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EVALUATION OF CERVICAL LAMINECTOMY ON INTERSEGMENTAL MOTIONS USING A VALIDATED PARAMETRIC SUBJECT-SPECIFIC FINITE ELEMENT MODEL

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Summary: Spinal stenosis, or the abnormal narrowing of the spinal canal, is one of the most commonly diagnosed and treated pathological conditions affecting the spine at all levels. Decompression of the spinal canal through cervical laminectomy is currently the standard treatment for cervical stenosis. However, studies have shown that laminectomy may increase segmental instability unless fusion is performed. Spinal fusion also comes with its own set of disadvantages, including altered spinal biomechanics and increased risk of adjacent disc degeneration. Biomechanical investigations of cervical intersegmental motion patterns and stability associated with laminectomy are hence critical to provide surgeons with additional tools for informed decision making. This study presents a novel experimentally-based parametric subject-specific Finite Element (FE) model approach to analyze the cervical intersegmental ranges of motion associated with increased level of laminectomy. Nine patients who have undergone 2-level (C3-C4, N=5) and 3-level laminectomy (C3-C5, N=4) participated in this study upon informed consent. All parameters were extracted from Lateral and anterior-posterior (AP) X-Ray radiographs pre-operation and again at the 3 months post-op and exported to our previously validated parametric FE model to generate 18 subject-specific models (9 intact and 9 laminectomy). The lamina, yellow ligament, spinous process, and interspinous ligaments were removed in the laminectomy models, while the facet joints remained intact. One Nm pure sagittal moment was applied to the top endplate of the laminectomy models (N=9). The average rotation of the intact models was 29.8 (±5.94), and 27.34 (±6.31) degrees, for flexion and extension, respectively, in alignment with literature. In the laminectomy FE models, the average intersegmental rotation in flexion/extension at the upper levels (C2-3, C3-4) increased by 17.93% (±4.72), while the intersegmental rotation at the lower levels (C5-6, C6-7) decreased by 22.37% (±6.36). On the other hand, the rotation did not change after surgery during axial rotation and lateral bending. Significantly altered intersegmental rotation in flexion/extension after laminectomy may affect the stability of the cervical spine, hence potentially influencing the clinical decision-making process. Our preliminary results demonstrate that the novel validated subject-specific FE model presented here can provide surgeons with valuable quantitative data for surgery planning towards better clinical outcomes.