Naomi Kibrya, ID #23590964

Spring 2015 Research Project Abstract

EFFECT OF INJURY AND AXIAL COMPRESSION PRELOAD ON INTERVERTEBRAL DISC TORSIONAL MECHANICS

Naomi Kibrya, BioMechanical Engineering

Professor Grace D. O'Connell

About 80% of adults experience lower back pain at some point in their lives. However, treatment for intervertebral disc (IVD) degeneration and back pain is limited, due to a lack of understanding of the mechanics and function of the disc. The intervertebral disc is composed of the fiber-reinforced annulus fibrosis (AF) and the gelatinous nucleus pulposus (NP). An early degenerative change in the disc is the reduction of sulfated glycosaminoglycan (GAG) content in the nucleus, which decreases the capability of the nucleus to store water and bear load. The purpose of this study is twofold: 1) to verify the effect of axial compression preload on the torsional mechanics of the disc as reported from a study on healthy discs. 2) To compare the behavior of injured intervertebral discs to healthy discs, in order to differentiate the mechanical function of the NP from the AF. The experiment included five intervertebral disc samples that were dissected and prepared in bone-disc-bone motion segments, then potted in bone cement to ensure parallel surfaces for testing. Samples were injected with a 200µL solution of chondroitinase ABC (chABC) and 1x phosphate-buffered saline (PBS) for an injection amount of 0.3 units enzyme per mL. Samples were tested at 20N, 200N, and 500N of axial compressive preload, in random order to account for the effect of loading history. Following mechanical testing, the discs were removed from the vertebral bodies to measure their geometry. The results verified the linear trends between hysteresis energy loss and torsional stiffness with preload stress. Additionally, the results showed that stiffness of the disc changes with the onset of injury but there is no significant change in hysteresis energy loss due to injury. This validates the hypothesis that the nucleus is most responsible for compressive mechanics of the disc while the annulus fibrosis is most active during torsional motion.

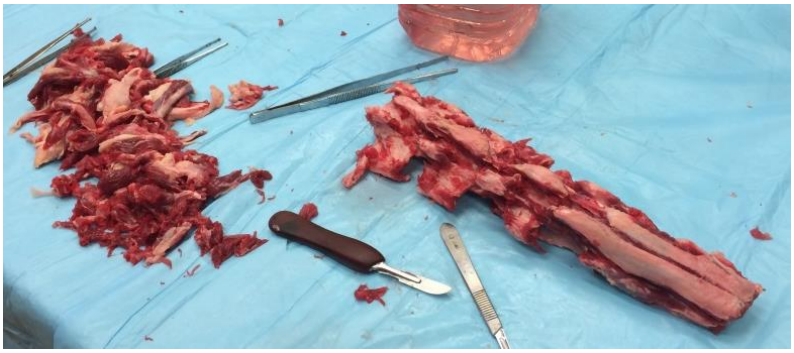

Figure.1: Partially dissected spine

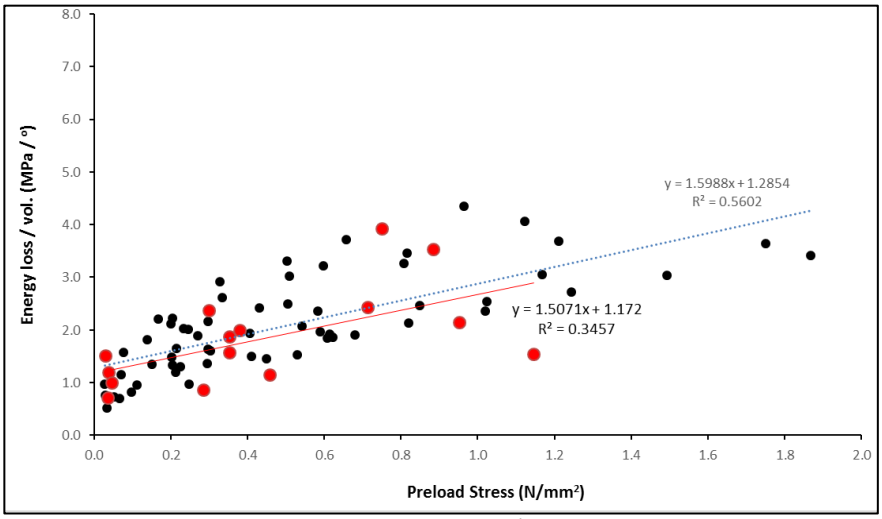

Fig.2: Sample results showing hysteresis energy loss/volume vs. preload stress. Injured samples are plotted in red, healthy samples in black. There is no change with injury.

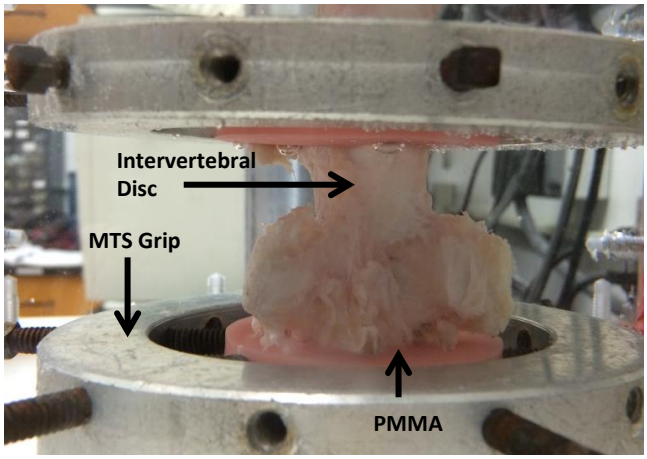

Fig.3: Experimental setup for mechanical testing with MTS

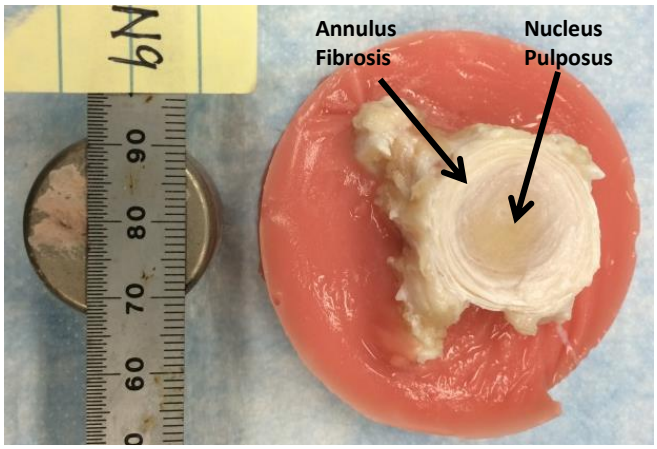

Fig.4: Cut disc with scale for reference