



A comparison of muscle activation as measured by ultrasound in axial and radicular low back pain patients’ undergoing PT

Esther Chung, B.S.¹, Wendy Wang, M.D.², Richard Murray, PT², Xiangyi Xi, Ph.D.², Hung-Mo Lin, Sc.D., M.S. ², Kanishka Rajput, M.D.²

¹Quinnipiac University Frank H. Netter MD School of Medicine, North Haven, CT 06473

² Yale University School of Medicine, New Haven, CT 06510

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Introduction:

Low back pain (LBP), a major cause of disability in the US, is categorized into axial (localized) and radicular (radiating) pain¹. Physical Therapy (PT) helps by strengthening back muscles but its effectiveness by pain type is less understood. This is important as axial and radicular pain may respond differently due to potential neurologic impairments in radicular pain. Most studies on the effectiveness of PT rely on subjective metrics, with limited use of objective measures such as ultrasound-measured muscle activation^{2,3}.

Methods:

This prospective pilot study aimed to investigate whether axial and radicular LBP patients differ in their ability to activate lumbar multifidus (LM) and transversus abdominis (TA) muscles during PT. We hypothesized that axial LBP patients have greater muscle activation and that higher pain/disability correlates with reduced muscle activation.

- 15 patients, ages 18-65, with axial (n=6) OR radicular (n=9) LBP, presenting for PT were included.
- Patients with mixed pain, red flags or BMI>40 excluded.

Variables collected at enrollment (Pre PT)and 6-8 week follow-up (Post PT):

- BPI and OSW scores
- US measurements of LM and TA muscles at rest and contraction, for 3 trials totaling 6 measurements per muscle^{3,4,5}.
- Muscle thickness measured using ImageJ software
- Muscle activation measured as: [(thickness contracted- thickness rest)/thickness rest] x100% ²

Results:

- Mean pain and disability scores were non-significantly higher in axial pain patients pre- and post-PT but decreased in both groups after PT.
- No significant difference was noted in pre-PT muscle activation between pain groups for both muscles, though LM showed higher activation for axial pain patients with high variability(Table 2).
- Weak negative correlations were observed between muscle activation and pain measures for radicular pain; for axial pain, correlations were less consistent and weaker. (Table 3).

Table 1: Descriptive Statistics of Pre-PT and Post-PT Pain Measures by Pain Type

Measure	Overall	Axial	Radicular	P-value
Mean Age (SD)	47 (14)	48 (11)	47 (16)	>0.9
Gender (Female, Male)	9 (60%), 6 (40%)	4 (67%), 2 (33%)	5 (56%), 4 (44%)	>0.9
BMI Mean (SD)	27.5 (5.0)	28.7 (6.4)	26.6 (4.1)	0.6
Previous Spine Surgery (No, Yes)	13 (87%), 2 (13%)	5 (83%), 1 (17%)	8 (89%), 1 (11%)	>0.9
Injection (No, Yes)	13 (87%), 2(13%)	6 (100%), 0 (0%)	7 (78%), 2 (22%)	0.5
Pre-PT worst pain, Post-PT worst pain Mean (SD)	4.20(3.14), 3.6(2.8)	5.17 (2.86), 4.2 (2.39)	3.56 (3.32), 3.0 (3.32)	0.3, 0.5
Pre-PT avg Pain, Post-PT avg pain Mean (SD)	2.87(2.50), 2.13(2.41)	3.83(2.93), 2.20 (2.17)	2.22 (2.11), 2.05(2.9)	0.3, 0.8
Pre-PT mean pain*, Post-PT mean pain Mean (SD)	2.7(2.2), 2.06(2.04)	3.21(2.23), 2.21(1.17)	2.36(2.24), 1.90(2.81)	0.3, 0.3
Pre-PT Pain Interference, Post-PT Pain Interference Mean (SD)	2.36(2.79), 1.64(2.04)	2.36(2.75), 1.69(1.39)	2.37(2.98), 1.60(2.73)	0.3, 0.7
Pre-PT OSW%, Post-PT OSW% Mean (SD)	14(10), 10(17)	16(7), 8(4)	13(11), 12(24)	0.2, 0.2

- N = Overall: 15, Axial: 6, Radicular: 9
- Wilcoxon rank sum test; Fisher’s exact test
- * mean pain= Average of 4 pain questions of BPI (worst, best, current, and average pain)

- A strong negative partial correlation was found between change in worst pain and muscle activation ($r = -0.650, p=0.081$), indicating greater pain reductions with larger muscle thickness increases. Similar trends were observed for OSW ($r = -0.520, p=0.186$, Figure 2), though not statistically significant for other pain measures (Table3).

