

July 16, 2015

Dear Editor,

Please find enclosed the edited manuscript in Word format (file name: 20156-Review).

Title: Reliability and validity of electromagnetic tracking systems and digital inclinometers for collecting shoulder kinematic data: a literature review.

Author: Hannah DC, Scibek JS

Name of Journal: *World Journal of Orthopedics*

ESPS manuscript NO: 20156

We would like to thank the reviewers for providing insightful comments, which have been utilized to generate a more polished product. The manuscript has been revised according to their suggestions as outlined below:

Editor Comments

- 1. Title should be no more than 12 words. It should be specific, descriptive, concise and comprehensible to readers outside the subject field, and it should include the wording related to the field of gastroenterology. All nonfunctional words should be deleted, such as "a", "an", "the", and "roles of", etc. Avoid abbreviations if possible.**

Revised title: Collecting shoulder kinematics with electromagnetic tracking systems and digital inclinometers: a review.

- 2. Please put the reference numbers in square brackets in superscript at the end of citation content or after the cited author's name. Please check across the text.**

Revised.

Reviewer 03065771

- 1. Please provide a correction of english wording. In some sentences there are minor flaws, that can be easily corrected.**

The paper has been reviewed for grammatical errors.

Reviewer 03070252

- 1. Overall a good review of the literature on these shoulder kinematic measurement systems. I would recommend a few paragraphs on the utility of these measurements both in the clinical setting (i.e. diagnostic and treatment) as well as in research. Why should the reader care about this technology? Page 9: caution against using the term**

'gold standard' unless this is a commonly used technique and has been validated in clinical trials.

As a result of comments from multiple reviewers we have added a section on the clinical implications of utilizing these instruments in the collection of shoulder complex kinematic data. We agree with the reviewer that the term "gold standard" may not be the most appropriate choice; however, we have decided to utilize this term to maintain consistency with the established literature.

Reviewer 01221818

- 1. I found the paper to be quite interesting and generally well written. I would suggest a table summarizing the principal advantages and disadvantages about the ETSs and digital inclinometers.**

As a result of comments from multiple reviewers we have added a section on the clinical implications of utilizing these instruments in the collection of shoulder complex kinematic data.

Reviewer 03068313

General Comments

- 1. Would it be possible to number the titles? It's difficult to follow section vs subsection titles.**

Revised.

- 2. It is not clear for me if your objective is to describe ETS used in a clinical context only or also for in-vitro studies. According to me the objectives, focus and conclusions would differ depending the case. In that sense, if your objective is to review both, maybe should you clearly highlight the advantages and drawbacks of ETS in each case (clinical and in-vitro).**

Please find our responses to the specific comments below that address this comment.

- 3. Moreover, you stated several times that invasive methods, even if gold-standard, cannot be used due to their inherent nature. However, what is the problem if used for in-vitro studies?! Maybe should you discuss this point a little.**

Please find our responses to the specific comments below that address this comment.

- 4. Several times in your review (abstract, end of your introduction...) you stated that your objective was to compare / quantify the possible use of ETS vs inclinometers by clinicians and researchers. However, I noted that you indeed did it only in the section "Humeral tracking methods". Please, revise: either adapt your objectives, or add some comments. I understand that your plan was 1/ ETS, 2/Inclinometers and 3/ comparison; but, according to me, you did not match to your plan and this result in a missing comparison.**

Please find our responses to the specific comments below that address this comment.

5. It would probably helpful if you could add 2-3 sentences at the end of your introduction to describe the plan of your review and a short description of the content of each section.

Please find our responses to the specific comments below that address this comment.

Specific Comments

Abstract

6. Please, revise, based on comments I wrote below.

Revised.

Introduction

7. p.4, l. 20 - Reference 14: authors do not use any electromagnetic system.

Revised.

8. p.5, l. 5-7 - "Clinically accessible methods have been established that qualitatively and quantitatively assess scapular resting position and scapular orientation during humeral elevation:" Who / What study did established it? Have you a/several reference(s) or is it your assumption?

References have been added.

