provide P-values here or state whether they are referring to the fast, slow or averaged walking speed.”

P-values are given for comparisons in walking speed between time points for each sex because this related to the hypothesis stated correctly in the revised manuscript.

• Line 169: What is being measured here as 23%? A difference between men and women or a difference between normal and fast walking speeds? This is not clear.”

We have rephrased this sentence to clarify that the largest difference between sexes in normal or fast walking speed was 23%.

Line 66

• What is the rationale for taking the mean of the normal and fast walking speeds (Table 2)? Is this a valid measure of performance?”

Thank you for this comment. Mean walking speed is not a valid measure of performance. We have excluded mean speeds from Table 2.

Table 2.
• The same statistical issues arise for the step and stride regularity results in that the outcomes from the ANOVA are not correctly presented in the text. The authors state “Although the autocorrelation coefficients for P1 increased from TD1 to TD3 in patients with THA” there is no statistical data to support this statement.”

As stated above, we have included results of the ANOVAs before describing results of the posthoc tests in the revised manuscript.

Lines 181-222

• Lines 182-183: This statement is not appropriate: In female patients with THA, the increase from TD1 to TD3 was apparent but not significant (P>0.050). If it was not significant there was no difference. The discussion section can be used to explain the results, but if you have determined 0.05 to be a cutoff for your significance, then there was no difference if p>0.05.”

We have deleted this sentence accordingly.

• There is no description of the rehabilitation protocol that was taking place during this time. This is an important consideration as the type of rehabilitation likely has a large effect on the outcomes. Was symmetry being specifically trained during this rehabilitation protocol?

Gait symmetry was not specifically trained during the rehabilitation protocol although therapists aim at achieving a subjective symmetric gait pattern. We have included this information in the revised manuscript.

Lines 80-83

• What surgical approaches were used in this sample?

All patients received a total hip endoprothesis with anterior and medial surgical approaches. We have included this information in the Methods section.

Lines 75-76

• Were all patients undergoing THA because of osteoarthritis progression or did subjects also undergo THA for avascular necrosis, rheumatoid arthritis, hip fracture, etc.?

All patients underwent THA because of osteoarthritis progression. We have added this information to the Methods section.

Lines 75
• Lines 237-239: This statement requires additional studies and evaluation
  “These results are relevant for rehabilitation and we propose that female patients
  should be more intensely advised and encouraged to walk faster, even if they
  might be out of their comfort zone”. There is serious concern that for women
  walking slow may be a mechanism to prevent falls in the presence of physical
  impairments, such as muscle strength and motor performance. Perhaps rather a
  more appropriate strategy would be to improve these underlying impairments to
  increase walking speed, although this requires additional study.”

  Thank you for raising this concern. We agree with your argument and have
  revised this paragraph accordingly.

Lines 259-262

  “In general, this is an interesting paper with some value to researchers in the
  areas of biomechanics and clinical outcomes after joint arthroplasty.”

  Thank you.

  “The statistical analyses and subsequent results are inappropriate as written and
  prevent the reader from an accurate interpretation of the results. There is a lack
  of detail pertaining to the rehabilitation protocol, the surgical sample, and the
  rationale for the analysis based on gender. More clarity is needed on the
  methods used to identify events, as this is the basis for all symmetry measures.”

  Thank you. We have addressed all points summarized here and outlined in detail
  above.

Level of interest: An article whose findings are important to those with closely
related research interests

Quality of written English: Acceptable

Statistical review: Yes, and I have assessed the statistics in my report.

Declaration of competing interests:
'I declare that I have no competing interests

Reviewer 2

Reviewer’s report
Title: Improvement of walking speed and gait symmetry in older patients after hip
arthroplasty: a prospective cohort study

Version: 1

Date: 12 February 2015
Reviewer: Katherine Boyer

Reviewer's report:

BMC review- Improvement of walking speed and gait symmetry in older patients after hip arthroplasty: a prospective cohort study.

Overall this was an interesting study that examines change in walking speed and gait symmetry in total hip arthroplasty patients during an inpatient rehabilitation period. The initial question is well posed and the experimental design and methodology appear sounds. However, while this is an interesting question with an innovative study design, the manuscript lacks details throughout making it difficult to understand the data treatment, results and discussion. Detailed comments below provide indicate the major compulsory changes needed.

Introduction:

“I would like to see some background on asymmetry in OA gait in the introduction. Given that aim of this study is to examine the improvement in gait symmetry in THA patients it would be nice to know how asymmetrical unilateral OA patient are during walking. A quick pubmed search indicates there are at least two studies to examine this. Lugade et al., 2010; James et al., 1994. This will help in the discussion and interpretation of the results.”

We have included additional background information on gait asymmetry in patients with hip OA to the introduction section.

Lines 58-61

Methods:

“Paragraph 2- The inclusion of patient with bi-lateral arthroplasty may influence the symmetry measures of this study? Are they really needed in this analysis? The message of the study may be stronger if only unilateral patients are considered.”

As discussed above, all patients with contralateral hip THA had received their contralateral hip THA more than 1 year prior and were pain and symptom free. The reviewer is correct with the argument that asymmetry in this subsample may be a result of decreased performance on the original side, not due to improvements in the operated side. However, such developments would rather increase than decrease discrepancies to healthy subjects. Because these patients were pain and symptom free in the opposite side, we decided to include these patients. We have included this aspect in the discussion section.

Lines 77-78, 304-311

“Paragraph 3- selection of the reference group from a training group at the
university may introduce physical activity as a confounding variable in the walking speed results. Please consider in the discussion of the results."

You raised a valid point. We had already included this aspect in the original discussion section: “In addition, we recruited our reference subjects from training courses and hence these subjects may have had a better individual physical fitness level."

