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MYOFASCIAL PAIN (R GERWIN, SECTION EDITOR)

Clinical Implication of Latent Myofascial Trigger Point

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Abstract Myofascial trigger points (MTrPs) are hyperirritable points located within a taut band of skeletal muscle or fascia, which cause referred pain, local tenderness and autonomic changes when compressed. There are fundamental differences between the effects produced by the two basic types of MTrPs (active and latent). Active trigger points (ATrPs) usually produce referred pain and tenderness. In contrast, latent trigger points (LTrPs) are foci of hyperirritability in a taut band of muscle, which are clinically associated with a local twitch response, tenderness and/or referred pain upon manual examination. LTrPs may be found in many pain-free skeletal muscles and may be "activated" and converted to ATrPs by continuous detrimental stimuli. ATrPs can be inactivated by different treatment strategies; however, they never fully disappear but rather convert to the latent form. Therefore, the diagnosis and treatment of LTrPs is important. This review highlights the clinical implication of LTrPs.

Keywords Myofascial trigger points · Latent myofascial trigger points · Active myofascial trigger points · Myofascial pain · Taut band palpation · Tenderness · Alternated muscle activation patterns · Motor dysfunction · Musculoskeletal pain · Muscle weakness · Range of motion · Muscle cramp · Muscle fatigue · Injection therapy · Dry needling · Joint manipulation · Strain/counterstrain · Ischemic compression · Massage therapy · Myofascial release therapy · Muscle energy techniques · Transverse friction · Transcutaneous electrical nerve stimulation · Ultrasound · Laser

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Introduction

Myofascial trigger points (MTrPs) are classified as either active myofascial trigger points (ATrPs) or latent myofascial trigger points (LTrPs) and are clinically significant because they cause pain and neuromuscular dysfunction [1, 2]. ATrPs produce spontaneous pain, tenderness in a taut band, familiar pain, a local twitch response when stimulated manually or with a needle, and referred pain [3]. LTrPs are minor, subclinical neuromuscular lesions, which do not cause pain except when compressed [4]. In addition, LTrPs are foci of hyperirritability in a taut muscle band, which are clinically associated with a local twitch response, tenderness and/or referred pain that is distant from the pain site upon manual examination [5]. LTrPs can become ATrPs when the stimuli that produced them persists [6].

LTrPs can be activated by prolonged and unwonted exercises, low-load repetitive muscle work, persistent stress of the muscle and prolonged ischemia.

This article aimed to summarize the clinical implication of LTrPs, including the symptoms, the assessment techniques and the treatments.

Etiology of MTrPs

The etiology of MTrPs is not well known; however, recent studies have suggested that the pathogenesis of MTrPs involves injured or overloaded muscle fibers [7], which could lead to involuntary shortening, a loss of oxygen and nutrient supply, and an increased metabolic deficiency in local tissues [2]. The most reliable etiologic theory for the pathogenesis of MTrPs is the combined hypothesis that abnormal depolarization of motor end-plates and prolonged muscle

contractions give rise to a localized "adenosine triphosphate energy crisis" that is associated with sensory and autonomic reflex arcs due to central sensitization [2, 8]. The integrated hypothesis is based on the two most widely accepted theories: the energy crisis theory and the motor end-plate theory. When combined, these theories provide a reasonable explanation for MTrPs [6]. A third theory suggests that the primary pathologic site of MTrPs is the spinal nerve, which causes secondary muscle changes [9]. The most widely accepted theory suggests that muscle cells and motor end-plates are the primary pathologic sites [10]. However, these theories remain controversial, and more research is needed.

Significance of LTrPs

Recent studies have demonstrated that LTrPs cause the following musculoskeletal problems:

- Local tenderness without referred pain and local tenderness with referred pain upon mechanical stimulation [11•]
- Restricted range of motion (ROM) [2, 12•, 13•, 14]
- Muscle weakness [4, 11•, 15]
- Muscle fatigue [15]
- Alternating muscle activation patterns [16, 17•, 18••]
- Induced muscle cramping [16, 17•, 18••]

LTrPs can be emerged by prolonged or unaccustomed exercise, low-load repetitive muscle work, acute and mechanical trauma continues stress, and prolonged ischemia due to cause mentioned musculoskeletal problems above and disability. Therefore, diagnosis and management of LTrPs are very important in the clinical settings.

Prevalence and Distribution of LTrPs

The presence of LTrPs is common in the general population [19–21]. Sola et al. found that LTrPs produced focal tenderness in shoulder girdle muscles in 54 % of female participants and in 45 % of male participants. Of these participants, 25 % exhibited referred pain [19]. The upper trapezius is the most affected muscle in the shoulder region [20, 21]. Fischer demonstrated that the upper trapezius is the most sensitive of eight different muscles (the upper trapezius, the pectoralis major, the levator scapulae, the teres major, the supraspinatus, the gluteus medius, the infraspinatus, and the paraspinals) to the pressure of an algometer [22].

