Dynamic Response of a Human Neck Replica to Axial-Compression Impact Loading

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Purpose: A human neck replica was made to simulate dynamic response to axial loading, H1. Dynamic loading of neck replica can simulate realistic axial-compression injury to the cervical spine. H2. Severity of measured neck force depends upon impact load and velocity. H3. Neck flexion-extension position affects measured neck force. H4. Simulated neck musculature affects neck stability. Procedure: Flexible life-sized neck replica was constructed with plastic vertebrae and intervertebral discs, surrogate head, and 5 neck muscle groups were simulated with cables and static weights. Drop tower impactor instrumented with force transducer applied consistent axial loads. Force plate at base of the spine measured response at 5000 sample/sec. Motion analysis of spine segments performed with reflective markers, high-speed camera at 600 fps, and image analysis software. Sensor output amplified, and converted to force (Newtons) using data acquisition system. Neck tested in 5 positions, 2 impact loads, 2 velocities, with low and high tension neck muscles, with minimum of 3 trials per condition. Force, impulse, impulse time, and loading rate in various conditions compared with ANOVA with repeated measures, $P<0.05$. Data/Conclusions: Neck model replicated dynamic response of the neck to axial loading. Higher impact magnitude and velocity resulted in higher measured force at the base of the spine. Impact force was much higher in head-down or spear-tackling position. Impact caused extension in middle cervical spine (C2-5) and flexion in upper (C0-2) and lower (C5-7). High tension muscles resulted in higher loading rate, shorter impulse time, lower impulse, higher force, and less intersegmental motion.