JITEN B. BHATT, PT, MPT[1] • RANDAL GLASER, PT, DPT[2] • ANDRE CHAVEZ, PT, DPT[3] • EMMANUEL YUNG, PT, DPT[3,4]

Middle and Lower Trapezius Strengthening for the Management of Lateral Epicondylalgia: A Case Report

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Lateral epicondylalgia, commonly called tennis elbow, is described as a tendinopathy at the common extensor origin at the lateral epicondyle of the humerus.[25,26,39] Lateral epicondylalgia is the most common elbow problem in athletes, especially in tennis players.[1,17] At-risk populations also include those with professions that require repetitive and/or forceful/heavy manual tasks,[44,45,50] nonneutral wrist postures,[45] and repetitive gripping.[9,52,53,55] To date, there is no consensus on the optimal treatment approach for lateral epicondylalgia, which is in large part due to its unclear underlying etiology.[10,52]

Because most treatment approaches for lateral epicondylalgia are based on the premise of impairments of the wrist extensor musculature or elbow joint mobility, interventions tend to focus on addressing the elbow region. Accordingly, proposed interventions include manual therapy,[51-53] iontophoresis,[49] strengthening and stretching of the wrist extensor and forearm supinator musculature,[36] nonsteroidal anti-inflammatory drugs,[33] eccentric training,[38] splinting and bracing,[33] cortisone injections,[12] or a wait-and-see policy.[46] Bisset et al[10] concluded that more research is required to examine the effects of these interventions. Dick et al[15] concluded that an analysis of workplace management of lateral epicondylalgia was not possible, due to the poor quality of research. To date, research that has tested the effect of any single intervention for the treatment of lateral epicondylalgia is scarce,[10,21] including interventions that focus on addressing weakness of the scapular musculature.

STUDY DESIGN: Case report.

BACKGROUND: Addressing weakness of the shoulder region, especially the rotator cuff and scapular musculature, is often suggested clinically for the treatment of individuals with lateral epicondylalgia. However, to our knowledge, the clinical effectiveness of this approach has not been established.

CASE DESCRIPTION: The patient was a 54-year-old woman with a 5-month history of right lateral elbow pain, whose symptoms were reproduced with clinical tests typically used to diagnose lateral elbow tendinopathy. The patient also demonstrated weakness in her middle and lower trapezius muscles, and the medial border of her scapula, measured with a tape measure, was 11 cm lateral from the spinous processes of the thoracic spine with the patient standing in relaxed stance. Based on improved grip strength and reduced associated elbow pain when tested with the scapula manually corrected in a more adducted position, treatment focused solely on strengthening of the middle and lower trapezius muscles over a 10-week period.

OUTCOMES: Following the intervention, the patient presented with improved scapular position, with the medial border of the scapula being 9 cm lateral to the midthoracic spine. The patient's middle and lower trapezius strength improved from 3+/5 and 4−/5, respectively, to 5/5, and her grip strength from 26.1 to 42.2 kg. The patient's scores on the Disabilities of the Arm, Shoulder and Hand questionnaire also improved from 44.2 at the initial evaluation to 0 at the completion of therapy, with the patient being able to perform all of her daily activities in a pain-free manner.

DISCUSSION: The results of this case report suggest that assessment and treatment of scapular musculature warrant consideration in the management of individuals with lateral epicondylalgia.

LEVEL OF EVIDENCE: Therapy, level 4.
J Orthop Sports Phys Ther 2013;43(11):841-847. Epub 9 September 2013. doi:10.2519/jospt.2013.4659

KEY WORDS: *scapula, shoulder, tendinopathy, tennis elbow*

[1]Kaiser Permanente Panorama City Orthopaedic Physical Therapy Residency Program, Panorama City, CA. [2]Kaiser Permanente Panorama City, Santa Clarita, CA. [3]Kaiser Permanente West Los Angeles Orthopaedic Physical Therapy Residency Program, Los Angeles, CA. [4]Doctor of Physical Therapy Program and Orthopaedic Physical Therapy Residency Program, Sacred Heart University, Fairfield, CT. The methods described in this case report are the standard of care for patients seen in this clinic; as such, Institutional Review Board approval was not required. Nevertheless, informed consent was obtained and patient rights were protected according to the established policies and procedures of the Southern California Kaiser Permanente Institutional Review Board Committee. The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article. Address correspondence to Jiten B. Bhatt, 8250 Woodman Ave, North 2 Building, Physical therapy Department, Panorama City, CA 91402. E-mail: JBhatt37@gmail.com Copyright ©2013 *Journal of Orthopaedic & Sports Physical Therapy®*

Clinically, based on expert opinion, rotator cuff and scapular musculature weakness in individuals with lateral epicondylalgia is commonly addressed by reducing the stresses placed on the wrist/forearm musculature.[4,16] Alizadehkhaiyat et al[4] identified weaker rotator cuff musculature in patients with lateral epicondylalgia compared to that of a control group, but did not address scapular musculature strength. More recently, Lucado et al[29] reported the presence of lower trapezius muscle weakness in tennis players with lateral epicondylalgia. Clinically, the authors of this case report noted that modifying scapular position into adduction in individuals with weak scapular musculature and an abducted scapula also modifies the position of the humerus and reduces lateral epicondylalgia symptoms. More importantly, we have found that this scapular correction often results in improvement in grip strength.

