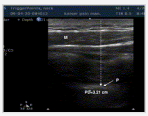
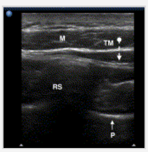
Article outline Show full outline

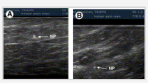
Keywords
Technique of ultrasound-guided trigg...

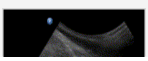
Conclusions
References

Figures and tables







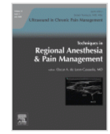


ELSEVIER

Techniques in Regional Anesthesia and Pain Management

Volume 13, Issue 3, July 2009, Pages 179–183

Ultrasound in Chronic Pain Management



Ultrasound-guided trigger point injections

David Chim, DO[a, b], , Peter H. Cheng, DO[c]

Show more

Myofascial trigger point injections are frequently indicated for myofascial pain syndrome and are performed as blind procedures. Although these injections are usually safe and effective, complications resulting in pneumothorax, epidural abscess, skeletal muscle toxicity, and intrathecal injection been reported. Avoiding the risk of radiation, ultrasonography provides real-time visualization of soft tissue, bone, cartilage, and foreign body, and may be used to guide injections.

The clinical manifestation of myofascial pain syndrome and trigger points will be presented. A review of the etiology and identification of trigger point will be introduced.

This paper presents the technique of ultrasound (US)-guided trigger point injections. It will also discuss the advantages of US guidance over the blind technique, including minimizing risks. The technical challenges and their solutions for needle visualization and guidance will be presented.

Keywords

Musculoskeletal ultrasound; Myofascial pain syndrome; Trigger point injection; Ultrasound-guided blocks

Conflict of interest: David Chim, DO, is supported by National Institute of Health T32 Institutional Grants 2-T32-DA-07272-16-A1 and 5-T32-DA-07272-18.

Address reprint requests and correspondence: David Chim, DO, 2130 Huntington Drive, Suite 307, South Pasadena, CA 91030

This article belongs to a special issue

Ultrasound in Chronic Pain Management
Edited By Samer Narouze

Other articles from this special issue

Ultrasonography in pain medicine: A welco...
Samer Narouze more

Ultrasound-guided peripheral nerve block in...
Rachael K. Seib, Philip W.H. Peng more

Ultrasound-guided transversus abdominus ...
Loran Mounir Soliman, Samer Narouze more

MSK ULTRASOUND GUIDED INJECTIONS

MUSCULOSKELETAL ULTRASOUND AND ULTRASOUND-GUIDED INJECTIONS

EDUCATION, REIMBURSEMENT AND ULTRASOUND SALES

Welcome

Diagnostic Instruments, Inc. is focused solely on Musculoskeletal (MSK) Ultrasound . Our team has over 48 years of combined experience in MSK Ultrasound. So... whether you are just getting started or already have an ultrasound system, our team has the knowledge to make your portable ultrasound purchase "Turn-Key". Put our experience to work for you! We have an A+ BBB Rating, so you can also feel confident putting your trust in us.

Diagnostic Instruments, Inc. is proud to be **Mindray's Exclusive MSK Ultrasound and Guided Injection Authorized Distributor** in the USA!

Musculoskeletal Ultrasound and Ultrasound Guided Injections can truly be a practice builder. Patients love to see the dynamic ultrasound images and you will appreciate the additional revenue stream and diagnostic information it

Quick Contact

If you'd like to request a quote, or to speak with one of our representatives, let us know how we can best contact you.

First Name: *

Last Name: *

State: * AL

Phone: *

Question: *

Email: *

Submit Reset

Ultrasound-Guided Injections

CPT 76942

Benefits:

1. It allows the doctor to see where he is putting the needle, thus increasing the efficacy of the injection/nerve block. The patient gets better pain relief--which is the goal.

The patient is happy and so is the referring physician. This should lead to more referrals

2. This visualization decreases the chance of complications. This is better patient care and decreases liability.

3. With ultrasound guidance, a doctor may feel more comfortable performing a wider variety of procedures. The ability to have more

provides. Ultrasound Guided Injections may improve your outcomes and the patients can see on the screen the needle being directed to the exact location. See the Indications and Reimbursement pages for more information. We would be happy to set up a time when we can go over all the benefits Ultrasound can add. Call us at (800-516-2663) or email us today.

Clinical Benefits of MSK Ultrasound

- Same day diagnosis
- Moves patients to treatment phase faster
- Increases interactive nature of the examination
- The dynamic, real-time nature of sonography requires personal interaction with the patient, often resulting in a more directed examination, specific for each individual.
- Better Visualization
- See the needle and the injectate in precise location
- Visualize blood vessels and nerves before advancing needle
- Many Applications
- Tendons, Ligaments, Bone Surface, Nerves, Bursa, Synovium, Cartilage, Foreign Bodies, ect.
- Interventional Procedures
- Ultrasound can be used to guide needles for biopsy, aspiration, injections and dry needling

Proven clinical benefits for MSK Ultrasound

- High treatment compliance rate
- No wait for imaging results
- Patients in pain get treated faster
- Enhanced patient perception
- Affordable technology exists

Diagnostic Musculoskeletal Ultrasound

MSK Ultrasound shows full spectrum of shoulder injuries

By Shalmali Pal

AuntMinnie.com staff writer
September 29, 2006

About Mindray

Mindray is a leading developer, manufacturer and marketer of medical devices worldwide. The company maintains global headquarters in Shenzhen, China, U.S. headquarters in Mahwah, New Jersey and multiple sales offices in major international markets. From our main manufacturing and engineering base in China and through our worldwide distribution network, we are able to supply globally a broad range of products across three primary business segments, comprised of patient monitoring and life support products, in-vitro diagnostic products and medical imaging systems. We currently offer more than 70 products across these three segments and provide after-sales services to distributors and hospitals in and outside China.

Mindray is listed with the NYSE as MR

Go to MR on Yahoo

options for pain relief, increases patient care and increases his/her ability to keep the patient in his practice.

4. Using ultrasound can decrease the actual time spent doing the procedure. This is easier on the patient which improves patient care and allows the practitioner to see more patients in a day. This also improves patient care.

Ultrasound Guided Pain Managment Injection Techniques - Steven D. Waldman

Recent Studies Show Ultrasound Guidance is More Accurate

"They found that approximately one third of knee and ankle injections were extra-articular, only half of the wrist injections were definitely intra-articular, with even less accuracy reported for shoulder injections. Remarkably, even the ability to aspirate synovial fluid was not a perfect predictor of intra-articular placement of steroid injections with almost half of extra-articular injections having been associated with successful aspiration of synovial fluid. Experience beyond advanced trainee/registrar level did not appear to influence the accuracy of injection placement."