Prevalence of LTrPs have been reported in two studies [23••, 24]. Lucas et al. examined 154 healthy adults for the presence of LTrPs in the scapular positioning muscles and found that approximately 90 % of the population had at least one trigger point in these muscles [23••]. In addition, Celik et al. detected LTrPs in 60.5 % of the scapular muscles (47.8 % on one side and 39.2 % on both sides) that were assessed in their study. In their study, two out of five LTrPs that they detected were found in the upper trapezius muscle [24].

The assessment of LTrPs

LTrPs have the same clinical characteristics as ATrPs; therefore, the assessment of LTrPs is similar to ATrPs. No laboratory test or imaging technique has been established to diagnose MTrPs; however, several methods are used to evaluate trigger points. These methods include thumb palpation, pressure pain threshold (PPT), intramuscular needling, surface electromyography-guided assessment, infrared thermography and laser Doppler flowmetry. Regardless of the method used, the localization of the MTrPs should first be identified and located. The assessment of MTrPs should be conducted while the patient is in a relaxed prone position on an examination table, and the upper body is exposed. Then, the subject is positioned to lengthen the muscle that will be assessed to create a perceptible increase in its resistance to movement. In this position, the normal muscle fibers remain loose, but the fibers of any taut bands or nodules are placed under additional tension, thereby rendering them more easily recognizable. Then, cross-fiber palpation should be used to detect any taut bands or nodules using "flat palpation" the examiner traps the MTrP between their fingertips and the underlying bone. However "pincer palpation", trapping the MTrP between the thumb and fingers, may be used for some of the muscles for instance the upper trapezius, pectoralis major, teres major and minor, latissimus dorsi and triceps. If a taut band or nodules are identified, the examiner continues to palpate along the taut band searching for a slightly enlarged point or the "focus" of the contraction. The testing procedure can be repeated bilaterally to ensure the accuracy of the trigger point examination [24]. To establish the presence of MTrPs [7, 21, 25], the following four criteria are used:

1. The presence of a tender spot in a taut band or nodules of skeletal muscle
2. Subject recognition of pain upon palpation of a tender spot
3. Subject referred pain pattern (pain distribution expected from a trigger point in that muscle)
4. The presence of a local twitch response (a transient local contraction of the skeletal muscle fibers in response to palpation)

Thumb Palpation

Thumb palpation of MTrPs is a reliable method of detection [25, 26]. However, Lew et al. demonstrated that the detection of MTrPs in asymptomatic subjects was poor when

thumb palpation was applied. The subjects were asked whether the MTrPs were tender when manually compressed [27]. A positive response can indicate MTrPs. In addition, the reliability of palpation in identifying trigger points depends on the level of experience of the person applying the test. The therapist should practice this technique with eyes closed and open while applying manual pressure to a weight scale to determine how much pressure is being applied to the MTrP. LTrPs are present if there is pain at a pressure of above 3.5 kg/cm^2 [20].

Pressure Pain Threshold (PPT)

MTrPs can be identified using an electronic digital algometer to determine the PPT. The algometer consists of a flat, circular, rubber disk with a 1.0 cm^2 surface. The disk connects to a pressure pole, which is inserted into a gauge that records pressure in kilograms, and the pressure measurements are expressed as kg/cm^2. The pressure values range from 0–10 kg/cm^2, and the values are recorded per 0.1 kg. The assessor applies continuous pressure at a rate of approximately 1.0 kg/cm^2/s perpendicularly to the local LTrP until the algometer records a value. Pressure thresholds indicate the presence of LTrPs at the upper trapezius and scapular muscles. If the PPT was less than that of "normal" muscle tissue it can be considered as LTrP. The reliability of pressure algometry has been found to be high in the same day [intraclass correlation coefficient=0.91 (95 % confidence interval (CI), 0.82–0.97)] [28]. Gerwin et al. found good interexaminer reliability of the PPT (κ=0.84–0.88) [7].

Intramuscular Needle Electromyography (EMG)

Intramuscular needle EMG is a technique for evaluating and recording the electrical activity produced by ATrPs and LTrPs [29]. An EMG needle is inserted intramuscularly into the MTrPs to detect spontaneous electrical activity. Rabbit and human studies have demonstrated the presence of spontaneous low-voltage motor end-plate noise and high-voltage spike activity, which are highly characteristic of MTrPs but not pathognomonic [29]. Hubbard et al. reported that high-amplitude spike potentials are characteristic of trigger points [30]. Intramuscular needle electromyography has high selectivity for individual motor unit action potentials and is used to measure motor unit activity. Ibarra et al. observed high intramuscular electric activity in LTrPs of the posterior deltoid muscle [31]. In an EMG analysis, Xu et al. reported that painful stimulation of LTrPs can initiate widespread central sensitization and muscle cramps contribute to the induction of local and referred pain [17•]. Intramuscular needle EMG may not be used because of patient discomfort.

