SHANNON M. PETERSEN, PT, DScPT, OCS, COMT, FAAOMPT[1] • **SARAH N. WYATT**[2]

Lower Trapezius Muscle Strength in Individuals With Unilateral Neck Pain

Patients with neck pain often have subjective complaints of muscle stiffness, tension, or tightness in addition to their pain.[33,35] Various authors have also proposed that prolonged tightness or overactivity of the upper trapezius muscle can lead to middle and lower trapezius muscle weakness, resulting in postural adaptations and pain.[20,31] Although it has been suggested that individuals with neck pain may have limited strength and endurance of the lower trapezius muscle, no published studies have investigated lower trapezius strength in individuals with neck pain.[2,12,27]

The majority of research on scapulothoracic muscle dysfunction has examined individuals with shoulder pathologies such as shoulder impingement, rotator cuff insufficiency, and shoulder instability.[7-9] Such research has focused on scapulothoracic muscle imbalances, which disrupt normal scapular positioning, resulting in impaired biomechanics and, ultimately, pain.[7-9] Janda[15] described muscle imbalances as impaired relationships between muscles prone to tightness that lose extensibility, and those prone to inhibition and weakness. It has been suggested that muscle imbalances in the scapulothoracic region occur when the upper trapezius becomes tight and the middle trapezius and lower trapezius become weak.[7,8,20] Exercises that enhance the ratio of lower trapezius to upper trapezius strength have been suggested to reduce this muscle imbalance and improve scapulothoracic posture in patients with shoulder pathologies.[8,32]

STUDY DESIGN: Descriptive and within-subject comparative study.

OBJECTIVES: To examine lower trapezius muscle strength in individuals with unilateral neck pain.

BACKGROUND: Previous research has established the presence of reduced cervical flexor, extensor, and rotator muscle strength in individuals with neck pain. Some authors have suggested that individuals with neck pain have limited strength of the lower trapezius muscle, yet no research has investigated this claim.

METHODS: Twenty-five individuals with unilateral neck pain participated in this study. Participants completed the Northwick Park Neck Pain Questionnaire (NPQ) as a measure of disability. Side of neck pain, duration of neck pain, and hand dominance were recorded. Lower trapezius muscle strength was assessed bilaterally in each participant, using a handheld dynamometer.

RESULTS: A significant difference in lower trapezius strength was found between sides ($P<.001$), with participants demonstrating an average of 3.9 N less force on the side of neck pain. The tested levels of association between NPQ score and percent strength deficit ($r = -0.31$, $P = .13$), and between symptom duration and percent strength deficit ($r = -0.25$, $P = .22$), were not statistically significant. No significant association was found between hand dominance and side of stronger lower trapezius ($P = .59$).

CONCLUSION: The results of this study demonstrate that individuals with unilateral neck pain exhibit significantly less lower trapezius strength on the side of neck pain compared to the contralateral side. This study suggests a possible association between lower trapezius muscle weakness and neck pain. *J Orthop Sports Phys Ther 2011;41(4):260-265, Epub 2 February 2011. doi:10.2519/jospt.2011.3503*

KEY WORDS: *cervical spine, scapula, shoulder*

Characteristics of scapulothoracic muscle imbalances are found not only in patients with shoulder pathologies but also in individuals with neck pain and cervicogenic headaches.[18,19] Jull et al[19] determined that upper trapezius tightness was more prevalent in individuals with cervicogenic headaches than in asymptomatic individuals. Additionally, textbook authors[15,18] have stated that individuals with neck pain clinically exhibit limited strength or endurance of the lower trapezius muscle, though currently there is no research evidence to support this claim.

