Reviewer's report

Title: Comparison of dynamic navicular motion measured using the stretch-sensor between barefoot, shod, treadmill and over-ground walking and running: A cross sectional study

Version: 2 Date: 30 August 2014

Reviewer: Chris Bishop

Reviewer's report:

The authors provide a very interesting study to addresses a pertinent issue relating to human movement and footwear design. Currently, the methods to assess in-shoe movement rely either on placing markers on the skin-surface (which therefore requires structural modification of the shoe) or fluoroscopic techniques (which require the use of ionising radiation). If a technique could be developed using a wearable sensor that was accurate to detect foot motion, this would be a giant step forward for the industry.

The authors certainly provide a thorough paper, yet after reading it still numerous time, I'm not clear on how the results can be interpreted and thus improve our understanding of in-shoe foot function. I do believe it will benefit from further review. My comments for improvement are attached.

MAJOR ESSENTIAL REVISIONS

Background

1. Given you are essentially assessing navicular motion, please provide a rational how this is representative of rearfoot motion. Typically when clinicians consider the rearfoot, its purely the calcaneus. It could be argued that despite a loose coupling relationship, the navicular is actually part of the midfoot. Therefore, are you looking at midfoot pronation or hindfoot pronation?

2. In addition to the above comment, please classify what you consider pronation. This is a pertinent issue in the literature in my eyes, given that a particular muscle primarily controls a movement is a particular plane, and the out of plane movements are controlled by ligaments +/- joint constraints. What component of pronation are you measuring, or is this a combined vector of the three movements as an overall 3-d movement?

Methods

3. I personally believe, in light of the novel status of this device, more information is required in relation to how the device measures navicular motion. A short description would be beneficial for the reader.

4. Please provide a justification of why the conditions were not randomised? You have five conditions and a combination of walking and running. How do you know
the previous running trials (Trial 2 or 4) would not have fatigued the participants prior to the walking trials (Trial 3 and 5)? I know all participants followed the same order, but randomisation would essentially get rid of this issue. I'm not convinced by your justification in your limitations section – you can still match speeds if randomised.

5. Do you believe those who were closer to two minutes may have been fatigued less than those acclimatized for close to five minutes? Please justify why the same acclimatization period was not provided to all participants.

6. Were shoes standardised? If not (and it doesn't look like they were), what effect would footwear choice have on in-shoe foot movement? What about the age of the shoe?

7. I have concerns about the motion you are actually measuring and how to interpret this. You state that the ‘magnitude of navicular motion was calculated as the difference between elongation of the stretch-sensor at heel-strike and maximal elongation at stance”. Yes this will provide the range, but what say kinematic measure may this relate to? Do you have any comparison data? How do you expect people to use this data (i.e. in say a foot orthotic prescription??).

8. Please justify your choice of statistical tests. You have a repeated measures analysis – all participants conducted testing in all 5 conditions. How have you allowed for multiple comparisons? Why haven’t you run a mixed model or ANOVA and then corrected for multiple comparisons post-hoc??

Results

9. I need to be ensured that the testing order of your condition did not induce systematic fatigue before I can believe the results you present.

Discussion

10. You state this is a viable method to assess in-shoe foot motion. Please do not exaggerate your results. If anything you have shown it can measure navicular motion, but even with this, you haven’t provided an interpretation as to what plane the motion is in.

11. Again you state navicular and rearfoot motion can be considered proxies for foot pronation – either provide references to support this, but i consider the rearfoot and navicular to do two different things. This has been proven with Nester and co’s bone pin work.

Limitations

12. You state data from one participant was excluded for treadmill running? Please ensure that this participant wasn’t then included in the other conditions? I would expect this participant to be excluded from all data comparisons and therefore from the study. Please confirm each condition had a sample of 20 subjects.

Conclusions
13. You are not measuring in-shoe ‘foot’ motion. This is easily misinterpreted. Throughout the paper, please ensure you state you described navicular motion.

MINOR ESSENTIAL REVISIONS

Background

14. The authors provide a number of references to support their argument which is great. In light of developments in technology and advances in methods to assess foot movement, I do believe more recent references (rather than or in addition to 1982 papers for example) seem appropriate.

15. In relation to the Christensen paper, please provide accuracy information about the sensor. I need more the reliability here – Just because something is reliable, doesn’t mean it is accurate. Think SEM, sensitivity/specificity. This may either fit in the background or methods, but given the aim and outcome measures sued, I would want to know how accurate your new device is.

Methods

16. Please provide demographics of participants (including height, body mass, BMI) here. I understand they are in results, but I don’t believe they need a table and simply could be written in text to describe your population.

17. Please provide anthro details of participants. Info relating to navicular height, foot length or truncated length, FPI etc would all be interesting data.

18. Please provide a reference for the Declaration of Helsinki

19. Acclimatization is difficult. How did you measure their comfort, and why was this chosen?

20. Please provide a reference indicating the accuracy of detecting heel strike with a heel switch.

Results

21. If you excluded 6 people, don’t state your sample is 26 upfront. State its 20. This could easily confuse people.

22. Please provide Units in Table 2 for motion. Also, I presume the brackets are the 95% CI for navicular motion – please state this as its not clear

23. Where you provide percentages which I agree are easy to interpret, please provide magnitude of change and the effect size also.

Discussion

24. Throughout the discussion, please do not infer results from the navicular equal ‘foot’ motion. Report exactly what you measured and found.

25. When you talk about differences over-ground vs treadmill, the discussion would benefit from citing the 3D kinematics literature of what’s available and been found previously.
Limitations

26. How could you be sure the stretch-sensor hadn’t be loosened but undetected in other conditions?

**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