BP-08

Cervical Muscle Adaptations and Spinal Alignment Changes Under Helmeted Conditions from Upright MRIs

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Background: Certain occupations such as firefighters and defence personnel wear helmets. Added helmet mass is associated with increased prevalence of neck pain and early spine pathologies. Understanding biomechanical impacts of these devices on cervical musculature is crucial for preventing long-term complications.

Research Question: How do muscle morphology and alignment adapt to added axial loading across different levels, and what are the implications for neck stability?

Design: Prospective study using upright MRI to quantify changes in muscle cross-sectional areas and spinal alignment parameters before and after helmet wear.

Methods: Twenty-three healthy subjects (men age 33±4 years) wore helmets for 4 hours. Upright MRIs were obtained before and after helmet use. Cross-sectional areas of sternocleidomastoid (SCM) and multifidus (MF) muscles were measured at C2-C7. Segmental Cobb angles, disc geometries, and muscle morphometrics were obtained. Inter- and intra-observer reliability was statistically assessed (ICC[3,1]).

Results: Pre- and post-helmet measurements showed consistent patterns of muscle area distribution across cervical levels, with larger cross-sectional areas at lower cervical segments for both muscles. ICC(3,1) showed excellent measurement intra- and inter observer reliabilities. While individual muscle measurements showed minimal acute changes, analysis revealed evidence of coordinated adaptation patterns between flexor and extensor muscles, particularly at the cervicothoracic junction.

Discussion: Despite the lack of acute morphological changes, coordinated muscle responses suggest an adaptive mechanism to added helmet loading on the in vivo head-neck. These findings provide quantitative evidence of cervical muscle behavior under axial loading and have implications for military and civilians. Understanding these adaptations is crucial for developing strategies to prevent neck pain and optimizing helmet design.

Fig. 1

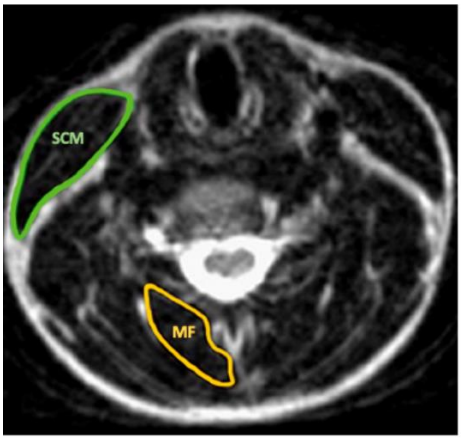


Fig. 2

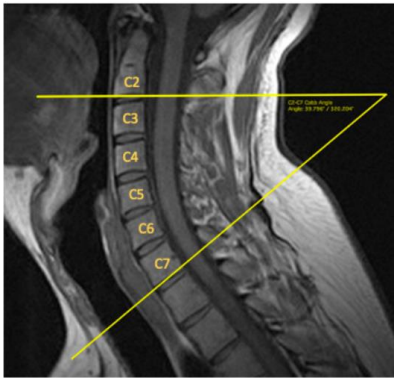


Fig. 3

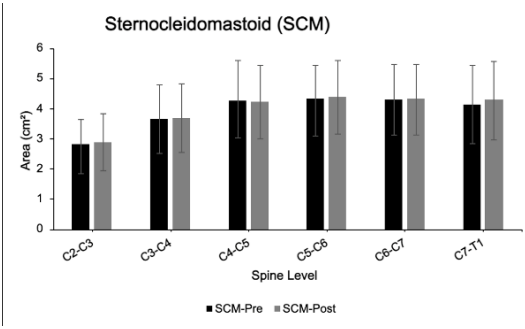
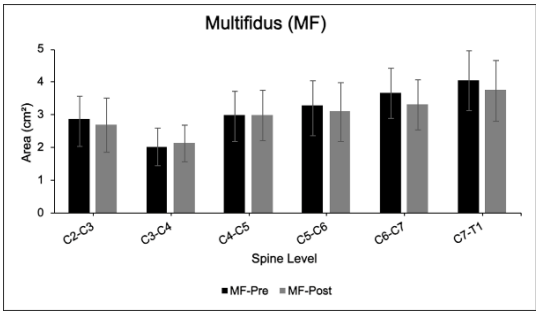

Sternocleidomastoid (SCM)
Area (cm²)
0
1
2
3
4
5
6
C2-C3
C3-C4
C4-C5
C5-C6
C6-C7
C7-T1
Spine Level
SCM-Pre
SCM-Post

Fig. 4


Multifidus (MF)
Area (cm²)
0
1
2
3
4
5
C2-C3
C3-C4
C4-C5
C5-C6
C6-C7
C7-T1
Spine Level
MF-Pre
MF-Post