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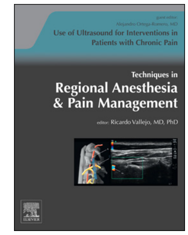

Myofascial trigger points: New insights in ultrasound imaging

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ABSTRACT

Puncture of trigger points in myofascial syndrome can be performed with greater safety for the patient under ultrasound-guided techniques. The identification of potentially hazardous structures in the path of the needle, together with the development and validation of tools like sonoelastography, spontaneous muscle contraction (twitch response), or vascular dynamics, helps us to be more accurate, specially in cases where the trigger points are in deep fasciae or muscular layers. Ultrasound-guided interfascial block, a known regional anesthetic technique, is emerging as a promising approach with minimum traumatic damage to the muscles.

Introduction

Myofascial trigger points (TrPs), are hyperirritable areas of muscle tissue or fascia that are tender when compressed and give rise to referred pain. They are commonly associated with limited range of motion, fatigue, impaired muscle coordination, and vegetative phenomena.[1] Physical examination remains the gold standard for TrPs localization in myofascial pain syndrome in experienced personnel.[2-4] A recent hypothesis proposes that central nervous system–maintained global changes in α-motoneuron function, resulting from sustained plateau depolarization, underlie the pathogenesis of TrPs. A continuum of muscle nociceptor sensitization between active TrPs (spontaneously painful) and latent TrPs (painful only after evoked stimulus) may explain its different behavior. Either this hypothesis or the classic-integrated TrPs hypothesis explain the sustained muscular contraction and vascular compression, resulting in an "adenosine triphosphate energy crisis" that perpetuates the circle and further sensitizes the nervous system.[5] Finally, clear differences not only in pain scores but also in their repercussion on health-related quality of life, mood, and function have been shown between those patients with active or latent TrPs.[6]

Ultrasonography as a diagnostic tool to detect TrPs

A persistent focal muscular contraction using static 2-dimensional images is not always easy to visualize if this contraction has not resulted in tissue damage. Nonetheless, in different imaging studies, TrPs have been shown to be mainly hypoechogenic but also hyperechogenic spots with fusiform or elliptical shape.[7-11] Furthermore, normal patients and patients with tender points in fibromyalgia syndrome also exhibited similar hypoechogenic spots as seen in myofascial TrPs.[12] This, together with the interrater variability, muscle, fasciae anisotropy, and the difficulty in visualization deep structures, has made researchers look for additional tools to improve its diagnostic accuracy.[13]

Local twitch response, an involuntary spinal reflex, is one of such available tools. When a needle enters an active TrP, ultrasound imaging can show an elicited involuntary muscle

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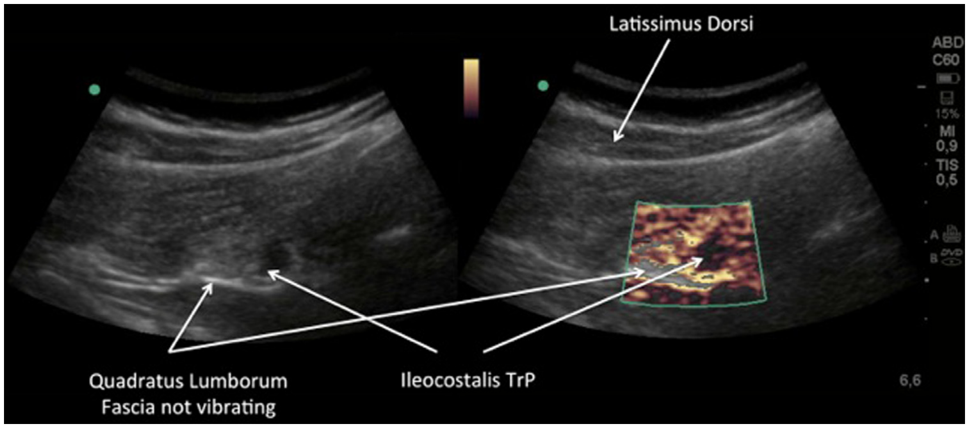

Fig. 1 – A hypoechogenic rounded TrP is seen in the deep layers of the iliocostalis muscle. When vibration sonoelastography is applied in PW imaging, neither the iliocostalis TrP nor the fascia of the quadratus lumborum muscle shows vibration most probably because of focal stiffness. PW, Color Power Doppler.