The purpose of this case report was to document the effects of an exercise program focused solely on changing the strength of the scapular musculature and position of the scapula to address the pain and functional limitations of an individual with lateral epicondylalgia.

CASE DESCRIPTION

Patient Characteristics

The patient was a 54-year-old, right-handed woman with a height of 1.75 m, a body mass of 76 kg, and a body mass index of 24.8 kg/m^2. Her primary activities were to care for her 2 children and to perform daily household activities. Informed consent was obtained and patient rights were protected according to the established policies of the Kaiser Permanente Institutional Review Board Committee.

The patient described a 5-month history of right lateral elbow pain that she first noticed after performing volunteer work that included carrying tarps and mulch. The patient had seen her primary-care physician, who prescribed pain medication, and, after a follow-up visit with her physician, was referred to physical therapy for evaluation and treatment. The patient's symptoms had not improved in the 5-month period prior to her physical therapy evaluation and did not change with pain medication. The patient stated that she had right lateral elbow pain that occurred with movements requiring wrist extension and activities of daily living, such as lifting her child and scrubbing her kitchen counter. The pain also consistently interrupted her sleep once a night. To manage her symptoms, she applied ice on her elbow, which helped temporarily. She had not received any prior therapeutic intervention. The patient's goal was to return to her prior level of pain-free elbow function for her everyday activities.

Examination/Evaluation

Functional Status Prior to each treatment session, the patient completed a self-administered Disabilities of the Arm, Shoulder and Hand (DASH)[6] questionnaire to document the functional status of her upper extremity. The DASH disability/symptom component consists of 30 questions, each scored on a 1-to-5-point scale. The DASH raw score is transformed to a score out of 100, with higher scores indicating poorer function. The minimal detectable change for both elbow pain and elbow problems is 9.33 points.[13] The minimal clinically important difference for elbow pain and elbow problems is 10.32 and 9.11 points, respectively.[13] The DASH minimal detectable change and minimal clinically important difference for shoulder pain are 13 (mean) and 15 points, respectively.[7] The preintervention score was 44.2 points.

Pain An 11-point numeric pain rating scale (NPRS)[47] was used to quantify the severity of her symptoms during pain-provoking activities. NPRS scores range from 10 to 0, with lower scores indicating improvement in pain. The minimal clinically important difference for the NPRS in patients with shoulder pain is 2.17 points.[32] The patient indicated a similar NPRS score of 7/10 when attempting to pick up her child and also when cleaning the shower.

Cervical Spine and Shoulder Examination The patient demonstrated full and pain-free cervical spine, shoulder, and elbow active range of motion. Accessory and passive joint mobility testing of the cervical spine and glenohumeral joint, as described by Childs et al[11] and Yung et al,[56] was performed, as these structures can be possible sources of referred pain to the elbow and did not elicit the patient's symptoms. Further, all upper-limb neurodynamic tests, peripheral nerve trunk palpation,[19,27] and the Spurling[54] test were negative.

Elbow Examination Symptom reproduction of lateral elbow pain occurred with the following clinical tests commonly used for the diagnosis of lateral elbow tendinopathy: the Cozen test, the Maudsley test, and the lateral epicondylitis test.[18] Furthermore, palpation along the common wrist extensor tendon over the lateral epicondyle also reproduced the patient's elbow symptoms. Resisted wrist extension also elicited the patient's symptoms, precluding a valid strength measurement from being performed.[22,37]

Standing Posture Upper extremity alignment was measured independently by 2 physical therapists and assessed qualitatively in a standing position, as described by Kendall et al[22] and Sahrmann.[40] In this case, the patient demonstrated an abducted position of her scapula that accompanied a relative internal rotation of the humerus, with the cubital fossa facing anterior and medial. Upon manual correction of the scapular position into a more adducted position, as described by Sahrmann,[40] humeral position returned to neutral, with the cubital fossa facing anterior. This indicated an abducted scapula on her affected side, without any specific humeral fault. Last, as described by Sobush et al,[48] 2 separate testers, using a tape measure, independently quantified the distance between the medial border of the scapula and the midline of the thorax (spinous processes). The measured distance was 11 cm for the affected

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

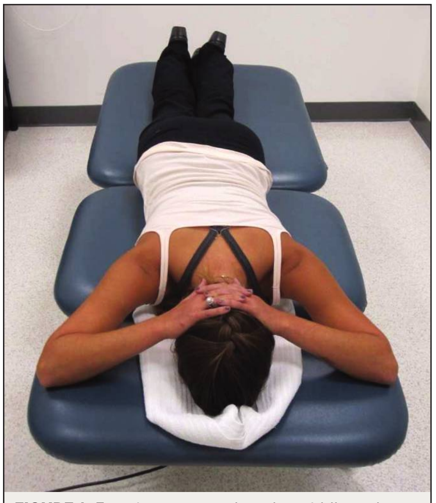

FIGURE 1. Exercise to strengthen the middle and lower trapezius muscles using a short lever arm for resistance. The patient is asked to contract the middle and lower trapezius muscles, focusing on quality and control of activation without the compensatory use of the upper trapezius and posterior deltoid muscles. The patient is asked to lift the elbows toward the ceiling.

