

# Detecting Local Twitch Responses of Myofascial Trigger Points in the Lower-Back Muscles Using Ultrasonography

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**ABSTRACT.** 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;92:1576-80.

**Objective:** To evaluate the role of ultrasonography for detecting local twitch responses (LTRs) of myofascial trigger points (MTrPs) in deeply located lower-back muscles.

**Design:** Case-control study. Active MTrP was diagnosed in all patients based on the criteria proposed by Travell and Simons in their upper-trapezius or lower-back muscles. One investigator administered trigger point injections while observing LTRs on ultrasonography. The other investigator observed LTRs visually during the procedure.

**Setting:** University rehabilitation hospital.

**Participants:** Patients (n=41; mean age, 51.8±11.8y) with MTrPs in the upper-trapezius muscles and patients (n=62; mean age, 56.8±11.9y) with MTrPs in the erector spinae or quadratus lumborum were recruited from April 29 to October 31, 2010.

**Interventions:** Ultrasound-guided trigger point injection.

**Main Outcome Measures:** LTR detection rate according to the depth of MTrPs; subjective pain intensity using a visual analog scale before and immediately after the trigger point injection.

**Results:** In upper-trapezius muscles, all LTRs were detected by means of both ultrasonographic and visual inspection. In the lower-back muscles, many LTRs were detected only on ultrasonography during the trigger point injection. For deep muscles, ultrasound helped identify LTRs that were not detected by using visual assessment. Pain was alleviated more significantly in the group with LTRs during trigger point injections compared with the group without LTRs.

**Conclusions:** These findings suggest that ultrasonography was useful for detecting LTRs of MTrPs, especially for LTRs in the deep muscles. Ultrasound guidance may improve the therapeutic efficacy of trigger point injection for treating MTrPs in the deep muscles.

**Key Words:** Myofascial pain syndrome; Rehabilitation; Trigger points, myofascial; Ultrasonography.

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A MYOFASCIAL TRIGGER POINT (MTrP) is a highly localized painful or sensitive spot located in a palpable taut band of skeletal muscle fibers in patients with myofascial pain syndrome (MPS).<sup>1</sup> Pain from active MTrPs can occur spontaneously or in response to movement. A latent MTrP is defined as a sensitive spot at which pain or discomfort is elicited by compression only.<sup>2</sup> The diagnosis of MPS, which manifests with 1 or more MTrP, usually is based on the patient's subjective symptoms and the presence of an MTrP characterized by (1) tender spots in 1 or more palpable taut band, (2) a referred pain pattern, (3) a local twitch response (LTR), and (4) restricted range of motion.<sup>1,3</sup> However, the presence of an MTrP is a controversial subject because (1) patient's symptoms and signs overlap with other conditions,<sup>4</sup> (2) clinicians use different criteria for diagnosis,<sup>3</sup> and currently, (3) there are no objective laboratory tests for diagnosing MTrPs.<sup>4</sup> In addition, diagnostic reliability studies have yielded inconsistent results.<sup>2,5</sup>

An LTR is a momentary contraction (fasciculation) of the taut band in response to mechanical stimulation.<sup>6</sup> An LTR is visible or palpable when a needle is placed into an MTrP. Thus, LTRs are considered a more objective sign of an MTrP than other diagnostic criteria. Despite the usefulness of the LTR for detecting MTrPs,<sup>7</sup> some studies described it as the least reliable diagnostic test.<sup>7-9</sup> Hsieh et al<sup>2</sup> showed that an LTR has the lowest interexaminer reliability in the trunk and lower-limb muscles. They reported that an LTR was not easily elicited and palpated in deeply located muscles, although it could be identified consistently in superficial muscles, such as the extensor digitorum.<sup>7</sup> Simons et al<sup>3</sup> also reported that the quadratus lumborum presents special problems for examination, especially in terms of LTR identification. Another important issue is that LTRs are associated with MTrP inactivation. Therefore, it is essential to elicit LTRs during trigger point injections for immediate and complete pain relief.<sup>10</sup> Because precise needling into the MTrP seems to be more important for the therapeutic efficacy of trigger point injection than the injected local anesthetic, LTR is a valuable indicator for identifying the MTrP.