“Please include more details on the gait training course at the rehab center.”

This term relates to the inpatient rehabilitation. We have clarified this fact throughout the manuscript. The inpatient rehabilitation program comprised 3-weeks of daily training with physiotherapy (5 sessions/week), lymph drainage or massage (3 sessions/week), water exercise (3 sessions/week after wound healing), activity of daily living training (2 sessions/week) and patient education on OA and prosthesis (3 sessions). We have included this information in the Methods section.

Lines 80-83

“Line 106-106- Please include a more detailed description of the offset correction and coordinate transformation for the inertial sensor unit.”

We have added that the line connecting these two points defined the forward direction regardless of the position of the sensors, and the other two directions were defined orthogonal to this axis. The sensor coordinate system is transformed to match the vertical axis, and hence the calculations are not affected by small deviations in sensor placement on the body.

Lines 123-127

“Signal processing (Line 120- 133) Without a visual reference it’s difficult to follow the methods used to identify heel-strike. It’s not clear what a “trigger with constant negative delay of 50ms” is? Please include a sample trace/figure to illustrate how heel contact was identified. Perhaps label figure 1 with these points to help the reader locate heel-contact.”

We have modified Figure 1 to clarify the definition of the trigger and added this description to the Figure legends accordingly.

Figure 1

“Line 135- 147- The parameter calculation is difficult to follow. What portion of the signal is being analyzed in each autocorrelation calculation? Is it the entire signal (20 steps) or are left and right leg foot contacts for each stride compared. A sample plot of at least a portion of the auto correlation coefficient plots where the first and second peak (P1 and P2) were determine is needed.”
The entire signal except the first and last four steps are used for the analysis. The data processing is described in detail in the subsequent original paragraph.

“Statistical analysis- What is the motivation for including Gender in the statistical model? Is there evidence from the literature that symmetry differs by gender or that the response to the gait training would be different by gender? Include this in the introduction and the study hypothesis.”

As shown in the literature (Sims et al. 2009), the interplay of gait mechanics, pain, and disability differs between men and women with osteoarthritis. We have included this reference in the Introduction section and rephrased the hypothesis to reflect the fact that sex may be an important factor in this context. Please note that we have replaced “gender” by “sex” throughout the manuscript because we here refer to the biological difference between men and women.

Lines 59-61, 66

“Figure 2: is this a THA or Reference group subject? If THA, the contralateral and THA leg labels would make more sense.”

The data presented in this Figure is of a patient with THA. We have included this information in the Figure legend.

Figure legend

Results:

“The results should include a presentation of the statistical model main effects before the results from the post-hoc testing are presented. Were there significant gender effects and time effects?”

Thank you for noting this oversight. We have included this information in the Results section.

Lines 181-222

“If improvement in walking speed is the primary outcome metric then the starting speed, and difference in speed by gender, is not that important. Consider de-emphasizing the difference in gender speed differences.”

As outlined above, sex differences were an important aspect of this study. We have not changed this wording.

Discussion:

“The rehab program is called different things throughout the paper please be consistent.”
The program was an inpatient rehabilitation program. We have corrected the terminology throughout the paper.

“Line 223-224 – Change to: At TD3, there was not a significant difference in walking speed between male patients with THA and the male reference subjects.”

We have rephrased this sentence accordingly.

Lines 244-245

“Line 221-229 Have walking speed improvements post THA been reported elsewhere? Refer to the appropriate literature to put this studies results in the context of others that may not have used an intensive rehab program.”

Intensive supervised rehabilitation has been shown to increase postoperative walking speed faster than unsupervised training (Mikkelsen et al. 2014). We have included this information and reference in the Discussion section.

Lines 243-244

“Line 221 – 241 There is too much speculation on walking speed differences between males and females. Could males and females not walk at different speeds simply because they have different leg lengths? Given that females could walk at speeds similar to the reference subjects how relevant is this difference for understanding THA rehab? Beyond the difference in age there is no data available in this study to support any of the other possible explanations.”

Indeed, women walk slower than men even when speed is normalized to leg length. However, this paragraphs discusses the differences between patients and healthy subjects, and we have included references to healthy peers to clarify this comparison.

Lines 244-245

“Lines 242 – 249- In this paragraph there is a discussion of an “stationary” phase of the rehabilitation program. What is this and how long is it? Please add to methods.”

This term relates to the inpatient rehabilitation. We have clarified this fact throughout the manuscript. The inpatient rehabilitation program comprised 3-weeks of daily training with physiotherapy (5 sessions/week), lymph drainage or massage (3 sessions/week), water exercise (3 sessions/week after wound healing), activity of daily living training (2 sessions/week) and patient education on OA and prosthesis (3 sessions). We have included this information in the Methods section.
“Line 248-253- This paragraph indicates that “daily force mobility, flexibility and coordination training” are part of the program and that it lasts for about 27 days. The authors also suggest that this may be too short a time to completely reverse the asymmetry. I agree with the author here and thus was surprised with the explanation of the asymmetry in THA patients was explained in the next paragraph (line 255-265) to be due to patients needing to unlearn a gait pattern they may have adopted to avoid pain. While this “motor program” is certainly one explanation for the lack of symmetry in the THA patients. An equally possible explanation is that with pain, joint degeneration and altered gait patients with hip arthritis may also suffer from significant muscle strength losses and inhibition of muscles due to pain. It would not be possible to regain the strength in a 27 day program. Especially given the possible strength loss on the symptomatic side would have progressed over years and not days.”

Thank you for this comment. We have included the possible explanation for the deficits that patients with hip OA suffer from significant muscle strength loss and altered muscle activity, and it is not to be expected that these deficits would be reversed after a 3-week program.

Lines 259-262

“A discussion of the study limitations should be included.”

We have included a discussion of the study limitations.