Ultrasound-guided dextrose solution perimysium dissection for posterior shoulder myofascial pain

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Abstract

Background: To assess the efficacy and safety of perimysium dissection for posterior shoulder myofascial pain.

Methods: This retrospective single-arm study was performed at a medical center between April 2016 and August 2017. Fifty-seven participants with refractory chronic posterior shoulder pain of myofascial origin underwent ultrasound (US)-guided perimysium dissection with hypertonic dextrose solution. Visual analog scale (VAS) scores and complication rate were evaluated before treatment and 4 weeks after treatment.

Results: US-guided perimysium dissection with dextrose solution resulted in excellent treatment efficacy and safety. Nineteen participants (33.3%) were free of pain after treatment, and 32 (56.1%) had >50% improvement in pain score. Forty-nine participants had complete VAS records. Overall mean pre- and posttreatment VAS scores were 7.18 ± 1.60 and 1.91 ± 2.04 (mean difference −5.27, 95% CI −5.99 to −4.55, $p < 0.0001$), respectively, including 7.26 ± 1.44 and 1.84 ± 1.98 (mean difference −5.43, 95% CI −6.33 to −4.52, $p < 0.0001$) for those with infraspinatus myofascial pain, and 7.00 ± 1.96 and 2.07 ± 2.26 (mean difference −4.93, 95% CI −6.23 to −3.62, $p < 0.0001$) for those in the teres minor subgroup. No complications were reported in any of the participants. One participant received retreatment for teres minor myofascial pain.

Conclusion: US-guided perimysium dissection is an easy, safe, and effective injection method to manage posterior myofascial shoulder pain.

Keywords: Myofascial pain; Myofascial trigger point; Perimysium dissection

1. INTRODUCTION

Shoulder pain is very common and can originate from soft or periarticular tissue lesions, joint impairment, or bone diseases. Prevalence of self-reported shoulder pain is 16–26%, and it is the third most common musculoskeletal problem seen in primary care consultations.[1] The etiology of shoulder pain varies, and subacromial impingement syndrome secondary to periarticular tissue damage and degeneration is the most common cause[2,3] with bone disease and joint impairment contributing to a lesser degree.[4] Nevertheless, a lack of optimal diagnostic tools and effective treatment modalities for shoulder pain suggest that other possible etiologies exist.[5–7] Myofascial pain syndrome (MPS) is caused by myofascial trigger points (MTrPs) and is considered a possible etiology of shoulder pain.[8] Infraspinatus and teres minor myofascial pain are common origins of posterior shoulder pain.[9] Treatments for shoulder pain of myofascial origin vary[9–13] and are only moderately effective in relieving pain.[14]

Trigger point injection therapy is the main method used to manage myofascial pain.[15,16] Many medications, techniques, and treatment sessions have been developed for MTrP injections, including dry needle, steroid, lidocaine, and botulinum toxin. In addition, hyperosmolar dextrose solution injection has a long history and widespread use for chronic musculoskeletal pain, particularly when other standard treatment fails.[17] Local hyperosmolar dextrose may attract inflammatory mediators and release growth factors, which can then facilitate tissue remodeling and symptom relief.[17,18] The identification of MTrPs by physical palpation is unreliable and has poor inter-rater reliability, and therefore hinders accurate injection therapy. Ultrasound (US) can be used to navigate the injection needle, offers dynamic images of the immediate response to injection therapy, facilitates localization, increases injection accuracy, and reduce adverse events.[19] Although studies have suggested that potential US findings of MTrPs include hypoechoic, stiff, and spherical-shaped area with measurable viscoelastic properties, but there is still no definite consensus.[19,20] In some circumstances, MTrPs have been shown to be quite small and difficult to assess, even in recent US studies.[20,21] US-guided injection is not recommended in patients without typical MTrP findings.[19] Perimysium, a sheath of connective tissue that groups muscle fibers into bundles, is easily identified under US. This network system parallel with myofibers transmits forces from contracted myofibers to the tendons.[22] We hypothesized that hydro-dissection of perimysium at MTrPs may stop sarcomere contracture transmission and relieve myofascial pain, since hyperosmolar dextrose solution offers further tissue remodeling from microtrauma. Perimysium surrounding muscle fascicles is highly reflective

