Larger and Lordotic Discs are Associated with Better Lumbar Muscle Health: A Retrospective Review of Disc Geometry and Posterior Muscle Characteristics

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INTRODUCTION: There have been several studies examining paralumbar muscle health and patient-reported outcomes. However, there is limited data on the association between disc morphology and paralumbar muscle. This study aimed to provide a comprehensive analysis on the association between disc morphology and paralumbar muscle health at each individual lumbar spinal levels between L1-S1.

METHODS: This was a retrospective single center/single surgeon study including 615 lumbar degenerative patients. Outcomes included lumbar lordosis between the superior endplates of L1-S1 (LL), disc geometry (focal lordosis, posterior disc height, and listhesis), and posterior muscle characteristics included cross-sectional area over BMI (CSA/BMI), lumbar indentation value (LIV), and Goutallier classification at each disc level from L1-L5. Associations between disc shape and muscle health at each individual lumbar levels were evaluated using a partial correlation controlling for age and sex. Patients were then stratified by the amount of listhesis at L4-S1 as retrolisthesis (R) if ≤ -5mm, spondylolisthesis (S) if ≥ 5mm, or neutral (N). Demographic data were compared between listhesis groups and an ANCOVA analysis controlling for significant demographics parameters were conducted to evaluate differences in muscle characteristics.

RESULTS SECTION: 435 patients were included (age: 55.6±15, BMI: 29.5±6, 60.9% Female, 41.3% White). Muscle health median characteristics were CSA/BMI=140 (IQR 112-170), LIV=13 (IQR 9-17), and Goutallier Classification of 1 (IQR 1-2). Mean lordosis for the cohort was 54.6±14° between L1-S1, 20.9±7 (38.4% of LL) at L5-S1, and 21.3±8 (39.3% of LL) at L4-L5.

Partial correlations between focal disc parameters and muscle health while controlling for age and sex showed moderate significant positive associations between focal lordosis and lumbar indentation value (LIV) at every level (Mean r = 0.264 between L1-L5, $p<0.001$), weak positive association between focal lordosis and CSA/BMI (Mean r=0.113 at L2-L5, $p <0.03$) and weak negative associations between disc height and Goutallier Classification (Mean r=0.158 at L1-L5, $p<0.03$).

Stratification by listhesis at L4-S1 revealed that 6.9% (N=30) patients presented with spondylolisthesis (mean: 9±3mm), 6% (N=26) presented with retrolisthesis (mean: 6±1mm), and 87.1% (N=377) presented with no listhesis (mean: 1.3±1.5mm). Comparison between groups revealed that S was significantly older than R and N (65 vs 52 & 55, $p<0.005$), R had significantly more males (69.2% vs 38.1% & 23.3%, $p=0.01$), but no difference in BMI ($p=0.067$). ANCOVA controlling for sex and age demonstrated no significant association between S and R groups and CSA/BMI, LIV, or Goutallier classification ($p>0.1$).

DISCUSSION: Posterior muscle health was significantly associated with disc shape, especially disc height and disc lordosis, with larger and more lordotic discs being associated with better muscle health. Disc listhesis was not significantly associated with muscle quality when controlling for demographic characteristics, and no differences in muscle health parameters were observed in patients with spondylolisthesis versus retrolisthesis. Overall, results highlight key associations between lumbar compensation, disc geometry, and posterior muscle health, which may have implications in identifying spinal parameters that predict better lumbar muscle health.

SIGNIFICANCE/CLINICAL RELEVANCE: Patients with smaller lumbar discs and less lordosis may be at higher risk for poorer lower back muscle health.