Cazzola, D, Holsgrove, T, Preatoni, E, Gill, H & Trewartha, G 2016, MASI: a novel Musculoskeletal model for the Analysis of Spinal Injuries. in Conference Abstracts of Biomechanics and Neural Control of Movement (BANCOM) 2016. BANCOM 2016: Biomechanics and Neural control of Movement, Mount Sterling, USA United States, 12/06/16.

Publication date:
2016

Document Version
Peer reviewed version

Link to publication

Publisher Rights
Unspecified

University of Bath

Alternative formats
If you require this document in an alternative format, please contact: openaccess@bath.ac.uk

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Cervical spine trauma from sport collisions or vehicle accidents can have devastating consequences for individuals and a high societal cost. The precise mechanisms of such injuries are still unknown as investigation is hampered by the difficulty in experimentally replicating the conditions under which these injuries occur.

We report on the creation and validation of a generic musculoskeletal model for the analyses of cervical spine loading in healthy subjects. The novel improvements embedded in MASI consist of i) a scapula-clavicular joint (SCJ) that provides the coupled motion of scapula and clavicle with respect to humeral elevation, ii) the inclusion of body inertial parameters to permit dynamic analyses, and iii) an optimised scaling of neck muscles maximum isometric force. The verification and validation procedures consisted of i) SCJ kinematic validation, ii) a dynamic verification, and iii) a dynamic validation.

The ‘Musculoskeletal model for the Analysis of Spinal Injuries’ (MASI) was created in OpenSim 3.2 and Matlab 2013b software. MASI inherited the structure of the OpenSim head and neck model [1] which we embedded into a full body model (OpenSim ‘2354’). Experimental data of full body kinematics (Oqus, Qualisys), ground reaction forces (9287BA, Kistler) and neck muscles’ EMG (Delsys Trigno, DelsysInc) of a healthy male subject (age: 64 years, height: 1.67 m, mass: 75 kg) were collected during neck flexion, extension, lateral bending and axial rotation movements. The SCJ kinematics throughout the humeral range of motion were within 2 standard deviations (SD) of previous in vivo and in silico studies. The passive neck joint moments were comparable with in vitro data (2 Nm) [2], and maximal net joint moments were comparable with healthy male subjects’ neck strength (Ext: 50.8 Nm, Flex: 10.3 Nm, Lat Bend: 31.3 Nm, Ax Rot: 12.4 Nm). Finally, computed muscle control simulations driven by in vivo neck kinematic data successfully simulated neck muscles’ activation (Fig. 1).

**Figure 1:** The simulated muscles (solid line) activation showed a similar pattern and activation level in comparison with the recorded EMGs (dashed line) across the neck movements.

The implementation of MASI for the analysis of dynamic loading experienced in both sporting and occupational activities will provide a greater understanding of the underlying mechanisms of cervical spine injuries.

**References**

**Acknowledgments**
This project is funded by the Rugby Football Union (RFU) Injured Players Foundation.