

# Trapezius Excitation is Altered without Kinematic Differences in Asymptomatic Scapular Dyskinesis

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## 1. Introduction

Scapular dyskinesia (SD) is aberrant scapular position and/or movement at rest or during motion and is often implicated in shoulder pathology (Costa e Silva Cabral et al, 2024). However, SD is also common in asymptomatic individuals, making its clinical significance unclear. Although SD has been shown to alter scapular kinematics (Huang et al, 2015), potentially due to differences in trapezius muscle excitation, most research has focused on pathological shoulders. Therefore, the purpose of this study was to compare scapular kinematics and regional trapezius excitation (upper [UT], middle [MT], and lower [LT]) during arm elevation in asymptomatic individuals with and without SD.

## 2. Methods

Fifty-three right-handed participants ( $n=53$ ,  $26\pm 8$  years, 34 female) completed the scapular dyskinesia test and were classified as SD ( $n=25$ ; subtle or obvious SD) or control (normal scapular kinesis [CON];  $n=28$ ). Participants performed five repetitions each of weighted shoulder flexion and abduction using a dumbbell (1.4 or 2.5 kg for participants  $<68.1$  kg and  $>68.1$  kg, respectively). Scapular kinematics (upward/downward rotation, internal/external rotation, anterior/posterior tilt) and high-density surface electromyography of the UT, MT, and LT and were collected. Muscle excitation for each region during the arm elevation task was

normalized to the peak root mean square obtained for that region. Kinematics and excitation were extracted at nine angles during flexion (F) and extension (E; F/E) and abduction (AB) adduction (AD; AB/AD): start of elevation (START), 45°, 75°, 105°, top of elevation (TOP), 105°, 75°, 45°, end of lowering (END). Two-way (group\*angle) mixed ANOVAs were conducted on all kinematic and muscle excitation variables, with Tukey's HSD post-hoc testing applied to significant interactions ( $p<.05$ ). Small, medium and large effect size ( $\eta^2$ ) were interpreted as .01, .06, and .14, respectively.

## 3. Results and Discussion

Regional trapezius excitation results can be found in **Table 1**. No significant interactions or main effects were observed for kinematics, UT excitation, or MT excitation during AB/AD ( $p>.05$ ). However, significant group-by-angle interactions with small-to-moderate effect sizes were observed during F/E for both MT ( $p=.041$ ,  $\eta^2=.051$ ) and LT excitation ( $p=.046$ ,  $\eta^2=.049$ ), and in LT excitation during AB/AD ( $p=.045$ ,  $\eta^2=.049$ ). Pairwise comparisons revealed that these interactions were driven by distinct excitations patterns throughout the movement. Specifically, the SD group demonstrated higher MT excitation during the middle stages of flexion (75°;  $p=.035$ ) and extension (75°;  $p=.043$ ), and at peak elevation (TOP;  $p=.046$ ). For the LT, the SD group exhibited consistently greater excitation than CON during the beginning and end stages of both tasks. In

**Table 1.** Mean and standard deviation of regional trapezius excitation (% of maximal root mean square) for scapular dyskinesis and control during raising and lowering phases of flexion and abduction arm elevation.