contraction as seen in the Video.[13,14] Local twitch response is easily visualized in superficial TrPs but in deeper muscular layers, ultrasonography has shown to be superior to simple visual inspection.[13]

Blood flow in the neighborhood of TrPs has been assessed using Doppler imaging and a grading scale has been proposed: 0, normal arterial flow in muscle—no visible vessel; 1, elevated diastolic flow; and 2, high-resistance flow waveform with retrograde diastolic flow.[9-11] Preliminary findings show that active TrPs have significantly higher peak systolic velocities and negative diastolic velocities compared with latent TrPs and normal muscle sites when measured in the vicinity. No differences were found between latent TrPs and normal sites. Other measures as pulsatility index also may contribute to differentiate between active TrPs and normal muscle.[10]

Finally, ultrasound elastography in its different modalities, from vibration sonoelastography, strain elastography to the new shear-wave sonoelastography, may evaluate regional stiffness. Interobserver reliability, lack of systematic agreement on how every muscle should be examined, and cost make this promising technique still not a standard. The position, in which the muscles are examined, is very important. As an example, shear-wave elastography with the transducer in transverse position and parallel to the trapezius fibers has shown a clear decrease in segmental stiffness in the trapezius muscle TrPs just moving from a sitting position but relaxed to a prone position. Dry needling of the same TrPs also show a nice quantified decrease in shear-wave measured stiffness, even in sitting position.[15]

The inexpensive vibration elastography gives us qualitative but useful information even in the deep muscular layers, as seen in Figure 1. In brief, an external vibration source (around 100 Hz) is applied to the skin near the target structure, while ultrasound B-Mode examination and power Doppler is set to recognize the effects of such vibration on color Doppler variances.[8]

More sophisticated techniques have been developed by different ultrasound-manufacturing companies looking for real-time mechanical comparisons between regions of interest.[16-18] There are 2 main commercially available elastography techniques, semiquantitative (strain elastography) and

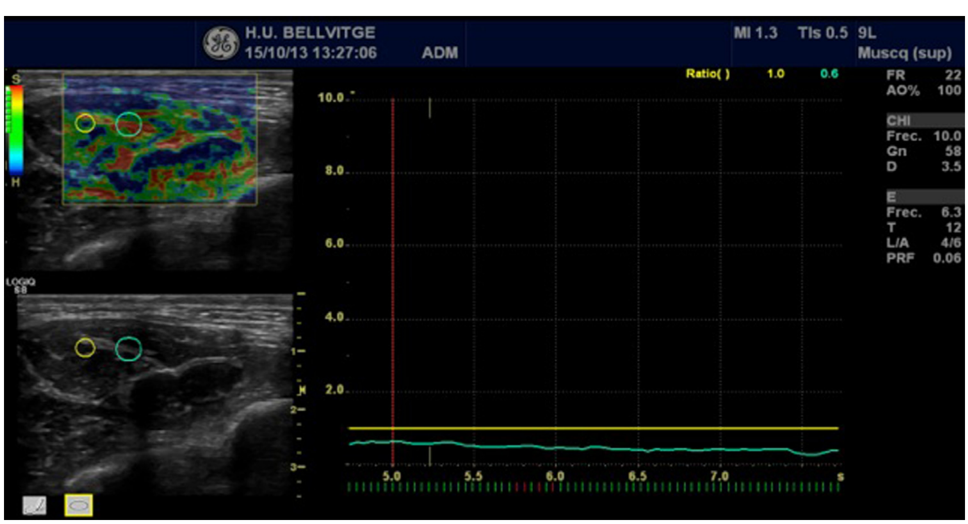

Fig. 2 – Strain elastography of the forearm volar muscles. Color-coded elasticity scale (red = soft to blue = hard) and comparison analysis of the 2 regions of interest showing consistent reduced stiffness in the green area compared with the yellow one.

