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Decoding the impact of thoracic flexibility on cervical alignment: Advanced predictive modeling of disability outcomes in posterior cervical fusion

Devender Singh[1], Matthew Geck[1], Morgan Laviolette[1], Rory Mayer[1], Vik Kohli[1], John Stokes[1], Eeric Truumees[1], Sara Sheikh[1]

[1]Ascension, Spine, Suite 200 Austin, TX, United States

Background: Standing multi-view X-rays and MRIs/CTs are standards of care in preoperative planning for patients undergoing cervical fusions.

Research question: Explore the relationship between thoracic flexibility, cervical alignment, and clinical outcomes in patients undergoing posterior cervical fusion.

Design: Retrospective study

Methods**:** 227 patients who underwent multi-level posterior cervical fusion were studied. Thoracic flexibility was measured as the difference in T1 slope between upright X-rays and supine MRI/CT scans, while cervical alignment was assessed using C2-C7 lordosis and changes in sagittal vertical axis (SVA).

Results: Interaction analysis showed that thoracic flexibility (Δ T1 slope) combined with sagittal imbalance (Δ SVA) moderately impacted disability, although this combination did not explain all variability in outcomes. Patients with higher BMI experienced greater disability due to sagittal imbalance. Analysis identified a non-linear relationship between Δ T1 slope and Δ SVA, indicating a more complex impact of thoracic flexibility on cervical alignment. Small changes in thoracic flexibility led to disproportionately large impacts on cervical sagittal alignment in certain patients. Patients with high thoracic flexibility and significant sagittal imbalance reported the highest levels of disability and pain. Modelling revealed additional biomechanical or psychosocial factors are needed to improve prediction accuracy.

Conclusion: Thoracic flexibility and cervical alignment significantly influence disability but have limited predictive power for pain and overall outcomes. The interaction between BMI, thoracic flexibility, and sagittal imbalance exacerbated disability, but additional factors may be necessary for more accurate predictions. The advanced models indicated that the current set of clinical variables lacks sufficient power to predict outcomes. Understanding these relationships lays a foundation for personalized treatments.