The Symmetry of Functional Muscle in the Posterior and Anterior Lumbar Muscle Compartments is Related to Maintenance of Sagittal Alignment Parameters Following Spinal Fusion Surgery

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INTRODUCTION: A major goal of spinal fusion surgery in individuals with adult spinal deformity is to restore normal spinal alignment. There is concern for progressive loss of alignment after reconstructive surgery as this deviation can lead to burdensome symptomology and possibly the need for revision. The purpose of this study is to investigate lumbar muscle composition and symmetry as a possible contributor to the loss of sagittal alignment.

METHODS: This study was approved by the IRB. 29 patients who underwent multilevel spinal fusion surgery (>4 levels with fusion to the pelvis) for adult spinal deformity with a preoperative lumbar MRI, 1 month postoperative x-ray and 1 year postoperative x-ray were included in this study. Functional muscle was determined by obtaining cross sectional area (CSA) and subtracting the percent of fatty infiltration present within the psoas, erector spinae and multifidus muscles at the L4 level from T2 weighted MRIs. Change in sagittal alignment parameters were obtained by subtracting 1 year from the 1 month postoperative values as an indicator of long term compensatory alignment changes after surgery. Pearson correlation testing was performed on change in sagittal parameters and the ratio of posterior to anterior functional muscle CSA (PA-CSA). Linear regression was performed to adjust for possible covariates of change in sagittal parameters. Significance was set at alpha of 0.05.

RESULTS SECTION: The sample population was composed of 79% women with a mean age of 62.6 ± 17.4 and body mass index (BMI) of 25.9 ± 5.2. The most common upper instrumented vertebrae were T10 (38%), and the average number of levels fused was 8.7 ± 1.8 (Table 1). Mean preoperative muscle CSA's and change in sagittal parameters are reported in Table 1 with standard deviations in parentheses. On univariate testing, the PA-CSA showed a trend toward correlation with change in C2-pelvic axis (C2-PA), though this did not reach statistical significance. On multivariate testing with sex included as a covariate, the PA-CSA was significantly associated with a change in C2-PA (B_1=-5.571, p-value=0.00234) and T4-PA (B_1=-3.694, p-value=0.0276). These coefficients indicate an increase in relative posterior muscle mass is related to a decrease in postoperative alignment change measured by C2-PA and T4-PA (Figure 1A and B).

DISCUSSION: Our results suggest that the symmetry of posterior and anterior lumbar muscles contribute to maintaining sagittal balance following spinal fusion surgery. The findings that the PA-CSA correlates with changes in C2-PA and T4-PA over the postoperative period indicate that characteristics of PA muscle balance contribute to postoperative maintenance of alignment, which seems to be more profound for men. Limitations include the small sample size and relatively few male patients.

SIGNIFICANCE/CLINICAL RELEVANCE: (1-2 sentences): Identifying non-invasive biomarkers that represent biological and physiological processes associated with sagittal imbalance after spinal fusion surgery is an important direction to improve clinical decision making. Surgeons may use these data to inform expectations for prognosis, as well as identify tissues at risk for failure which may be augmented during surgery.

Table 1.

Age	62.6 (17.4)
Female sex	23 (79%)
BMI (kg/m^2)	25.9 (5.2)
# of Levels Fused	8.7 (1.8)
Posterior Functional CSA	30.02 (7.49)
Anterior Functional CSA	20.23 (6.71)
Posterior to Anterior Ratio	1.55 (0.38)
Change in Pelvic Incidence-Lumbar Lordosis (PI-LL)	0.96 (4.53)
Change in L1-PA	1.89 (3.93)
Change in T4-PA	2.25 (3.28)
Change in C2-PA	2.46 (3.76)
Change in C2 Tilt	-0.64 (3.52)

Figure 1A

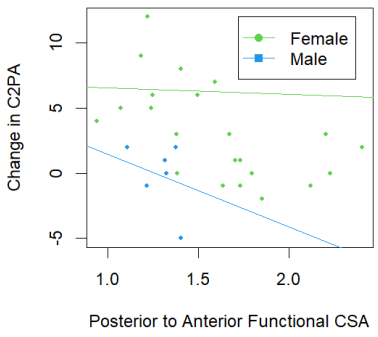
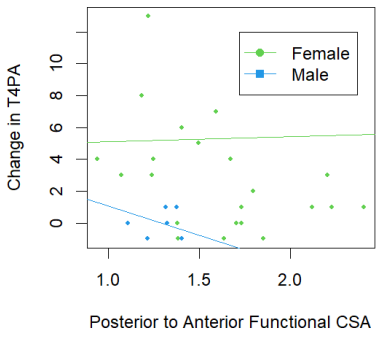
Figure 1B