Modern ultrasonographic machines have improved progressively in terms of imaging quality. These machines are inexpensive, portable, and readily accessible because they become standard equipment in most hospitals. Furthermore, ultrasonography is a reliable tool that allows for real-time scanning of the targeted structure. In addition, ultrasound-guided injection

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## List of Abbreviations

CI	confidence interval
LTR	local twitch response
MPS	myofascial pain syndrome
MTrP	myofascial trigger point
OR	odds ratio
VAS	visual analog scale

techniques have been used widely for musculoskeletal disorders involving tendons, bursae, ligaments, and joint pathologic states. However, ultrasonographic studies have been limited to the MPS field to date. One previous study attempted to visualize the region of clinically identified active MTrPs by using diagnostic ultrasonography, but did not observe significant soft-tissue changes confirming the presence of MTrPs.<sup>9</sup>

We assumed that ultrasonography would be useful for detecting LTRs in MTrPs in deeply located muscles. In addition, we thought that ultrasound guidance could facilitate depth control during injection for even the deep and less accessible muscles in the lower-back area and reduce potential inadvertent injuries that could be caused by improper needle placement. To our knowledge, there has been no study of the benefit of ultrasonography for detecting LTRs and for the efficacy of trigger point injections in patients with MPS.

The first aim of this study was to evaluate the role of ultrasonography in detecting LTRs of MTrPs in deeply located lower-back muscles in comparison to superficially located upper-trapezius muscles. The second aim was to investigate the clinical importance of eliciting LTRs during trigger point injections for pain reduction.

## METHODS

### Participants

We recruited consecutive patients (n=41; 15 men, 26 women; mean age, 51.8±11.8y; age range, 26–72y) with MTrPs in the upper trapezius muscles and patients (n=62; 31 men, 31 women; mean age, 56.8±11.9y; age range, 33–86y) with MTrPs in the erector spinae or quadratus lumborum from April 29 to October 31, 2010. These patients were referred to the outpatient section of the university rehabilitation hospital to alleviate muscle pain in the neck, upper back, lower back, buttocks, or legs. This study was approved by the institutional review board and human subjects review committee before the study began. Written informed consent was obtained from all participants after they were briefed on the purpose and procedures of the study.

Diagnosis of an active MTrP was based on the modified criteria described by Simons et al<sup>3</sup>: (1) tender spots in the upper trapezius, erector spinae, or quadratus lumborum; (2) a typical pattern of referred pain is elicited when tender spots are compressed<sup>11</sup>; and (3) restricted range of motion.<sup>11</sup> However, the criterion of a palpable or visible LTR on snapping palpation at the most sensitive spot in the taut band was excluded for diagnosing MTrPs because we assumed that the taut bands of lower-back muscles were located too deeply to palpate in this study. In addition, we elicited and assessed LTRs during trigger point injections.

Patients were excluded from this study if they had (1) received an MTrP injection within 6 months; (2) undergone neck, shoulder, and/or lower-back surgery within 1 year; (3) used narcotic medicine within 1 month; (4) shown symptoms and signs meeting the 1990 American College of Rheumatology criteria for fibromyalgia; (5) received a diagnosis of cervical or lumbar radiculopathy or myelopathy; (6) had severe disk or skeletal lesions; (7) had hyperesthesia in the shoulder, neck, lower back, or ipsilateral leg; (8) had evidence of cognitive deficit; or (9) showed inadequate cooperation.<sup>2</sup>

### Detection of LTRs During Injection Using Ultrasonographic and Visual Inspection

All patients had a diagnosis of at least 1 active MTrP based on the previously outlined criteria. Sites for trigger point in-

jection were identified and gently marked on the skin with a plastic needle cap. The skin covering that area was prepared with povidone-iodine and alcohol.

Using the ACCUVIX V10 system<sup>a</sup> with sterile coupling gel and latex-free transducer cover, the target muscle with tender spots in the upper trapezius, erector spinae, or quadratus lumborum was visualized. The region was scanned using a 5- to 12-MHz linear array transducer. Under ultrasound guidance, a 25-gauge 3.8-cm needle connected to a 3-mL syringe containing 0.5% lidocaine was inserted into the upper-trapezius muscle at the presumed MTrP region. A 23-gauge 6.0-cm needle connected to a 3-mL syringe was used for lower-back muscles.