Ann Rheum Dis 2004, 63:1007-1008
doi:10.1136/ard.2004.020685

Concise summaries of recent journal articles chosen for clinical significance

Ultrasonographic guidance boosts joint injection accuracy

Corticosteroid injection in the joints of patients with inflammatory arthritis results in significant alleviation of symptoms and improvement in functional status. Ultrasound-guided injections are significantly more accurate than clinical examination (CE)-guided injections.

Ultrasound-guided injections were accurate in 83% of patients, compared with 66% of patients who had CE-guided injections. There was a trend toward increased accuracy with US-guided injections for all joints, particularly the shoulder, elbow, and ankle. The greater accuracy of US-guided injections held true regardless of the physician's level of experience.

The Journal of Musculoskeletal Medicine. Vol. 27 No. 9

Arthritis Rheum 2010, 62:1862-1869

Learn More about Mindray Ultrasound Products.

Visit us at Mindray Ultrasound

New MSK Ultrasound Website

Anesthesiology Research and Practice

Anesthesiology Research and Practice
Volume 2012 (2012), Article ID 492452, 5 pages
http://dx.doi.org/10.1155/2012/492452

Review Article

A New Look at Trigger Point Injections

Clara S. M. Wong and Steven H. S. Wong

Department of Anaesthesiology, Queen Elizabeth Hospital, 30 Gascoigne Road, Kowloon, Hong Kong

Received 31 May 2011; Revised 28 July 2011; Accepted 30 July 2011

Academic Editor: Andrea Trescot

Abstract

Trigger point injections are commonly practised pain interventional techniques. However, there is still lack of objective diagnostic criteria for trigger points. The mechanisms of action of trigger point injection remain obscure and its efficacy remains heterogeneous. The advent of ultrasound technology in the noninvasive real-time imaging of soft tissues sheds new light on visualization of trigger points, explaining the effect of trigger point injection by blockade of peripheral nerves, and minimizing the complications of blind injection.

1. Introduction

Myofascial pain syndrome is a common, painful musculoskeletal disorder characterized by the presence of trigger points. They have been implicated in patients with headache, neck pain, low back pain, and various other musculoskeletal and systemic disorders [1–4]. The prevalence of myofascial trigger points among patients complaining of pain anywhere in the body ranged from 30% to 93% [5]. Although the most important strategy in treatment of myofascial pain syndrome is to identify the etiological lesion that causes the activation of trigger points and to treat the underlying pathology [6], trigger point injections are still commonly practised pain interventional technique for symptomatic relief.

Despite the popularity of trigger point injections, the pathophysiology of myofascial trigger points remains unclear. Localization of a trigger point is often based on the physician's examination. However, such physical examination is often unreliable. Lack of objective clinical measurements has also been a barrier for critically evaluating the efficacy of the therapeutic methods.

Ultrasound is used extensively for noninvasive real-time imaging of soft tissues including muscle, nerve, tendon, fascia, and blood vessels. With the advent of portable ultrasound technology, ultrasound is now commonly employed in the field of regional analgesia. In this paper, we will look at the potential application of ultrasound in trigger point injections.

2. Diagnosis of Trigger Points

Physician's sense of feel and patient expressions of pain upon palpation are the most commonly used method to localize a trigger point. The most common physical finding is palpation of a hypersensitive bundle or nodule of muscle fibre of harder than normal consistency. The palpation will elicit pain over the palpated muscle and/or cause radiation of pain towards the zone of reference in addition to a twitch response [7].

In myofascial pain syndrome, trigger points have been classified into active or latent. In an active trigger point, there is an area of tenderness at rest or on palpation, a taut band of muscle, a local twitch response, and referred pain elicited by firm compression similar to the patient's complaint. Latent trigger points are more commonly seen. They may display hypersensitivity and exhibit all the characteristics of an active trigger point except that it is not associated with spontaneous pain [7].

Trigger points have also been further classified into key or satellite. An active key trigger point in one muscle can induce an active satellite trigger point in another muscle. Inactivation of the key trigger point often also inactivates its satellite trigger point without treatment of the satellite trigger point itself [7].

The diagnosis of trigger points depends very much on the subjective experience of the physician. Pressure algometry has been used to quantify the sensitivity of trigger points. A hand-held pressure meter with a 1 cm^2 rubber disc attached to a force gauge calibrated up to 10 kg is applied over a trigger point to measure its pain threshold [8]. However, this method is not commonly employed clinically, and there have not been any imaging criteria for the diagnosis of trigger points.

3. Pathophysiology of Trigger Points

Trigger points are defined as palpable, tense bands of skeletal muscle fibres. They can produce both local and referred pain when compressed.

The local pain could be explained by the tissue ischemia resulting from prolonged muscle contraction with accumulation of acids and chemicals such as serotonin, histamine, kinins, and prostaglandins [9]. These changes are fed into a cycle of increasing motor or sympathetic activity and can lead to increased pain. A painful event can sustain itself once a cycle is established even after the initial stimulus has been removed [10].

The pathogenesis of trigger points is probably related to sensitized sensory nerve fibres (nociceptors) associated with dysfunctional endplates [11]. In fact, endplate noise was found to be significantly more prevalent in myofascial trigger points than in sites that were outside of a trigger point but still within the endplate zone [12].

Studies have found that development of trigger points is dependent on an integrative mechanism in the spinal cord. When the input from nociceptors in an original receptive field persists (pain from an active trigger point), central sensitization in the spinal cord may develop, and the receptive field corresponding to the original dorsal horn neuron may be expanded (referred pain). Through this mechanism, new "satellite trigger points" may develop in the referred zone of the original trigger point [11].

4. Mechanisms of Action of Trigger Point Injections

Noninvasive measures for treatment of trigger points include spray and stretch, transcutaneous electrical stimulation, physical therapy, and massage. Invasive treatments include injections with local anaesthetics, corticosteroids, or botulinum toxin, or dry needling [13–18].

Hong reported that with either lidocaine injection or dry needling of trigger points, the patients experienced almost complete relief of pain immediately after injection if local twitch responses were elicited. On the other hand, they experienced only minimal relief if no such response occurred during injection. Hong has suggested that nociceptors (free nerve endings) are encountered and blocked during trigger point injection if local twitch response can be elicited [19].