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and easily identifiable under US. Instead of unreliable MTrP injection with inconsistent guiding methods,[19–21] the precision and simplicity of perimysium identification near the physically located MTrPs facilitates hydro-dissection. The aim of this study was to evaluate the effectiveness of local hyperosmolar dextrose solution injection to dissect MTrP perimysium in the treatment of posterior myofascial shoulder pain originating from infraspinatus and teres minor.

2. METHODS

2.1. Participant Selection and Outcome Assessment

We conducted this single center, single-arm study between April 2016 and August 2017 after approval from the Institutional Ethics Committee of Taipei Veterans General Hospital, Department of Radiology. Informed consent was obtained from each subject before participation in this study. Subjects with posterior shoulder pain who met the following criteria were enrolled: (1) posterior shoulder pain with tenderness over the infraspinatus and teres minor under compression; (2) pain for over 3 months; (3) pain was refractory to oral non-steroidal anti-inflammatory drugs (NISADs); (4) pain with visual analog scale (VAS) score ≥4; and (5) diagnosis of MPS in the infraspinatus and teres minor according to the criteria described by Travell and Simons.[6] The exclusion criteria were as follows: (1) presence of significant other pathologies for rotator cuff pain such as fracture or rheumatic diseases; (2) presence of symptoms and signs of neuropathy; (3) MPS other than infraspinatus and teres minor muscles; (4) history of previous local injection therapy; (5) presence of uncontrolled systemic diseases; and (6) allergy history to lidocaine. All participants received high-concentration dextrose solution perimysium dissection of the affected muscle under US guidance. The primary outcome was pain severity as recorded on a 10-cm horizontal VAS ranging from no pain (score 0) to the worst imaginable pain (score 10). Pain was assessed before and 4 weeks after treatment. Treatment success was defined as >50% reduction in pain score.

Secondary outcomes were complication and retreatment rates. None of the patients received oral NSAIDs, opioids, or physical therapy during the 2 weeks before and after perimysium dissection.

2.2. Technique of Ultrasound-guided Perimysium Dissection

Physical examination for identifying MTrPs of infraspnatus and teres minor was performed before US-guided injection. The target sites of hydro-dissection were perimysium at the physical MTrPs. All US-guided perimysium dissection procedures were performed by one radiologist with 25 years of experience in musculoskeletal ultrasonography. S3000 (Siemens Medical Solutions, Malvern, PA) and LOGIQ E9 (GE Healthcare, Wauwatosa, WI) US system were utilized for our investigation. B-mode, real-time ultrasonography with sterile methods with a 9 MHz linear transducer was used to target the injection site in the infraspinatus and teres minor muscles. Under sterile conditions, 10 cc of 15% dextrose solution mixed with 2 cc of 2% lidocaine was used for targeted perimysium dissection.

The patients were placed in the lateral decubitus position on a bed with the lesion side facing upward. The tender point was marked with a surgical pen, and grayscale ultrasonography was used to localize the muscle requiring treatment (infraspinatus or teres minor muscle). Under US-guidance, a 70-mm long 23# needle was connected to a 10-mL syringe, and the mixture of dextrose solution was injected into the targeted perimysium with layering dissection (Fig. 1).

