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P95. In Vivo Loads in the Cervical Spine: A Preliminary Investigation Using a Force-Sensing Implant

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BACKGROUND CONTEXT: It is estimated that up to 80% of the general population will experience at least one significant bout of low back pain in their lifetime. The leading known cause of low back pain is degenerative disc disease (DDD). Many established risk factors for low back pain and DDD are mechanical in nature and are often related to occupational activities, such as poor posture and frequent/heavy lifting. Altered mechanical loading in the spine has been shown to be a potential stimulus for disc degeneration. However, a link between occupational/environmental factors and intervertebral loading has never been demonstrated in vivo. We hypothesize that intervertebral loading is highly dependent on muscle activation and recruitment. These relationships are significant because they provide a potential connection between everyday activities and low back pain.

PURPOSE: The purpose of this study was to use a novel force-sensing interbody implant to measure in vivo loads in the disc space of the goat cervical spine in real time and analyze their dependence on activity, posture, rate of motion, and whole body compensation.

STUDY DESIGN/SETTING: In vivo large animal model.

METHODS: A novel force-sensing implant was developed to directly measure uniaxial compressive loads in the goat cervical disc space in vivo. Following IACUC approval, Alpine-Nubian cross bred goats underwent anterior cervical discectomy and implant placement at C4-C5. Postoperatively, the goat performed several prescribed activities while interbody forces were measured and activities were recorded to video. For flexionextension and walking trials, measured loads were correlated to factors including head position, neck position, rate of motion, and technique.

RESULTS: For each of the 125 flexion-extension trials, the change in force magnitude was substantial with a maximum shift of 179 N as the head and neck moved from full extension to full flexion. In all trials, peak loads corresponded to extensor muscle activation during deceleration of the head/neck. Data suggest that increasing extensor muscle activity causes increased interbody loading. Altering neck position, head position, or rate of motion strongly affected the magnitude of loading. A distinct pattern of forces was also observed for walking and running that coincided with the gait cycle. Like flexion/extension data, highest forces appeared to correspond with extensor muscle activity. Force magnitude was highly dependent on head position, rate of acceleration or deceleration, and gait speed (walking versus running).

CONCLUSIONS: Results from this study indicate a strong correlation between interbody force and activity, with substantial and repeatable changes in force observed for several motions. Although muscle recruitment was not specifically measured in this study, the highest force measurements consistently correlated to maximum head deceleration during neck flexion. These points likely correspond with maximum contraction of the primary neck extensors to decelerate the head and maximum contraction of the primary neck flexors to pull the head into flexion. Furthermore, slight alterations in the technique used to achieve motion caused significant differences in the resulting loads. These results imply that muscle forces are the major contributor to axial compressive spinal loads during motion, and may play a primary role in the development of low back pain.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.