Surface Electromyography (sEMG)

sEMG can be used to assess LTrPs [15, 16, 18••]. This technique is more comfortable and more easily tolerated by patients compared with needle EMG; however, the spike activity that is characteristic of myofascial trigger points may not be as clearly detected as needle EMG [3].

Infrared Thermography (IRT)

Thermographic imaging uses point estimates to describe the temperature of body regions. IRT is a useful tool for assessing skin temperature abnormalities in pathologies, such as complex regional pain syndrome, because this method is noncontact and noninvasive. However, it is difficult to identify painful areas of the body using this method because of the limitations of currently available specific tests. IRT is a useful method to objectively visualize a functional abnormality; therefore, several authors have used this method to diagnose LTrPs [3, 32].

Laser Doppler Flowmetry (LDF)

The temperature and blood flow in patients with MTrPs can be altered [3]. These alterations can be measured using laser Doppler flowmetry, which provides a simple, noninvasive, real-time measurement of local blood flow. LDF is an accurate and reliable method for assessing microcirculatory function [32].

Treatments for LTrPs

Many treatments are available for LTrPs and can be divided into invasive and noninvasive techniques.

Invasive techniques include trigger point injections and dry needling. Various injectable substances have been investigated, including local anesthetics (procaine and lidocaine), isotonic saline, anti-inflammatory agents, vitamin B_{12}, corticosteroids and Botox. The effectiveness of these injections has been demonstrated for MTrPs [4, 33–35]. However, there is no study in the literature to investigate the effectiveness of injections for LTrPs. Dry needling can be applied deep into the muscle or superficially to release muscle tension [36, 37]. There are no studies in the literature that support the use of EMG needling for LTrPs; however, Lucas et al. suggested that superficial dry needling, followed by post-isometric relaxation stretching, reduces the clinical signs of LTrPs from scapular rotator muscles and normalizes muscle activation patterns in LTrP subjects after post-fatigue [18••].

Noninvasive techniques include manual therapy techniques and electrotherapy modalities. Manual therapy techniques for the treatment of myofascial trigger points include

joint manipulation, strain/counterstrain, ischemic compression and pressure, massage therapy, myofascial release therapy, muscle energy techniques, point pressure release and transverse friction massage [12•, 26, 38, 39]. However, only four manual therapy techniques for the treatment of LTrPs have been found in the literature.

Joint Manipulation

Preliminary evidence suggests that thrust manipulation can provoke a hypoalgesic effect in LTrPs that are located in muscles innervated by the same segment [40, 41•]. Oliveira-Campelo et al. found that the application of an atlanto-occipital thrust manipulation technique targeted to the suboccipital muscle led to an immediate increase in the pressure pain threshold of LTrPs in the masseter and temporalis muscles and an increase in the maximum active mouth opening [41•]. Ruiz-Saez et al. suggested that cervical spine manipulation applied at the C3 segment through the C4 segment induced pressure sensitivity changes in LTrPs of the upper trapezius muscle. Therefore, cervical spine manipulation is effective for relieving pain due to LTrPs [40].

Strain/Counterstrain (SCS)

SCS is a positional release technique developed by Jones in 1981, which is based on the specific positioning of a patient and the affected muscular region to reduce the sensitivity of tender points [42]. Dardzinski et al. reported that this technique may be helpful in reducing pain and improving function in patients with localized muscle pain [43]. Atienza-Meseguer et al. have demonstrated that the SCS technique was effective at reducing mechanical pain sensitivity in tender points within the upper trapezius muscle [44]. Rodriguez-Blanco et al. were the first to demonstrate that the SCS technique, in addition to exercise, is effective at improving active mouth opening when applied to LTrPs in the masseter muscle [45]. In addition, Ibanez-Garcia et al. reported isolated effects of the SCS technique in the management of active mouth opening, and the results were similar to those obtained by Rodriguez-Blanco et al. [45, 46].