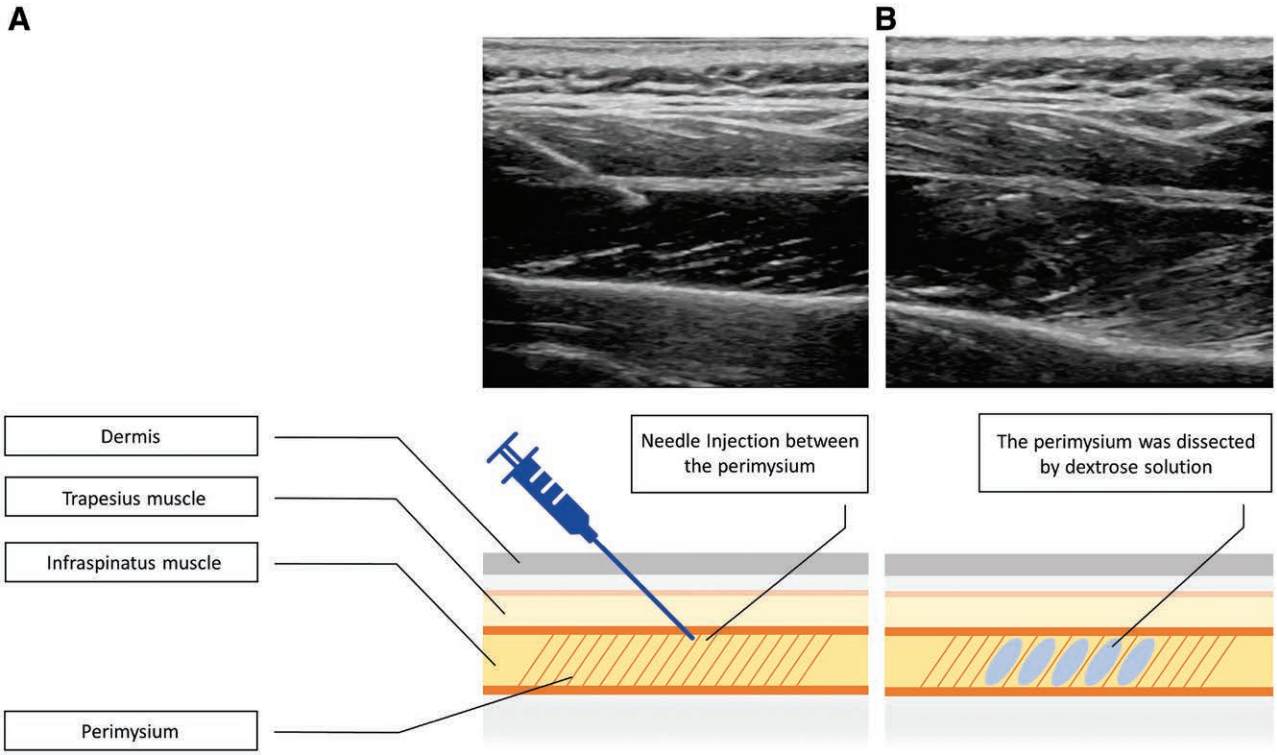

Fig. 1 US-guided perimysium dissection in a 57-year-old female with left infraspinatus myofascial pain. (A) A 70 mm long, 23# needle insertion between the perimysium at the myofascial point of the infraspinatus under US-guidance (B) Postdissection status. US = ultrasound.

2.3. Statistical Analysis

The independent and paired sample t-test was used to compare pre- and posttreatment VAS score regarding the different sites (infraspinatus/teres minor) of injection. The Chi-square test was used to evaluate categorical variables. A p value <0.05 was considered to be statistically significant. MedCalc Statistical Software version 19 (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2019) was used for all analyses.