Two clinicians who were experienced in the diagnosis and treatment of MTrPs participated in the LTR inspection. One clinician observed LTRs by using ultrasonography while performing trigger point injections. Using a coaxial method, the needle passing through the skin and adipose tissue to penetrate the muscle was visualized. The LTR was defined as a momentary contraction of the target muscle, which was elicited by needle penetration and shown on ultrasonography ([video 1] available online at <http://www.archives-pmr.org>). Simultaneously, the other clinician visually inspected the number of LTRs. The 2 clinicians discussed the presence of an LTR immediately after each needling. Then LTRs were elicited by using multiple needle insertions. The needle was withdrawn from the subcutaneous tissue layer, but not completely out of the skin, and inserted into the MTrP region of muscle. Repeated needling was performed to different loci in that region to elicit as many LTRs as possible. If no LTR was observed after 10 attempts, needling was stopped in that patient. After that, a drop of 0.5% lidocaine was injected to reduce postneedling soreness. The injection site was pressed to ensure proper homeostasis after the procedure. The entire procedure was filmed using the ultrasound machine.

### Assessment of the Effectiveness of Trigger Point Injection

In each patient, subjective pain intensity was assessed before and immediately after performing trigger point injection. Pain intensity was described by the patient on a visual analog scale (VAS) of 0 to 10, for which 0 signified no pain and 10 signified the most severe pain ever experienced.

### Statistical Analysis

A generalized logit model was used to investigate whether there was an advantage of ultrasonographic detection of LTRs in the lower-back muscles compared with the upper-trapezius muscles. This method also was used to investigate the effect of muscle depth on the sensitivity of ultrasonographic detection of LTRs. For estimating parameters of the generalized logit model, weighted least squares and generalized estimating equation methods were applied considering repeated measurements of ultrasonographic and visual inspections for each patient.

VAS results were compared between the LTR-positive and LTR-negative groups before and after trigger point injections by using a mixed model for both the lower-back and upper-trapezius muscles. This model included the main effects of time and group, as well as the interaction of these factors. For significant interactions, a post hoc test was performed to examine differences in functional parameters.

Statistical calculations and analyses were performed using SAS<sup>b</sup> software (version 9.1.3), and  $P < .05$  was considered significant.

## RESULTS

All LTRs in the upper-trapezius muscles were detected by using both ultrasonographic and visual inspections. In the lower-

**Table 1: Detection of LTRs in Lower-Back and Upper-Trapezius Muscles Using Ultrasonographic and Visual Inspection**

	Low Back (n=1004)	Upper Trapezius (n=548)
U(-) V(-)	653	383
U(+) V(-)	196	0
U(-) V(+)	0	0
U(+) V(+)	155	165

Abbreviations: (-), negative; (+), positive; U, ultrasonographic detection; V, visual detection.

back muscles, needlings were performed 1004 times, and 196 LTRs were detected by using only ultrasonography (table 1). The ultrasonographic detection rate of LTRs for the lower-back muscles was significantly higher than that for the upper-trapezius muscles (odds ratio [OR], 1.26; 95% confidence interval [CI], 1.22–1.30;  $P < .001$ ).

All LTRs were observed at a depth of less than 2cm in the upper-trapezius muscles, but at various depths in the lower-back muscles, ranging from less than 2 to more than 3cm. To analyze whether the LTR detection rate differed according to MTrP depth, the depth of MTrPs in the lower-back muscles was classified as 2cm or less, 2 to 3cm or less; and greater than 3cm.

In the lower-back muscles, the ultrasonographic detection rate was higher in 2- to 3-cm deep MTrPs (OR, 4.77; 95% CI, 2.08–10.93;  $P < .001$ ) and greater than 3cm (OR, 5.05; 95% CI, 2.11–12.08;  $P < .001$ ) compared with the group with depth less than 2cm (table 2). In analysis of all LTRs for both the upper-trapezius and lower-back muscles, the ultrasonographic detection rate significantly increased in deeply located compared with superficial muscles (OR, 3.01; 95% CI, 2.40–3.77;  $P < .001$ ).