FIGURE 2. Exercise to strengthen the middle trapezius muscle using a longer lever arm for resistance. The patient is asked to contract the middle trapezius muscle, focusing on quality and control of the activation without compensation of the upper trapezius and posterior deltoid muscles. The wrists stay in a neutral position, and the scapulae are brought into retraction as the arms are lifted toward the ceiling.

side and 9 cm for the nonaffected side, whereas previously reported normal values were (mean ± SD) 8.3 ± 1.25 cm.[48]

Grip Strength Grip strength was assessed with and without manual scapular correction. The purpose of this test was to assess the effect scapular position had on the patient's grip strength and elbow pain during a gripping task. For testing, a Jamar dynamometer (Sammons Preston Rolyan, Bolingbrook, IL) was used, and the patient's elbow was flexed to 90°, with the wrist and forearm held in neutral and the glenohumeral joint in a neutral resting position. Only scapular position was modified between the tests, and for each scapular position the patient performed 3 trials of 5 seconds in duration. With the scapula in its usual resting position, the patient had a grip strength of 26.1 kg prior to lateral elbow pain rated at 7/10. In comparison, with the scapula passively manually corrected into a more adducted and posteriorly tilted position, as described by Sahrmann,[40] grip strength, without any elbow pain, was 33.7 kg.

Scapular Musculature Strength testing of the middle and lower trapezius was performed in a prone testing position, as described by Kendall et al,[22] with the scapula in its usual resting position. Testing was performed independently by 2 licensed physical therapists, and scores from 0 to 5 were used as described by Kendall et al.[22] Middle trapezius strength was considered to be 3+/5, whereas lower trapezius strength was 4–/5.

Electromyography and Grip Strength To potentially gain additional insight on the influence of scapular repositioning on the activation level of the wrist musculature, electromyographic (EMG) signals for the extensor carpi radialis brevis (ECRB) and biceps brachii were collected when performing a standardized grip task with and without correction of scapular position. The EMG signals were recorded at 1500 Hz and subsequently band-pass filtered (80-250 Hz). Data were full-wave rectified, and a moving-average smoothing algorithm (50-millisecond window) was used to generate a linear envelope. EMG processing and smoothing were performed using MyoResearch XP Master Edition 1.08.17 (Noraxon USA Inc, Scottsdale, AZ). Disposable, self-adhesive Ag/AgCl dual electrodes (Noraxon USA Inc) were used, spaced 2 cm apart over the ECRB and biceps brachii muscles, according to the criterion described by Delagi and Perotto.[14]

For testing, the same dynamometer and shoulder and elbow position described earlier were used. The patient was instructed on maintaining a standard grip force of 31.75 kg for 5 seconds. Once able to perform this task, after a 3-minute rest period, the patient was asked to perform 6 trials of 5 seconds in duration, while EMG and force data were recorded. The first 3 trials were performed with the patient in her usual scapular resting position. Following another 3-minute rest period, the last 3 trials were performed with an examiner giving tactile cues for the patient to hold her scapula in a more adducted position.[40] The results indicated a reduction of EMG signal amplitude for both the ECRB (decreased by 44%) and the biceps brachii (23%) when performing the grip task with active correction of scapular position.

Diagnosis

Based on the clinical examination, we determined that the patient matched the presentation for lateral epicondylalgia. We also postulated that significant weakness of her scapular musculature and poor scapular positioning might have contributed to her clinical condition. Therefore, it was our hypothesis that an exercise program focused on improving the strength of the scapular adductor muscles would result in pain resolution with gripping tasks and improved scapular position.

Interventions

The patient was seen for treatment either once a week or once every 2 weeks, depending on availability, for a total of 5 visits over the course of 10 weeks. On the initial visit, the patient first received education on her condition and the intended treatment approach. The patient was then instructed on an exercise program for strengthening of the middle and lower trapezius, with the goal to promote scapular stability and improve scapular position.[34,40] The patient performed these exercises in a prone position, using a short lever arm for resistance in the first exercise (**FIGURE 1**). She was instructed to do 3 sets of 10 repetitions twice a day.[5]

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

FIGURE 3. Exercise to strengthen the middle trapezius muscle using a long lever arm for resistance. The patient is asked to contract the middle trapezius muscle, focusing on quality and control of the activation without the compensatory use of the upper trapezius and posterior deltoid muscles. With the elbows straight, the patient retracts and adducts her scapulae, lifting her arms toward the ceiling.

FIGURE 4. Wall-slide exercise to strengthen the middle and lower trapezius in a functional overhead position. The patient is asked to bring her back against the wall. Her shoulders are in 90° of external rotation at 90° of abduction. The patient contracts the middle and lower trapezius, focusing on quality and control of activation without compensation of the upper trapezius. She simultaneously slides her hands up the wall as far as she can, while keeping her back, elbows, and wrists against the wall.