3. RESULTS

Fifty-seven participants (16 male and 41 female) with chronic NSAID-refractory posterior shoulder pain were enrolled in our analysis. Duration of posttreatment follow-up ranged from 2 to 52 weeks, and the mean age of the participants was 57.3 years (range: 38 to 85 years). After US-guided perimysium dextrose solution dissection, 19 participants (33.3%) were pain-free, 32 (56.1%) had a >50% pain score improvement, and six (10.5%) did not have pain relief after treatment. Forty-nine patients had complete VAS records. Overall mean pre- and posttreatment VAS scores were 7.18 ± 1.60 and 1.91 ± 2.04 (mean difference −5.27, 95% CI −5.99 to −4.55, p < 0.0001), respectively (Fig. 2A). In the infraspinatus group, the mean pre- and posttreatment VAS scores were 7.26 ± 1.44 and 1.84 ± 1.98 (mean difference −5.43, 95% CI −6.33 to −4.52, p < 0.0001), respectively (Fig. 2B), compared with 7.00 ± 1.96 and 2.07 ± 2.26 (mean difference −4.93, 95% CI −6.23 to −3.62, p < 0.0001) (Fig. 2C) in the teres minor group. No VAS differences were noted between infraspinatus and teres minor groups (Table 1). No complications such as injection site infection, allergic skin reaction, or hematoma were noted in any of the 57 participants. Only one participant with left side teres minor tenderness underwent a second perimysium dissection. The improvement in VAS score was limited (from 10 to 9) after the two treatment sessions.

4. DISCUSSION

This is the first study to focus on dextrose solution perimysium dissection in the treatment of myofascial pain of infraspinatus and teres minor muscles. We enrolled participants with chronic shoulder pain refractory to oral medications and physical therapy. A significant mean improvement in VAS pain score of 5.27 (p < 0.0001) from baseline was noted in the participants overall. Significant pain improvement was also observed in the infraspinatus and teres minor subgroups after perimysium dissection. The treatment success rate was 89.4%, and no complications were reported. The US-guided injection method was able to precisely localize the MTrP perimysium of affected muscles to facilitate dextrose solution dissection and decrease possible complications. Although follow-up data for long-term efficacy are lacking, our results suggest that US-guided perimysium dissection is effective and safe for the management of myofascial pain originating from the infraspinatus and teres minor muscles.

MPS is a major cause of chronic shoulder pain, and it is considered to originate from subacromial impingement.[9] Myofascial trigger points are pressure-sensitive local points which trigger referral pain, muscle dysfunction, and sympathetic hyperactivity. Few prevalence studies focusing on MTrPs on shoulder pain have been published. Simons et al. revealed that MTrPs within infraspinatus muscle (which were most prevalent) causes myofascial shoulder pain.[6] Further study showed that active MTrPs in patients with chronic shoulder pain are most prevalent in the infraspinatus muscle and the fourth most common in the teres minor muscle.[9] We choose infraspinatus and teres minor as the target muscles not only for high MTrP prevalence, but also smaller size than trapezius muscle, that may reduce the bias of multiple treatment.