	Raising (mean ± standard deviation)				Lowering (mean ± standard deviation)				
	START	45°	75°	105°	TOP	105°	75°	45°	END
<b>Upper Trapezius Flexion and Extension</b>									
SD	24.9 ±8.4	38.8 ±11.7	52.6 ±13.8	65.4 ±10.9	57.4 ±8.3	44.9 ±10.9	37.6 ±9.2	28.2 ±9.3	16.5 ±6.7
C	21.9 ±10.1	33.4 ±12.5	46.6 ±15.5	59.7 ±12.2	59.7 ±13.2	42.3 ±9.1	34.2 ±9.0	25.1 ±9.1	14.8 ±7.2
<b>Upper Trapezius Abduction and Adduction</b>									
SD	25.7 ±8.0	46.5 ±12.4	57.6 ±11.0	67.1 ±8.5	56.2 ±11.3	45.2 ±6.8	39.0 ±8.3	29.3 ±6.9	18.9 ±6.6
C	21.4 ±8.3	40.3 ±16.0	48.0 ±14.7	58.5 ±12.5	55.8 ±13.9	40.2 ±9.2	33.7 ±8.3	25.3 ±8.4	15.4 ±6.1
<b>Middle Trapezius Flexion and Extension*</b>									
SD	32.3 ±9.1	49.9 ±11.9	57.3 ±9.3	56.4 ±9.41	48.6 ±11.3	42.0 ±9.2	42.7 ±9.1	37.1 ±11.3	20.5 ±7.8
C	27.4 ±11.3	43.4 ±15.7	49.5 ±15.8†	50.8 ±13.2	54.7 ±10.3†	36.8 ±8.8	37.9 ±9.2†	31.3 ±9.6	17.8 ±8.7
<b>Middle Trapezius Abduction and Adduction</b>									
SD	28.9 ±7.1	48.8 ±8.9	59.8 ±9.2	66.3 ±8.9	53.9 ±12.3	44.2 ±7.3	39.6 ±8.6	28.4 ±6.4	18.0 ±6.0
C	26.5 ±9.7	46.8 ±14.3	56.0 ±13.0	65.2 ±10.3	56.7 ±9.8	42.2 ±8.0	37.8 ±8.5	28.3 ±9.0	17.2 ±7.6
<b>Lower Trapezius Flexion and Extension*</b>									
SD	27.7 ±8.9	45.8 ±9.4	57.7 ±11.8	59.2 ±10.9	58 ±10.6	51.4 ±10.4	44.1 ±8.4	32.8 ±8.6	20.9 ±11.9
C	19.8 ±9.1†	37.5 ±11.2†	50.9 ±13.0	54.5 ±11.8	56.6 ±9.3	39.4 ±10.1†	34.0 ±11.2†	21.4 ±10.2†	11.8 ±9.2†
<b>Lower Trapezius Abduction and Adduction*</b>									
SD	22.6 ±9.6	35.1 ±10.3	44.2 ±12.0	56.3 ±11.6	67.4 ±7.8	41.2 ±9.9	35.8 ±9.6	28.0 ±10.4	22.8 ±12.4
C	14.5 ±8.5†	29 ±10.4†	41.4 ±12.0	55.8 ±9.7	64.2 ±8.9	35.6 ±8.3†	27.1 ±9.3†	20.1 ±10.2†	14 ±10.4†

C= control; SD= scapular dyskinesis; \* $p < .05$ = two-way interaction, † $p < .05$  pairwise comparison.

F/E, LT excitation was higher in SD at START, 45°E, and throughout the lowering phase (105°E to END; all  $p < .01$ ). Similarly, the SD group had greater LT excitation during AB/AD at START and during the majority of the adduction phase ( $p < .05$ ).

These findings deviate from prior reports of reduced MT and LT excitation in individuals with SD (Huang et al, 2015, Costa e Silva Cabral et al, 2024, Cools et al., 2014). In contrast, our results demonstrated that asymptomatic SD is characterized by a moderate increase in MT and LT excitation despite a lack of detectable kinematic differences. This may be explained by the scapular force-couple relationship; the serratus anterior (SA) works synergistically with the trapezius to facilitate upward rotation and posterior tilt. It is possible that the increased MT and LT excitation observed represents a neuromuscular compensation for SA insufficiency. By over-recruiting the trapezius, individuals with SD may successfully maintain kinematics and remain asymptomatic, albeit through altered motor strategies. However, the absence of SD

subgrouping by pattern may have obscured more specific kinematic deviations (Huang et al, 2015).

## 4. Conclusions

In asymptomatic individuals, scapular dyskinesis was not associated with altered scapular kinematics during F/E or AB/AD but was characterized by greater MT and LT excitation across arm raising and lowering. The lack of SD subgrouping may have obscured pattern-specific differences, highlighting the importance of considering SD classification when interpreting neuromuscular and kinematic outcomes.

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## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

## Contributor Roles

SB: formal analysis, investigation, methodology, visualization, writing-original draft, writing-review & editing; BB: data curation, formal analysis, investigation, methodology, project administration; AL: methodology, software; TS: conceptualization, methodology, resources, supervision, writing-review & editing.

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