The Effect of Spinal Disc Herniation on Multifidus Muscles

+[1]Dendorfer, S; [2]Rasmussen, J; [1]Tørholm, ST; [3]Robie, B
+[1]AnyBody Technology, Aalborg, Denmark, [2]Department of Mechanical Engineering, Aalborg University, Denmark, [3]ARO Medical LLC, Glen Rock, NJ USA
sd@anybodytech.com

INTRODUCTION:

Schmidt et al. [1] and Thompson et al. [2] have both shown that the axial rotation stiffness of cadaveric lumbar spine segments is reduced in the presence of disk herniations, whereas there is no reduction in stiffness for other motions.

Clinically, Hyun et al. [3] has measured the cross sectional area (CSA) of the multifidus bilaterally in patients with herniations and shown that the CSA is smaller on the side with the herniation. An animal experiment by Hodges et al. [4] found that an annular incision mimicking a lateral herniation induced an immediate loss in the CSA of the m. multifidus on the side of the annular incision. MacIntosh et al. [5] showed that the multifidus is a significant axial rotation stabilizer of lumbar spine segments, generating more than 1/3 of the axial rotation torque created by the posterior muscles, and Ward et al. [6] demonstrated, based on muscle architecture, that the multifidus is designed to serve as a dynamic stabilizer of the lumbar spine.

The reason for the loss of CSA in the multifidus is not known. It is hypothesized that the loss in stiffness in the annulus due to the herniation results either in a significant increase in the load on the multifidus, or in excessive stretch of the multifidus. Both have been associated with muscle atrophy.

The purpose of this study is to find the effect of spinal disc herniation in the L5-S1 disc on the activity and forces in the multifidi muscles.

METHODS:

Musculoskeletal simulation software, the AnyBody Modeling System™, is used to compute the in-vivo muscle activations, muscle and joint forces under various activities of daily living. The full body model in question contains more than 1000 individual muscle branches.
The biomechanical model of the lumbar spine has been described in detail by de Zee et al. [7], see Fig.1, and validated by Rasmussen et al. [8].

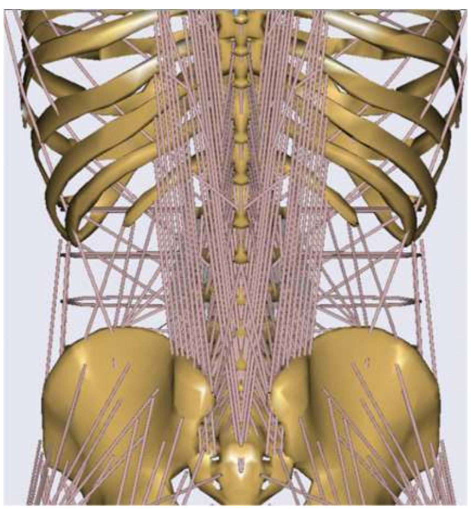

Fig.1: Musculoskeletal model of the spine.

The simulations were divided into two groups. In the first group, additional intervertebral disc stiffnesses were implemented for the lumbar spine segment (Schmidt et al. 1998) to represent the normal, healthy spine (NG). In the second group, reduced stiffness values typical for herniation taken from the same study were used in the L5-S1 disc (HG).

The motions analyzed were 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 analyzed parameters were the forces acting on the L5-S1 disc and the forces in all branches of the multifidus muscles of the model on the right side of the spine.

RESULTS SECTION:

The inclusion of the herniation in the L5-Sacrum joint significantly increased forces in the branches of the multifidus muscles for axial rotation (up 55%) and flexion-extension (30%) (see Fig.2), but resulted a small decrease in lateral bending.

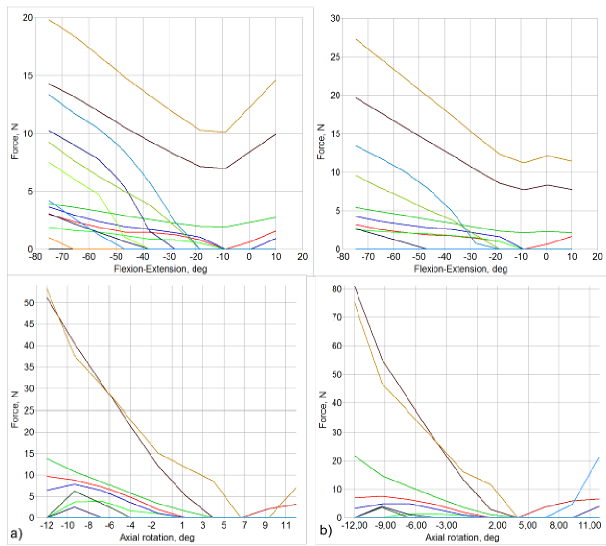

Fig. 2: Forces in the individual branches of the multifidus muscles in flexion-extension and axial rotation for the two different groups: a) with intact discs (NG), b) with herniation in the L5-S1 disc (HG).

The intervertebral disc forces revealed to be rather insensitive to the inclusion of a hernitation for lateral bending and flexion-extension movements. The largest impact was found for axial rotation, where a ten percent increase in the maximum joint force could be observed.

DISCUSSION:

Inclusion of the hernitation in the L5-S1 joint causes increased forces in the multifidus muscle branches by up to 55 percent for the shown load cases, in contrast the joint reaction forces seems not to be effected significantly by the hernitation.

The results presented here, originate from a limited number of load cases. More load cases and activity of daily living should be evaluated to get more detailed information.

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