Figure 1: Ultrasound Measurements of the transversus abdominus (TA) and lumbar multifidus (LM) at Rest and Contraction

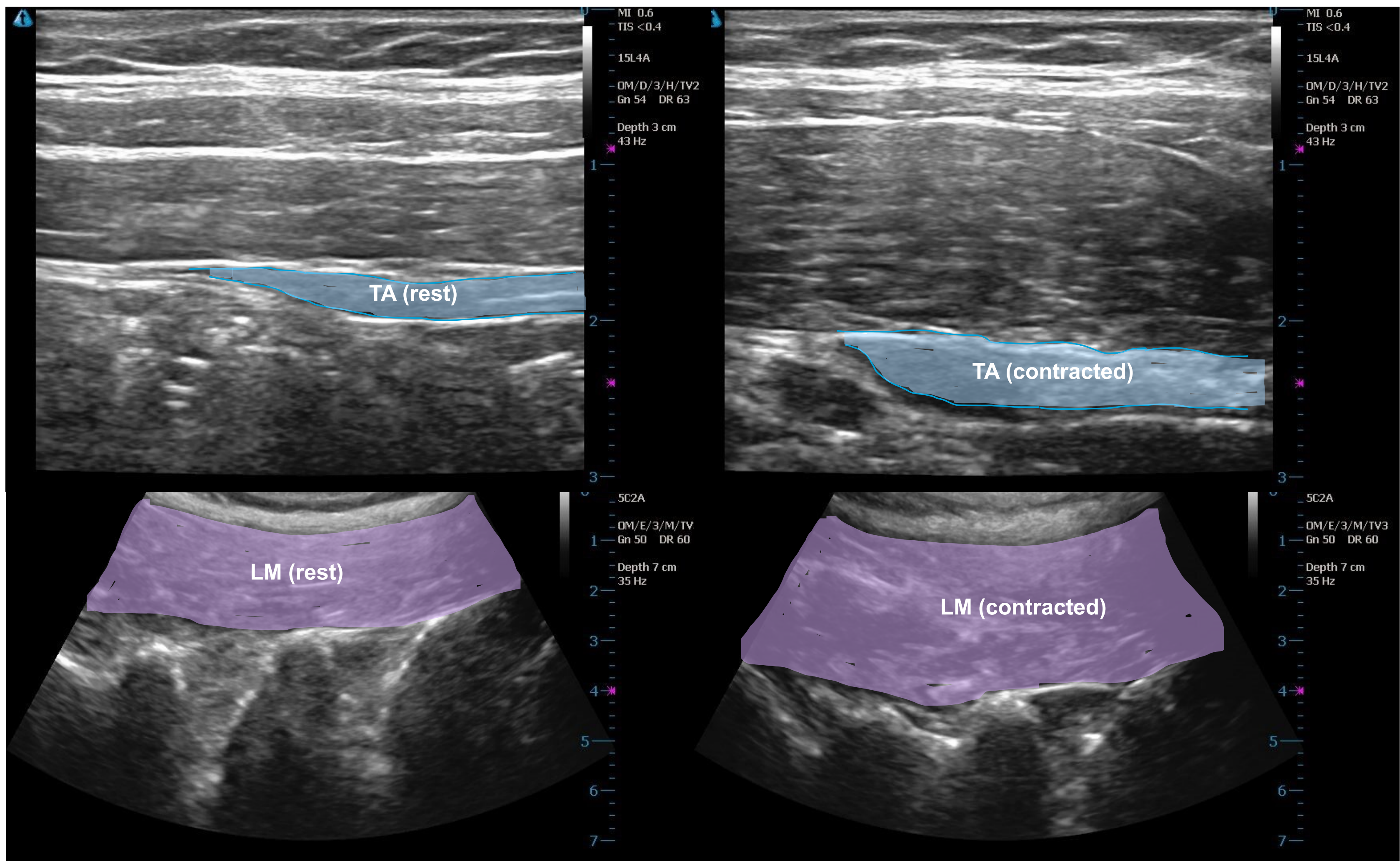


Figure 2: Scatter Plots and Smoothed Trend for Muscle Activation vs Average Pain by Type of Pain (left) and Muscle Contraction vs OSW (%) by Type of Pain (right)