To analyze whether the therapeutic efficacy of trigger point injection differed according to the presence of LTRs during needling, VAS values were compared between the LTR-positive and LTR-negative groups before and after injection in both the lower-back and upper-trapezius muscles. There was a significant difference in VAS scores after injection ( $P < .001$  for both the lower-back and upper-trapezius muscles), but not before injection ( $P = .26$  for the lower-back muscle,  $P = .98$  for the upper-trapezius muscle) between the LTR-positive and LTR-negative groups. Pain alleviation shown by using the VAS was more significant in the LTR-positive group than the LTR-negative group after injection (table 3) ( $P < .001$  for both lower-back and upper-trapezius muscles).

## DISCUSSION

In the upper-trapezius muscles, all LTRs, if present, were detected by using both ultrasonographic and visual inspection.

**Table 3: Comparison of VAS Scores Between LTR-Positive and LTR-Negative Groups Before and After Trigger Point Injection**

	Pre VAS Score	Post VAS Score
Lower back		
LTR (+)	7.70 ± .16	2.91 ± .15*†
LTR (-)	7.33 ± .29	5.13 ± .27
Upper trapezius		
LTR (+)	7.61 ± .21	2.65 ± .20*†
LTR (-)	7.60 ± .38	5.50 ± .36

NOTE. Values are estimated as least square means ± SEs. Analyzed by using a mixed model with post hoc test.

Abbreviations: (-), negative; (+), positive.

\* $P < .001$ , comparison of post VAS score between LTR(+) and LTR(-) groups.

† $P < .001$ , comparison of interactions between LTR(+) and LTR(-) groups.

In the lower-back muscles, many LTRs were not detected visually, but only by using ultrasonography during trigger point injections ([video 2] available online at <http://www.archives-pmr.org>). For deeper muscles, ultrasonography was more helpful to identify LTRs that were missed by using visual assessment.

Based on the description by Simons et al,<sup>3</sup> a palpable or visible LTR on snapping palpation at the most sensitive spot in the taut band is 1 of the criteria for diagnosing active MTrPs. However, some previous studies reported that all criteria for diagnosing MTrPs are not suitable for any muscle.<sup>6</sup> Even if a taut band and its LTR cannot be palpated because of the deep location, the possibility of a clinically relevant MTrP cannot be excluded. Intra- and interexaminer reproducibility for palpating MTrPs have been poor in patients with lower-back pain.<sup>2,5,12</sup> As a result, the presence of an MTrP is still confirmed by using clinical examination, and LTRs of taut bands have been accepted as 1 of the requisites for diagnosis, especially those in deep-located lower-back muscles.<sup>3,6</sup>

The lack of a valid and reliable diagnostic procedure to confirm the presence of MTrPs limits the research in this area. Until such an objective diagnostic procedure becomes available, MTrPs will remain as only a syndrome supported by case studies and speculation. Although some electromyographic studies have shown spontaneous electrical activity localized to an MTrP,<sup>13</sup> Simons<sup>14</sup> argued that the electrical activity may result from factors not related to MTrPs. Recently, some studies reported that magnetic resonance elastography for a taut band is a potential tool for the diagnosis of MTrPs,<sup>15</sup> and sonoelastography can distinguish myofascial tissue containing MTrPs from normal myofascial

**Table 2: LTR Depth and Relationship to the Sensitivity of Ultrasonographic Detection Compared With Visual Detection in Lower-Back and Upper-Trapezius Muscles**

	Depth ≤2cm	2cm < Depth ≤3cm	3cm < Depth
Lower back			
U(+) V(-) (n=196)	9	123	64
U(+) V(+) (n=155)	37	93	25
OR (95% CI)	1 (reference)	4.77 (2.08–10.93)	5.05 (2.11–12.08)
Upper trapezius			
U(+) V(-) (n=0)	0	0	0
U(+) V(+) (n=165)	165	0	0

NOTE. Analyzed by using a generalized logit model with generalized estimating equation method for estimating parameters. Abbreviations: (-), negative; (+), positive; U, ultrasonographic detection; V, visual detection.

