

DEVELOPMENT OF AN EXPERIMENTAL APPARATUS TO PRODUCE INTERVERTEBRAL DISC HERNIATION IN A HUMAN CADAVER SPECIMEN USING REPETITIVE COMBINED COMPRESSION AND FLEXION LOADING

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ABSTRACT

Lumbar spine intervertebral disc herniations are observed clinically but reproducing these injuries in laboratory settings has been difficult due to the necessity of application of thousands of controlled compression/flexion cycles. This project was designed to develop an experimental apparatus to subject isolated human cadaver lumbar motion segments to repeated flexion with underlying axial compressive forces. The apparatus will eventually be used to demonstrate the tolerance for axial force/bending/number of cycles at which herniation of the intervertebral discs will be initiated.

Specimens were prepared by potting the superior half of upper vertebra of a lumbar motion segment and the inferior half of the lower vertebra in PMMA and fixing each half to aluminum plates. To better document any movement of the disc nucleus during testing a mixture of blue dye and radio-opaque barium-sulphate was injected into the specimen. The inferior plate was fastened to a loadcell which was, in turn, was rigidly mounted to the frame of the apparatus. The superior plate was fastened to a cart with four wheels on its upper extent. A curved track is lowered onto the wheels of the cart. The cart and track were designed to restrain the bending motion of the upper half of the vertebra to flexion/extension in the sagittal plane. The track itself was constrained to a vertical motion by means of linear bearings sliding on vertical posts.

Weights were added on top on this plate to provide axial compressive forces to the specimen. The center of rotation of the curved track was aligned in the vertical and anterior-posterior direction with that of the specimen. A lever was attached to the upper specimen plate extending downward to the center of rotation of the specimen. The lever was fastened through a flexible axle to a variable speed motor to impart a predetermined alternating flexion motion.

Prior to each test, the specimen was X-Rayed in place using a portable machine. During the testing the output of the loadcell was recorded throughout each cycle. After a predetermined number of cycles the specimen was X-Rayed again and the images compare to those preceding to check to signs of herniation.

Keywords: lumbar, disc, herniation, prolapse, flexion loading

INTRODUCTION

Back pain is associated with certain results of disc degeneration such as a radial fissure in the anulus fibrosus [1] or a posterior disc herniation [2]. The biomechanical mechanisms for these defects have been a matter of much study and debate, although both are most likely to result over time from a degenerative process involving thousands of cycles. Single-cycle pure axial compressive loading of the disc [3] can result in vertebral body endplate fractures or body fractures [4] [5], although Brinckmann and Porter produced disc prolapse after either axial compression or compression combined with flexion of the motion