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The Basic Unit of a Myofascial Trigger Point

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This report summarized recent studies on the basic structures of a myofascial trigger point (MTrP). A MTrP is a hyperirritable spot in a palpable taut band of skeletal muscle fibers. Spot tenderness, recognized pain, and taut band are now demonstrated to be reliable diagnostic criteria of an MTrP. Referred pain (ReP) or local twitch response (LTR) is a confirmatory sign of MTrP. There are multiple loci in an MTrP region. The basic unit of an MTrP is the MTrP locus which contains a sensory component (the sensitive locus) and a motor component (the active locus). A sensitive locus is the site from where a local pain, an ReP, or an LTR can be elicited by needle stimulation to that site. The sensitive loci are probably sensitized nerve fibers (nociceptors). They are widely distributed in the whole muscle, but concentrated in the MTrP region. Recent electrophysiological studies on both human and rabbit skeletal muscles suggested that both ReP and LTR are related to the spinal cord mechanism. An active locus is the site from where spontaneous electrical activity (SEA) can be recorded. SEA is abnormal endplate potentials due to excessive release of acetylcholine, which may cause the formation of a taut band. Recent histological studies have demonstrated a nerve fiber at the vicinity of a sensitive locus or an active locus in rabbit skeletal muscle. The pathogenesis of MTrPs is probably related to integrative mechanisms in the spinal cord in response to sensitized nerve fibers associated with abnormal endplates. (J Rehab Med Assoc ROC 1998; 26(4): 161 – 168)

Key words: electrophysiology, injection, muscle, pain, trigger points

INTRODUCTION

Myofascial trigger point (MTrP) is a common cause of muscle pain syndrome[1,2]. MTrP has been defined as a highly localized and hyperirritable spot in a palpable taut band of skeletal muscle fibers[3-6]. MTrPs can be associated with other neuromusculoskeletal disorders,[1,7-10] and can be perpetuated or aggravated by some medical conditions (perpetuating factors)[5,11-13]. The diagnostic criteria of a MTrP are now considered as 1). “spot tenderness” (in a well-defined site), 2). “pain recognition” (reproduction or aggravation of patient’s usual complaints), and 3) “taut band” (containing the tender spot, MTrP)[14,15]. “Referred pain” and “local twitch response (LTR)” are confirmatory signs of the MTrP. Based on recent research studies, mainly electro-physiological, on both human and animal subjects,

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the pathophysiology of a MTrP is now much clearer[1,2,14]. This review article is to discuss the basic components of a MTrP based on the current research studies.

MULTIPLE LOCI THEORY

Hong developed a hypothesis of multiple sensitive loci in an MTrP region based on the clinical observation during MTrP injection[7,8]. This hypothesis has now been confirmed by the studies on both human and animal [1,2,14,16-24]. In the animal studies, myofascial trigger spots (MTrS), with similar characteristics as in human MTrPs, can be identified in palpable taut bands of rabbit skeletal muscle[23,24].

During MTrP injection, the needle should be inserted into multiple sites in the entire MTrP region in order to eliminate pain and tightness[5]. Sharp pain, and sometimes referred pain (with the same patterns described by Travell and Simons[5,6]), can be elicited when the needle tip encounters certain sites in the MTrP region. When more and more of these sites are "stimulated" by the needle, the pain from the MTrP may be better released after injection. Hong has developed a new technique of MTrP injection by moving the needle quickly during multiple insertions in order to reduce the time required to inject an MTrP and to reduce the muscle tissue damage from the side movement of the needle[7,8]. By using this "fast-in, fast-out" technique, an LTR can be elicited each time the needle tip encounters a sensitive locus of the MTrP region[7,8,16,25]. When an LTR is elicited during MTrP injection, it is always associated with a sharp pain or discomfort and frequently associated with a ReP with patterns similar to that elicited by snapping palpation of the MTrP[7,8]. It is essential to elicit LTRs during an MTrP injection to obtain the immediate and complete pain relief[16]. Hong has defined these sites (LTRs can be elicited when these sites are mechanically stimulated by a needle tip) as "sensitive locus"[7,8]. These sensitive loci (LTR loci) are the sites from which pain, referred pain, and LTR can be elicited.

