Neuromuscular Ultrasound Application to the Electrodiagnostic Evaluation of Quadrilateral Space Syndrome

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Quadrilateral space syndrome (QSS) is a rare neurovascular compression syndrome that results from the compression of the axillary nerve and posterior circumflex humeral artery in the quadrilateral space. Electromyography often is used to evaluate for the presence of neuropathic changes in the deltoid and teres minor in cases of suspected QSS. Needle examination of the teres minor may be challenging because of the muscle's small size and proximity to the infraspinatus. In cases in which patients are overweight or have significant teres minor atrophy, localization of the muscle through conventional methods may be extremely difficult. We present a case of an overweight man with posterior shoulder pain who was diagnosed with QSS via the use of a combination of ultrasound and electromyography.

PM R 2014;6:845-848

INTRODUCTION

Quadrilateral space syndrome (QSS) is a rare neurovascular compression syndrome that results from the compression of the axillary nerve and posterior circumflex humeral artery in the quadrilateral space. The quadrilateral space is an anatomic space that is bounded by the humerus laterally, long head of the triceps medially, teres minor superiorly, and teres major inferiorly. Compression of the structures may be static or dynamic [1]. The typical presentation of this syndrome is poorly localized posterior shoulder pain, exacerbated with abduction and external rotation of the upper extremity. The common differential diagnoses for posterior shoulder pain include rotator cuff disease (infraspinatus and teres minor), impingement syndrome, labral tears, osteoarthritis, shoulder dislocation, shoulder instability, scapula and humerus fractures, and cervical radiculopathy.

Electromyography (EMG) often is used to evaluate for the presence of neuropathic changes in the deltoid and teres minor in cases of suspected QSS. Needle examination of the teres minor may be challenging because of the muscle's small size and proximity to the infraspinatus. In cases in which patients are overweight or have significant teres minor atrophy, localization of the muscle through conventional methods may be extremely difficult. Boon et al [2] found that ultrasound-guided needle insertion was more accurate than nonimage-guided needle insertion in cadavers. We present a case report of an overweight patient with QSS and describe our use of neuromuscular ultrasound and EMG to establish the diagnosis.

CASE PRESENTATION

A right-handed, 30-year-old overweight man presented to the outpatient musculoskeletal clinic with vague right shoulder pain for 5 years that only occurred with overhead activities. When the pain occurred, it was localized to the posterolateral shoulder. The pain was dull and aching in nature and was relieved with rest. Examination revealed no visible atrophy of the shoulder or spine musculature. Range of motion was within normal limits, and results of Neer, Hawkin, Yocum, and Scarf tests were negative. There was mild tenderness to

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Disclosure: nothing to disclose

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Disclosure: nothing to disclose

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Disclosure: nothing to disclose

Submitted for publication May 30, 2013; accepted January 13, 2014.

palpation at the posterior aspect of the glenohumeral joint inferior to the acromion, and pain was reproduced with shoulder abduction and external rotation.

A diagnostic ultrasound was performed in the clinic, which revealed a normal biceps tendon, subscapularis, supraspinatus, and infraspinatus in both the long and the short axis. Dynamic sonographic assessment of the subacromial bursa was negative and revealed no pooling of bursal fluid or "catching" of the tendon under the acromion. Evaluation of the posterior labrum revealed no abnormalities.

Sonographic evaluation of the right teres minor demonstrated fatty change and degeneration of the muscle (Figure 1). The muscle was also noted to be smaller in size when compared with the left teres minor (Figure 1).

Electrodiagnostic testing was performed the same day to evaluate for QSS. Needle EMG testing of the teres minor was attempted without ultrasound guidance and was negative for any neuropathic changes. Because of the findings of fatty change and degeneration of the teres minor on ultrasound, a sonographically guided needle EMG examination of the teres minor was performed. Once the EMG needle was visualized inside the muscle, both fibrillations and positive sharp waves appeared. Results of a needle EMG examination of the deltoid, biceps brachii, triceps, pronator teres, and cervical paraspinals were within normal limits.

Upon diagnosis of QSS, the patient was presented with treatment options of either conservative or surgical management. The patient opted for conservative management, which included restriction from aggravating activities, over-the-counter nonsteroidal anti-inflammatory drugs for relief, and a home exercise program consisting of scapular stabilization, posterior capsule stretching, and rotator cuff strengthening. With this treatment regimen, the patient's symptoms improved during the period of 3 months.