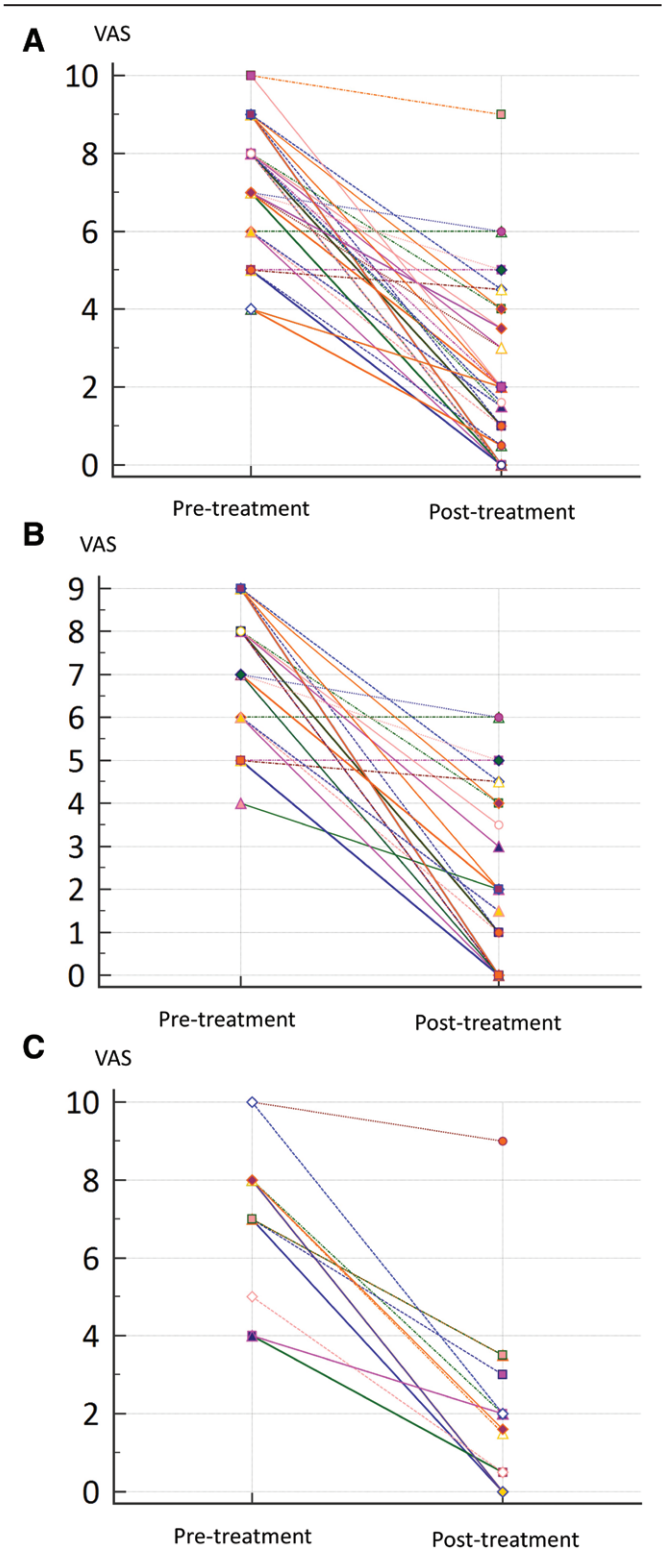

Fig. 2 VAS score change pre- and posttreatment. (A) All participants with complete VAS records (n = 49). (B) Infraspinatus myofascial pain subgroup (n = 34). (C) Teres minor myofascial pain subgroup (n = 15). VAS = visual analog scale.

Treatment of shoulder pain of myofascial origin includes pharmacologic treatment, dry needling, acupuncture, fascial manipulation, laser therapy, MTrP injection, and multimodal

Table 1

Comparison of perimysium dissection in infraspinatus and teres minor muscles

	Infraspinatus	Teres minor	*p*
No. of patients	40	17	
Mean age, y	57.43 ± 11.78	56.82 ± 9.04	0.8517
Female (%)	75	64.7	0.9035
No. of patients with complete VAS score	34	15	
Mean retreatment VAS	7.26 ± 1.44	7.00 ± 1.96	0.5995
Mean posttreatment VAS	1.84 ± 1.98	2.07 ± 2.26	0.7152
Complication rate (%)	0	0	

VAS = visual analog scale.

treatments with varying efficacy.[11–16,23] MTrP injections can involve medications including dry needling, local anesthetics, steroids, and botulinum toxin; however, the results of MTrP injections remain controversial.[24]

An optimal injection relies on the accurate identification of MTrPs by manual palpation, which is associated with poor agreement and reliability. B-mode US can be used to identify MTrPs as hypoechoic regions with measurable viscoelastic properties.[19] US-guided trigger point injections in the brachialis muscle achieved significant improvements in symptoms in patients with upper arm myofascial pain had been reported.[25] However, a lack of definite consensus on the use of US to identify MTrPs limits injection accuracy. In addition, the small size of MTrPs under US, ranging from 0.05 to 0.21 cm^2 in recent studies, further hinders the accuracy of injections despite the imaging assistance.[19]