Recent human and rabbit studies have demonstrated that spontaneous electrical activity (SEA) can be recorded from multiple minute sites in a MTrP (human) or a MTrS (rabbit) region[18-21]. These SEA loci have been considered as dysfunctional endplates ("motor structures"), and they are defined as active loci to distinguish them from the sensitive loci which are "sensory structures". During the search for SEA, either SEAs or LTRs, or both, could be observed at different sites in a MTrP region[20,21]. Both SEA and LTR are usually associated with a sharp pain sensation that is similar to the patient's usual complaint. Therefore a sensitive locus is probably in the immediate vicinity of an active locus, and both structures together may form a **MTrP locus**, a basic unit of MTrP (Fig. 1).

NATURE OF SENSITIVE LOCI (LTR LOCI)

A sensitive locus is the sensory component of the MTrP locus. A recent primitive histological study has demonstrated a sensory nerve fiber near the LTR locus[26]. Therefore, it is very likely that the sensitive locus (LTR locus) is a sensitized nociceptor (or sensitized nociceptors). These sensitive loci are widely distributed in the whole muscle, but more concentrated in the endplate zone based on clinical observation during MTrP injection and an algometer study[27]. In that algometer study, referred pain could also be elicited by stimulating on the non-MTrP sites, even in the normal muscle tissues. An animal study on the rat biceps femoris muscles (mapping LTR loci) has also supported that[28].

Recent studies have demonstrated the evidences of spinal cord integration for either referred pain or LTR[23,24,29-36]. When the stimuli from nociceptors in an original receptive field persists (pain from an active MTrP), central sensitization in the spinal cord may develop and the receptive field corresponding to the original dorsal horn neuron may be expanded (referred pain)[31-37]. Therefore, new MTrPs, or "satellite MTrPs" [5,6], may develop in the referred zone of the original MTrP. The spread of MTrPs to other sites (referred zone) is basically due to central sensitization of the sensitive loci (LTR loci). Injection (mechanical stimulation to the sensitive loci) into a key MTrP (original MTrP) may suppress both the original and the satellite MTrPs through the spinal mechanism[7,8,38]. A high pressure is required to hit the sensitive loci in order to inactivate an MTrP through the spinal cord integration. Both referred pain and LTRs can be elicited more frequently by needling

than by palpation[17].

NATURE OF ACTIVELOCI (SEA LOCI)

An active locus is the motor component of the MTrP locus. Spontaneous electrical activity recorded from an active locus consists of continuous low-amplitude action potentials (10-50 microvolts, occasionally up to 80 microvolts). Intermittent spike activity (100-600 microvolts, biphasic, initially negative), accompanied with SEA, can be recorded only from active MTrPs but not from latent MTrPs. Simons et al found that SEA could be recorded more often in an MTrP region (which was always in the endplate zone) than in a non-MTrP control site[20,21]. In an animal study by Simons et al, a similar result was also obtained[19]. Wiederholt has described an electrical activity similar to SEA in a study on rabbit skeletal muscle and he confirmed this activity as "endplate noise" based on histological and pharmacological studies[39]. However, Liley[40] confirmed these electrical potentials (SEA) as abnormal endplate potentials by applying mechanical stimuli to the endpalte region to convert the normal (discrete negative monophasic) endplate potentials into abnormal continuous noise-like action potentials (similar to the SEA). Ito et al [41] also demonstrated this abnormal endplate potentials as a consequence of excessive release of acetylcholine (ACh) packets. It has been now accepted that SEA are abnormal endplate potentials recorded from dysfunction of endplates [1,2,14,42-44]. Taut bands are probably formed as persistent contracture (a state of muscle contractile activity without EMG activity) of muscle fibers due to excessive ACh leakage in the active loci [14,42,43]. Unlike sensitive loci, active loci are not influenced by the spinal cord activity dierectly [45].