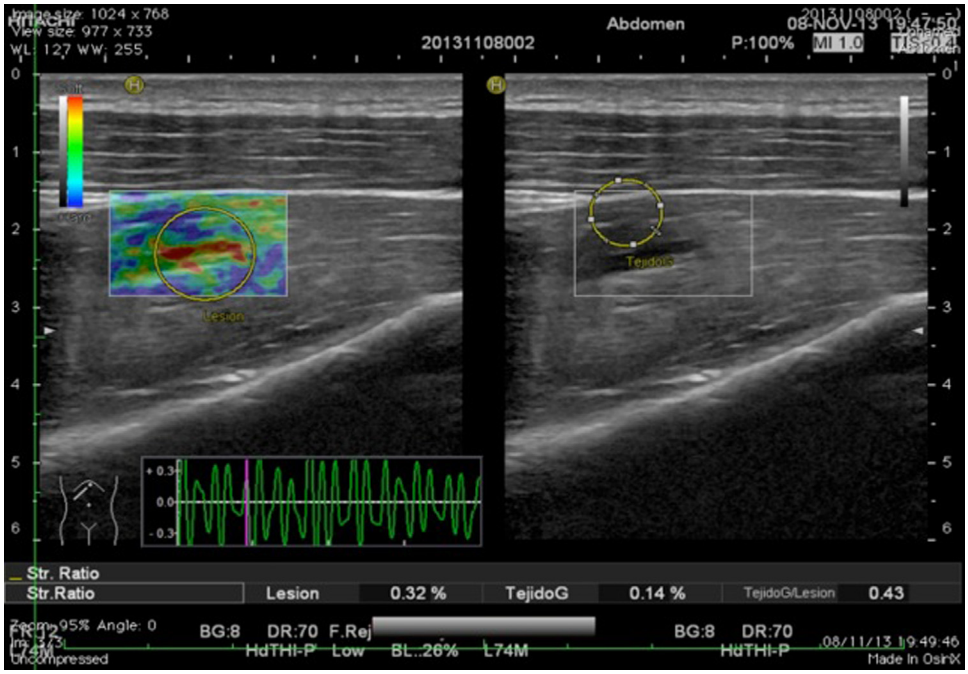

Fig. 3 – A hypoechogenic elongated image at the supraspinatus muscle assessed with strain (compression) elastography and showing reduced stiffness (softer = red) compared with the surrounding normal tissue. A traumatic muscle tear was suspected as Doppler imaging ruled out the presence of any blood vessel. (Color version of figure is available online.)

quantitative (shear-wave elastography), both extensively validated in different pathologies in organs, such as the liver, thyroid, breast, and pancreas. With strain elastography, an optimal repetitive compression of the transducer produces a mechanical deformity of the target tissue that, after comparison with basal B-Mode image, is transformed to a color-coded real-time image that may even allow for quantitative assessment of different regions of interest, as seen in Figures 2 and 3. Shear-waves propagate perpendicular to the pulses of the ultrasound beam and are independent of the mechanical deformation needed in strain elastography. These waves attenuate approximately 10,000 times faster than conventional ultrasound and certain depth of tissue penetration is needed for optimal generation and interpretation. True,

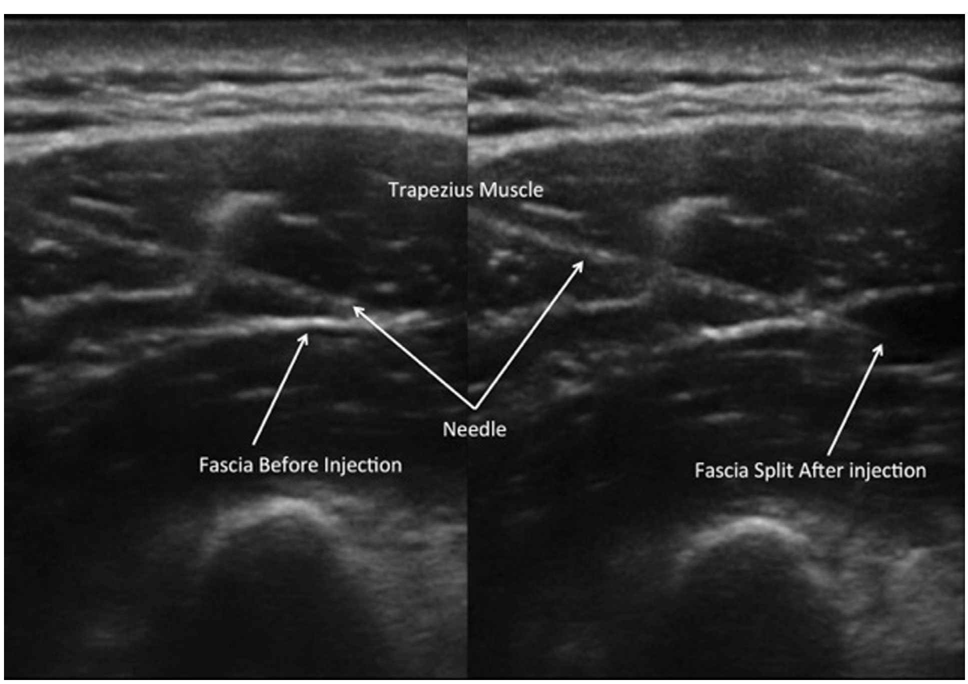

Fig. 4 – Interfascial injection of local anesthetic. A short bevel needle is shown inside the fasciae plane of the trapezius supraspinatus muscles (left). After injection, a split of both layers of the fasciae is seen, with no muscle fibers inside the hypoechoic image corresponding to the local anesthetic injected.

