INTRODUCTION
Rollover accidents are highly dynamic and complex events in which occupants frequently contact interior vehicle areas such as the roof. When roof contacts are headfirst, injuries to the head, spine, and spinal cord can occur. Cadaveric drop tests at the University of British Columbia have shown that the type of spine injury sustained in a headfirst impact depends on vertebral alignment and the level of muscular forces at the time of impact. However, the actual configuration of the cervical spine and the level of muscle contraction immediately before a headfirst impact remain unknown. The aim of this study was to explore vertebral alignment and muscle activation in subjects asked to react how they believed that they would prior to a headfirst impact.

METHODS
Eleven human subjects were positioned in a seated, inverted posture using a custom-built chair apparatus. While inverted, subjects were instructed to perform two tasks: 1) relax and 2) use their neck and shoulder muscles to stiffen and simultaneously draw in their neck to simulate preparation for a headfirst impact. During these two tasks, neck muscle activity was recorded using wire electrodes in eight superficial and deep neck muscles (Figure 1). Subjects underwent a series of maximal isometric muscle contraction trials, and each muscle’s activation was normalized to the activation elicited in these maximum voluntary contractions (MVC). Vertebral alignment was also measured for the two tasks using fluoroscopy (dynamic x-rays captured at 30 frames per second). The alignment of the cervical spine was assessed using 2D kinematic analysis of the dynamic x-rays.

RESULTS
Compared to their inverted resting electromyographic (EMG) activity, subjects increased their EMG activity by an average of 19% (SE: 5%) of their maximal voluntary contraction during the inverted tensed task (Figure 1). Compared to their inverted relaxed posture, subjects flexed their neck forward by 12° (SE: 4.5°) in the inverted tensed task (Figure 2). This increased muscle activation and neck flexion resulted in changes in the intervertebral alignment. Specifically, on average there was a decrease in the cervical spine curvature (Figure 2).

DISCUSSION & CONCLUSIONS
These data show that there may be large muscle activations and a realignment of the cervical vertebrae prior to a headfirst impact in a rollover collision. Although these findings will need to be confirmed in dynamic rollover conditions, they show that prior cadaver tests may not have used initial conditions relevant to a rollover collision.

ACKNOWLEDGEMENTS
Thanks to Mircea Oala-Florescu and Jeff Nickel for their help. This project was funded by NSERC-MITACS.