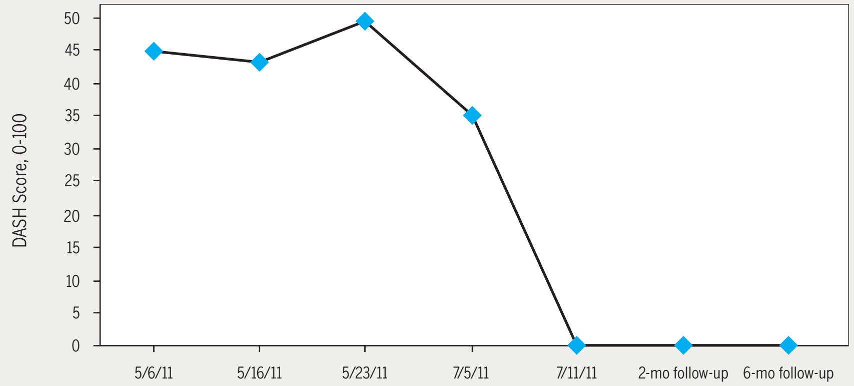

FIGURE 5. Scores on the DASH questionnaire over the course of treatment and at 2- and 6-month follow-ups. DASH scores vary from 100 to 0, with a lower score showing improvement in function. Abbreviation: DASH, Disabilities of the Arm, Shoulder and Hand.

The exercise progression was implemented as described by Sahrmann,[40] using a progressively more demanding position of the upper extremities for resistance (**FIGURES 1** through **4**). At each treatment session, the patient was shown how to specifically execute her home exercises, focusing on quality and control of movement using the middle and lower trapezius muscles. The patient progressed to the next exercise once she showed good quality and control of activation and did not compensate with either her upper trapezius or posterior deltoid muscle. Through the course of her therapy, the patient experienced no pain in her elbow while executing her exercises. This was the only intervention provided to the patient.

To monitor changes over time, the patient completed the NPRS and DASH[6] questionnaire every therapy session. These data served as a proxy for assessing changes in pain and functional status, respectively. Changes in specific functional goals were only assessed on visit 5, once the patient had reached a 15-point change on the DASH,[7] as a 15-point change is considered clinically significant[7] (**FIGURE 5**).

OUTCOMES

The patient's changes in score on the DASH questionnaire throughout the course of therapy and at 2- and 6-month follow-ups are illustrated in **FIGURE 5**. The slight increase in pain at the time of the third visit was attributed to an increase in activity level at home. From an initial score of 44.2, the patient's DASH score dropped 14 points by visit 4. By visit 5, the patient had a DASH score of zero, which was maintained at 2 and 6 months posttherapy.

Changes in the patient's scores on the NPRS for activities such as picking up her child and cleaning the shower throughout the course of therapy and at 2- and 6-month follow-ups are illustrated in **FIGURE 6**. An increase in pain was noted at visits 3 and 4, which might have been in response to an increase in activity level related to the initial marked reduction in pain between visits 1 and 2. Pain level at the last therapy session was 0/10, and the patient reported no pain at 2 and 6 months posttherapy.

At the patient's last therapy session, the resting position of the medial border of the scapula, measured using the same methods as those used at the initial evaluation, was 9 cm. This position was 2 cm closer to midline and equal to the position of the left scapula.

Also, at the last therapy session, the strength of the middle and lower trapezius was 5/5, a marked improvement from 3+/5 and 4−/5, respectively, at initial evaluation. Finally, her hand grip strength was 42.2 kg, a 38% increase compared to the initial evaluation, and did not cause pain.

DISCUSSION

This case report describes the evaluation, intervention, and outcomes of a patient with primary symptoms of lateral elbow pain, who responded favorably to a program de-

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

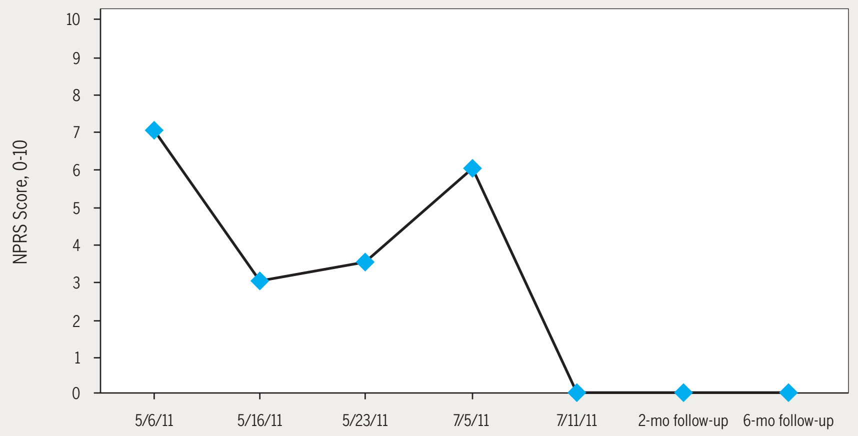

FIGURE 6. Scores on the NPRS over the course of treatment and at 2- and 6-month follow-ups. NPRS scores vary from 10 to 0, with a lower score showing decrease in pain. Abbreviation: NPRS, numeric pain rating scale.

signed to strengthen the scapular adductors. Resolution of symptoms and return to full function were achieved without interventions commonly used for the treatment of lateral epicondylalgia (iontophoresis, stretching and strengthening of the wrist extensors, joint mobilization, and cross-friction massage). This suggests that the underlying causes of lateral epicondylalgia may not be restricted to the elbow region.