observer-independent quantitative data either of elasticity (in kPa) or of shear-wave velocity (cm/s), as well as color-coded maps, are presented.[16,18]

Ultrasonography as an aid for TrPs injections

Myofascial trigger point injections are not without risk. Two reviews of the American Society of Anesthesiologists closed claims' analysis have shown increasing number of complications related to interventional long-term pain management, with TrP injections being associated mainly with pneumothorax.[19,20] This topic was already discussed in a previous article of this journal by Chim and Cheng,[21] who recommended sonograms to be documented not only for education but also in case of litigation. Ultrasound may, in theory, reduce the risk of complications by identifying potentially hazardous structures in the path of the needle, especially in cases where the TrPs are in deep fasciae or muscular layers. Even if the needle is not clearly seen, other techniques, such as knowing the depth of the TrP compared with the length of the needle, software and hardware solutions, movement of surrounding tissues, and hydrodissection with or without the use of color Doppler, are safer than blind methods.[22]

Ultrasound-guided interfascial block, a known regional anesthetic technique, is emerging as a promising approach in myofascial pain with minimum traumatic damage to the muscles.[23] Local anesthetics injected in the interfascial planes provide direct blockade of somatic nerve endings and perhaps sympathetic nervous fibers, both also piercing each fasciae and giving profound long-lasting muscle relaxation and pain relief.[24] The technique requires the aid of ultrasound imaging and a short bevel needle to be accurate enough, as the pop-up feeling of the needle crossing the fascia is not reliable, mainly in deep fasciae (Figure 4).

Conclusions

In recent years, ultrasound imaging techniques, owing to its higher resolution, the dynamic nature of the test, and the possibility of assessing both vascular dynamics and muscle elasticity, have provided valuable new knowledge in myofascial pain syndrome. Although some conflicting results warrant further investigation and standardization to better identify active and latent TrPs, ultrasound imaging is now a great tool that is helping doctors to be more accurate and minimize risks for patients.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1053/j.trap.2014.01.017.

