

# Quantitative Measure of Cervical Paraspinal Sarcopenia is Correlated with Improvement in PROMIS Scores in Patients Undergoing Anterior Cervical Decompression and Fusion

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**Introduction:** Sarcopenia is a progressive loss of skeletal muscle mass associated with frailty, falls, fractures, and mortality, making it an important risk and prognostic factor in surgical procedures. Prior literature in spine surgery demonstrates sarcopenia is an important risk and prognostic factor, although lack of standardized tools to measure sarcopenia gives it questionable value. There is increasing evidence that the muscle cross-sectional area (CSA) and fatty infiltration (FI) of patients undergoing posterior cervical surgery correlates with patient reported outcomes, however there is limited information regarding outcomes in anterior cervical surgery. The present study aims to assess the correlation between percentage of fatty infiltration (FI) of the paracervical musculature – which is a potential metric for preoperative cervical sarcopenia–on PROMIS PF and PI score improvement at 12 months following an anterior discectomy and fusion (ACDF) procedure.

**Methods:** The study included patients over 18 years who underwent cervical decompression with or without fusion at a single academic institution between 2012 and 2018 and underwent cervical MRI within 1 year preoperatively. Muscle group FI was measured using ImageJ, and Goutalier classification was performed on each patient. PROMIS-PF and PI scores were collected at baseline, 6-weeks, 3-months, and 12-months postoperatively. The study defined a minimum clinically important difference (MCID) as a 4.5 increase in PF and 4.9 decrease in PI from baseline to 12-months post-surgery. Bivariate and multivariate analyses were performed to determine the correlation between perioperative change in PF and PI with quantitatively measured fatty infiltration through image analysis. Bivariate analyses also compared the median FI between the MCID and non-MCID subgroups, and multivariate logistic regression analyses controlling for demographic and clinical characteristics were subsequently performed.

**Results:** A total of 78 patients were included. Mean age was 54.8 [49.0-63.75] and 29 (37.1%) were female. MCID was achieved in 34 patients for PROMIS-PF and 26 for PROMIS-PI score. When comparing perioperative change in PI with fatty infiltration, a significant inverse relationship was found (coefficient = -0.1130, p = **0.028**). Age (coefficient = 0.1019, p = **0.055**) and Goutalier classification (coefficient = 1.1519, p = **0.073**) were also found to be significantly positively correlated with perioperative change in PI. BMI (p = 0.364) and sex (p = 0.836) were not significant covariates. Perioperative changes in PF were compared with fatty infiltration while controlling for age, BMI, sex, and Goutalier through a multivariate analysis. A negative correlation (coefficient = -0.1683) was found although the difference was not significant (0.206). Additionally, age, BMI, sex, and Goutalier classification were not significant covariates of perioperative change in PF. In patients that achieved MCID for either PF or PI, there was a positive relationship with fatty infiltration, although it was not significant for either in bivariate analyses. From multivariate analyses, fatty infiltration was found to be a significant predictor of ability to achieve MCID for PI, not PF.

**Discussion:** The present study is the first to assess the relationship between quantitatively measured cervical paraspinal sarcopenia and PROMs following ACDF. A decrease in measured fatty infiltration was associated with an increase in perioperative change in PI, implying that severity of preoperative paraspinal sarcopenia is inversely correlated with worsening pain interference post-ACDF. In other words, less fatty infiltration preoperatively is associated with worsening of pain interference perioperatively. Physical function (PF) did not have the same significant association, implying that perceived pain interference is more implied than physical function to worsen in ACDF patients. Additionally, through multivariate analysis, it was suggested that age and Goutalier classification were directly correlated with increased perioperative PI score changes; this implies that an increase in age and Goutalier classification is associated with worsening of pain interference postoperatively. This study has several limitations. First, this study may be subject to selection bias due to its retrospective nature. Secondly, using ImageJ to quantitatively assess fatty infiltration based on reference images introduces variability, especially with reviewers having varying knowledge and precision in measuring small muscle groups. Employing two reviewers per image aimed to control for inter-rater variability but there is still potential for measurement error. Third, this study includes 78 patients, which may limit the ability of this study to detect small differences in PROMs. Further statistical analysis through MCID further narrows the cohort, reducing power. However, previously validated studies have studied cohorts with a comparable number of patients, typically with n < 100. Fourth, this study assessed only fatty degeneration of the multifidus muscle, making it impossible for this study to draw conclusions regarding the relationship between degeneration of other cervical muscles and postoperative outcomes.

**Significance:** The results of this study suggest that patients with more severe preoperative paraspinal sarcopenia are more likely to demonstrate a clinically significant improvement in pain postoperatively, resulting in improved perceived pain control. This may imply that quantitative measure of preoperative paraspinal sarcopenia may act as a predictor for pain improvement postoperatively in ACDF patients.

Table 1: PROMIS-PF Bivariate and Multivariate Analyses Comparing MCID and non-MCID

	MCID (n = 34)	Non-MCID (n=44)	Bivariate p-value*	Multivariate p-value*
Age	52.5 [48.3-58.3]	56.6 [49.8-65.3]	0.10	0.18
BMI	27.7 [24.0-30.0]	29.2 [25.8-32.2]	0.23	0.25
Female Sex (%)	12 (35.3%)	17 (38.6%)	0.77	0.72
Multifidus FI (%)	33.8% [25.0-42.4]	33.8% [23.3-42.4]	0.99	0.81
Goutalier classification	1.65 [1.0-2.0]	1.84 [1.0-2.0]	0.39	0.33
*Complete bivariate and multivariate analyses provided in the supplemental data.				

Table 2: PROMIS-PI Bivariate and Multivariate Analyses Comparing MCID and non-MCID

	MCID (n = 26)	Non-MCID (n=52)	Bivariate p-value	Multivariate p-value
Age	52.2 [47.3 - 59]	56.2 [49.0-65.0]	0.13	0.19
BMI	29.2 [25.6-31.6]	28.2 [24.7-30.6]	0.45	0.25
Female Sex (%)	11 (42.3%)	18 (34.6%)	0.51	0.99
Multifidus FI (%)	36.0% [29.4-44]	32.7 [23.1-42.3]	0.24	<b>0.07</b>
Goutalier classification	1.46 [1.0-2.0]	1.9 [1.0-2.0]	<b>0.06</b>	<b>0.06</b>
*Complete bivariate and multivariate analyses provided in the supplemental data.				