Lower trapezius muscle strength has not been examined in individuals with neck pain, but there has been extensive research focusing on the relationship between neck muscle strength and neck pain. Numerous authors have found limitations in cervical flexor, cervical

[1]Assistant Professor, Doctor of Physical Therapy Program, Des Moines University, Des Moines, IA. [2]Student, Doctor of Physical Therapy Program, Des Moines University, Des Moines, IA. This study was approved by The Des Moines University Institutional Review Board. Funding was provided by The Iowa Osteopathic Education Research Fund. Address correspondence to Dr Shannon Petersen, Des Moines University, Physical Therapy Program, Osteopathic Medical Center, 3200 Grand Avenue, Des Moines, IA 50325. E-mail: shannon.petersen@dmu.edu

extensor, and cervical rotator muscle strength in individuals with neck pain and cervicogenic headaches, as compared to asymptomatic individuals.[1,17,36] Methods for neck muscle strengthening have been described in the literature,[11] and, although there is no consensus on which strengthening exercises provide the best outcomes, neck strengthening exercises have been observed to have positive effects in individuals with neck pain and whiplash-associated disorders.[13,16,30,37,38] Neck strengthening exercises have been shown to be effective in alleviating pain, increasing cervical muscle strength, increasing cervical range of motion, and decreasing both short-term and long-term disability in individuals with neck pain.[13,16,30,37,38]

Although neck muscle strength impairments have been found in individuals with neck pain, no studies to date have examined lower trapezius muscle strength in this population. The purpose of this study was to examine lower trapezius muscle strength in individuals with unilateral neck pain, as an initial step in determining if impairments need to be assessed and addressed in this population.

METHODS

Participants

A convenience sample of 7 male and 18 female participants (n = 25) between the ages of 23 and 52 years (mean ± SD, 30.4 ± 9.4 years) was recruited through advertising in a graduate university setting. The criteria for inclusion in this study were neck pain perceived by the individual as being on one side of the neck and neck pain 3 or more months in duration. Exclusion criteria were neck pain perceived by the individual as being centrally located or on both sides of the neck, neck pain duration of less than 3 months, radicular symptoms, history of spinal surgery, involvement in workers' compensation, involvement in litigation, and previous physical therapy intervention for the upper extremity or spine. Each participant received a verbal explanation of the testing procedure and a written informed consent form, which all participants signed. This investigation was approved by The Des Moines University Institutional Review Board.

FIGURE 1. Lower trapezius manual muscle test position.

Data Collection

Each participant completed an intake questionnaire to report demographic information, side of symptoms, symptom duration, and hand dominance. Participants also completed the Northwick Park Neck Pain Questionnaire (NPQ), which has been found to be reliable, valid, and sensitive in objectively measuring neck pain and associated disability.[23,24]

The JTech Power Track II handheld dynamometer (JTech Medical, Salt Lake City, UT) was used to assess lower trapezius strength by measuring the amount of force (N) required by the examiner to overcome the participant's maximum muscular effort.[3] Handheld dynamometry has been found to have high interrater and intrarater reliability[3,4,10] and has been determined to be a valid method of strength assessment.[25,26]

Strength of the lower trapezius muscle was tested in the standard position, as described by Kendall et al[21] (**FIGURE 1**). The participant was given instructions regarding the test procedure, then positioned in prone, with the upper extremity diagonally overhead, in line with the fibers of the lower trapezius muscle.[21] A towel roll was placed under the participant's forehead to maintain the cervical spine in a neutral position. All participants were able to attain the test position against gravity. To avoid compensations during the test, the examiner provided manual fixation by placing one hand just inferior to the participant's contralateral scapula.

The participant was then instructed to maintain the arm in the test position, while the examiner provided resistance. The handheld dynamometer force sensor was applied to the distal one third of the participant's radial forearm, and force was applied by the examiner in a downward direction, toward the floor, until the participant's maximal muscular effort was overcome. The maximum handheld dynamometer force reading was recorded. Two trials were recorded consecutively on each upper extremity, with a 30-second rest between trials. The average of the trials for each side was used for data analysis. The initial side of testing was randomized for each participant, and the examiner was blinded to the side of neck pain and side of hand dominance.

Statistical Analysis

Descriptive statistics for gender, age, symptom duration, NPQ score, side of symptoms, and handedness were calculated. A 2-way, random-model (2,1) intraclass correlation coefficient (ICC) was used to determine between-trial intrarater reliability for both extremities. Standard error of measurement (SEM) was calculated using the formula $SEM = SD\sqrt{(1-ICC)}$. A dependent *t* test was used to detect differences between lower trapezius strength on the side ipsilateral to neck pain and lower trapezius strength on the side contralateral to neck pain. Percent strength deficit on the side of neck pain was determined by subtracting lower trapezius strength on the ipsilateral side from lower trapezius strength on the contralateral side and dividing the result by lower trapezius strength on the contralateral side. The correlation coefficient for NPQ score and percent strength deficit was calculated using a Pearson correlation analysis. The correlation coefficient for symptom duration and percent strength deficit was also calculated. A chi-square test was used to determine if an association existed between side of hand dominance and side of the stronger lower trapezius muscle. A significance level of $P<.05$ was selected for this study. All statistical analysis was performed with GraphPad Prism, Version 4 (GraphPad Software, Inc, San Diego, CA) and custom software written in LabVIEW programming language.