Perimysium is involved in the transmission of lateral contractile force and is easier to identify under US compared with MTrPs.[26] Microscopically, highly ordered networks of collagen fibers of perimysium are arranged in a honeycomb structure, which connects the tendons. This network system in parallel with myofibers transmits forces from contracted myofibers to tendons.[22] The pathophysiology of myofascial pain is sustained sarcomere contracture secondary to noxious stimuli triggering local ischemia, energy crisis, and the release of sensitizing substances.[24] Therefore, we hypothesized that terminating sarcomere contraction by dissecting perimysium at the MTrPs may stop the myofascial pain cascade. US-guided MTrP perimysium dissection need not target the actual MTrPs and therefore simplifies the injection technique. Dissection can be easily performed with hyperosmolar dextrose solution under US guidance to accurately localize and monitor the procedure in real time. Dextrose injections for chronic musculoskeletal pain have been used in clinical practice for more than 80 years. Hypertonic dextrose solutions dehydrate cells and cause tissue trauma, which attracts granulocytes and macrophages, and promotes tissue remodeling and facilitates the healing process.[27] In patients with myofascial pain, dextrose treatments was associated with improved VAS pain score and pressure threshold tolerance compared with treatment with saline or lidocaine.[28]

This pilot study revealed that perimysium dissection with dextrose solution was an effective and safe method to manage chronic shoulder myofascial pain. However, there are several limitations to this study. First, this is a single-arm study with no sham group to determine potential placebo effect. Second, the number of patients was small and the follow-up period was short. The long-term efficacy of perimysium dissection remains undetermined. Third, risk factors for poor treatment responders could not be investigated due to the small number of patients and short follow-up period. Fourth, confounding factors for myofascial pain such as emotional stress, lifestyle, and exercise patterns were not fully evaluated.

In conclusion, this single-arm pilot study demonstrated that US-guided MTrP perimysium dissection, a novel injection method with hyperosmolar dextrose solution, reduced chronic shoulder pain of myofascial origin without increasing complications. The results of this study provided clinical evidence for the effect of perimysium on contractile force transmission and also the use of dextrose solution for myofascial pain relief. Further larger-scale randomized control trials are warranted to evaluate the long-term safety and efficacy of perimysium dissection.