The mechanism of action of trigger point injections is thought to be disruption of the trigger points by the mechanical effect of the needle or the chemical effect of the agents injected, resulting in relaxation and lengthening of the muscle fibre. The effect of the injectate may include local vasodilation, dilution, and removal of the accumulated nociceptive substrates. Botulinum toxin A has been used to block acetylcholine release from the motor nerve ending and subsequently relieve the taut band [6].

While the relief of local pain could easily be explained by the relaxation of the muscle fibre, the relief of referred pain could not be explained without attributing it to a peripheral nerve blockade. However, little has been said in the literature regarding the mechanism of trigger point injection in this respect.

5. Could the Application of Ultrasound Solve the Mystery of Trigger Points?

5.1. Direct Visualization of Trigger Points

As mentioned above, the most common physical finding of a trigger point is palpation of a hypersensitive bundle or nodule of muscle fibre of harder than normal consistency. Attempts to confirm the presence of myofascial trigger points using imaging have been demonstrated by magnetic resonance elastography [20]. For ultrasound, earlier studies have failed to find any correlation between physical findings and diagnostic ultrasound [21]. This may be attributed to poorer quality of ultrasound imaging in earlier dates.

Recently, Sikdar et al. have tried to use ultrasound to visualize and characterize trigger points. They found that trigger points appeared as focal, hypoechoic regions of elliptical shape, with a size of 0.16 cm [22]. This is promising as ultrasound can provide a more objective diagnosis of trigger point. Even if visualization of individual trigger point is difficult due to the small size, some advocate the use of ultrasound to guide proper needle placement in muscle tissue and to avoid adipose or nonmusculature structures during trigger point injections [23].

5.2. Injection of Peripheral Nerves

Trigger point injections have been implicated in patients with headache, low back pain, and various other musculoskeletal and systemic disorders. Some of these injections may involve injectate deposition directly to the nerves supplying the region. Indeed, entrapment, compression, or irritation of the sensory nerves of local regions has been implicated in various conditions.

5.2.1. Greater Occipital Nerve

Entrapment of the greater occipital nerve is often implicated as the cause of cervicogenic headache, and the characteristic occipital headache can be reproduced by finger pressure over the corresponding occipital nerve over the occipital ridge [3, 24–26]. This referral pattern of pain coincides with that of the properties of a trigger point, and it could explain the mechanism of referred pain for trigger points.

Simons has considered that the effect of greater occipital nerve injection is due to the release of the entrapment by relaxation of semispinalis muscle [7]. However, injection of local anaesthetics with or without steroid over the occipital nerve has been found to result in alleviation of occipital headache [27]. In migraine headaches, local injection of local anaesthetics or botulinum toxin type A to the greater occipital nerve has been demonstrated to provide relief of the condition [24].

There are several techniques of ultrasound-guided blockade of greater occipital nerve. The classical distal block technique involves placing the transducer at the superior nuchal line, while for the new proximal approach, the transducer is placed at the level of C2, and the greater occipital nerve lies superficial to the obliquus capitis inferior muscle [28, 29].

5.2.2. Abdominal Cutaneous Nerve

Kuan et al. showed that local injection of anaesthetics or steroid can treat some patients with lower abdominal pain presenting with trigger points in the abdomen, thus avoiding diagnostic laparoscopy and medications [30].

Trigger points over the abdominal wall may in fact be entrapped cutaneous nerves. Peripheral nerve entrapment (e.g., ilioinguinal-iliohypogastric nerves, thoracic lateral cutaneous nerve) has been suggested to cause lower abdominal pain [31, 32].

Ultrasound-guided blocks for ilioinguinal and iliohypogastric nerves have been practised widely in anaesthesia [33–35]. Recently, ultrasound-guided transversus abdominis plane (TAP) block is also commonly used to provide postoperative pain relief for patients undergoing laparotomy [35–38].

By placing the ultrasound probe about 5 cm cranial to the anterior superior iliac spine, the ilioinguinal and iliohypogastric nerves can be found between the transverse abdominal and the internal oblique muscle [39]. For TAP block, the transducer can be placed in a transverse plane between the iliac crest and the anterior axillary line. Local anaesthetics can be deposited between the transversus abdominis muscle and the internal oblique muscle [40].

5.2.3. Dorsal Ramus of Spinal Nerve

Low back pain is a common chronic pain syndrome; however, in most cases, a specific diagnosis cannot be established. Trigger point injections have been found to relieve myofascial low back pains. However, there has been lack of evidence in the literature to support its efficacy. This could be attributed to the heterogeneity in the diagnosis and technique of localization of trigger points in low back pain. Most of the studies employed subjective localization of trigger points, and the techniques of localization and injection of trigger points were not well described.

Miyakoshi et al. demonstrated that CT-guided total dorsal ramus block was effective in the treatment of chronic low back pain in a group of patients with overlapping facet syndrome with myofascial syndrome with pain originating from myofascial structure, facet joint, or both [41]. They demonstrated that a single injection of a larger volume of local anaesthetics over the conventional target point for medial branch block, which was the junction of the L5 superior articular process and the transverse process, was effective to block the medial, intermediate, and lateral branches of the lumbar dorsal ramus, with significantly better pain reduction compared to conventional trigger point injection. The findings in this study shed light to the possibility of relief of myofascial pain syndrome by a single nerve injection. It may explain the poor results of pure intramuscular injections in controlled studies, in contrast to the better results with uncontrolled studies and case reports, in which some of the results may be attributable to accidental nerve injection using the conventional blind injection techniques.

For ultrasound-guided medial branch block, the transducer is first placed longitudinally to find the respective transverse process and localize the lumbar level. Then the transducer can be rotated into a transverse plane to delineate the transverse process and the superior articular process of the adjacent facet joint. The bottom of the groove between the lateral surface of the superior articular process and the cephalad margin of the respective transverse process was defined as the target site [42].

Ultrasound-guided technique may be adapted to perform injection of the lower back, targeting at the dorsal rami of the lumbar spinal nerves to increase the efficacy of injection.

5.2.4. Lumbar Plexus

There have been case reports on the use of trigger point injection for treatment of pain that was remote from the site of trigger points. Interestingly, Iguchi et al. used trigger point injection for the amelioration of renal colic. In their paper, they described the injection technique as follows. Trigger points were located over the paraspinal region at around L3 level. A long needle (23-gauge 6 cm) was inserted deep into the trigger points, and 5–10 mL of 1% lignocaine was injected [43]. Such injection was in fact into the psoas muscle, and the effect could be attributed to a lumbar plexus block.