ULTRASOUND TECHNIQUE FOR TERES MINOR

The patient was asked to sit. The transducer was placed medial to the glenohumeral joint in an orientation perpendicular to the axis of the spine of the scapula (Figure 2). The spine of the scapula was used as a landmark to distinguish between the supraspinatus fossa and the infraspinatus fossa. In the infraspinatus fossa, the infraspinatus and teres minor were visualized in a cross-sectional view at the myotendinous junction (Figure 3). With this view, we were able to distinguish between the 2 rotator cuff muscles. The probe was then moved inferiorly until the teres minor was centered

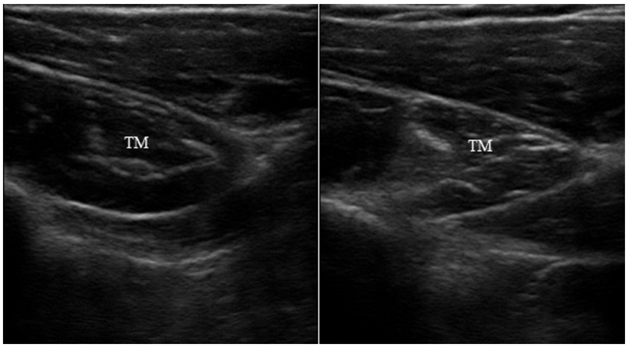

Figure 1. Short-axis views of unaffected left (left) and atrophied right (right) teres minor muscles (TM).

Figure 2. Position of the ultrasound probe to find the myotendinous injunction of the infraspinatus and teres minor muscle.

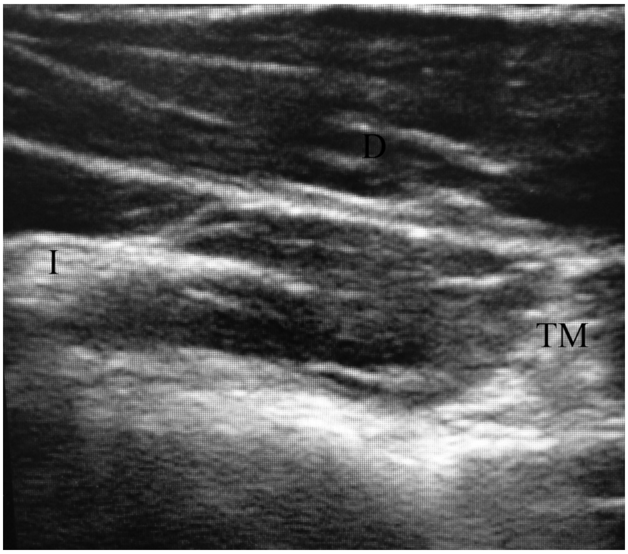

Figure 3. Short axis view of the infraspinatus fossa with the myotendinous junction of the infraspinatus (I), teres minor (TM) visualized. The deltoid (D) muscle also is visualized.

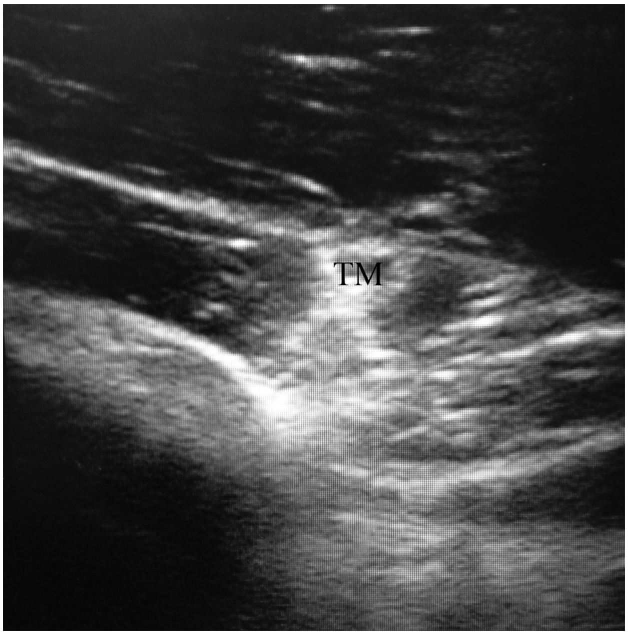

Figure 4. Short-axis view of the teres minor (TM) myotendinous junction.