In a more recent histological study on rabbit skeletal muscle [46], it was found that small nerve fibers (probably nociceptive nerve endings) were in the vicinity of SEA loci. This result is similar to that found in an earlier histological study of a type of "insertion activity" (morphologically similar to SEA) [47]. Therefore the active locus in a MTrS region is probably related to nociceptors. The activity of active loci is also related to

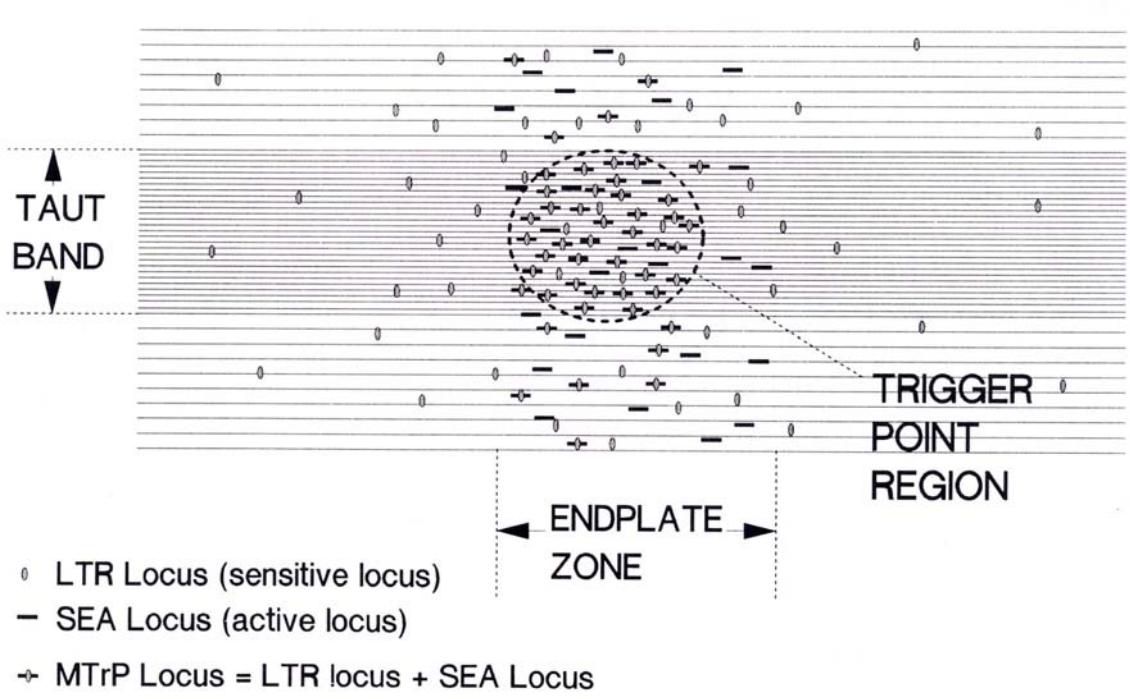

Fig. 1. Sensitive loci and active loci around a myofascial trigger point region.

