Importance of the cervical paraspinal muscles on postoperative patient-reported outcomes and maintenance of sagittal alignment after anterior cervical discectomy and fusion

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INTRODUCTION: The aim of this study was to investigate the influence of preoperatively assessed paraspinal muscle parameters on postoperative patient-reported outcomes and maintenance of cervical sagittal alignment after anterior cervical discectomy and fusion (ACDF).

METHODS: Patients with preoperative and postoperative cervical spine lateral radiographs in a standing position and preoperative cervical magnetic resonance imaging (MRI) who underwent an ACDF between 2015 and 2018 were reviewed. Muscles from C3 to C7 were segmented into 4 functional groups: anterior, posteromedial (PM), posterolateral (PL), and sternocleidomastoids. The functional cross-sectional area (fCSA), and percent fat infiltration (FI) were calculated for all groups. Radiographic alignment parameters collected preoperatively and postoperatively included C2-7 lordosis and C2-7 SVA. Neck Disability Index (NDI) scores were recorded preoperatively and at 2 and 4-6 months postoperatively. To investigate the relationship between muscle parameters and postoperative changes in sagittal alignment, multivariable linear mixed models were conducted. Multivariable linear regression models were conducted to analyze the correlations between the changes in NDI scores and the muscles FI.

RESULTS SECTION: A total of 201 patients were reviewed with a median follow-up of 364 days. The mixed models showed that a greater fCSA of the PL muscle group at each subaxial levels and less FI at C4-6 were significantly associated with less progression of C2-7 SVA over time. Moreover, there was a significant correlation between greater FI of the PM muscle group measured at the C7 level and less NDI improvement at 4-6 months after ACDF.

DISCUSSION: By using quantitative muscle measurements, our study demonstrated the importance of the posterolateral cervical muscle group in maintaining C2-7 SVA over time after ACDF. Moreover, the severity of FI of the multifidus at C7 was significantly associated with less improvement in NDI scores after ACDF. Our study highlighted the importance of a preoperative assessment of the cervical paraspinal muscles morphology as predictor for patient-reported outcomes and for the maintenance of postoperative sagittal alignment.

SIGNIFICANCE/CLINICAL RELEVANCE: Our findings highlight the importance of considering cervical paraspinal muscles morphology as part of the preoperative assessment. How to improve and maintain sagittal alignment after cervical surgery is a complex problem that spine surgeons should consider preoperatively. Our results suggest that specific neck muscle exercises should be an important component in the rehabilitation process to strengthen cervical paraspinal muscles. In addition, surgeons should consider using an anterior surgical approach in patients with high fat infiltration of the posterior cervical muscles if both anterior and posterior approaches can be safely performed. The anterior approach could preserve the posterior cervical muscles from iatrogenic posterior muscle damage.

Table 1: Results of the multivariable linear mixed models summarizing the correlations between the changes (Δ) in C2-7 SVA over time and the muscle parameters, accounting for repeated measures over time and adjusted for age, sex, BMI, length of follow-up, and Timepoint 2 C2-7 SVA. PL: posterolateral muscle group; PM: posteromedial muscle group; fCSA: functional cross-sectional area; FI. Fat infiltration; CI: confidence interval. Significant values are in bold.

Dependent	Independent	Estimate	95% CI	p-value
ΔC2.7 SVA	PL.$_{fCSA}$.3	-0.003	(-0.005, -0.001)	**0.012**
ΔC2.7 SVA	PL.$_{fCSA}$.4	-0.004	(-0.006, -0.001)	**0.002**
ΔC2.7 SVA	PL.$_{fCSA}$.5	-0.004	(-0.007, -0.002)	**< 0.001**
ΔC2.7 SVA	PL.$_{fCSA}$.6	-0.003	(-0.005, -0.001)	**0.004**
ΔC2.7 SVA	PL.$_{fCSA}$.7	-0.002	(-0.005, -0.000)	**0.040**
ΔC2.7 SVA	PL.$_{FI}$.3	0.089	(-0.056, 0.235)	0.228
ΔC2.7 SVA	PL.$_{FI}$.4	0.203	(0.061, 0.344)	**0.005**
ΔC2.7 SVA	PL.$_{FI}$.5	0.168	(0.051, 0.285)	**0.005**
ΔC2.7 SVA	PL.$_{FI}$.6	0.118	(0.022, 0.214)	**0.017**
ΔC2.7 SVA	PL.$_{FI}$.7	0.116	(-0.049, 0.281)	0.166
ΔC2.7 SVA	PM.$_{fCSA}$.3	-0.010	(-0.018, -0.002)	**0.021**
ΔC2.7 SVA	PM.$_{fCSA}$.4	-0.009	(-0.024, 0.007)	0.255
ΔC2.7 SVA	PM.$_{fCSA}$.5	-0.001	(-0.009, 0.007)	0.802
ΔC2.7 SVA	PM.$_{fCSA}$.6	-0.013	(-0.030, 0.005)	0.156
ΔC2.7 SVA	PM.$_{fCSA}$.7	-0.000	(-0.015, 0.014)	0.957
ΔC2.7 SVA	PM.$_{FI}$.3	0.029	(-0.013, 0.071)	0.171
ΔC2.7 SVA	PM.$_{FI}$.4	0.013	(-0.049, 0.074)	0.689
ΔC2.7 SVA	PM.$_{FI}$.5	0.029	(-0.036, 0.095)	0.375
ΔC2.7 SVA	PM.$_{FI}$.6	0.039	(-0.024, 0.102)	0.221
ΔC2.7 SVA	PM.$_{FI}$.7	0.039	(-0.024, 0.102)	0.219