9. General comment - I found your introduction rather difficult to read; I have been unable to understand your organisation and what are really the problems and limitations of previous studies you cited. In fact, it is as if you started your review in the introduction. According to me you should reduce the length; be more concise, summarize your text and succinctly explain why you think that a review is needed (and, like you, I am convinced of it!!)

The introduction has been reduced in length and revised to improve understanding for the reader.

Electromagnetic Tracking Systems

10. p.6, l. 7-9 - About direct and alternating current: why did you mentioned the two types of ETS? If you consider this difference as an important aspect, you should describe the consequence of choosing one or the other.

This information has been omitted as it is not an important aspect of this paper

Standardization of Analyzing and Reporting Shoulder Kinematics

11. General Comment - I am not sure this aspect has to be described with such a level of details. In fact shoulder kinematics analysis is not inherent to ETS: whatever the acquisition method is, a post-treatment analysis is needed to extract arm motion using transform matrices and rotations sequences.

After review of the paper we agree with the reviewer's comment. As such, this section has been omitted from the paper. A comment regarding the post-treatment analysis has been added to the end of the Electromagnetic Tracking Systems section to make note of the necessary component of data analysis.

12. p.6, l. 19 - **"This recommendation is an updated version of the initial proposal by van der Helm": I would have appreciate a little more detailed description regarding the difference(s) between ISB and Van der Helm, for both systems? Maybe 2-3 sentences to explain to the reader the rationale of these differences and/or a table to easily visualise differences between versions.**

Please see our response to comment #11.

13. p.7, l.8 - **"While the risk of clinical misinterpretation exists, the decreased risk of approaching gimbal lock takes precedence to avoid associated measurement errors". Maybe could you cite the study of {Senk:2006kk}: in this paper, authors were interested in studying the effect of rotation sequence on gimbal-lock and amplitude interpretability of the performed movements.**

Please see our response to comment #11.

Calibration

14. **General Comment - Very interesting paragraph! Did you also read the paper of Hagemeister and col about a simple method to correct field distortion when using Fastrack system {Hagemeister:2008ga}? If not, it could interest you.**

We thank the reviewer for the suggested reference; however, the intention of our paper is to focus on those techniques specific to the collection of shoulder kinematics. As the Hagemeister et al paper examines the effects of field distortion while collecting knee kinematics, and considering there are several other published papers regarding calibration techniques for various applications, we feel that a separate review paper would be more appropriate to address this topic thoroughly.

Scapula Tracking Methods

15. p.9, l.3 - **"Three methods have been described": I see only 2 methods: invasive and non-invasive. What is the third?**

The wording in this section has been revised to identify the three noninvasive methods: scapula locator, scapula tracker, and acromion method.

16. p.9, l.3 - **"Non-invasive dynamic methods have been described and validated11; however, the use of the scapular locator during quasi-static analysis has been viewed as the "silver" standard":**
a. **Why "However"?!**

Revised

- b. **Why "quasi-static"? You mentioned "dynamic" methods; are they the same?**

No. Comments have been added to the first paragraph of the Scapula Locator section to provide clarification.

- c. **This is right for clinical studies; but invasive methods are appropriated for in-vitro studies. Could you discuss? (See general comment at the beginning of my review)**

This section has been revised to provide clarification.

Scapula Locator

17. **p.9, l.10 - "An electromagnetic sensor affixed to the jig to allowed orientation of the locator relative to the thorax to be recorded by an ETS": I don't understand. Please, check language.**

Revised.

18. **p.9, l.11 - "This apparatus eliminated the need to individually digitize the three anatomical landmarks as described by van der Helm,¹³ which decreased error and increased speed of analyses": Has it been tested in terms of accuracy and/or repeatability? If yes, what are the results? Could you discuss a little more about the drawbacks of this method since it seems to solve the main problems related to scapula?**

Please see the last two paragraphs in the Scapula Locator section that address these questions.

19. **p.9, l.23-24 - "The authors¹² speculated an improvement compared to Johnson et al¹⁶ based on an improved design of the scapula locator": Which one?!**

In addition to the sentence being omitted, the preceding sentence was revised to add clarification.