Numerous authors mention the need for assessing shoulder and scapular muscle strength in patients with elbow pain.[4,23,24,34] Alizadehkhaiyat et al[4] previously reported a 25% to 35% decrease in shoulder strength in individuals with lateral epicondylalgia when compared to control groups. Mandalidis and O'Brien[30] have also previously reported that lower grip strength seems partially correlated with lower shoulder isokinetic strength. Lucado et al[29] found diminished lower trapezius and wrist extensor strength in female tennis players with lateral epicondylalgia compared to a comparison group without lateral epicondylalgia. In spite of shoulder muscle weakness, Alizadehkhaiyat et al,[3] Kibler and Sciascia,[24] and Kibler[23] noted that shoulder symptoms do not always coexist. They argued that symptoms at the shoulder may only be exposed when more distal compensatory mechanisms fail.

It should be noted that during treatment, the patient received no specific training on functional activities. Nevertheless, motor learning could have occurred, as the patient learned that if she brought her scapula closer to her spine, her elbow symptoms could be alleviated. Such learning could happen separately from muscle strengthening alone. It is plausible that improvements with gripping might have occurred from a combination of improved motor control of the scapula and improved muscular strength of the scapular musculature.

Pain inhibition might have also played a role in our patient. Alexander and Harrison[2] previously suggested that reflex connections exist between forearm/hand muscle afferents and the scapular muscles. The results of their study suggest that gripping activation in the forearm/hand muscles may facilitate activation of the serratus anterior and trapezius muscles, which may occur to provide and maintain scapular control when moving the arm during a lifting task.[2] The authors of another study[4] have reported that, compared to controls, patients with lateral epicondylalgia demonstrated significantly reduced extensor carpi radialis activity and global upper-limb muscle weakness. They further indicated that this was due to protective pain-related inhibition. Our patient had primary symptoms of lateral elbow pain when picking up her child and attempting to clean her shower. Subsequent to strengthening of her trapezius muscles, these activities could again be performed in a pain-free manner. It is plausible that pain occurring with gripping might have inhibited the patient's trapezius muscles. By addressing this impaired control with corrective scapular exercises, normal motion might have been restored, resulting in resolution of pain with activities and a return to pain-free gripping for the patient.

The middle and lower trapezius muscles are scapular adductors that assist in maintaining scapular and humeral alignment[20,40] and timing of muscle recruitment with reaching.[40] With scapular correction, the middle and lower trapezius, along with the rhomboids, can alter humeral position.[40] In this patient, at preintervention, passive manual scapular repositioning into adduction produced a decrease in the patient's symptoms, as well as an improvement in hand grip strength. Postintervention, the patient had a 38% improvement in hand grip strength, which was also performed free of pain. This improvement coincided with clinically significant improvement in middle and lower trapezius strength, as assessed with manual muscle testing. These findings suggest the potential importance of including a thorough examination of scapular position, including repositioning, and strength of the scapular musculature as part of the clinical examination for lateral epicondylalgia. Last, our EMG data, although very limited, also suggest the role that the scapular muscles may have in modulating the activation level of muscles such as the ECRB[8,41-43] in activities like gripping.

The literature suggests that muscles that cross 2 joints in the lower extremity are more prone to fatigue and overuse.[28,35] Other studies have shown that strengthening the proximal hip stabilizers (the gluteus maximus and gluteus medius) resulted in improved hip mechanics and functional gains in the distal 2 joint muscles.[31] In the present case, it is noted that,

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

preintervention, the EMG signal amplitude of the biceps brachii and ECRB decreased with cues to adduct the scapula on the affected side. While acknowledging the limitations of these data, we believe that the scapula could serve as a stable base from which 2 joint muscles in the upper extremity may work more efficiently. This is analogous to what has been shown in the lower extremity with proximal stabilizing exercises for the gluteal muscles.

CONCLUSION

This case report presents a patient with lateral epicondylalgia who demonstrated scapular muscle weakness and responded well to an intervention solely targeting the muscles of the shoulder girdle. Further research is indicated to further define the role proximal shoulder muscles play in patients with lateral epicondylalgia and to identify which patients may best benefit from this treatment approach. ◉

ACKNOWLEDGEMENTS: *The authors wish to thank Christopher Powers, PT, PhD for data collection related to surface EMG readings, as well as guidance with regards to the study itself. Lastly, the authors also wish to thank Clare Frank, DPT for her support and tutelage which made this study possible.*

