

Importance of Spinal Muscle Function on Intervertebral Disc and Facet Joint Health

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Study Design. Radiological and histological laboratory experimental repeated measures design using a rabbit model.

Objective. To demonstrate the relationship between experimentally induced spinal muscle weakness and degenerative changes of the intervertebral disc and facet joints.

Summary of Background Data. Spinal muscles are important to ensure spinal stability, which has led to the advancement of minimally invasive surgeries and other surgical techniques that minimize damage to spinal muscles. Despite these advances, there remains a critical need to determine the relationship between spinal muscle function and spine health.

Methods. Twenty-four rabbits will be divided into three equal groups (n=8/group), consisting of two experimental groups and one control groups. The two experimental groups will be injected with either 3.5 Units/kg or 8.0 Units/kg of botulinum toxin type-A (BOTOX, Allergan, Irvine, CA) in the lumbar paraspinal musculature, respectively. The control group will be injected with an equivalent volume of 0.9% NaCl solution. Each rabbit will be evaluated using magnetic resonance imaging for morphological changes of the muscle, intervertebral disc, cartilaginous endplates and facet joints at their final time point (before euthanasia). After euthanasia, the spinal unit (intervertebral discs with adjacent vertebrae) will be carefully dissected and the specimens will be fixed in neutral buffered formalin and decalcified before being embedded in paraffin for histological assessment. To evaluate the histological morphology, specimens will be routinely stained with hematoxylin and eosin. To evaluate the proteoglycan content of the spinal segments, specimens will be special stained with Safranin-O with fast-green counterstaining. Comparisons of degenerative changes will be made between imaging findings and histological findings. Statistical analyses will be performed between the three groups using non-parametric statistics for levels of degeneration, whereas continuous dependent variables (e.g., disc height) will be evaluated with ANOVA. If statistical significance ($p < 0.05$) is detected, appropriate posthoc analyses will be conducted to determine if degenerative changes will scale with the dosage of botulinum toxin type-A injection.

Conclusion. This proposal aims to investigate the relationship between muscle function and spine health by experimentally impairing spinal muscle function (botulinum toxin injection) and determining the morphological and histological changes to the spinal anatomy (muscles, intervertebral disc and facet joints) in a rabbit model. Findings from this study will advance our understanding of the underlying mechanisms of spine degeneration and may help generate additional hypothesis-driven studies related to optimizing minimally invasive spine surgeries that preserve the paraspinal musculature and spine rehabilitation that emphasizes paraspinal muscle performance.