tissue.<sup>16</sup> However, these studies had several limitations, including a small study population and expensive devices. Moreover, it is difficult to control the amount of pressure and angle at which the ultrasound transducer head should be held to scan the tissue in the case of sonoelastography. In our experience with gray-scale ultrasound imaging, MTrPs could not be distinguished from normal muscle tissue. A previous study also failed to visualize soft-tissue changes in the region of clinically identified active MTrPs.<sup>9</sup>

In our study, we did not compare ultrasonographic images of the MTrP with those of normal muscle tissue. Instead, we investigated the value of ultrasonography for detecting LTRs within deeply located musculature. To our knowledge, this is the first study to show the usefulness of ultrasonography for detecting LTRs.

During trigger point injections, ultrasonography detected more LTRs in deeply located lower-back muscles than those identified by using visual inspection, whereas all LTRs detected by using ultrasonography also were detected by using visual inspection in the superficially located upper-trapezius muscle (see tables 1 and 2). Trigger point injection is not only a therapeutic technique for MTrPs, but also a diagnostic procedure to confirm MPS by eliciting LTRs. When an LTR is elicited during the injection, a pattern of referred pain also can be defined. Hong et al<sup>17</sup> showed that needling a sensitive locus elicited referred pain more severe than snapping palpation of the MTrP. Therefore, more sensitive detection of LTRs could facilitate the diagnosis of MPS and localization of responsive MTrPs for patients' referred pain.

Another advantage of ultrasonography is the ability to guide injection. Ultrasonography is a reliable tool that allows real-time scanning of the targeted muscle, adjacent structures, and needle advancement in the tissue. With ultrasonography, the depth of needle insertion can be controlled better during injection for even the small, deep, and less accessible muscles in the neck, chest wall, abdomen, or lower-back area. Therefore, ultrasound-guided trigger point injection into an MTrP is expected to improve injection accuracy and reduce potential inadvertent injuries made by an improperly placed needle. In a previous study,<sup>18</sup> ultrasound-guided trigger point injections were performed in the cervicothoracic musculature. The study showed that ultrasonography guidance assisted in the confirmation of proper needle placement in the target muscles and decreased the potential for a pneumothorax from unintended perforation of pleura.<sup>18</sup> In our study, we did not observe an adverse event caused by improper needle placement.

The present study also showed that pain was alleviated more significantly in the LTR-positive group than the LTR-negative group after trigger point injection in both the lower-back and upper-trapezius muscles. This finding is consistent with previous studies that showed it is essential to elicit LTRs during trigger point injections for maximal effectiveness.<sup>10,19</sup> In 1 MTrP region that was clinically identified by means of palpation with a finger, there were many small needle-head-sized loci that were sensitive to needle penetration.<sup>10</sup> Therefore, needle insertion should be performed as many times as possible in 1 MTrP region to identify responsive loci during the trigger point injection. Without detecting all LTRs, it is difficult to inactivate all responsive loci. Therefore, ultrasound-guided trigger point injection might improve therapeutic efficacy compared with blind injection, especially for the deeply located musculature.

## Study Limitations

First, LTRs could be palpated even if they were not visually detected. However, we did not compare ultrasonographic detection of LTRs with visual detection with palpation.

Second, we should have had a clear definition of LTRs on ultrasonography, although LTRs usually are obvious. Further study of the inter- and intrareliability of LTR detection on ultrasonography is required.

## CONCLUSIONS

Ultrasonography was helpful for detecting LTRs in deeper muscles that were missed on visual inspection. In addition, alleviation of pain was more significant when LTRs were elicited by using trigger point injection. These findings suggest that ultrasound-guided trigger point injection may improve the detection rate of LTRs and the therapeutic efficacy of trigger point injection for MTrPs in deeply located muscles in patients with MPS.

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#### Suppliers

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**VIDEO LEGEND**

**Video 1.** Four LTRs were observed at a depth of more than 3cm in the lower-back muscles.

**Video 2.** In the lower back muscle, the trigger point injection site was identified and marked on the skin with a plastic needle cap. Although the center of the ultrasound probe was placed at the marked point, and the needle was inserted into the assumed MTrP, the LTR was detected at the lower left corner of the sonographic field of view where it was far from the midline.