Ischemic Compression

The therapeutic mechanisms of pressure treatments and ischemic compression are based on equalizing the length of sarcomeres and reactivating hyperemia in the MTrP region. In addition, a spinal reflex mechanism relieves muscle spasms [10]. There is no consensus on the necessary amount of pressure to apply during pressure techniques. Pressure is sustained until the clinician feels a release of the underlying tissues, which usually occurs within 60 s. Recent studies have demonstrated that the time duration can range from 60–90 s [13•]. Several studies have found that the ischemic compression technique is effective at decreasing pressure pain sensitivity in LTrPs [38, 47] and in ATrPs [26]. These studies have reported changes in the range of motion of the affected tissue after the LTrPs were treated. Aguilera et al. found that ischemic compression improves active ROM, the basal electrical activity of the trapezius muscles and the pain threshold of LTrPs [13•].

Transverse Friction Massage

Transverse friction massage is a deep tissue technique that is performed at the site of the MTrP. Soft tissue is remodeled to improve flexibility and functionality. Hong et al. hypothesized that deep massage can offer effective stretching and mobilization of taut bands [48]. Therefore, transverse friction massage may provide useful transverse mobilization to the taut band. Fernandez-de-las-Penas et al. suggested that transverse friction massage is effective at decreasing tenderness due to active and latent trigger points [26]. In addition, Trampas et al. applied nonpainful cross-fiber friction massage with slowly increased pressure and stretching exercises and reported significant improvements in ROM and PPT [12•].

Post Isometric Relaxation

Post-isometric relaxation is directed toward the relaxation of hypertonic muscles, especially with MTrP involvement [49, 50]. As described by Lewit et al., the hypertonic muscle is stretched to the point where an increase in resistance is observed [50]. Then, the subject performs an isometric contraction of the stretched muscle for 5–10 s. At the end of each contraction, stretching is passively increased by the therapist until a new increase in resistance is observed [50]. Rodríguez-Blanco et al. used this technique to treat temporomandibular dysfunction and found that the mouth opening increased after the technique was applied. Therefore, the post-isometric relaxation technique can be used to treat LTrPs in the masseter muscle [45].

Electrotherapy Modalities

Most of the research on LTrPs has focused on using electrotherapy modalities for pain management, such as ultrasound and TENS.

Transcutaneous Electrical Nerve Stimulation (TENS)

TENS is an effective treatment option for relieving pain caused by different disorders. The effectiveness of TENS for the treatment of active and latent trigger points has not been established; therefore, TENS has not been accepted as

a specific treatment modality [51]. However, many studies have investigated the effectiveness of traditional TENS on trigger point pain [52, 53]. A recent systematic review found moderate evidence that TENS is effective at providing immediate relief of pain caused by MTrPs. Only two studies in the literature have reported the effectiveness of TENS for the treatment of LTrPs [54•, 55•]. Gemmell et al. first used TENS to treat latent trigger points in the upper trapezius. The results were unsatisfactory because the ROM did not increase; however, better outcomes were observed for TENS compared with a placebo [54•]. Rodríguez-Fernández et al. used burst-type TENS and concluded that 10 minutes of this technique slightly improved the referred pressure pain threshold of upper trapezius LTrPs and increased ipsilateral ROM [55•].

Ultrasound

Several studies have reported satisfactory results from using ultrasound to treat ATrPs [56, 57]. However, few studies have demonstrated the effectiveness of ultrasound for the treatment of LTrPs [13•, 58•]. Only Aguilare et al. demonstrated that intermittent ultrasound treatment was more effective than sham ultrasound at decreasing the basal electrical activity and the pain threshold of upper trapezius LTrPs [13•]. Additionally, Sarrafzadeh et al. compared pulsed ultrasound and phonophoresis with hydrocortisone for the treatment of LTrPs in the upper trapezius [58•]. They found that phonophoresis with hydrocortisone was more effective than pulse ultrasound at reducing pain intensity.

Laser

There is substantive evidence (level A) that laser therapy is an effective treatment for ATrPs [59]. However, no study has demonstrated the effectiveness of laser treatments for LTrPs.

Conclusion

LTrPs cause ROM limitations, pain, motor dysfunction, muscle cramps, muscle fatigue, altered muscle activation patterns, and local tenderness. The diagnosis of LTrPs is important, and detecting the PPT with an algometer is the most useful diagnostic technique. This method is reliable, affordable and easy to perform. In the literature, treatments for MTrPs have usually focused on ATrPs. Therefore, the treatment of LTrPs is usually based on that for ATrPs. Evidence-based practices have demonstrated that cervical spine manipulation, strain-counterstrain, ischemic compression, transverse friction massage, post-isometric relaxation, TENS and ultrasound are effective treatments for LTrPs.

Compliance with Ethics Guidelines

Conflict of Interest Dr. Derya Celik reported no potential conflicts of interest relevant to this article.

Dr. Ebru Kaya Mutlu reported no potential conflicts of interest relevant to this article.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- •• Of major importance

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