(Figure 4). The probe was then moved proximally until only the teres minor muscle was visualized (Figure 5). In this view, an EMG needle was directed in the short axis into the belly of the teres minor. Needle placement into muscle tissue was confirmed by asking the patient to externally rotate the shoulder but may also be confirmed by rotating the probe and visualizing the muscle in the long axis.

Figure 5. Short-axis view of the teres minor (TM) muscle.

DISCUSSION

The teres minor muscle is innervated by the posterior branch of the axillary nerve. The axillary nerve originates from the posterior cord of the brachial plexus and courses anterior to the subscapularis muscle. The nerve then travels inferiorly, passing through the quadrilateral space with the posterior circumflex humeral vessels and divides into the anterior and posterior branches. The anterior branch supplies the anterior and middle deltoid, whereas the posterior branch divides into 3 terminal endings: the sensory superolateral brachial cutaneous branch, the motor nerve supply to the posterior deltoid, and the motor nerve to the teres minor [3].

QSS occurs with entrapment of the axillary nerve. Entrapment has been reported to be static (fibrous bands, occlusion of posterior circumflex artery, muscle hypertrophy) or dynamic (compression in certain positions of the shoulder), with etiology from fibrous muscle bands in the quadrilateral space, paralabral cysts, ganglions, tumors, and even hematomas [4,5]. Cases of QSS have been reported in various athletes, including volleyball players, tennis players, and throwing athletes [4-7]. Cases have also been reported from trauma to the shoulder [8] and as a complication of thoracic surgery [9].

The diagnosis of QSS is usually established through a combination of good history, physical examination, and diagnostic tests. Diagnosis is difficult to make based on any of these entities alone. Patients with this diagnosis will typically report poorly localized posterior shoulder pain with or without paresthesias in the cutaneous axillary nerve distribution, correlating to the lateral shoulder. Findings of the physical examination include tenderness to palpation over the quadrilateral space and reproducible pain with abduction and external rotation of the upper extremity. On clinical grounds alone, the diagnosis is difficult to establish because the presentation may present similarly to rotator cuff pathology or shoulder impingement syndrome.

Imaging modalities for QSS generally involve magnetic resonance imaging or sonographic evaluation, where evidence of teres minor fatty atrophy may be found [10-13]. There is considerable anatomic variation in the branch of the axillary nerve supplying the teres minor. Friend et al [3] performed cadaveric dissections of 9 shoulder specimens and found anatomic variations of the branch supplying the teres minor, revealing several points where it may be vulnerable to impingement or injury along its course. Therefore, entrapment of the axillary nerve at the quadrilateral space may result in isolated teres minor atrophy and sparing of the deltoid.

Magnetic resonance angiography or a dynamic examination technique of the quadrilateral space under Doppler ultrasound may also be an option to visualize occlusion of the posterior humeral circumflex artery in patients with suspected QSS [14,15]. An additional diagnostic test for QSS includes EMG and nerve conduction studies but has been reported with inconsistent results [16].

Management of QSS should begin with conservative treatment, including the administration of analgesics, physiotherapy, and avoidance of aggravating activities [17]. Physiotherapy should include glenohumeral joint mobilization, rotator cuff and scapular strengthening, cross-friction and active-release soft-tissue massage techniques to the quadrilateral space, and stretching into horizontal adduction and internal rotation [17]. Surgical management typically involves decompression of the quadrilateral space with lysis of fibrotic tissue. In general, the results of surgery have been positive. A previous case series demonstrated that all 4 patients who received surgical decompression of the quadrilateral space obtained good symptomatic relief [16]. Another study demonstrated that 16 of 18 patients had moderate-to-complete resolution of symptoms with surgical decompression [18]. There have been multiple other cases of QSS in which patients underwent surgical management had good symptomatic outcomes [8,19,20].

Routine needle EMG examinations use anatomic landmarks to determine proper needle placement into the muscle of interest. In previous studies, the accuracy of routine nonimage-guided needle placement in cadavers ranged from 0% to 83%, depending on the muscle examined [21]. Inadvertent needle placement into the incorrect muscle may often lead to an erroneous conclusion on the part of the electromyographer, and as such use of ultrasound guidance to ensure placement into the desired muscle is likely to improve the sensitivity and specificity of the electrodiagnostic consultation.

