Biomechanical Effects of C2-C7 Inter-Segmental Stability due to Laminectomy with Unilateral and Bilateral Facetectomy

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Study Design. The biomechanical responses due to laminectomy with graded unilateral and bilateral facetectomy were quantified using a three-dimensional nonlinear FE model of the C2-C7 motion segments.

Objective. To study the influence of laminectomy with graded unilateral and bilateral facetectomy on the cervical spinal biomechanics.

Summary of Background Data. Cervical spinal stenosis is a condition that is caused by the narrowing of the spinal canal. Laminectomy and facetectomy are the commonly used surgical procedures for decompressing cervical spinal stenosis. Resection of the posterior structures cause instability and affect the internal stresses of the cervical spinal components. Till date, the influence of these surgical procedures on the biomechanical responses of the cervical spine has not been studied.

Methods. A nonlinear finite element model of the intact C2-C7 was constructed and validated. Ten surgically altered models were created from the intact model and were tested under physiological loading. Because of the inclusion of five motion segments, it was possible to determine the inter-segmental responses and internal cortical shell and disc stresses in the adjacent altered and unaltered spinal components.

Results. Under combined flexion and extension, inter-segmental motions at C4-C5 and C5-C6 increased significantly after C5 laminectomy. Subsequent facetectomy performed at C5 and C6 on the laminectomized model only affects the responses at the C5-C6 segment. Overall, slight inter-segmental responses of up to 5% were observed at the adjacent levels of C3-C4 and C6-C7. Laminectomy does not cause any significant increase in the inter-segmental motions under lateral bending and axial rotation. Extending the surgical procedures to unilateral and bilateral facetectomy only increases the inter-segmental motions slightly.

Similar increases in the intervertebral disc and the cortical shell stresses were observed. These findings may partially explain the clinical observations of enhanced osteophytes formation.

Conclusions. This study provides a better understanding of the surgically altered cervical spinal biomechanics and may help formulate treatment strategies such as spinal implants.

Mini Abstract. The biomechanical responses due to laminectomy with graded unilateral and bilateral facetectomy were quantified using a three-dimensional nonlinear finite element model of the C2-C7 motion segments.

Keywords: Stresses, Analysis, Biomechanics, Finite Element, Cadaver, Cervical, Spine, Orthopaedic, Surgery