Neck posture and muscle activation: a human volunteer study comparing the effect of upright and inverted postures

Newell, R.1,2*, Siegmund, G.P., Blouin, J.S., Street, J.2,5, Crompton, P.A.1,2

1Orthopaedic & Injury Biomechanics Group, Departments of Mechanical Engineering and Orthopaedics (Division of Orthopaedic Engineering Research), University of British Columbia; 2International Collaboration on Repair Discoveries (ICORD); University of British Columbia; 3School of Human Kinetics and 4Brain Research Center, University of British Columbia; 5MEA Forensic Engineers & Scientists, Richmond; 6Combined Neurosurgical and Orthopedic Spine Program, University of British Columbia

Introduction

Rollover accidents are highly dynamic and complex events in which occupants frequently contact the interior of the vehicle. Injuries to the head, spine and spinal cord, due to head-first impact, are common in occupants involved in rollover accidents. Cadaveric drop tests at the University of British Columbia have shown that the type of injury sustained in a head-first impact depends on compressive neck muscle forces and the alignment of the cervical vertebrae. However, there is little understanding of how the neck posture changes when someone is upside down or how muscle control can alter this posture.

Research Aim

The aim of this study is to quantify which neck muscles are active and what the spinal posture is in an upside-down configuration.

Methods

• Subjects (n=3) were placed in an upright and inverted configuration using a custom built chair apparatus (Figure 1).
• For both conditions, neck muscle activity was recorded using electromyography (EMG) and vertebral alignment was measured using fluoroscopy.

Methods – Electromyography (EMG)

• Indwelling wire electrodes (Figure 2) were used to measure neuromuscular response of 7 cervical muscles (Figure 3) and surface EMG was used to measure Sternohyoid activity.

Methods - Fluoroscopy

• A fluoroscopic c-arm was used to capture dynamic X-rays of the cervical spine (Figure 4).
• Cervical Curvature Index (C.C.I.) was used to quantify the changes in neck posture [2].

Results

• Neck muscle activity increased in the inverted position; for the SCM and SPL it was >10 times higher (Figure 5).
• Compared to the upright configuration, the C.C.I. increased slightly when the subjects were inverted and looking forward, and doubled when they relaxed (Figure 6).

Expected Contributions

This study provides a unique in vivo data set of vertebral and muscular response to inverted configurations, which can be used to develop, improve and validate head-first injury models. Ultimately, application of this data has the potential to advance injury prevention strategies through vehicle design and improved sporting equipment.

References:

*Contact: newellr@interchange.ubc.ca

Figure 1: Photos of a subject in the inverting device.