Author's response to reviews

Title: The effects of a three-week use of lumbosacral orthoses on trunk muscle activity and their response to trunk perturbations.

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Author's response to reviews: see over
Editor,  
BMC Musculoskeletal Disorders  

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RE: The effects of a three-week use of lumbosacral orthoses on trunk muscle activity and their response to trunk perturbations.

Dear Editor,

Enclosed please find our revised manuscript, which we would like you to consider for publication in BMC Musculoskeletal Disorders. This material and results have not been published or submitted for publication elsewhere. The manuscript contains information relevant to current rehabilitation strategies for low back pain. We addressed all of the points raised by the reviewers and described our changes below.

Sincerely yours,

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We thank the reviewers for their insightful and constructive comments. We addressed all of the points raised by the reviewers in the revised manuscript. We feel that these changes greatly improved the quality of our manuscript. Below is the list of specific revisions and responses to all comments.

**Dr. Hans-Rudolf Weiss**

1. In this paper the most important literature is cited, however it is not discussed, that in this literature most of bracing strategies have been prone to malcompliance. The success rate of such a treatment in general does not appear to be high and compliance is generally described as moderate or poor [3,4,5], however a significant pain reduction has not been reported upon in the literature [5,6]. I feel it is necessary to discuss more the problems with bracing in general…

We added the following paragraph to the introduction:

A systematic review within the framework of Cochrane Database [18] concluded that there was no evidence that lumbar supports are effective in preventing LBP, but it remained unclear whether they are effective in the treatment of LBP. However, the authors noted that the overall methodological quality of the studies in this review was rather low. One of the most frequent threats to validity was low patient compliance.

2. Discuss, why specifically this brace has been tested and not another kind of braces.

The LSO used in the current study (Aspen) was compared with Boston and Cybertech braces. It provided similar biomechanical effects. However, the aspen LSO was considered much more comfortable, which would likely increase subject compliance. We already have the following statement in the methods:

This device restricted trunk range of motion and increased trunk stiffness by amounts similar to comparable orthoses on the market, but was rated significantly more comfortable to wear by subjects [4].

3. Additionally I have no clue, how the authors come to the conclusions, that a 3 hr. period / day will have a significant influence. Was this brace wearing time chosen randomly or is that based on certain reasons? Would the conclusions be the same when the brace would have been worn longer?

We added the following explanation in the methods/protocol section:

Our preliminary studies suggested that healthy subjects might not comply with wearing an LSO for a longer period.

The question of whether any effects of LSOs could be realized with longer period of use is very interesting and requires a separate study. Our results are limited to a 3-week, 3-hour/day of use of the LSO. In every conclusion presented in the manuscript, we clarified that a LSO was worn only for “3 hours a day”. We also have a statement in discussion about the study limitations:
Wearing a LSO 3 hrs a day for 21 days may not have been enough time for significant neuromuscular changes to occur.

4. A description of the brace to more extend would be helpful to understand brace action. Also some more figures from all four sides of the brace would help the reader to understand the specifics of this very brace.

We now included anterior, lateral, and posterior views of the LSO used in the current study in Figure 1.

Dr. Jim Potvin

This study was well done and very clearly presented. The authors have evaluated the effects of a particular lumbosacral orthosis on spine’s anticipation and response to sudden unloading in young, healthy adults. The presentation and interpretation of the results was extremely effective and the study represents very good science addressing a relevant issue. The author delimit the constraints of the study and identify the need for further studies with longer duration use and use by subjects with LBP, for whom such devices are often targeted.

Major Compulsory Revisions:
None

Minor Essential Revisions:
1. p6/l18: It is stated that: “The pressure measurement was repeated at the beginning of each testing session to standardize the LSO tension for all subjects”. Please clarify this statement. Is it fair to assume you mean the pressure was set to 35 mmHg before each session?

We clarified this statement as suggested:

The pressure measurement was set to 35 mmHg at the beginning of each testing session to standardize the LSO tension for all subjects.

2. p7/l11: Was there a particular rationale for setting the female values to 70% of that for males?