REFERENCES

1. Abrams GD, Renstrom PA, Safran MR. Epidemiology of musculoskeletal injury in the tennis player. *Br J Sports Med*. 2012;46:492-498. http://dx.doi.org/10.1136/bjsports-2012-091164
2. Alexander CM, Harrison PJ. Reflex connections from forearm and hand afferents to shoulder girdle muscles in humans. *Exp Brain Res*. 2003;148:277-282. http://dx.doi.org/10.1007/s00221-002-1256-9
3. Alizadehkhaiyat O, Fisher AC, Kemp GJ, Frostick SP. Strength and fatigability of selected muscles in upper limb: assessing muscle imbalance relevant to tennis elbow. *J Electromyogr Kinesiol*. 2007;17:428-436. http://dx.doi.org/10.1016/j.jelekin.2006.04.007
4. Alizadehkhaiyat O, Fisher AC, Kemp GJ, Vishwanathan K, Frostick SP. Upper limb muscle imbalance in tennis elbow: a functional and electromyographic assessment. *J Orthop Res*. 2007;25:1651-1657. http://dx.doi.org/10.1002/jor.20458
5. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41:687-708. http://dx.doi.org/10.1249/MSS.0b013e3181915670
6. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. *J Hand Ther*. 2001;14:128-146.
7. Beaton DE, van Eerd D, Smith P, et al. Minimal change is sensitive, less specific to recovery: a diagnostic testing approach to interpretability. *J Clin Epidemiol*. 2011;64:487-496. http://dx.doi.org/10.1016/j.jclinepi.2010.07.012
8. Bergeron MF. Muscle cramps during exercise – is it fatigue or electrolyte deficit? *Curr Sports Med Rep*. 2008;7:S50-S55.
9. Bhargava AS, Eapen C, Kumar SP. Grip strength measurements at two different wrist extension positions in chronic lateral epicondylitis – comparison of involved vs. uninvolved side in athletes and non athletes: a case-control study. *Sports Med Arthrosc Rehabil Ther Technol*. 2010;2:22. http://dx.doi.org/10.1186/1758-2555-2-22
10. Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *Br J Sports Med*. 2005;39:411-422. http://dx.doi.org/10.1136/bjsm.2004.016170
11. Childs JD, Cleland JA, Elliott JM, et al. Neck pain: clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2008;38:A1-A34. http://dx.doi.org/10.2519/jospt.2008.0303
12. Coombes BK, Bisset L, Brooks P, Khan A, Vicenzino B. Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. *JAMA*. 2013;309:461-469. http://dx.doi.org/10.1001/jama.2013.129
13. Dawson J, Doll H, Boller I, et al. Comparative responsiveness and minimal change for the Oxford Elbow Score following surgery. *Qual Life Res*. 2008;17:1257-1267. http://dx.doi.org/10.1007/s11136-008-9409-3
14. Delagi EF, Perotto A. *Anatomic Guide for the Electromyographer: The Limbs*. 2nd ed. Springfield, IL: Charles C. Thomas; 1980.
15. Dick FD, Graveling RA, Munro W, Walker-Bone K. Workplace management of upper limb disorders: a systematic review. *Occup Med (Lond)*. 2011;61:19-25. http://dx.doi.org/10.1093/occmed/kqq174
16. Ellenbecker TS, Pieczynski TE, Davies GJ. Rehabilitation of the elbow following sports injury. *Clin Sports Med*. 2010;29:33-60. http://dx.doi.org/10.1016/j.csm.2009.09.013
17. Eygendaal D, Rahussen FT, Diercks RL. Biomechanics of the elbow joint in tennis players and relation to pathology. *Br J Sports Med*. 2007;41:820-823. http://dx.doi.org/10.1136/bjsm.2007.038307
18. Fairbank SM, Corlett RJ. The role of the extensor digitorum communis muscle in lateral epicondylitis. *J Hand Surg Br*. 2002;27:405-409.
19. Fernández-de-las-Peñas C, Ortega-Santiago R, Ambite-Quesada S, Jiménez-García R, Arroyo-Morales M, Cleland JA. Specific mechanical pain hypersensitivity over peripheral nerve trunks in women with either unilateral epicondylalgia or carpal tunnel syndrome. *J Orthop Sports Phys Ther*. 2010;40:751-760. http://dx.doi.org/10.2519/jospt.2010.3331
20. Graichen H, Hinterwimmer S, von Eisenhart-Rothe R, Vogl T, Englmeier KH, Eckstein F. Effect of abducting and adducting muscle activity on glenohumeral translation, scapular kinematics and subacromial space width in vivo. *J Biomech*. 2005;38:755-760. http://dx.doi.org/10.1016/j.jbiomech.2004.05.020
21. Green S, Buchbinder R, Barnsley L, et al. Non-steroidal anti-inflammatory drugs (NSAIDs) for treating lateral elbow pain in adults. *Cochrane Database Syst Rev*. 2002:CD003686. http://dx.doi.org/10.1002/14651858.CD003686
22. Kendall FP, Provance P, McCreary EK. *Muscles: Testing and Function*. 4th ed. Baltimore, MD: Williams & Wilkins; 1993.
23. Kibler WB. The role of the scapula in athletic shoulder function. *Am J Sports Med*. 1998;26:325-337.
24. Kibler WB, Sciascia A. Current concepts: scapular dyskinesis. *Br J Sports Med*. 2010;44:300-305. http://dx.doi.org/10.1136/bjsm.2009.058834
25. Kotnis NA, Chiavaras MM, Harish S. Lateral epicondylitis and beyond: imaging of lateral elbow pain with clinical-radiologic correlation. *Skeletal Radiol*. 2012;41:369-386. http://dx.doi.org/10.1007/s00256-011-1343-8
26. Kraushaar BS, Nirschl RP. Tendinosis of the elbow (tennis elbow). Clinical features and findings of histological, immunohistochemical, and electron microscopy studies. *J Bone Joint Surg Am*. 1999;81:259-278.
27. Lim EC, Sterling M, Pedler A, Coombes BK, Vicenzino B. Evidence of spinal cord hyperexcitability as measured with nociceptive flexion reflex (NFR) threshold in chronic lateral epicondylalgia with or without a positive neurodynamic test. *J Pain*. 2012;13:676-684. http://dx.doi.org/10.1016/j.jpain.2012.04.005
28. Lischuk AW, Dorantes TM, Wong W, Haims AH. Imaging of sports-related hip and groin injuries. *Sports Health*. 2010;2:252-261. http://dx.doi.org/10.1177/1941738110366699
29. Lucado AM, Kolber MJ, Cheng MS, Echternach JL, Sr. Upper extremity strength characteristics