RESULTS

Descriptive data are summarized in **TABLES 1** and **2**. Intrarater test-retest reliability, as indicated by the ICCs, was 0.96 (95% CI: 0.91, 0.98) for lower trapezius strength measurements on the side ipsilateral to pain and 0.95 (95% CI: 0.90, 0.98) on the side contralateral to pain. The standard error of measurement (SEM) was 2.0 N for the ipsilateral side and 2.5 N for the contralateral side. The dependent *t* test comparing lower trapezius strength on the side of neck pain to lower trapezius strength on the contralateral side revealed a significant difference in strength between sides ($P<.001$; mean difference, 3.9 N; 95% CI: 1.8, 6.0 N), with the side of neck pain being weaker (**FIGURES 2** and **3**).

The association between NPQ scores and percent strength deficit was not statistically significant ($r = -0.31$, $P = .13$), nor was the association between symptom duration and percent strength deficit statistically significant ($r = -0.25$, $P = .22$). Removal of 1 outlier for symptom duration (360 months) did not significantly change this relationship ($r = 0.07$, $P = .74$).

The chi-square test determined that the association between hand dominance and the side of stronger lower trapezius was not significant ($\chi^2 = 0.29$, $df = 1$, $P = .59$). Because 2 participants had equal lower trapezius strength bilaterally, those 2 participants were omitted from the chi-square analysis.

TABLE 1 Descriptive Data

Variable	Mean ± SD	Range
Age (y)	30.4 ± 9.4	23-52
Symptom duration (mo)	58.2 ± 77.1	3-360
NPQ score (%)	17.9 ± 7.4	2.8-38.9
Strength ipsilateral (N)*	21.8 ± 10.0	4.4-44.0
Strength contralateral (N)†	25.7 ± 11.5	6.6-50.6

Abbreviations: NPQ, Northwick Park Neck Pain Questionnaire.
**Lower trapezius strength ipsilateral to the side of neck pain.*
†Lower trapezius strength contralateral to the side of neck pain.

TABLE 2 Descriptive Data

Variable	n
Males	7
Females	18
Right-hand dominance	22
Left-hand dominance	3
Right-sided symptoms	15
Left-sided symptoms	10

DISCUSSION

The results of this study demonstrate a significant difference in lower trapezius strength between sides ipsilateral and contralateral to pain in individuals with unilateral neck pain. No significant associations were found between NPQ score and percent strength deficit, symptom duration and percent strength deficit, or hand dominance and stronger lower trapezius side. The findings of this study are also consistent with impairments described in the physical therapy Neck Pain Clinical Practice Guidelines, which are linked to The World Health Organization's International Classification of Functioning, Disability, and Health (ICF) and the associated International Statistical Classification of Diseases and Related Health Problems (ICD-10).[5] These guidelines state that patients presenting clinically with coordination, strength, and endurance deficits of the neck and upper quarter muscles, including the lower trapezius, fit into the ICF impairment-based category of neck pain with movement coordination impairments and the associated ICD-10 category of sprain and strain of the cervical spine.[5] The findings of the current study support strength testing of the lower trapezius muscle in clinical examination of patients who present with neck pain. This may help identify impairment and assist in patient classification into this ICF impairment-based category of neck pain with movement coordination impairments and the associated ICD-10 category of sprain and strain of the cervical spine.[5]

Furthermore, the neck pain clinical practice guidelines recommend that clinicians consider strengthening, endurance, and coordination exercises as interventions for patients in the ICF impairment-based category of neck pain with movement coordination impairments and the associated ICD-10 category of sprain and strain of the cervical spine to reduce neck pain and headache.[5] As the current study did not include an

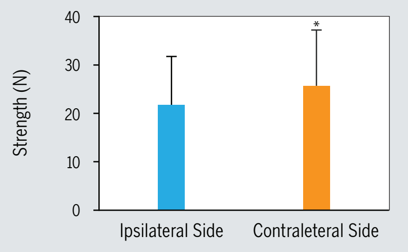

FIGURE 2. Lower trapezius strength (N) ipsilateral and contralateral to neck pain. *Significant difference between sides based on dependent *t* test (P<.001). Error bars denote SD.

