THE UNIVERSITY OF HONG KONG

DEPARTMENT OF MECHANICAL ENGINEERING

SEMINAR

Title: SPINES IN SPACE. MICROGRAVITY EFFECTS ON SPINAL DISCS

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Time: 4:00 p.m.

Venue: HW7-37, Haking Wong Building, HKU

The intervertebral disc is a viscoelastic structure that supports the human spinal column by its ability to retain fluid and bear compressive load. The anatomical composition of the disc includes a thick, collagenous annulus fibrosus which functions as a ligament, attaching to the circumference of the adjacent vertebral endplates and by doing so, retaining the proteoglycan-rich nucleus pulposus. Proteoglycans are hydrophilic and osmotically attract fluid, which facilitates the swelling that supports compressive loading on the disc. The intervertebral disc normally experiences a diurnal cycle of loading and unloading. Fluid is slowly expelled from the disc due to gravity-induced stresses that exceed the osmotic pressure, and then re-imbibed once load is removed during rest. Disc height and intra-discal pressure decrease during constant loading and are reconstituted with load removal. The time-dependent change in disc height that occurs from a constant load is termed the creep response that is well-characterizedby a fluid transport model based on permeability, viscoelasticity, and swelling pressure.

Exposure to microgravity reduces disc compressive loading. Prolonged microgravity is known to lengthen the vertebral column more than double the diurnal values, reduce spinal curvature, and atrophy spine-stabilizing muscles. Spaceflight crewmembers experience low back pain during spaceflight and a heightened incidence of herniated nucleus pulposus (HNP) post-spaceflight.

To better understand mechanisms of microgravity-induced injury risk, we characterized post-flight morphologic and biomechanical changes to lumbar and tail discs in mice acquired as part of the NASA Biospecimen Sharing Program. Sixteen female, 16-week-old, wild-type C57BL/C mice were received 48 hours after the landing of 15-day NASA shuttle mission, STS-131. Mice maintained on ground in similar cage conditions were used as controls. Compressive creep biomechanical testing was conducted on lumbar and caudal discs.

This study demonstrates that microgravity has a degenerative effect on intervertebral discs and that this effect is enhanced in discs that are less mechanically constrained. These results suggest that countermeasure efforts should focus on constraining spinal movement upon return to Earth's gravity while nucleus swelling can acclimate to terrestrial conditions. Future studies should explore the rate and effect of recovery (post-landing) on the disc to determine if the degenerative effect that microgravity poses on the disc is truly reversible.

ALL INTERESTED ARE WELCOME

For further information, please contact Dr. B.P. Chan at 2859 2632.