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

in female recreational tennis players with and without lateral epicondylalgia. *J Orthop Sports Phys Ther*. 2012;42:1025-1031. http://dx.doi.org/10.2519/jospt.2012.4095

30. Mandalidis D, O'Brien M. Relationship between hand-grip isometric strength and isokinetic moment data of the shoulder stabilisers. *J Bodyw Mov Ther*. 2010;14:19-26. http://dx.doi.org/10.1016/j.jbmt.2008.05.001
31. Mascal CL, Landel R, Powers C. Management of patellofemoral pain targeting hip, pelvis, and trunk muscle function: 2 case reports. *J Orthop Sports Phys Ther*. 2003;33:647-660. http://dx.doi.org/10.2519/jospt.2003.33.11.647
32. Michener LA, Snyder AR, Leggin BG. Responsiveness of the numeric pain rating scale in patients with shoulder pain and the effect of surgical status. *J Sport Rehabil*. 2011;20:115-128.
33. Nilsson P, Baigi A, Sward L, Möller M, Månsson J. Lateral epicondylalgia: a structured programme better than corticosteroids and NSAID. *Scand J Occup Ther*. 2012;19:404-410. http://dx.doi.org/10.3109/11038128.2011.620983
34. Page P, Frank CC, Lardner R. *Assessment and Treatment of Muscle Imbalance: The Janda Approach*. Champaign, IL: Human Kinetics; 2010.
35. Palmer WE, Kuong SJ, Elmadbouh HM. MR imaging of myotendinous strain. *AJR Am J Roentgenol*. 1999;173:703-709. http://dx.doi.org/10.2214/ajr.173.3.10470908
36. Pienimäki TT, Tarvainen TK, Siira PT, Vanharanta H. Progressive strengthening and stretching exercises and ultrasound for chronic lateral epicondylitis. *Physiotherapy*. 1996;82:522-530. http://dx.doi.org/10.1016/S0031-9406(05)66275-X
37. Rainville J, Noto DJ, Jouve C, Jenis L. Assessment of forearm pronation strength in C6 and C7 radiculopathies. *Spine (Phila Pa 1976)*. 2007;32:72-75. http://dx.doi.org/10.1097/01.brs.0000251002.39417.2c
38. Raman J, MacDermid JC, Grewal R. Effectiveness of different methods of resistance exercises in lateral epicondylosis—a systematic review. *J Hand Ther*. 2012;25:5-25; quiz 26. http://dx.doi.org/10.1016/j.jht.2011.09.001
39. Ruiz-Ruiz B, Fernández-de-las-Peñas C, Ortega-Santiago R, Arendt-Nielsen L, Madeleine P. Topographical pressure and thermal pain sensitivity mapping in patients with unilateral lateral epicondylalgia. *J Pain*. 2011;12:1040-1048. http://dx.doi.org/10.1016/j.jpain.2011.04.001
40. Sahrmann SA. *Diagnosis and Treatment of Movement Impairment Syndromes*. St Louis, MO: Mosby; 2001.
41. Schwellnus MP. Cause of exercise associated muscle cramps (EAMC) – altered neuromuscular control, dehydration or electrolyte depletion? *Br J Sports Med*. 2009;43:401-408. http://dx.doi.org/10.1136/bjsm.2008.050401
42. Schwellnus MP. Muscle cramping in the marathon: aetiology and risk factors. *Sports Med*. 2007;37:364-367.
43. Schwellnus MP, Derman EW, Noakes TD. Aetiology of skeletal muscle 'cramps' during exercise: a novel hypothesis. *J Sports Sci*. 1997;15:277-285. http://dx.doi.org/10.1080/026404197367281
44. Shiri R, Viikari-Juntura E. Lateral and medial epicondylitis: role of occupational factors. *Best Pract Res Clin Rheumatol*. 2011;25:43-57. http://dx.doi.org/10.1016/j.berh.2011.01.013
45. Shiri R, Viikari-Juntura E, Varonen H, Heliövaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. *Am J Epidemiol*. 2006;164:1065-1074. http://dx.doi.org/10.1093/aje/kwj325
46. Smidt N, van der Windt DA, Assendelft WJ, Deville WL, Korthals-de Bos IB, Bouter LM. Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomised controlled trial. *Lancet*. 2002;359:657-662. http://dx.doi.org/10.1016/S0140-6736(02)07811-X
47. Smidt N, van der Windt DA, Assendelft WJ, et al. Interobserver reproducibility of the assessment of severity of complaints, grip strength, and pressure pain threshold in patients with lateral epicondylitis. *Arch Phys Med Rehabil*. 2002;83:1145-1150.
48. Sobush DC, Simoneau GG, Dietz KE, Levene JA, Grossman RE, Smith WB. The Lennie test for measuring scapular position in healthy young adult females: a reliability and validity study. *J Orthop Sports Phys Ther*. 1996;23:39-50. http://dx.doi.org/10.2519/jospt.1996.23.1.39
49. Stefanou A, Marshall N, Holdan W, Siddiqui A. A randomized study comparing corticosteroid injection to corticosteroid iontophoresis for lateral epicondylitis. *J Hand Surg Am*. 2012;37:104-109. http://dx.doi.org/10.1016/j.jhsa.2011.10.005
50. van Rijn RM, Huisstede BM, Koes BW, Burdorf A. Associations between work-related factors and specific disorders at the elbow: a systematic literature review. *Rheumatology (Oxford)*. 2009;48:528-536. http://dx.doi.org/10.1093/rheumatology/kep013
51. Vicenzino B. Lateral epicondylalgia: a musculoskeletal physiotherapy perspective. *Man Ther*. 2003;8:66-79.
52. Vicenzino B, Cleland JA, Bisset L. Joint manipulation in the management of lateral epicondylalgia: a clinical commentary. *J Man Manip Ther*. 2007;15:50-56. http://dx.doi.org/10.1179/106698107791090132
53. Vicenzino B, Smith D, Cleland J, Bisset L. Development of a clinical prediction rule to identify initial responders to mobilisation with movement and exercise for lateral epicondylalgia. *Man Ther*. 2009;14:550-554. http://dx.doi.org/10.1016/j.math.2008.08.004
54. Wainner RS, Fritz JM, Irrgang JJ, Boninger ML, Delitto A, Allison S. Reliability and diagnostic accuracy of the clinical examination and patient self-report measures for cervical radiculopathy. *Spine (Phila Pa 1976)*. 2003;28:52-62.
55. Walker-Bone K, Palmer KT, Reading I, Coggon D, Cooper C. Occupation and epicondylitis: a population-based study. *Rheumatology (Oxford)*. 2012;51:305-310. http://dx.doi.org/10.1093/rheumatology/ker228
56. Yung E, Asavasopon S, Godges JJ. Screening for head, neck, and shoulder pathology in patients with upper extremity signs and symptoms. *J Hand Ther*. 2010;23:173-185; quiz 186. http://dx.doi.org/10.1016/j.jht.2009.11.004