Lumbar plexus block with ultrasound guidance has been described. A curved transducer can be placed in the transverse plane at L2–L4 level for the lumbar plexus block. This transverse view should show the psoas muscle without the transverse process. The target of the needle tip is within the posterior 1/3 of the psoas muscle bulk [40].

5.2.5. Pudendal Nerve

Langford et al. reported the effective use of levator ani trigger point injection in the treatment of chronic pelvic pain. Trigger points were identified by manual intravaginal palpation, and the trigger points were injected with a large volume (up to about 20 mL) of a mixture of local anesthetics and depot steroid. The effect of such injection might in fact be caused by the concomitant pudendal nerve block [44].

Pudendal nerve blockade with ultrasound guidance can be performed via the transgluteal approach. The probe is placed transverse to the posterior superior iliac spine and moved caudally until the piriformis muscle is seen. The probe is then moved further caudad to identify the ischial spine, in which the pudendal nerve will be seen lying medial to the pudendal artery [29].

6. Other Advantages of Ultrasound in Trigger Point Injections

Trigger point injections are commonly performed in clinics as an outpatient procedure. Serious complications, although of rare occurrence, have been reported (e.g., pneumothorax, haematoma, intravascular injection of local anaesthetics, and intrathecal injections) [45]. Direct visualization of surrounding soft tissues and important structures can reduce the risk of such complications. Moreover, ultrasound allows real-time imaging of the spread of the injectate around the relevant structures and increases the success rate of injection.

7. Future Directions

The nonspecific diagnosis and lack of objective clinical measurements for trigger points mean that the evidence for the effectiveness of trigger point injection remains heterogenous. There is so far no strong evidence for the effectiveness of trigger point injections, and many physicians consider trigger point injections a little more than, if not equivalent to, placebo effects.

With the advancement of ultrasound technology, the quality of scans for soft tissues and musculature has improved dramatically. Future studies may focus on more objective diagnostic criteria of trigger points using ultrasound imaging. For the technique of trigger point injections, real-time visualization of trigger points, relaxation of locally contracting muscles, and visualization of surrounding tissues or important structures may improve the outcome and minimize complications of such treatments.

Moreover, efficacy of some of the trigger point injections traditionally performed may be related to some kind of peripheral nerve blocks, the implication which is yet to be explored.

References

1. S. C. Han and P. Harrison, "Myofascial pain syndrome and trigger-point management," *Regional Anesthesia*, vol. 22, no. 1, pp. 89–101, 1997. View at Google Scholar · View at Scopus
2. T. A. Garvey, M. R. Marks, and S. W. Wiesel, "A prospective, randomized, double-blind evaluation of trigger-point injection

therapy for low-back pain," *Spine*, vol. 14, no. 9, pp. 962–964, 1989. View at Google Scholar · View at Scopus

3. A. Ashkenazi, A. Blumenfeld, U. Napchan et al., "Peripheral nerve blocks and trigger point injections in headache management—a systematic review and suggestions for future research," *Headache*, vol. 50, no. 6, pp. 943–952, 2010. View at Publisher · View at Google Scholar · View at Scopus

4. C. Bron, A. de Gast, J. Dommerholt, B. Stegenga, M. Wensing, and R. A.B. Oostendorp, "Treatment of myofascial trigger points in patients with chronic shoulder pain: a randomized, controlled trial," *BMC Medicine*, vol. 9, 2011. View at Publisher · View at Google Scholar

5. D. G. Simons, "Clinical and etiological update of myofascial pain from trigger points," *Journal of Musculoskeletal Pain*, vol. 4, no. 1-2, pp. 93–121, 1996. View at Publisher · View at Google Scholar · View at Scopus

6. C. Hong, "Myofascial Pain Therapy," *Regional Musculoskeletal Pain*, vol. 12, no. 3, pp. 37–43, 2004. View at Google Scholar

7. D. Simons, J. Travell, and L. Simons, *Travell & Simons' Myofascial Pain and Dysfunction: The Trigger Point Manual*, Williams & Wilkins, Baltimore, Md, USA, 2nd edition, 1999.

8. J. L. Reeves, B. Jaeger, and S. B. Graff-Radford, "Reliability of the pressure algometer as a measure of myofascial trigger point sensitivity," *Pain*, vol. 24, no. 3, pp. 313–321, 1986. View at Google Scholar · View at Scopus

9. J. Travel and S. H. Rinzler, "The myofascial genesis of pain," *Postgraduate Medicine*, vol. 11, no. 5, pp. 425–434, 1952. View at Google Scholar · View at Scopus

10. A. Sola and J. Bonica, "Myofascial pain syndromes," in *Bonica's Management of Pain*, J. Loeser, et al., Ed., Lippincott Williams & Wilkins, Philadelphia, Pa, USA, 3rd edition, 2001. View at Google Scholar

11. C. Z. Hong and D. G. Simons, "Pathophysiologic and electrophysiologic mechanisms of myofascial trigger points," *Archives of Physical Medicine and Rehabilitation*, vol. 79, no. 7, pp. 863–872, 1998. View at Publisher · View at Google Scholar · View at Scopus

12. D. G. Simons, C. Z. Hong, and L. S. Simons, "Endplate potentials are common to midfiber myofacial trigger points," *American Journal of Physical Medicine and Rehabilitation*, vol. 81, no. 3, pp. 212–222, 2002. View at Publisher · View at Google Scholar · View at Scopus

13. H. Iwama and Y. Akama, "The superiority of water-diluted 0.25% to neat 1% lidocaine for trigger-point injections in myofascial pain

syndrome: a prospective randomized, double-blinded trial," *Anesthesia and Analgesia*, vol. 91, no. 2, pp. 408–409, 2000. View at Google Scholar · View at Scopus

