Abstract: 411

Disc Herniation Induces 55% Increase in Load of Key Stabilizing Muscle - Impact on Herniation Treatment Devices?

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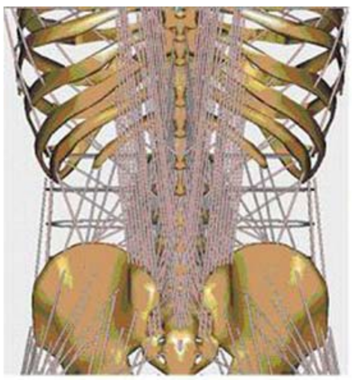
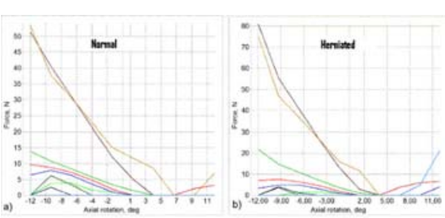
Introduction: A variety of devices to treat herniations have been proposed, most of whose intent is to prevent reherniation. But herniations are also associated with back pain [Atlas, 1996] and a decrease in the size of the multifidus muscle [Hyun, 2007], which is a key stabilizer of the spine [Ward, 2009]. Mechanically, cadaver testing has shown that herniations decrease the segment stiffness when loaded in axial rotation [Schmidt, 1998; Thompson, 2000]. As the multifidus is a significant stabilizer in axial rotation [MacIntosh, 1993], a herniation may result in an increased load in the multifidus as it compensates for the loss of segment stiffness in axial rotation, potentially inducing its atrophy and leading to reduced stability. Recently, musculoskeletal simulation software has been developed that permits analysis of muscle forces under a variety of activities. The AnyBody Modeling System™ contains more than 1000 individual muscle branches, and includes a validated lumbar spine model [de Zee, 2007; Rasmussen, 2008] which is shown in Figure 1. The purpose of this study is to examine the mechanical effect of a lumbar disc herniation, via the loss of segmental stiffness in axial rotation, on the force required by the different branches of the multifidus.



[Fig. 1 Musculoskeletal model of the spine]

Methods: The AnyBody System was used to analyze flexion-extension, lateral bending and axial rotation of the spine using a model of a standing human under influence of gravity. All analyses were performed with a body model representing an adult of 1.75 m height and 75 kg weight. The simulations were divided into two groups, one (NG) with a normal segmental stiffness based on Schmidt [1998], the second (HG) with a reduced segmental stiffness at L5-S1 typical for herniations, also based on Schmidt. The analyzed parameters were the forces in all branches of the multifidus muscles of the model on the right side of the spine.

Results: The herniation did result in significant increases in the force in the multifidus. The greatest impact was in axial rotation, where there was a 55% increase in force in one branch of the multifidus (Fig. 2). Lesser impact was seen in flexion-extension (maximum 33% increase), and a small decrease was seen in lateral bending.



[Fig. 2 Multifidus branch loads in axial rotation]

Discussion: The mechanical effect of the herniation, when combined with axial rotation motion, significantly increased the load required by certain branches of the multifidus. This may be a cause of muscle atrophy in patients with herniations. Implants under development to treat herniations may need to restabilize the spine in axial rotation so as to avoid this effect.