@ **MORE INFORMATION**
WWW.JOSPT.ORG

SEND Letters to the Editor-in-Chief

JOSPT welcomes **letters related to professional issues or articles published in the *Journal***. The Editor-in-Chief reviews and selects letters for publication based on the topic's relevance, importance, appropriateness, and timeliness. Letters should include a summary statement of any conflict of interest, including financial support related to the issue addressed. In addition, letters are copy edited, and the correspondent is not typically sent a version to approve. Letters to the Editor-in-Chief should be sent electronically to **jospt@jospt.org**. Authors of the relevant manuscript are given the opportunity to respond to the content of the letter.

This article has been cited by:

1. Sevtap Gunay Ucurum, Damla Karabay, Burcu Bahar Ozturk, Derya Ozer Kaya. 2019. Comparison of scapular position and upper extremity muscle strength in patients with and without lateral epicondylalgia: a case-control study. *Journal of Shoulder and Elbow Surgery* **28**:6, 1111-1119. [Crossref]
2. Kritika Sethi, Majumi M. Noohu. 2018. Scapular muscles strengthening on pain, functional outcome and muscle activity in chronic lateral epicondylalgia. *Journal of Orthopaedic Science* . [Crossref]
3. Dimitrios Stasinopoulos. 2017. Scapular and rotator cuff strengthening in patients with lateral elbow tendinopathy. *Hong Kong Physiotherapy Journal* **37**, 25-26. [Crossref]
4. Maggie Henjum, Justin Dudley. Training and Injury Prevention Strategies in Extreme Sports 337-355. [Crossref]
5. Randal Glaser, Jiten B. Bhatt, Andre Chavez, Emmanuel Yung. 2016. Management of Lateral Epicondylalgia Targeting Scapular Muscle Power Deficits: A Case series. *Journal of Hand Therapy* **29**:2, e5-e6. [Crossref]
6. Joseph M. Day, Heather Bush, Arthur J. Nitz, Tim L. Uhl. 2015. Scapular Muscle Performance in Individuals With Lateral Epicondylalgia. *Journal of Orthopaedic & Sports Physical Therapy* **45**:5, 414-424. [Abstract] [Full Text] [PDF] [PDF Plus]
7. Guillaume Christe. 2015. Décision kinésithérapique : épicondylalgie latérale. *Kinésithérapie, la Revue* **15**:159, 19-26. [Crossref]

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at Univ of Southern Cal-Norris Med Library on July 25, 2019. For personal use only. No other uses without permission.
Copyright © 2013 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.