

Relationship Between Preoperative Cervical Muscle Morphology and Reciprocal Cervical Alignment Changes After Lumbar PSO

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Introduction

Lumbar sagittal malalignment induces compensatory changes throughout the thoracic and cervical spine. Although lumbar correction procedures such as PSO are known to produce reciprocal changes in cervical alignment, the clinical determinants of this response remain poorly understood. Given the role of cervical musculature in stabilizing head posture and motion, cervical muscle morphology may influence these reciprocal alignment changes. The objective of our study is to evaluate whether preoperative cervical muscle morphology is associated with immediate cervical alignment changes following lumbar pedicle subtraction osteotomy (PSO).

Materials and Methods

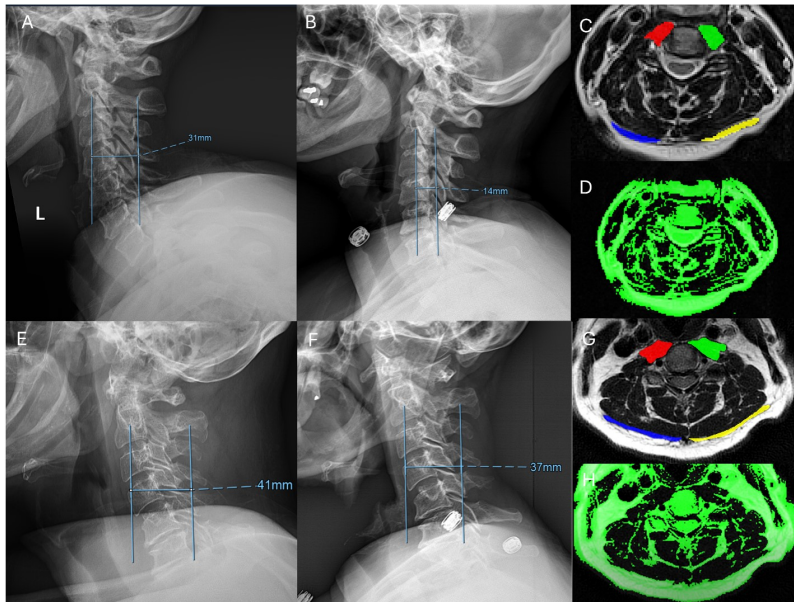
Patients who underwent lumbar PSO with preoperative and immediate postoperative (1-30 days) standing whole-spine lateral radiographs were reviewed. C2-7 sagittal vertical axis (cSVA) was measured at both timepoints. For muscle analysis, a subset with an available preoperative cervical MRI was included. At C3, anterior muscle group (AG) and trapezius (TP) functional cross-sectional area (fCSA) and fatty infiltration (FI) were obtained.

Results

Ninety-nine patients were included in the initial analysis. Mean cSVA significantly decreased from 30.4 to 26.7 mm. Twenty-two patients had a preoperative cervical MRI available for muscle analysis. Spearman analysis demonstrated that greater TP fCSA correlated with larger postoperative reductions in cSVA ($\rho = -0.45$, $p = 0.047$), whereas greater TP FI correlated with smaller reductions in cSVA ($\rho = 0.61$, $p = 0.005$). Larger AG fCSA also correlated with smaller reductions in cSVA ($\rho = 0.45$, $p = 0.044$).

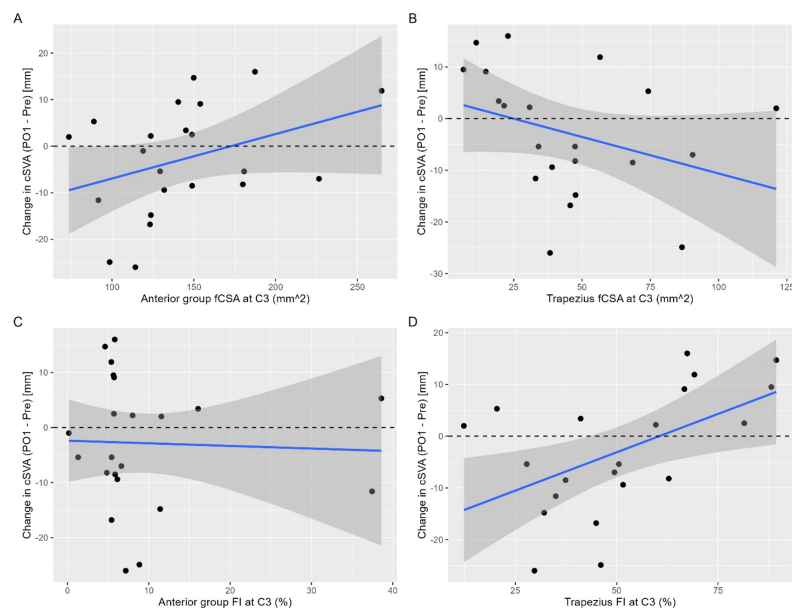
Conclusion

Preoperative cervical muscle morphology was associated with reciprocal cervical alignment changes after PSO. Greater TP fCSA correlated with larger postoperative reductions in cSVA, whereas greater TP FI correlated with smaller reductions. Larger AG fCSA also correlated with smaller immediate cervical alignment changes. Together, these findings suggest that the relative balance between posterior stabilizing and anterior cervical muscle quality may influence the magnitude of acute cervical decompensation following thoracolumbar realignment.



Representative examples of patients with contrasting cervical muscle morphologies and corresponding differences in immediate postoperative change in cervical sagittal vertical axis (Δ cSVA). Panels A-D show a 59-year-old male (Patient 1) with a larger decrease in cSVA from preoperative to immediate postoperative assessment (Pre: 31.0 mm; PO1: 14 mm; Δ cSVA = -16 mm), characterized by lower anterior group functional cross-sectional area (AG fCSA = 123.2 mm²), higher trapezius functional cross-sectional area (TP fCSA = 45.7 mm²), and lower trapezius fatty infiltration (TP FI = 44.9%). Panels E-H show a 57-year-old male (Patient 2) with a lower postoperative reduction in cSVA (Pre: 41 mm; PO1: 37 mm; Δ cSVA = -4 mm), characterized by higher AG fCSA (180.7 mm²), lower TP fCSA (34.1 mm²), and greater TP FI (50.5%). Notably, AG FI was similar between patients (AG FI: 5.41% vs 5.42%), consistent with the lack of association

observed between AG FI and Δ cSVA in the overall cohort. Preoperative and immediate postoperative alignment is shown using upright, standing whole-spine lateral radiographs, and muscle composition is illustrated using segmentation-based visualization at the C3 level.



Relationship between cervical paraspinal muscle morphology and immediate postoperative changes in cervical sagittal vertical axis (cSVA). Scatterplots illustrate the associations between anterior muscle group (AG) and trapezius (TP) functional cross-sectional area (fCSA) and fatty infiltration (FI) measured at C3, and the change in cSVA from preoperative to immediate postoperative assessment 1 (Change in cSVA = PO1 - Pre). Panels depict (A) AG fCSA, (B) TP fCSA, (C) AG FI, and (D) TP FI in relation to change in cSVA. Solid lines represent linear regression fits with 95% confidence intervals, and dashed horizontal lines indicate no change in cSVA (change in cSVA = 0).