Relationship between facet joint osteoarthritis and lumbar paraspinal muscle atrophy – a cross-sectional study

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INTRODUCTION: The paraspinal muscles play an essential role in the stabilization of the lumbar spine. Atrophy of the paraspinal muscles, characterized by decreased functional cross-sectional area (fCSA) and increased fatty infiltration (FI) has been linked to chronic back pain and degenerative processes of the lumbar spine, including facet joint osteoarthritis (FJOA). However, the relationship between the different paraspinal muscle groups and FJOA has not been fully explored.

METHODS: In this cross-sectional study, we analyzed adult patients who underwent lumbar spinal surgery between December 2014 and March 2023 for degenerative spinal conditions and had preoperative MRI and CT scans. Exclusion criteria were lumbar scoliosis with a Cobb angle over 20° and previous lumbar surgery. The FI and fCSA of the psoas, erector spinae and multifidus muscles were assessed on T2-weighted axial MRIs at the level of the upper end plate of L4 based on established studies and calculated using custom-made software. The fCSA was adjusted by height in meters squared, similar to body mass index (BMI). The Weishaupt classification (0-3) was used to assess FJOA at all lumbar levels (L1 to S1) on preoperative CT scans. In addition, the total lumbar FJOA score was determined by adding the grade of both sides at all five levels, resulting in 30 as the highest possible score. Correlation and linear regression analyses were conducted to assess the relationship between FJOA and paraspinal muscle parameters.

RESULTS SECTION: Inclusion criteria were met by 225 patients. The total FJOA score was significantly associated with age (rho = 0.624, $p < 0.001$), the FI of the multifidus (rho = 0.529, $p < 0.001$) and erector spinae (rho = 0.333, $p < 0.001$) muscles, as well as the fCSA of the multifidus (rho = -0.459, $p < 0.001$) and erector spinae (rho = -0.188, p = 0.004) muscles. After adjustment for age, sex, and BMI in the multivariable linear regression analysis, only multifidus fCSA (Est =-4.97, 95% CI = -7.21 – -2.74, $p < 0.001$) and FI (Est = 0.69, 95% CI = 0.38 – 1.00, $p < 0.001$) were independently predicted by the total FJOA score. A similar relation was seen with individual FJOA grades of each lumbar level.

DISCUSSION: This is the first study to our knowledge that shows the correlation between FJOA and paraspinal muscle atrophy is specific to the multifidus muscle. The unique anatomy, mechanical properties, and segmental innervation pattern of the multifidus muscle may explain these results. Our study was limited by its retrospective cross-sectional design, conducted at a single orthopedic center.

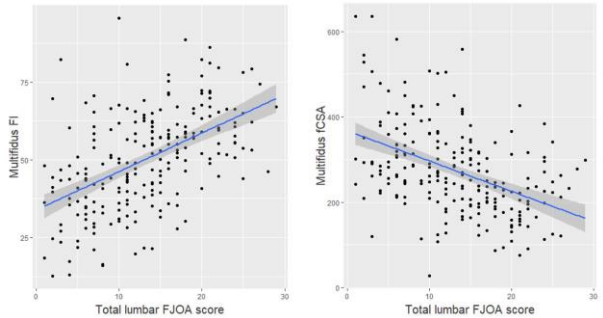
SIGNIFICANCE/CLINICAL RELEVANCE: Multifidus muscle atrophy is associated with FJOA in the lumbar spine. This correlation was not significant for the erector spinae and psoas muscles after adjustment, highlighting the unique involvement of the multifidus muscle in the spinal motion segment degeneration. Further research is necessary to understand the causal relationship and the clinical implications of these findings.

Table 1: Total FJOA score as a predictor of paraspinal muscle morphology

	Univariable Linear Regression Analysis		Multivariable Linear Regression Analysis*	
Dependent muscle variable	Estimate (95% CI)	p-value	Estimate (95% CI)	p-value
Multifidus				
fCSA	-7.08 (-8.97 – -5.18)	**<0.001**	-4.97 (-7.21 – -2.74)	**<0.001**
FI	1.24 (0.97 – 1.51)	**<0.001**	0.69 (0.38 – 1.00)	**<0.001**
Erector spinae				
fCSA	-7.02 (-11.97 – -2.06)	**0.006**	-0.27 (-6.07 – 5.53)	0.927
FI	0.50 (0.29 – 0.71)	**<0.001**	0.02 (-0.21 – 0.26)	0.859
Psoas				
fCSA	-5.59 (-10.54 – -0.65)	**0.027**	-2.32 (-7.12 – 2.48)	0.342

*Adjusted for age, sex and BMI. FJOA = facet joint osteoarthritis, fCSA = functional cross-sectional area adjusted by height in meters squared and reported in mm^2/m^2, FI = percentage fatty infiltration

Figure 1: Correlation between total lumbar FJOA score and multifidus muscle properties



FJOA = facet joint osteoarthritis, fCSA = functional cross-sectional area adjusted by height in meters squared and reported in mm^2/m^2, FI = percentage fatty infiltration.