Reviewer's report

Title: Are cervical multifidus muscles active during whiplash and startle? An initial experimental study.

Version: 1 Date: 19 December 2007

Reviewer: Paul Ivancic

Reviewer's report:

General

This is a very well written and clearly presented manuscript. The authors investigate the potential role of cervical multifidus muscles in contributing to loading and injury of capsular ligaments during whiplash. In the past, hypotheses regarding anatomic components injured during whiplash have been specific to anatomic site such as muscle, ligament, vertebral artery, etc. The present manuscript is novel as it provides data to demonstrate that multiple mechanisms may exist, causing injury at multiple anatomic sites.

Major Compulsory Revisions

1. Pg 6, line 13. Please provide standard deviations for these data, which I assume are averages. The duration of the acceleration pulse, 59 ms, seems short. The sled acceleration pulse specified by RCAR ranges from 88 to 94 ms. Why was the shorter duration pulse used?

2. Discussion, para 2. The authors note that multifidus activation must occur within 125 to 160 ms following the onset of sled acceleration in order for multifidus force to contribute to collision-induced peak in capsular ligament strain. This range is based on averages of several previous studies, with the upper limit at 160 ms. It was noted that multifidus was active in the present study within 160 ms in slightly more than half of the subjects, 56% (5 out of 9), during the sled perturbations. In what percentage of subjects was multifidus active within: the lower range limit of 125 ms and the middle range of 142.5 ms? It would be helpful to provide the multifidus onset times for each subject during the sled perturbations. If the majority of these data are within the 125 to 142 ms range, then this would provide additional support for the main conclusions.

3. Discussion, 4th para. The authors did not measure multifidus force, but have deduced from literature a peak force between 11 and 67 N. This upper limit of 67 N may be high, as I am not aware of any studies that have measured or estimated this load in humans. Mathematical models have been used to estimate peak multifidus force due to maximum voluntary head extension loading. Peak computed multifidus force ranged between 42 N (Moroney, JOR 6:713-20, 1988) and 49 to 55 N (Choi, Med Sci Sports Exerc, 32(4):830-8, 2000).

The authors note that the force required to cause subfailure injury of capsular
ligament is 45 N (SD 21 N) (Siegmund, Stapp Car Crash J. 2000 44:159-70). In this previous study, the authors stretched capsular ligaments to failure at slow elongation rate of 0.01 mm/s and reported complete ligament rupture at 94 N (SD 31 N). Previous studies have demonstrated increased capsular ligament failure force with increasing elongation rate. At fast elongation rates, higher average capsular ligament failure forces have been reported: 259.7 N at 10,000 to 12,000 mm/s (Shim, Exper Mechanics, 46:77-89, 2006) and 220 N at 723 mm/s (Ivancic, The Spine J, 7:659-65, 2007). The high ligament elongation rate during whiplash may cause high failure force of capsular ligament and corresponding increase in force required to cause subfailure injury.

These cumulative data suggest that even if the multifidus can activate early enough in some individuals, it may not be able to produce large enough force to contribute injurious loads to the capsular ligament during whiplash. Please discuss these cumulative data in relation to your main conclusions.

Minor Essential Revisions

1. Results, line 1. Figure 3 does not demonstrate muscle activation in eight of the nine subjects, but rather in two. Suggest re-wording as:
"Eight of the nine subjects exhibited multifidus activity after both stimuli, as demonstrated by the exemplar data of two subjects (Figure 3)."

2. Results, para 2, line 1. Please include reference to table 1 at the end of this sentence and remove from third sentence. This will direct the reader to Table 1 when reading the entire paragraph.

3. Pg 9, line 10. Suggest re-wording the sentence "Or short, reflex...".

4. Reference 35. Please change "<" to ",".

Discretionary Revisions

None

What next?: Unable to decide on acceptance or rejection until the authors have responded to the major compulsory revisions

Level of interest: An article of importance in its field

Quality of written English: Acceptable

Statistical review: No, the manuscript does not need to be seen by a statistician.

Declaration of competing interests:

1. I also conduct whiplash biomechanics research.
2. I know two of the authors of this manuscript.