14. H. Iwama, S. Ohmori, T. Kaneko, and K. Watanabe, "Water-diluted local anesthetic for trigger-point injection in chronic myofascial pain syndrome: evaluation of types of local anesthetic and concentrations in water," *Regional Anesthesia and Pain Medicine*, vol. 26, no. 4, pp. 333–336, 2001. View at Publisher · View at Google Scholar · View at Scopus
15. J. Borg-Stein and D. Simons, "Focused review: myofascial pain," *Archives of Physical Medicine and Rehabilitation*, vol. 83, no. 3, supplement 1, pp. S40–S49, 2002. View at Google Scholar
16. C. L. Graboski, D. Shaun Gray, and R. S. Burnham, "Botulinum toxin A versus bupivacaine trigger point injections for the treatment of myofascial pain syndrome: a randomised double blind crossover study," *Pain*, vol. 118, no. 1-2, pp. 170–175, 2005. View at Publisher · View at Google Scholar · View at Scopus
17. K. Y. Ho and K. H. Tan, "Botulinum toxin A for myofascial trigger point injection: a qualitative systematic review," *European Journal of Pain*, vol. 11, no. 5, pp. 519–527, 2007. View at Publisher · View at Google Scholar · View at Scopus
18. C. T. Tsai, L. F. Hsieh, T. S. Kuan, M. J. Kao, L. W. Chou, and C. Z. Hong, "Remote effects of dry needling on the irritability of the myofascial trigger point in the upper trapezius muscle," *American Journal of Physical Medicine and Rehabilitation*, vol. 89, no. 2, pp. 133–140, 2010. View at Publisher · View at Google Scholar · View at Scopus
19. C. Z. Hong, "Lidocaine injection versus dry needling to myofascial trigger point: the importance of the local twitch response," *American Journal of Physical Medicine and Rehabilitation*, vol. 73, no. 4, pp. 256–263, 1994. View at Publisher · View at Google Scholar · View at Scopus
20. D. G. Simons, "New views of myofascial trigger points: etiology and diagnosis," *Archives of Physical Medicine and Rehabilitation*, vol. 89, no. 1, pp. 157–159, 2008. View at Publisher · View at Google Scholar · View at Scopus
21. J. Lewis and P. Tehan, "A blinded pilot study investigating the use of diagnostic ultrasound for detecting active myofascial trigger points," *Pain*, vol. 79, no. 1, pp. 39–44, 1999. View at Publisher · View at Google Scholar · View at Scopus
22. S. Sikdar, J. P. Shah, T. Gebreab et al., "Novel applications of ultrasound technology to visualize and characterize myofascial trigger points and surrounding soft tissue," *Archives of Physical*

Medicine and Rehabilitation, vol. 90, no. 11, pp. 1829–1838, 2009. View at Publisher · View at Google Scholar · View at Scopus

23. K. P. Botwin, K. Sharma, R. Saliba, and B. C. Patel, "Ultrasound-guided trigger point injections in the cervicothoracic musculature: a new and unreported technique," *Pain Physician*, vol. 11, no. 6, pp. 885–889, 2008. View at Google Scholar · View at Scopus
24. J. E. Janis, D. A. Hatef, E. M. Reece, P. D. McCluskey, T. A. Schaub, and B. Guyuron, "Neurovascular compression of the greater occipital nerve: implications for migraine headaches," *Plastic and Reconstructive Surgery*, vol. 126, no. 6, pp. 1996–2001, 2010. View at Publisher · View at Google Scholar · View at Scopus
25. A. Blumenfeld and A. Ashkenazi, "Nerve blocks, trigger point injections and headache," *Headache*, vol. 50, no. 6, pp. 953–954, 2010. View at Publisher · View at Google Scholar · View at Scopus
26. A. Blumenfeld, A. Ashkenazi, B. Grosberg et al., "Patterns of use of peripheral nerve blocks and trigger point injections among headache practitioners in the USA: results of the American headache society interventional procedure survey (AHS-IPS)," *Headache*, vol. 50, no. 6, pp. 937–942, 2010. View at Publisher · View at Google Scholar · View at Scopus
27. A. Ashkenazi and W. B. Young, "The effects of greater occipital nerve block and trigger point injection on brush allodynia and pain in migraine," *Headache*, vol. 45, no. 4, pp. 350–354, 2005. View at Publisher · View at Google Scholar · View at Scopus
28. M. Greher, B. Moriggl, M. Curatolo, L. Kirchmair, and U. Eichenberger, "Sonographic visualization and ultrasound-guided blockade of the greater occipital nerve: a comparison of two selective techniques confirmed by anatomical dissection," *British Journal of Anaesthesia*, vol. 104, no. 5, pp. 637–642, 2010. View at Publisher · View at Google Scholar · View at Scopus
29. S. Narouze, Ed., *Atlas of Ultrasound-Guided Procedures in Interventional Pain Management*, Springer, New York, NY, USA, 2011.
30. L. C. Kuan, Y. T. Li, F. M. Chen, C. J. Tseng, S. F. Wu, and T. C. Kuo, "Efficacy of treating abdominal wall pain by local injection," *Taiwanese Journal of Obstetrics and Gynecology*, vol. 45, no. 3, pp. 239–243, 2006. View at Google Scholar · View at Scopus
31. J. L. Whiteside, M. D. Barber, M. D. Walters, T. Falcone, and A. Morse, "Anatomy of ilioinguinal and iliohypogastric nerves in relation to trocar placement and low transverse incisions," *American Journal of Obstetrics and Gynecology*, vol. 189, no. 6, pp. 1574–1578, 2003. View at Publisher · View at Google Scholar · View at Scopus

32. R. Peleg, J. Gohar, M. Koretz, and A. Peleg, "Abdominal wall pain in pregnant women caused by thoracic lateral cutaneous nerve entrapment," *European Journal of Obstetrics Gynecology*, vol. 74, no. 2, pp. 169–171, 1997. View at Publisher · View at Google Scholar · View at Scopus

33. S. L. Lim, S. Ng, and G. M. Tan, "Ilioinguinal and iliohypogastric nerve block revisited: single shot versus double shot technique for hernia repair in children," *Paediatric Anaesthesia*, vol. 12, no. 3, pp. 255–260, 2002. View at Publisher · View at Google Scholar · View at Scopus

34. F. Oriola, Y. Toque, A. Mary, O. Gagneur, S. Beloucif, and H. Dupont, "Bilateral ilioinguinal nerve block decreases morphine consumption in female patients undergoing nonlaparoscopic gynecologic surgery," *Anesthesia and Analgesia*, vol. 104, no. 3, pp. 731–734, 2007. View at Publisher · View at Google Scholar

35. C. Aveline, H. Le Hetet, A. Le Roux et al., "Comparison between ultrasound-guided transversus abdominis plane and conventional ilioinguinal/iliohypogastric nerve blocks for day-case open inguinal hernia repair," *British Journal of Anaesthesia*, vol. 106, no. 3, pp. 380–386, 2011. View at Publisher · View at Google Scholar

36. J. Chiono, N. Bernard, S. Bringuier et al., "The ultrasound-guided transversus abdominis plane block for anterior iliac crest bone graft postoperative pain relief: a prospective descriptive study," *Regional Anesthesia and Pain Medicine*, vol. 35, no. 6, pp. 520–524, 2010. View at Publisher · View at Google Scholar · View at Scopus