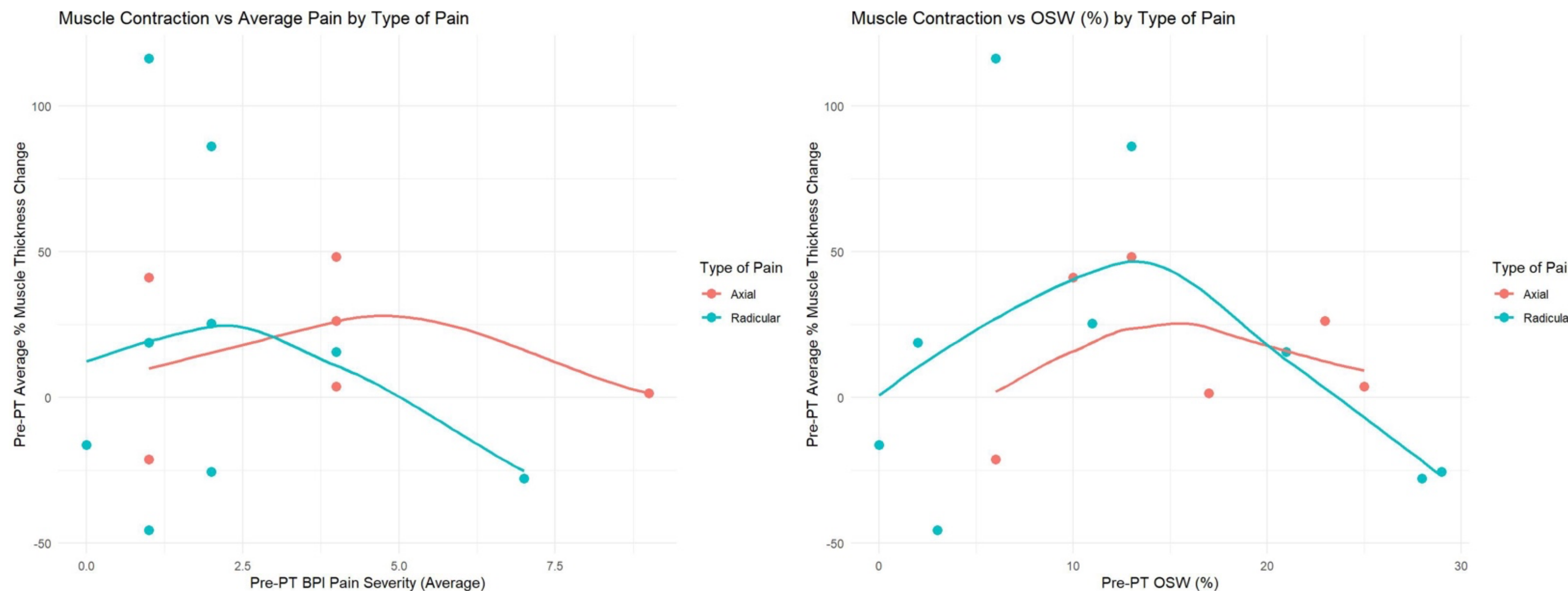


Table 2: Percent Change of Muscle Thickness (% Muscle Activation) by Muscle Type and Pain Type at Enrollment

Muscles	Overall	Axial	Radicular	P-value
Lumbar Multifidus (LM) (left+right)				
Median (Q1, Q3)	16 [-18, 30]	23 [-7.5, 47.5]	4 [-20.5, 27.5]	0.35
Min, Max	-40, 174	-29, 127	-40, 174	
Transversus Abdominis (TA) (left+right)				
Median [Q1, Q3]	3 [-18.5, 23.75]	-0.5 [-19.5, 30.5]	5 [-17.5, 32]	0.65
Min, Max	-57, 164	-26, 48	-56, 164	

- N = 15 for overall, N = 6 for axial, N = 9 for radicular
- Wilcoxon rank sum exact test

Table 3: Spearman Correlations: % Muscle Activation vs Pain Measures by Type of Pain (top) Partial Correlation: Change in Pain vs Change in Muscle Thickness between Pre and Post PT (bottom)

Spearman’s correlation	Axial Pain	Radicular Pain
Worst Pain	-0.06	-0.02
Average Pain	-0.03	-0.12
Mean Pain (Avg 4 Questions)	0.09	0.02
Pain Interference	0.20	-0.21
Oswestry Disability Index (OSW)	0.09	-0.15
Partial Correlation	Partial_r	p-value
Change in Worst Pain vs Δ MT	-0.65	0.081
Change in Average Pain vs Δ MT	-0.42	0.301
Change in Mean Pain (Avg 4 questions) vs Δ MT	-0.35	0.400
Change in Pain Interference vs Δ MT	0.19	0.654
Change in OSW (Disability) vs Δ MT	-0.52	0.186

Discussion

Preliminary results suggest a weak association between reduced muscle activation as pain and disability increase, especially in radicular patients. Axial LBP patients showed greater LM muscle activation despite higher pain scores, whereas radicular patients had persistently reduced muscle activation and higher dropout rates, indicating possible therapy engagement issues. Further data collection is needed to confirm these trends, assess clinical significance, and guide personalized therapy plans.

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