

Cervical spine injury in rugby: is buckling the most likely injury mechanism?

P Silvestros and D Cazzola

Department for Health, University of Bath, United Kingdom



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AIM

Investigate the effect of **i)** neck muscle activation level, and **ii)** neck flexion angle on individual vertebral loading due to misdirected rugby scrum loads.

METHODS

- Three-player rugby union front row engaged against a scum machine with an instrumented anthropometric testing device (ATD) (Hybrid III, Humanetics, Germany), (Fig 1).
- **Forward dynamic simulations** (OpenSim 3.3, Stanford University, USA) using the population specific “Rugby Model” [1] were run by prescribing experimental data.
- **Impact** force and moment data from ATD at 500 Hz
- **EMG bilaterally** from sternocleidomastoid and upper trapezius at 2 kHz (Delsys Trigno, Delsys Inc, USA).
- **Joint Reaction Analysis** was performed on **C4, C5 and C6** vertebral levels

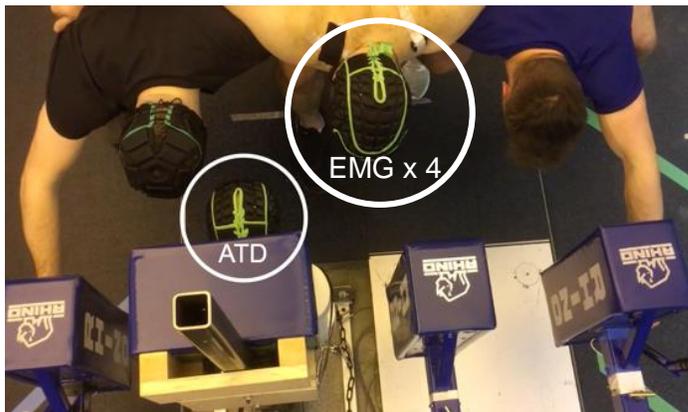


Fig 1: Experimental setup including an ATD positioned between scrum machine beams in the hooker position.

RESULTS

- **Timing of peak** compression was at 28-30 ms whilst peak impact load at 80 ms
- **Angles greater than 20°** increased compression on C4-C6 (Fig 2).
- **Higher muscle activations** increased cervical spine compressive load but decreased shear on C5 and C6

CONCLUSION

- **Contrary to previous studies** [2] our results showed a dual scenario: **i)** muscular pre-activation and higher levels of stiffening generates greater compressive forces potentially predisposing to injury, but **ii)** they can also decrease the shear load on C5 and C6.
- **Peak force timings support** that neck injuries occur significantly earlier than cervical hyperflexion [2].

REFERENCES

- [1] Cazzola D, et al. (2017). *PLoS ONE*. 12(1)
[2] Nightingale, R. W., et al. (2016). *Journal of Biomechanics*, 49(4), 558–564.

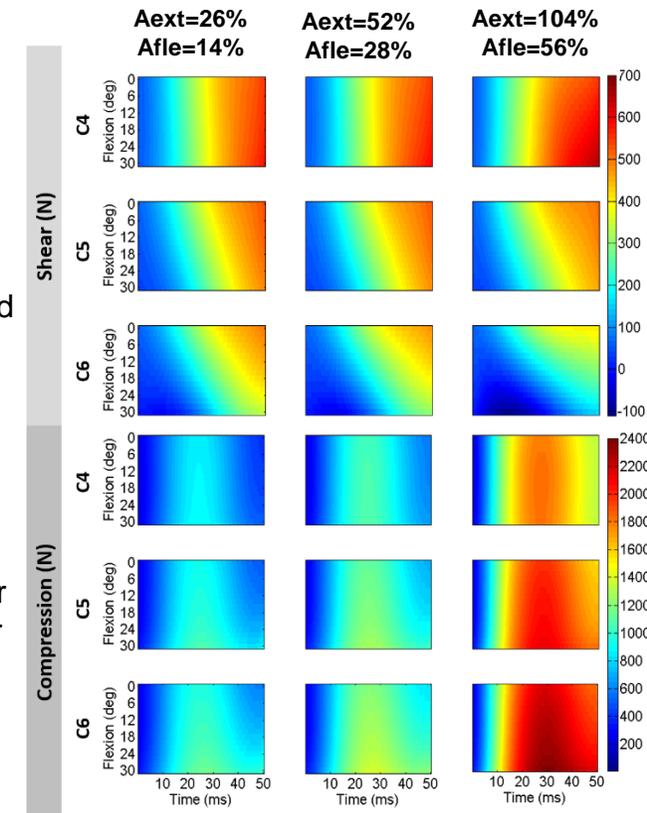


Fig 2: Vertebral (C4, C5 and C6) shear and compression response to impact load of ~ 2.2 kN during three linearly scaled muscle activations (normalised to MVC).

