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The Effect of Dynamic Injurious Axial Impact on Human Cervical Intervertebral Disc Pressure Response: Methodology & Initial Results

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Abstract-

Cervical spine (c-spine) injuries are a prominent concern in sporting activities, and dynamic axial (i.e., head-first) impacts are associated with a high risk of c-spine trauma. This methodology study implanted pressure sensors in post-mortem human subject (PMHS) cervical intervertebral discs (CIVDs) to assess biomechanical response and disc pressure changes during dynamic injurious axial impacts. Two fresh frozen male head–neck PMHS (cephalus with complete c-spine) were instrumented with miniature pressure sensors (Model 060S, Precision Measurement Company, Ann Arbor, MI, USA) at three CIVD levels (upper, middle, and lower c-spine). Experiments replicated the Nightingale et al. studies, simulating a rigid unconstrained head vertex (0°) axial impact. PMHS were raised to a drop height of 0.53 m to reach the desired impact velocity of ~3.2 m/s and were allowed to drop vertically. Results showed characteristic c-spine deformations/buckling motion patterns and marked CIVD pressure differences between CIVD levels. The more cranial (C2–C4) and caudal (C6–T1) CIVD exhibited greater and more comparable pressure values than those of the mid-spine (C4–C6), and the pressure in upper/lower levels was at least ~four to six times higher than that of the middle. This study establishes the feasibility and assesses the potential of CIVD pressure as a biomechanical metric for assessing injurious axial loading and contributes a novel experimental framework for future injury tolerance research and model validation.

Index Terms- biomechanics; cervical spine; neck; intervertebral disc; axial impact; cadaver; PMHS; pressure; dynamic; injury prevention

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