REFERENCES

1. Mitchell C, Adebajo A, Hay E, Carr A. Shoulder pain: diagnosis and management in primary care. *BMJ* 2005;**331**:1124–8.
2. Bigliani LU, Levine WN. Subacromial impingement syndrome. *J Bone Joint Surg Am* 1997;**79**:1854–68.
3. Koester MC, George MS, Kuhn JE. Shoulder impingement syndrome. *Am J Med* 2005;**118**:452–5.
4. Caliş M, Akgün K, Birtane M, Karacan I, Caliş H, Tüzün F. Diagnostic values of clinical diagnostic tests in subacromial impingement syndrome. *Ann Rheum Dis* 2000;**59**:44–7.
5. Simons DG. Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction. *J Electromyogr Kinesiol* 2004;**14**:95–107.
6. Simons DG, Travell JG, Simons LS. *Myofascial pain and dysfunction: the trigger point manual, Vol 1, upper half of body*. Philadelphia: Lippincott, Williams & Wilkins; 1999.
7. Yap EC. Myofascial pain–an overview. *Ann Acad Med Singap* 2007;**36**:43–8.
8. Hidalgo-Lozano A, Fernández-de-las-Peñas C, Alonso-Blanco C, Ge HY, Arendt-Nielsen L, Arroyo-Morales M. Muscle trigger points and pressure pain hyperalgesia in the shoulder muscles in patients with unilateral shoulder impingement: a blinded, controlled study. *Exp Brain Res* 2010;**202**:915–25.
9. Bron C, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. *BMC Musculoskelet Disord* 2011;**12**:139.
10. Liu L, Huang QM, Liu QG, Ye G, Bo CZ, Chen MJ, et al. Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: a systematic review and meta-analysis. *Arch Phys Med Rehabil* 2015;**96**:944–55.
11. Guerra de Hoyos JA, Andres Martin Mdel C, Bassas y Baena de Leon E, Vigara Lopez M, Molina Lopez T, Verdugo Morilla FA, et al. Randomised trial of long term effect of acupuncture for shoulder pain. *Pain* 2004;**112**:289–98.
12. Thornton AL, McCarty CW, Burgess MJ. Effectiveness of low-level laser therapy combined with an exercise program to reduce pain and increase function in adults with shoulder pain: a critically appraised topic. *J Sport Rehabil* 2013;**22**:72–8.
13. Day JA, Stecco C, Stecco A. Application of Fascial Manipulation technique in chronic shoulder pain–anatomical basis and clinical implications. *J Bodyw Mov Ther* 2009;**13**:128–35.
14. Sergienko S, Kalichman L. Myofascial origin of shoulder pain: a literature review. *J Bodyw Mov Ther* 2015;**19**:91–101.
15. Alvarez DJ, Rockwell PG. Trigger points: diagnosis and management. *Am Fam Physician* 2002;**65**:653–60.
16. Han SC, Harrison P. Myofascial pain syndrome and trigger-point management. *Reg Anesth* 1997;**22**:89–101.
17. Distel LM, Best TM. Prolotherapy: a clinical review of its role in treating chronic musculoskeletal pain. *PM R* 2011;**3**(6 Suppl 1):S78–81.
18. Cole B, Lam P, Hackett L, Murrell GAC. Ultrasound-guided injections for supraspinatus tendinopathy: corticosteroid versus glucose prolotherapy - a randomized controlled clinical trial. *Shoulder Elbow* 2018;**10**:170–8.
19. Kumbhare D, Singh D, Rathbone H A, Gunn M, Grosman-Rimon L, Vadasz B, et al. Ultrasound-guided interventional procedures: myofascial trigger points with structured literature review. *Reg Anesth Pain Med* 2017;**42**:407–12.
20. Sikdar S, Shah JP, Gebreab T, Yen RH, Gilliams E, Danoff J, et al. Novel applications of ultrasound technology to visualize and characterize myofascial trigger points and surrounding soft tissue. *Arch Phys Med Rehabil* 2009;**90**:1829–38.

21. Wong CS, Wong SH. A new look at trigger point injections. *Anesthesiol Res Pract* 2012;**2012**:492452.
22. Passerieux E, Rossignol R, Letellier T, Delage JP. Physical continuity of the perimysium from myofibers to tendons: involvement in lateral force transmission in skeletal muscle. *J Struct Biol* 2007;**159**:19–28.
23. Bron C, de Gast A, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. Treatment of myofascial trigger points in patients with chronic shoulder pain: a randomized, controlled trial. *BMC Med* 2011;**9**:8.
24. Borg-Stein J, Simons DG. Focused review: myofascial pain. *Arch Phys Med Rehabil* 2002;**83**(3 Suppl 1):S40–7, S48–9.
25. Suh MR, Chang WH, Choi HS, Lee SC. Ultrasound-guided myofascial trigger point injection into brachialis muscle for rotator cuff disease patients with upper arm pain: a pilot study. *Ann Rehabil Med* 2014;**38**:673–81.
26. Passerieux E, Rossignol R, Chopard A, Carnino A, Marini JF, Letellier T, et al. Structural organization of the perimysium in bovine skeletal muscle: Junctional plates and associated intracellular subdomains. *J Struct Biol* 2006;**154**:206–16.
27. Hauser RA, Lackner JB, Steilen-Matias D, Harris DK. A systematic review of dextrose prolotherapy for chronic musculoskeletal pain. *Clin Med Insights Arthritis Musculoskelet Disord* 2016;**9**:139–59.
28. Kim MY, Na YM, Moon JH. Comparison on treatment effects of dextrose water, saline, and lidocaine for trigger point injection. *J Korean Acad Rehabil Med* 1997;**21**:967–73.