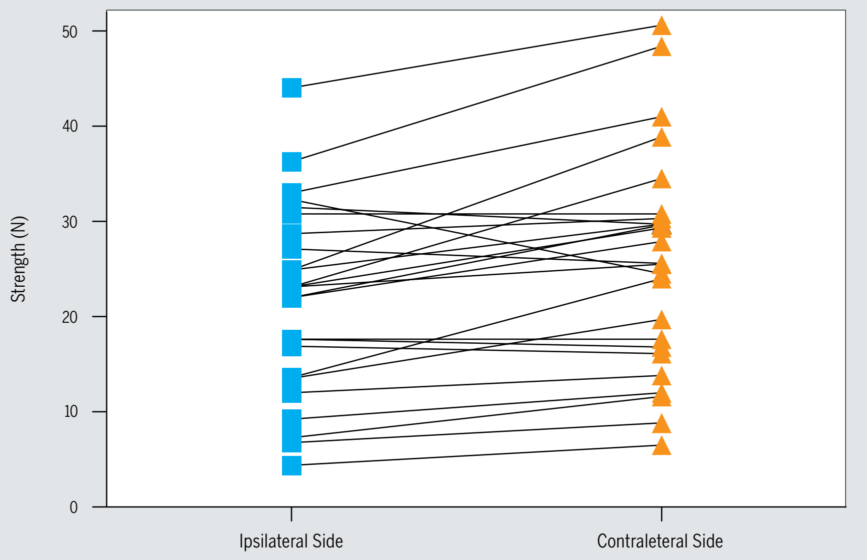

FIGURE 3. Individual participant data for lower trapezius strength ipsilateral and contralateral to the side of neck pain. Seventeen participants were stronger on the contralateral side, 5 participants were stronger on the ipsilateral side, and 2 had equal lower trapezius strength.

intervention protocol, no conclusion can be drawn in regard to the effects of lower trapezius strengthening on patients with neck pain. Previous research has suggested that exercises which increase the ratio of lower trapezius to upper trapezius strength in patients with shoulder pathologies may lessen scapulothoracic muscle imbalances and improve scapulothoracic posture.[8,32] The current study did not investigate the ratio of lower trapezius to upper trapezius strength, so it is unclear if exercises that increase the ratio of lower trapezius to upper trapezius strength would also benefit individuals with neck pain. Future investigation of this topic is warranted.

Although there are currently no other studies investigating lower trapezius strength in individuals with neck pain, there has been research on hip muscle strength for those with unilateral patellofemoral pain.[6] Cichanowski et al[6] found hip abductor strength and hip external rotator strength in collegiate female athletes to be significantly reduced on the side of patellofemoral pain as compared to the asymptomatic side. These results are consistent with the current study's findings that musculature biomechanically linked to an area of pain can potentially be weaker on the symptomatic side. In addition, Cichanowski et al[6] found no relationship between limb dominance and side of hip weakness, which is consistent with this study's findings that hand dominance was not associated with lower trapezius strength (P = .59).

The results of this study indicate a nonsignificant relationship between NPQ scores and percent strength deficit of the lower trapezius on the side of neck pain, which suggests that participants with higher NPQ scores, thus greater disability, did not have greater strength deficits than those with lower NPQ scores. This lack of association between lower trapezius strength and disability is consistent with previously published research.[29] Pearson et al[29] found significant neck strength deficits in individuals with whiplash-associated disorder, compared to controls, but did not find a significant association between neck strength and Neck Disability Index scores.