REFERENCES

1. Scott NA, Guo B, Barton PM, Gerwin RD. Trigger point injections for chronic non-malignant musculoskeletal pain: a systematic review. *Pain Med*. 2009;10(1):54–69 [10.1111/j.1526-4637.2008.00526.x].
2. Barbero M, Bertoli P, Cescon C, Macmillan F, Coutts F, Gatti R. Intra-rater reliability of an experienced physiotherapist in locating myofascial trigger points in upper trapezius muscle. *J Man Manip Ther*. 2012;20(4):171–177 [10.1179/2042618612Y.0000000010].
3. Gerwin RD, Shannon S, Hong CZ, Hubbard D, Gevirtz R. Interrater reliability in myofascial trigger point examination. *Pain*. 1997;69(1-2):65–73.
4. Bron C, Franssen J, Wensing M, Oostendorp RAB. Interrater reliability of palpation of myofascial trigger points in three shoulder muscles. *J Man Manip Ther*. 2007;15(4):203–215.
5. Hocking MJL. Exploring the central modulation hypothesis: do ancient memory mechanisms underlie the pathophysiology of trigger points? *Curr Pain Headache Rep*. 2013;17(7):931–938 [10.1007/s11916-013-0347-6].
6. Gerber LH, Sikdar S, Armstrong K, et al. A systematic comparison between subjects with no pain and pain associated with active myofascial trigger points. *PM R*. 2013;5(11):931–938. http://dx.doi.org/10.1016/j.pmrj.2013.06.006 [Epub 2013 Jun 28].
7. Thomas K, Shankar H. Targeting myofascial taut bands by ultrasound. *Current Pain Headache Rep*. 2013;17(7):349 [10.1007/s11916-013-0349-4].
8. Turo D, Otto P, Shah JP, et al. Ultrasonic tissue characterization of the upper trapezius muscle in patients with myofascial pain syndrome. *Conf Proc IEEE Eng Med Biol Soc*. 2012;2012:4386–4389 [10.1109/EMBC.2012.6346938].
9. Ballyns JJ, Shah JP, Hammond J, Gebreab T, Gerber LH, Sikdar S. Objective sonographic measures for characterizing myofascial trigger points associated with cervical pain. *J Ultrasound Med*. 2011;30(10):1331–1340.
10. Sikdar S, Ortiz R, Gebreab T, Gerber LH, Shah JP. Understanding the vascular environment of myofascial trigger points using ultrasonic imaging and computational modeling. *Conf Proc IEEE Eng Med Biol Soc*. 2010;2010:5302–5305 [10.1109/IEMBS.2010.5626326] [Aug. 31-Sept. 4].
11. Sikdar S, Shah JP, Gebreab T, et al. Novel applications of ultrasound technology to visualize and characterize myofascial trigger points and surrounding soft tissue. *Arch Phys Med Rehabil*. 2009;90(11):1829–1838. http://dx.doi.org/10.1016/j.apmr.2009.04.015.
12. Muro-Culebras A, Cuesta-Vargas AI. Sono-myography and sono-myoelastography of the tender points of women with fibromyalgia. *Ultrasound Med Biol*. 2013;39(11):1951–1957. http://dx.doi.org/10.1016/j.ultrasmedbio.2013.05.001.
13. Rha D-W, Shin JC, Kim Y-K, Jung JH, Kim YU, Lee SC. Detecting local twitch responses of myofascial trigger points in the lower-back muscles using ultrasonography. *Arch Phys Med Rehabil*. 2011;92(10):1576–1580. http://dx.doi.org/10.1016/j.apmr.2011.05.005 [e1].
14. Vulfsons S, Ratmansky M, Kalichman L. Trigger point needling: techniques and outcome. *Curr Pain Headache Rep*. 2012;16(5):407–412 [10.1007/s11916-012-0279-6].
15. Maher RM, Hayes DM, Shinohara M. Quantification of dry needling and posture effects on myofascial trigger points using ultrasound shear-wave elastography. *Arch Phys Med Rehabil*. 2013;94(11):2146–2150. http://dx.doi.org/10.1016/j.apmr.2013.04.021.
16. Drakonaki EE, Allen GM, Wilson DJ. Ultrasound elastography for musculoskeletal applications. *Br J Radiol*. 2012;85(1019):1435–1445 [10.1259/bjr/93042867].
17. Botar Jid C, Vasilescu D, Damian L, Dumitriu D, Ciurea A, Dudea SM. Musculoskeletal sonoelastography. Pictorial essay. *Med Ultrason*. 2012;14(3):239–245.
18. Guzmán Aroca F, Abellán Rivera D, Reus Pintado M. The clinical utility of elastography, a new ultrasound technique. *Radiologia*. 2012. http://dx.doi.org/10.1016/j.rx.2012.09.006.

19. Fitzgibbon DR, Posner KL, Domino KB, et al. Chronic pain management. *Anesthesiology*. 2004;100(1):98–105.
20. Metzner J, Posner KL, Lam MS, Domino KB. Closed claims' analysis. *Best Pract Res Clin Anaesthesiol*. 2011;25(2):263–276. http://dx.doi.org/10.1016/j.bpa.2011.02.007.
21. Chim D, Cheng PH. Ultrasound-guided trigger point injections. *Tech Reg Anesth Pain Manag*. 2009;13(3):179–183. http://dx.doi.org/10.1053/j.trap.2009.07.006.
22. Chin KJ, Perlas A, Chan VWS, Brull R. Needle visualization in ultrasound-guided regional anesthesia: challenges and solutions. *Reg Anesth Pain Med*. 2008;33(6):532–544.
23. Domingo-Rufes T, Blasi J, Casals M, Mayoral V, Ortiz-Sagristá JC, Miguel-Pérez M. Is interfascial block with ultrasound-guided puncture useful in treatment of myofascial pain of the trapezius muscle? *Clin J Pain*. 2011;27(4):297–303 [10.1097/AJP.0b013e3182021612].
24. Schilder A, Hoheisel U, Magerl W, Benrath J, Klein T, Treede RD. Sensory findings after stimulation of the thoracolumbar fascia with hypertonic saline suggest its contribution to low back pain. *Pain*. 2013. http://dx.doi.org/10.1016/j.pain.2013.09.025.