37. J. M. Baaj, R. A. Alsatli, H. A. Majaj, Z. A. Babay, and A. K. Thallaj, "Efficacy of ultrasound-guided transversus abdominis plane (TAP) block for post-cesarean section delivery analgesia—a double-blind, placebo-controlled, randomized study," *Middle East Journal of Anesthesiology*, vol. 20, no. 6, pp. 821–826, 2010. View at Google Scholar

38. Y. S. Ra, C. H. Kim, G. Y. Lee, and J. I. Han, "The analgesic effect of the ultrasound-guided transverse abdominis plane block after laparoscopic cholecystectomy," *Korean Journal of Anesthesiology*, vol. 58, no. 4, pp. 362–368, 2010. View at Publisher · View at Google Scholar · View at Scopus

39. U. Eichenberger, M. Greher, L. Kirchmair, M. Curatolo, and B. Moriggl, "Ultrasound-guided blocks of the ilioinguinal and iliohypogastric nerve: accuracy of a selective new technique confirmed by anatomical dissection," *British Journal of Anaesthesia*, vol. 97, no. 2, pp. 238–243, 2006. View at Publisher · View at Google Scholar · View at Scopus

40. V. Chan, S. Abbas, R. Brull, B. Moriggl, and A. Perlas, *Ultrasound*

Imaging for Regional Anesthesia—A Practical Guide, Vincent Chan, 3rd edition, 2010.

41. N. Miyakoshi, Y. Shimada, Y. Kasukawa, H. Saito, H. Kodama, and E. Itoi, "Total dorsal ramus block for the treatment of chronic low back pain: a preliminary study," *Joint Bone Spine*, vol. 74, no. 3, pp. 270–274, 2007. View at Publisher · View at Google Scholar · View at Scopus

42. M. Greher, L. Kirchmair, B. Enna et al., "Ultrasound-guided lumbar facet nerve block: accuracy of a new technique confirmed by computed tomography," *Anesthesiology*, vol. 101, no. 5, pp. 1195–1200, 2004. View at Publisher · View at Google Scholar · View at Scopus

43. M. Iguchi, Y. Katoh, H. Koike, T. Hayashi, and M. Nakamura, "Randomized trial of trigger point injection for renal colic," *International Journal of Urology*, vol. 9, no. 9, pp. 475–479, 2002. View at Publisher · View at Google Scholar · View at Scopus

44. C. F. Langford, S. U. Nagy, and G. M. Ghoniem, "Levator ani trigger point injections: an underutilized treatment for chronic pelvic pain," *Neurourology and Urodynamics*, vol. 26, no. 1, pp. 59–62, 2007. View at Publisher · View at Google Scholar · View at Scopus

45. L. S. Nelson and R. S. Hoffman, "Intrathecal injection: unusual complication of trigger-point injection therapy," *Annals of Emergency Medicine*, vol. 32, no. 4, pp. 506–508, 1998. View at Publisher · View at Google Scholar · View at Scopus

Technical Report

Ultrasound-Guided Trigger Point Injections in the Cervicothoracic Musculature: A New and Unreported Technique

Kenneth P. Botwin, MD[1], Kavita Sharma, DO[1], Romeo Saliba, MD[1], and Bharat C. Patel, MD[2]

From: Florida Spine Institute, Clearwater, FL; Deuk Spine Institute, Titusville, FL.

Dr. Botwin is Fellowship Director, Florida Spine Institute, Clearwater, FL.
Dr. Sharma is with the division of Pain Management, Florida Spine Institute, Titusville, FL.
Dr. Saliba is with the Florida Spine Institute, Clearwater, FL.
Dr. Patel is with the Deuk Spine Institute, Titusville, FL.

Address correspondence:
Kenneth P. Botwin, MD,
Florida Spine Institute
2250 Drew Street
Clearwater FL 33765
E-mail: cbarragan@floridaspineinstitute.com

Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: None.

Manuscript received: 07/03/2008
Revised manuscript received: 08/20/2008
Accepted for publication: 09/29/2008

Free full manuscript: www.painphysicianjournal.com

Background: Myofascial pain is defined as pain that originates from myofascial trigger points in skeletal muscle. It is prevalent in regional musculoskeletal pain syndromes, either alone or in combination with other pain generators. The myofascial pain syndrome is one of the largest groups of under diagnosed and under treated medical problems encountered in clinical practice. Trigger points are commonly seen in patients with myofascial pain which is responsible for localized pain in the affected muscles as well as referred pain patterns. Correct needle placement in a myofascial trigger point is vital to prevent complications and improve efficacy of the trigger point injection to help reduce or relieve myofascial pain. In obese patients, these injections may not reach the target tissue. In the cervicothoracic spine, a misguided or misplaced injection can result in a pneumothorax. Here, we describe an ultrasound-guided trigger point injection technique to avoid this potential pitfall. Office based ultrasound-guided injection techniques for musculoskeletal disorders have been described in the literature with regard to tendon, bursa, cystic, and joint pathologies. For the interventionalist, utilizing ultrasound yields multiple advantages technically and practically, including observation of needle placement in real-time, ability to perform dynamic studies, the possibility of diagnosing musculoskeletal pathologies, avoidance of radiation exposure, reduced overall cost, and portability of equipment within the office setting. To our knowledge, the use of ultrasound guidance in performing trigger point injection in the cervicothoracic area, particularly in obese patients, has not been previously reported.

Methods: A palpable trigger point in the cervicothoracic musculature was localized and marked by indenting the skin with the tip of a plastic needle cover. The skin was then sterile prepped. Then, using an ultrasound machine with sterile coupling gel and a sterile latex free transducer cover, the musculature in the cervicothoracic spine where the palpable trigger point was detected was visualized. Then utilizing direct live ultrasound guidance, a 25-gauge 1.5 inch needle connected to a 3 mL syringe was placed into the muscle at the exact location of the presumed trigger point. This guidance helps confirm needle placement in muscle tissue and not in an adipose tissue or any other non-musculature structure.

Results: The technique is simple to be performed by a pain management specialist who has ultrasound system training.

Conclusion: Ultrasound-guided trigger point injections may help confirm proper needle placement within the cervicothoracic musculature. The use of ultrasound-guided trigger point injections in the cervicothoracic musculature may also reduce the potential for a pneumothorax by an improperly placed injection.