The maximum trunk moments generated by females have been estimated in previous literature to be 50-60% of the moments generated by males (e.g. McNeill et al., 1980. Spine 5:529-538). In our experimental setup, we also noted trunk loads exceeding 115N become uncomfortable to the subjects and loads less than 80N provided negligible trunk displacements. We inserted the following sentence in the methods:

As in our previous studies, the target force was set at 115 N for men and 80 N for women. Upon release, these forces resulted in the largest possible trunk displacement without being physically uncomfortable to the subjects [6, 30].

As a side note, we corrected inaccurate force target values from 100N and 70N to 115N and 80N.
3. p8/L23: Why was the source not mounted to the sacrum? Are you confident that the pelvis did not move with respect to the testing apparatus? If not, this limitation should be addressed in the Discussion.

Had the source been mounted on the sacrum, it would have interfered with the posterior fixation of the pelvis. Significant movement of the pelvis was specifically addressed using 4 point pelvis fixation: at the acetabulum via fixed femurs, at the ischium, and at the anterior and posterior superior iliac spines. The target release force was also kept the same in all experimental conditions, which would control for any remaining variation as an equal force would result in equal pelvis displacement. As systematic error was controlled in this manner, we did not consider this as a limitation. However, we added a sentence to the methods to clarify why the movement of the pelvis was unlikely to affect our results:

_The pelvis was fixed at 4 points: the acetabulum via fixed femurs, the ischium, and at the anterior and posterior superior iliac spines. Thus, any postural adjustments through hip, knee or ankle joints were eliminated._

4. p10/L1: It is suggested that you change the wording "longer than 150 ms" to something like: "initiated more than 150 after the stimulus". The current wording implies that you are interested in the actual duration of the response, and not the timing of its initiation.

We re-wrote this sentence as follows:

_The assumption was made that reflex responses could not occur earlier than 20 ms after the stimulus. Responses occurring later than 150 ms after the stimulus may represent voluntary and not reflexive muscle activity._

5. p11/L18: With the EMG-based optimization, the gains can be different between samples, muscles, trials and conditions. For the purposes of this particular study, it is important that there was not a systematic difference in these gains between the control and LSO trials. Do you have data to confirm that there were no such systematic differences in gains, that could have masked potential differences in calculated muscle forces and, subsequently, compression forces between these conditions.

This is an interesting point. Unfortunately, there is not any practical way to compare the gains between samples, muscles, trials and conditions. There are 90 different gains (for 90 muscles) for each experimental condition and the study would then be underpowered for any statistical test to be valid. However, it is very unlikely that gains could introduce systematic errors. The optimization scheme is designed to increase and decrease the EMG-predicted forces in a roughly similar number of the muscles to match the external moments. If a different muscle recruitment pattern produces the same external moments, the optimization will preserve this relative pattern (Cholewicki et al., 1995. J Biomech 28:321-331).

6. p12/L3: The two sentences, regarding the Box-Cox transformation, are redundant.

The first sentence was deleted.
7. p13, last sentence: "Table 2" should be Table 3 and/or Figure 4. Also, Table 3 and Figure 4 show essentially the same information such that one could be removed.

We removed Table 3.

Discretionary Revisions

8. p13/L8: It is not clear that the LSO was solely responsible for the increased effective trunk stiffness. There may have been some muscle contribution to this. It may be more appropriate to state that the LSO condition resulted in significantly higher stiffness values.

Since trunk muscles’ EMG did not change when a LSO was worn, it is safe to conclude that the LSO was responsible for the increased trunk stiffness. Furthermore, effective stiffness and damping, as measured in our study, include muscular contributions. However, spurred by the reviewer’s accurate comment, we removed the word “passive” when referring to the effect of LSO. Furthermore, the reviewer might be implying that there could have been some contribution from deep trunk muscles, which we did not monitor with EMG. Therefore, we added this point to the list of limitations.

Deep trunk muscles were not monitored with EMG in the current study. It is possible that activities of these muscles changed in response to wearing a LSO and they contributed to the significant increase in trunk stiffness when the LSO was worn.

9. p16/Limitations: This study was only performed with one particular LSO. It is suggested that this be mentioned in the limitations. The authors are careful to refer to it as “the” LSO, but there is no acknowledgment that the results may have been different with another LSO design.

We added the following statement to the limitations:

*The results may have been different if another orthosis was used. However, the Aspen LSO provides similar biomechanical effects to other popular orthoses on the market and is therefore representative of commonly used devices [4, 45].*