INFLUENCE OF ACTIVE CERVICAL PARASPINAL MUSCULATURE ON FACET JOINT CAPSULE STRAINS AND LOADS

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INTRODUCTION
Previous work from our group has identified extensive ligamento-muscular reflex pathways between the cervical facet joint capsule (FJC) and the superficial and deep cervical paraspinal musculature, both ipsilateral and contralateral to the stretched FJC, which were activated by physiologic low-rate (0.5 mm/s) [1] and high-rate (100 mm/s) [2] FJC stretch. Since approximately 22% of the FJC is covered with muscle insertions [3], the effects of active physiologic and neuromuscular systems on FJC biomechanics warrant investigation. In this abstract, we report our qualitative observations of the influence of cervical paraspinal muscle activity on FJC strains and loads during mechanical testing in an in-vivo goat model.

METHODS
Ten caprine C5/6 FJC preparations were subjected to low-rate (0.5 mm/s) and high-rate (100 mm/s) incremental tensile stretch-to-failure paradigms. All animal handling procedures were reviewed and approved by our Institutional Animal Care and Use Committee. Capsule loads during the stretch applications were recorded via miniature load cell, and 3D capsule strains (based on stereoimaging of an array of markers on the FJC surface) were reconstructed using finite element methods. Muscle activity (EMG) during stretch applications was recorded from the sternomastoid (SM) and longus colli (LC) muscles bilaterally at the C5/6 level. The dorsal musculature on the left side of the spine was retracted to allow visualization of the left C5/6 FJC during tensile stretch, thus trapezius (TR) and multifidus (MF) muscle EMG was monitored at the C5 and C6 levels on the right side only, contralateral to the stretched FJC [1,2].

RESULTS
Under low-rate stretch, a rise in EMG (contralateral C6 MF in particular) corresponded to a rise in capsule strain and capsule load (Figure 1). Under high-rate stretch, increases in capsule load during the 10 s hold at maximum capsule displacement (i.e. while actuator was stationary) reflected contralateral C6 MF activity during this time (Figure 2). Muscle activity did not appear to influence capsule strains under high-rate stretch. Contralateral C5 and C6 TR activity also appeared to influence the magnitude of the peak loads achieved in each test increment under both low-rate and high-rate stretch, as well as the magnitude of the peak strains achieved in each test increment under low-rate stretch. Muscle activity was also observed in ipsilateral muscles from which EMG was not being recorded.

DISCUSSION AND CONCLUSIONS
The effects of active musculature are not a consideration in conventional in-vitro joint biomechanical tests. Although muscle activity could not be recorded from muscles directly attached to the left FJC, the results of this in-vivo study suggest that an active neuromuscular system may have a substantial impact on the biomechanical response of the cervical FJC in both physiologic and injurious ranges. Since many biomechanical modeling applications rely on tissue tolerance data to predict the biomechanical response and injury threshold of the tissue, and currently available cervical FJC injury tolerance data were largely derived from cadaveric tissue specimens [4,5], further investigation of the effects of active musculature on cervical FJC biomechanics is warranted.

REFERENCES

ACKNOWLEDGEMENTS
This research was supported by CDC grant #R49-CE000455 (JMC) and a Thomas C. Rumble Graduate Fellowship (NRA)