Key words: Trigger point injection, myofascial pain, ultrasound

Pain Physician 2008; 11:6:885-889

Myofascial pain syndrome is one of many painful conditions of the musculoskeletal system. It constitutes some of the most important chronic problems encountered in a clinical practice (1). Myofascial pain is defined as pain that originates from myofascial trigger points in skeletal muscle. It is prevalent in regional musculoskeletal pain syndromes, either alone or in combination with other pain generators. The myofascial pain syndrome is one of the largest group of under-diagnosed and under-treated medical problems encountered in clinical practice. An appropriate evaluation and management of myofascial pain is an important part of musculoskeletal rehabilitation of regional axial and limb pain syndromes (2). A myofascial trigger point is a hyperirritable spot, usually within a taut band of skeletal muscle, which is painful on compression and can give rise to characteristic referred pain, motor dysfunction, and autonomic phenomena (1,3). Trigger points have been proven causes of myofascial pain that are responsible for neck and back pain. Trigger points can be activated with local pressure or stretch of the tissue. They can also cause referred pain in a specific dermatomal and myotomal pattern. Trigger points may be relieved through noninvasive measures, such as spray and stretch, transcutaneous electrical stimulation, physical therapy, and massage. Invasive treatments for myofascial trigger points include injections with local anesthetics, corticosteroids or botulism toxin, or dry needling (1-6). Precise injections into the trigger points are vital in helping deactivate them.

Trigger points are usually palpated during physical examination before injecting them. It is very hard, and sometimes impossible, to palpate trigger points in the obese patients. At times, in these patients it is difficult to know if the needle is properly placed within the muscle tissue. This can perhaps lead to an increase in complications in these patients when performing trigger point injections in the posterolateral neck and thoracic spine musculature such as injection into the adipose tissue or pneumothorax.

A Medline/EMBASE review of literature did not reveal a description of this technique. Thus, this paper is the first to describe this new and previously unreported technique of trigger point injection utilizing ultrasound guidance in the cervicothoracic musculature. This report was approved by the institutional review board at the authors' institution.

Methods

After marking the trigger point injection site by indenting the skin with a plastic needle cover, the skin over that area is prepared by applying betadine and then alcohol. Then using an ultrasound system (Sonosite MicroMaxx compact ultrasound system [Fig. 1]) with sterile coupling gel and a sterile latex-free transducer cover, the musculature in the cervicothoracic spine where the palpable trigger point is detected was visualized. The region was scanned using at 13-6 MHz 38 mm broadband linear array transducer. On ultrasound the skin appears hyperechoic, the adipose tissue is a mixed echogenicity and the muscle has a hyperechoic marbled appearance. Utilizing direct live ultrasound guidance a 25-gauge 1.5-inch needle connected to a 3 mL syringe is placed into the muscle at the exact location of the presumed trigger point longitudinal to the transducer. When in the color mode the injectate can be clearly visualized (Fig. 2).

The needle is seen to pass through the skin and adipose tissue and into the muscle. Needle placement in the specific muscle to be injected can be confirmed by asking the patient to activate that particular muscle while observing the musculature under ultrasound. Once the proper localization is achieved, the injection with or without an injectate can be performed. If an injectate with particulate corticosteroid is utilized it appears hyperechoic, while saline and anesthetics appear anechoic on ultrasound. At completion the needle is removed. Pressure is applied at the injection site to ensure proper homeostasis. A bandage can be applied.

Discussion

Trigger point injections have been proven to be useful to relieve myofascial pain in patients suffering from neck and low back pain (4-13). There are 2 possible problems when performing trigger point injections in obese patients. First, in such patients, it is difficult at times to determine whether the needle tip is in the muscle or in the adipose tissue. If the needle is not in the muscle, the injection will not relieve any pain and symptoms related to a trigger point. Secondly, trigger point injections in cervical and thoracic spine in all patients can be associated with the possibility of a pneumothorax (14-17). Electromyographic guidance has been recommended during a Botulinum toxin A injection for the treatment of muscle spasticity in post-stroke patients, cerebral palsy, and dystonia for

Fig. 1. *MicroMaxx ultrasound system by with transducer in a CIV-Flex Sterile Transducer Cover.*

Fig. 2. *1.5-inch 25-gauge needle connected to 3 mL syringe is placed into the thoracic musculature utilizing continuous ultrasound guidance. The injectate can be seen spreading in the muscular tissue as seen in the color mode setting.*

precise localization of a specific muscle as well as the motor point in that muscle by observing MUAPs and end-plate potentials before injecting (18-27). Botwin and Patel (28) described a similar technique with electromyographic guidance that can be useful when performing trigger point injection in the cervicothoracic regions in obese patients; however, the actual needle location cannot be visualized with this technique. A closed claims study found that trigger point injections are the second most common cause of pneumothorax ranking behind intercostal nerve blocks in 21% of cases (29). Trigger point injections can also be inadvertently placed intrathecally (17).

Ultrasonography has gathered momentum for widespread application in musculoskeletal medicine. Adler and Sofka (30) have demonstrated the role of musculoskeletal ultrasound in office-based percutaneous injections evaluating and treating disorders of joints, tendons, bursae, cystic pathologies, as well as injection of neuromas. Diagnostically, the utility of ultrasound may potentially be extended to include assessment of chronicity in sports-related injury (31). Smith et al (32) and Huerto et al (33) recently outlined a technique for ultrasound-guided injection of the piriformis muscle which could also be performed with additional motor stimulation for real-time reproduction of symptoms in patients with piriformis syndrome. Deep intraarticular injections, previously thought to require fluoroscopic guidance, have been successfully targeted using sonography (34). Aforementioned studies have all shown consistency when ultrasound-guided techniques were compared with conventional methods for procedures.

There are several technical considerations in performing ultrasound-guided injections. First, the addition of image guidance will likely result in increased time taken to perform office procedures. As well, the office setting must allow for enough space to comfortably manipulate the equipment and position the patient, taking into account any special physical limitations that the patient may have. The cost of ultrasound machines varies, however, this is still a consideration in most practice settings and is noted. Lastly, there are some limitations for the single operator stemming from the simultaneous use of image-guidance and performance of the injection, which may become less significant as the practitioner gains a comfort level with continued use of this equipment.

Clinical studies need to be done to evaluate the effectiveness of this technique compared with the conventional technique of trigger point injection without ultrasound guidance.

Conclusion

An ultrasound-guided trigger point injection technique helps confirm accurate needle placement in the cervicothoracic musculature. This could help to avoid injection into adipose tissue which may minimize the injection's effectiveness. The ultrasound guidance also could help to avoid the potential complication of a pneumothorax or inadvertent intrathecal injection. Thus, the use of ultrasund guidance may increase the efficacy of trigger point injections to reduce or relieve myofascial pain while reducing the possibility of complications.

