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FINITE ELEMENT ANALYSIS SUGGESTS STRESS INCREASES IN THE PARS INTERARTICULARIS WITH INCREASING UNILAMINECTOMY BONE RESECTION

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A laminectomy, a surgical procedure that removes the spinous process of a vertebra, is performed over 480,000 times annually in the United States at roughly $18,000 per surgery. This surgery is done to alleviate patient back pain; however, it could have harmful consequences, namely stress fracture, due to the increased amount of stress placed on the pars interarticularis (pars). This research uses Finite Element (FE) models (computationally meshed and discretized surfaces) to collect stress data (Fig. 1). While current literature supports FE models as tools to model the spine, and suggests a strong correlation between laminectomy and stress increase in the pars, data is lacking to relate the amount of laminectomy bone resection to the corresponding stress increase.

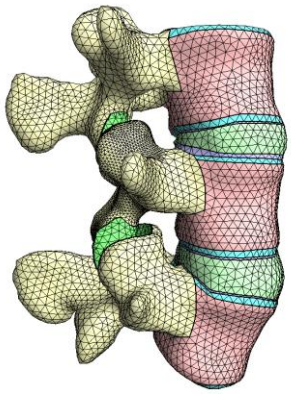

Figure 1. Tetrahedral Meshed Lumbar Vertebrae: The base laminectomy model used in this study.

The goal of this research was to quantify stress in the pars due to different amounts of unilaminectomy bone resection using an FE model. It was hypothesized that increased resection would lead to increased volumetric stress in the pars region during rotation. To test the hypothesis, we re-meshed surfaces obtained from Puttlitz et al. in ANSA using tetrahedral elements, pyramids, to represent the major spinal components: discs, vertebrae, and facet cartilage. We then created a base laminectomy model with additional unilaminectomy resections ranging from 25% to 75% additional bone loss. FE models axially rotated to twelve degrees were analyzed and processed using the FEBio suite of software.

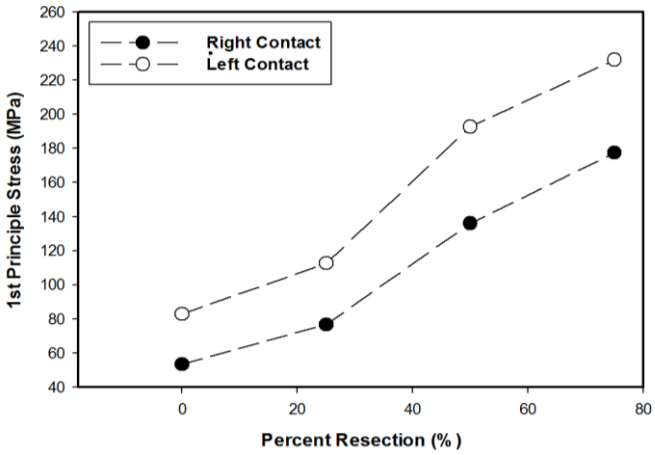

Figure 2. Line Plot of Tensile Stress in the Pars During Axial Rotation: Zero percent resection represents a base laminectomy cut. 1st Principle stress increases as resection increases.

Results of this study showed as bone resection increased, stress in the 1st and 3rd principle directions also increased, supporting the stated hypothesis (Fig. 2). These results suggest stress fracture to be more likely with increased amounts of bone resection. Ultimately, this research can advise doctors performing laminectomies of the increased likelihood of stress fracture with greater bone resection, and help provide quantifiable data regarding what amount of bone resection may be safe for the 480,000 patients undergoing this procedure annually. The hope is for patients to get the best treatment options possible for their specific spinal circumstances.