The results of the current study also indicate a nonsignificant relationship between symptom duration and percent strength deficit, which suggests that individuals presenting with neck pain for greater durations did not have greater lower trapezius strength deficits than those with shorter neck pain durations. No previous research has examined the effect of neck pain duration on lower trapezius strength; however, research on hip muscle strength supports the current findings that strength deficits and symptom duration are not correlated.[28] Niemuth et al[28] found no significant interaction between hip muscle strength and duration of symptoms in recreational runners.

Good intrarater test-retest reliability was demonstrated, with ICCs of 0.96 for the side ipsilateral to pain and 0.95 for the side contralateral to pain. SEMs were 2.0 N for the ipsilateral side and 2.5 N for the contralateral side. Although reliability and validity of the current lower trapezius manual muscle testing procedure has not been established in research, Michener et al[26] determined the reliability, error, and construct validity of a similar lower trapezius manual muscle testing procedure, modified with dynamometer placement on the scapula, in individuals with shoulder pain. These authors found an ICC of 0.93 for intertrial reliability and 0.89 for intrarater test-retest reliability for strength measurements of the lower trapezius.[26] Michener et al[26] also found the SEM at the 90% CI to be 1.5 kg. A pilot study by Turner et al,[34] using the same lower trapezius manual muscle testing procedure as those used by Michener et al,[26] demonstrated ICC values for intrarater reliability between 0.69 and 0.77 and ICC values for interrater reliability between 0.65 and 0.81; SEM values ranged between 9.86 and 13.92 N for individual examiners.

Currently, there is conflicting evidence in the literature as to which manual muscle test position best assesses the lower trapezius muscle.[22,26] The lower trapezius muscle test position utilized in this study was selected because it is the most commonly described position for testing lower trapezius muscle strength.[34] Michener et al[26] used the lower trapezius manual muscle test position described by Hislop et al,[14] which is similar to the position described by Kendall et al.[21] Michener et al[26] utilized surface electromyography to demonstrate that this test position yielded the highest lower trapezius muscle activation, compared to middle trapezius, upper trapezius, and serratus anterior manual muscle test positions. Conversely, Kinney et al[22] found significantly greater lower trapezius muscle activation for the lower trapezius manual muscle test when the upper extremity was placed at 90° and 125° of glenohumeral joint abduction versus 160°, or in line with the fibers of the lower trapezius muscle, as described by Kendall et al.[21]

Additionally, variability in dynamometer placement during lower trapezius muscle testing procedures has been presented in the literature.[26,34] Michener et al[26] applied force at the scapula, rather than at the upper extremity, to reduce involvement of joints other than the scapulothoracic joint. However, the most commonly described lower trapezius test utilizes force application at the upper extremity.[14,21] The current study elected to apply force at the upper extremity, as described by Kendall et al.[21]

When interpreting the results of this study, one must consider that all participants could attain the manual muscle test position for the lower trapezius muscle against gravity (muscle strength grade greater than 3/5). Although the current study found no significant correlations among lower trapezius strength, NPQ score, and symptom duration, these results cannot be generalized to individuals with lower trapezius strength of less than a 3/5 muscle grade. Additionally, this study compared lower trapezius strength between sides of symptomatic individuals and did not include an asymptomatic control group for comparison. It is uncertain whether side-to-side differences in lower trapezius strength exist in asymptomatic individuals. Potential reasons for the asymmetry observed cannot be determined based on the results of the current study.

The current study provides a foundation on which future intervention studies may investigate the effects of lower trapezius strengthening exercises on patients with neck pain. Future studies that examine lower trapezius strength in individuals with neck pain versus asymptomatic controls and that assess the strength of other scapulothoracic stabilizers in individuals with neck pain are also warranted.

CONCLUSION

In this study, participants with unilateral neck pain exhibited significantly less lower trapezius strength on the side of neck pain as compared to the contralateral side. Clinicians should, therefore, examine lower trapezius muscle strength in patients with complaints of neck pain. ◉

KEY POINTS

FINDINGS: Individuals with unilateral neck pain exhibited significantly less lower trapezius muscle strength on the side of neck pain compared to the contralateral side.

IMPLICATION: The assessment of lower trapezius muscle strength should be considered in individuals with unilateral neck pain.

CAUTION: This study did not include an asymptomatic group for comparison. The clinical efficacy of strengthening the lower trapezius in this population cannot be assumed.

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