20. **p.10, l.14-16 - "The scapula locator has been established as a reliable method for measuring quasi-static three-dimensional scapula kinematics. However, the locator has not been compared against the gold standard method to establish accuracy.": I am surprised and not sure I agree: I am not so convinced that about 12° to 17° (depending the axis) is really accurate. Maybe could you nuance the conclusion.**

This paragraph has been revised to add clarification. The Langenderfer et al study was a modeling study that demonstrated how much variability was added by palpation error of only 4 mm.

Acromion method

21. **General Comment - Overall, I would appreciate if you could detail just a little about the "acceptance criteria" to conclude that the described methods are accurate enough. How is the threshold value defined?!**

No specific value was defined. Please find the revision made to the Scapula Tracker section that addresses the "acceptance criteria."

22. p.12, l.17-18 - "In addition, these two methods have not been studied with ETSs; therefore, investigation into the utilization of these calibration techniques with ETSs is warranted": I don't understand the relation between the first part and the second part of your sentence. Could you clarify?

Revised.

Analysis of Isolated Planar Motion

23. General Comment - Why did you write this section here? I don't understand the logical relation with previous section.

The sections Analysis of Isolated Planar Motion and Analysis of Functional Activities discuss studies that have examined the reliability of tracking scapular motion utilizing the acromion method during either of the two situations. Additionally, we are hopeful that numbering the headings and subheadings will provide added clarification.

24. General Comment - Could you synthesize? The section is very interesting but you should summarize a little more to give only main conclusions to the reader.

Revised. Also, to improve clarification we have summarized the information into a table (see Table 1).

Analysis of Functional Activities

25. p.15, l.10-11 - "Only two studies in the literature were found that investigated the reliability of tracking dynamic scapular orientation angles during functional movement patterns": I know that the topic is ETS and that you made reference to such studies; but maybe could you clarify it (i.e., add "ETS" at the end of your sentence.

Revised.

Humeral Tracking Methods

26. p.16, l.17-20 - "Like the scapula, the current gold standard for tracking humeral kinematics involves invasive use of transcutaneous cortical pins being placed in the humerus.^{41,42} However, these types of studies are not applicable to large-scale clinical studies due to the invasive nature of the method": You already stated it. Please, synthesize.

Revised.

27. p.16, l.17-20 - "LaScalza et al⁴³ compared humeral kinematic data collected with a humeral cuff against a bone-fixed sensor in five cadaver specimens": Refer to my general comments (beginning of my review): before reading this section, I thought your objective was to describe ETS accuracy and advantages/drawbacks for a use in a clinical context.

While the study by LaScalza et al utilized cadaver specimens, we find this study to be valuable as the study attempted to establish a noninvasive method that can be utilized in a clinical context.

Inclinometers

- 28. p.18, l.23 to End Of Paragraph – Please, refer to my general comments (beginning of my review): are you limiting your review to tracking motion for clinicians? If yes, you should revise abstract, introduction and other non-clinical references thorough your text.**

In addition to the revised abstract and introduction, we find that the added Clinical Applications section provides added clarification.

- 29. General Comment – Same comment than in the section “Analysis of Isolated Planar Motion”: could you synthetize? Your review should be a summary / a comparison of all studies with a common focus; it should not be a list of results picked in the papers.**

The section has been revised to improve synthesis of the selected studies. Additionally, the reliability content has been condensed into a table (see Table 2) to improve clarity.

Conclusion

- 30. p.21, l.16-17 – “The evidence presented in this review demonstrates that ETSs and digital inclinometers are reliable and valid instruments”: I cannot see this “evidence” after reading your review. You should emphasize more on discussing and comparing the two methods, rather than only writing a list of results.**

Revised.

- 31. p.21, l.18-20 – “digital inclinometers are much more cost effective and practical in clinical settings.”: according to me your review does not support this conclusion. You are probably right, but it is not the topic of your comparison.**

The new section “Clinical Applications” provides added support for this conclusion.

We thank you again for considering our manuscript for publication in the *World Journal of Orthopedics*.

Cordially,

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