Medical Equipment

MicroMaxx ultrasound system (SonoSite, Inc. Bothell, WA, USA)

Aquasonic 100 ultrasound transmission gel, water soluble (Parker Laboratories, Inc., Fairfield, NJ, USA)

CIV-Flex Sterile Transducer Cover (CIVCO, Kalona, IA, USA)

References

1. Lavelle ED, Lavelle W, Smith HS. Myofascial trigger points. *Med Clin North Am* 2007; 91:229-239.
2. Borg-Stein J, Simons DG. Focused review: Myofascial pain. Arch Phys Med Rehabil. 2002 Mar; 83(3 Suppl 1):S40-7, S48-9. Review.
3. Simons DG, Mense S. Diagnosis and therapy of myofascial trigger points. *Schmerz* 2003 17:419-24. Review. German.
4. Simons DG, Travell JG. Myofascial origins of low back pain. Principles of diagnosis and treatment. *Postgrad Med.* 1983; 73:66, 68-70, 73.
5. Travell JG, Simond DG. *Myofascial Pain and Dysfunction: The Trigger Point Manual: The Lower Extremities. Vol. 1.* Baltimore, MD: Williams & Wilkins, 1983.
6. Fischer AA. Local injections in pain management. Trigger point needling with infiltration and somatic blocks. Physical Med Rehabilitation Clinic North America, 1995:6:851-870.
7. Graboski CL, Gray DS, Burnham RS. Botulinum toxin A versus bupivacaine trigger point injections for the treatment of myofascial pain syndrome: A randomized double blind cross over study. *Pain* 2005; 118:170-175.
8. Hamada H, Moriwaki K, Shiroyama K, Tanaka H, Kawamoto M, Yuge O. Myofascial pain in patients with post-thoracotomy pain syndrome. *Reg Anesth Pain Med* 2000; 25:302-305.
9. Staud R. Are tender point injections beneficial: The role of tonic nocieptor in fibromyalgia. *Curr Pharm Des* 2006; 12:23-27.
10. Borg-Stein J, Stein J. Trigger points and tender points: One and the same? Does injection treatment help? *Rheum Dis Clin North Am* 1996; 22:305-322.
11. Smith HS, Audette J, Royal MA. Botulinum toxin in pain management of soft tissue syndromes. *Clin J Pain* 2002; 18(6 Suppl):S147-S154.
12. Hong CZ, Hsueh TC. Difference in pain relief after trigger point injections in myofascial pain patients with and without fibromyalgia. *Arch Phys Med Rehabil* 1996; 77:1161-1166.
13. Kamanli A, Kaya A, Ardicoglu O, Ozgocmen S, Zengin FO, Bayik Y. Comparison of lidocaine injection, botulinum toxin injection, and dry needling to trigger points in myofascial pain syndrome. *Rheumatol Int* 2005; 25:604-611. Epub 2004 Sep 15.
14. Simond DG, Travell JG, Simons LS. *Travell and Simon's Myofascial Pain and Dysfunction: The Trigger Point Manual. 2nd Ed.* Baltimore, MD: *Williams & Wilins*, 1999:94-173.
15. Alvarez DJ, Rockwell PG. Trigger points: Diagnosis and management. *Am Fam Physician* 2002; 65:653-660.
16. Shafer N. Pneumothorax following "trigger point" injection. *JAMA*. 1970; 213:1193.
17. Nelson LS, Hoffman RS. Intrathecal injection: Unusual complication of trigger-point injection therapy. *Ann Emerg Med* 1998; 32:506-508.
18. Klein AW, Mantell A. Electromyographic guidance in injecting botulinum toxin. *Dermatol Surg* 1998; 24:1184-1186
19. O'Brien CF. Injection techniques for botulinum toxin using electromyography and electrical stimulation. *Muscle Nerve Suppl* 1997; 6:S176-S178S10.
20. Childers MK. The importance of electromyographic guidance and electrical stimulation for injection of botulinum toxin. *Phys Med Rehabil Clin N Am*. 2003; 14:781-792.
21. Finsterer J, Fuchs I, Mamoli B. Automatic EMG-guided botulinum toxin treatment of spasticity. *Clin Neuropharmacol* 1997; 20:195-203
22. Molloy FM, Shill HA, Kaelin-Lang A, Karp BI. Accuracy of muscle localization without EMG: Implications for treatment of limb dystonia. *Neurology* 2002; 58:805-807.
23. Comella CL, Buchman AS, Tanner CM, Brown-Toms NC, Goetz CG. Botulinum toxin injection for spasmodic torticollis: Increased magnitude of benefit with electromyographic assistance. *Neurology* 1992; 42:878-882.
24. Barbano RL. Needle EMG guidance for injection of botulinum toxin. Needle EMG guidance is useful. *Muscle Nerve* 2001; 24:1567-1568.
25. Lang AM. Botulinum toxin type A therapy in chronic pain disorders. *Arch Phys Med Rehabil* 2003; 84(3 Suppl 1):S69-S73.
26. Lang AM. Botulinum toxin therapy for myofascial pain disorders. C*urr Pain Headache Rep* 2002; 6:355-360.
27. Lang AM. A preliminary comparison of the efficacy and tolerability of botulinum toxin serotypes A and B in the treatment of myofascial pain syndrome: A retrospective, open-label chart review. *Clin Ther* 2003; 25:2268-2278.
28. Botwin KP, Patel BC. Electromyographically guided trigger point injections in the cervicothoracic musculature of obese patients: A new and unreported technique. *Pain Physician* 2007; 10:753-756.
29. Kalawokalani D. Malpractice claims for non-operative pain management: A growing pain for anesthesiologists. ASA Professional Information, 1999.
30. Adler RS, Sofka CM. Percutaneous ultrasound-guided injections in the musculoskeletal system. *Ultrasound Quarterly* 2003; 19:3-12
31. Koh ESC, McNally EG. Ultrasound of skeletal muscle injury. *Semin Musculoskeletal Radiology* 2007; 11:162-173.
32. Smith J, Hurdle MF, Locketz AJ, Wisniewski SJ. Ultrasound-guided piriformis injection: Technique description and verification. *Arch Phys Med Rehabil* 2006; 87:1664-1667
33. Huerto APS, Yeo SN, Ho KY. Piriformis muscle injection using ultrasonography and motor stimulation – Report of technique. *Pain Physician* 2007; 10:687-690.
34. Smith J, Hurdle MB. Office-based ultrasound-guided intra-articular hip injection: Technique for physiatric practice. *Arch Phys Med Rehabil* 2006; 87:296-298.