In addition to improvements in accuracy of EMG needle placement, ultrasound may provide additional diagnostic information, such as the presence of paralabral cysts, masses, fibrous bands, and hematomas in the region. In the case presented previously, ultrasound detected the presence of teres minor atrophy in the shoulder and improved the safety of needle EMG by helping to avoid needle damage to the adjacent axillary nerve and posterior humeral circumflex artery. Furthermore, the combination of ultrasound and EMG in the same clinic ensured efficient health care delivery, providing an accurate diagnosis and therapeutic plan on the same day without requiring a return trip for the patient to the clinic.

CONCLUSION

This case demonstrates the benefits of neuromuscular ultrasound in the electrodiagnostic evaluation of QSS and illustrates the potential of ultrasound applications in improving diagnostic accuracy and safety of EMGs.

ACKNOWLEDGMENTS

The authors thank Tiffany Lee for helpful suggestions in improving the manuscript.

REFERENCES

1. Perlmutter GS. Axillary nerve injury. Clin Orthop Relat Res 1999;(368): 28-36.
2. Boon AJ, Oney-Marlow TM, Murthy NS, Harper CM, McNamara TR, Smith J. Accuracy of electromyography needle placement in cadavers: Non-guided vs. ultrasound-guided. Muscle Nerve 2011;44:45-49.
3. Friend J, Francis S, McCulloch J, Ecker J, Breidahl W, McMenamin P. Teres minor innervation in the context of isolated muscle atrophy. Surg Radiol Anat 2010;32:243-249.
4. Hoskins W, Pollard H, McDonald A. Quadrilateral space syndrome: A case study and review of the literature. Br J Sports Med 2005;39:e9.
5. McClelland D, Paxinos A. The anatomy of the quadrilateral space with reference to quadrilateral space syndrome. J Shoulder Elbow Surg 2008;17:162-164.
6. Dugas JR, Weiland AJ. Vascular pathology in the throwing athlete. Hand Clin 2000;16:477-485.
7. Cormier PJ, Matalon TA, Wolin PM. Quadrilateral space syndrome: A rare cause of shoulder pain. Radiology 1988;167:797-798.
8. Francel TJ, Dellon AL, Campbell JN. Quadrilateral space syndrome: Diagnosis and operative decompression technique. Plast Reconstr Surg 1991;87:911-916.
9. Nishimura M, Kobayashi M, Hamagashira K, et al. Quadrilateral space syndrome: A rare complication of thoracic surgery. Ann Thorac Surg 2008;86:1350-1351.
10. Linker CS, Helms CA, Fritz RC. Quadrilateral space syndrome: Findings at MR imaging. Radiology 1993;188:675-676.
11. Helms CA. The impact of MR imaging in sports medicine. Radiology 2002;224:631-635.
12. Brestas PS, Tsouroulas M, Nikolakopoulou Z, Malagari K, Drossos C. Ultrasound findings of teres minor denervation in suspected quadrilateral space syndrome. J Clin Ultrasound 2006;34:343-347.
13. Wilson L, Sundaram M, Piraino DW, et al. Isolated teres minor atrophy: Manifestation of quadrilateral space syndrome or traction of the axillary nerve? Orthopedics 2006;29:447-450.
14. Mochizuki T, Isoda H, Masui T, et al. Occlusion of the posterior circumflex humeral artery: Detection with MR angiography in healthy volunteers and in a patient with quadrilateral space syndrome. AJR Am J Roentgenol 1994;163:625-627.
15. Robinson J, Marks P, Schneider-Kolsky M. Occlusion and stenosis of the posterior circumflex humeral artery: Detection with ultrasound in a normal population. J Med Imaging Radiat Oncol 2011; 55:479-484.
16. McAdams T, Dillingham M. Surgical decompression of the quadrilateral space in overhead athletes. Am J Sports Med 2008;36:528-532.
17. Manske RC, Sumler S, Runge J, et al. Quadrilateral space syndrome. Human Kinetics 2009;14:45-47.
18. Cahill BR, Palmer RE. Quadrilateral space syndrome. J Hand Surg Am 1983;8:65-69.
19. Gunes T, Demirhan M, Calay M. Quadrilateral space syndrome: A case report. Acta Orthop Traumatol Turc 2005;39:180-183.
20. Chen D, Cai P, Lao G, et al. Quadrilateral space syndrome. Chin Med J 1995;108:109-112.
21. Boon AJ, Smith J, Harper CM. Ultrasound applications in electrodiagnosis. PM R 2012;4:37-49.