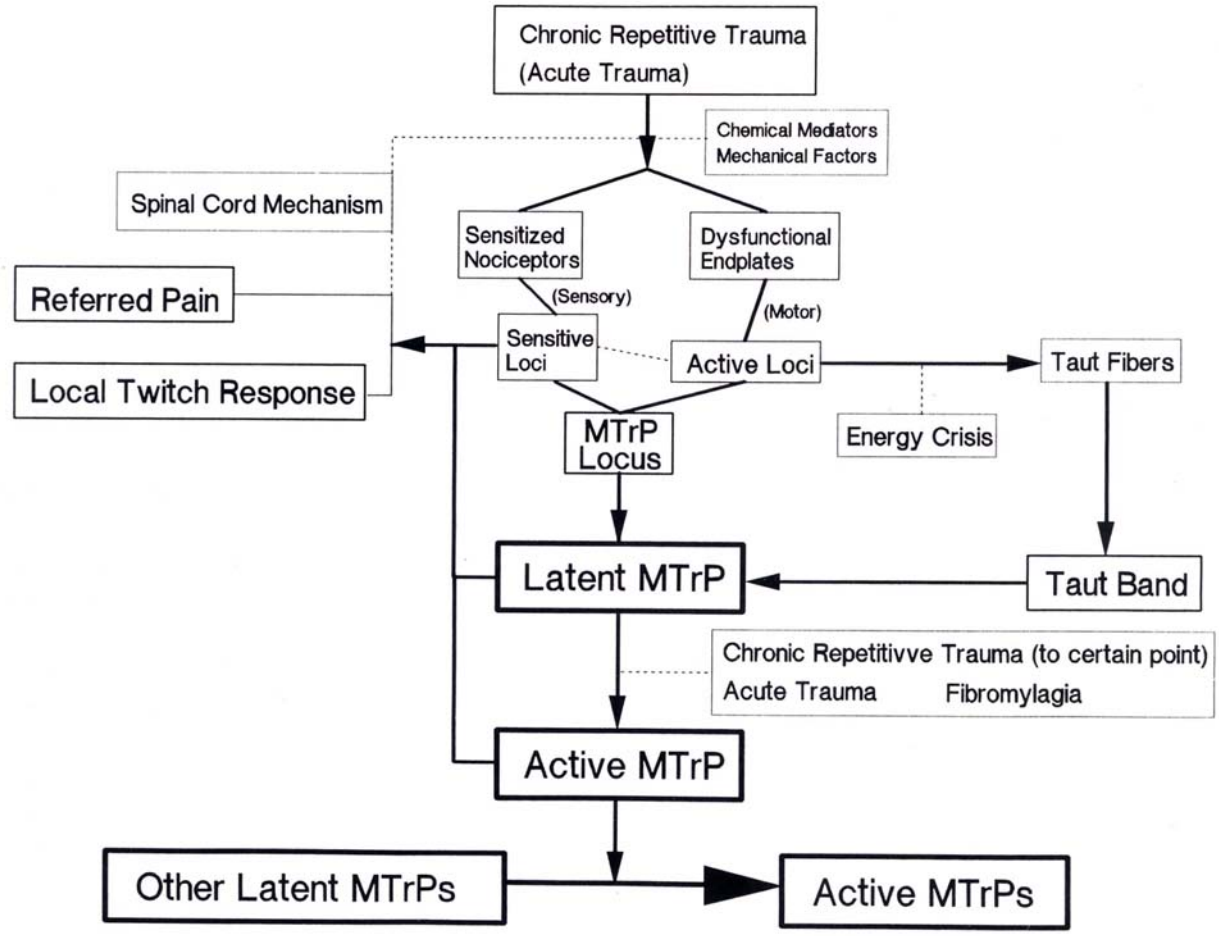

Fig. 2. Pathogenesis of myofascial trigger points.

autonomic nervous system [48-50].

FORMATION OF MTrP LOCI

The sensitive loci are widely distributed in the entire muscle with a tendency to accumulate more in the endplate zone[27,28], but the active loci are found only in the endplate zone [19-21]. Sensitive loci are nonspecific pain sites, and are not necessary found at the MTrP region. Only when the sensitive loci accumulated at the vicinity of active loci, an MTrP can be formed. Therefore, in the pathophysiological sense, an MTrP is better defined by the existence of active loci rather than sensitive loci. The sensitive loci not accompanied with active loci are probably non-specific sensitized nociceptors not related to the taut band. They can be caused by other factors such as local trauma or inflammation. On the other hand, active loci can be found only in the taut band (or precursor of taut band), and the taut band should contains active loci, although taut band may contains no MTrP. Therefore, the most important diagnostic criteria of MTrP should include "taut band". The "LTR" and "referred pain" are not essential.

PATHOGENESIS OF MTrPs

The pathogenesis of MTrPs is probably related to integrative mechanisms in the spinal cord in response to sensitized nerve fibers associated with abnormal endplates (Fig. 2) [1,2]. It is still unclear whether an active

locus forms prior to the development of a sensitive locus, or vice versa. A nociceptive nerve ending may be sensitized by excessive ACh leakage. On the other hand, a sensitized nociceptor may also induce excessive ACh leakage. Simons [14] has suggested that the taut band is the necessary precursor to the development of MTrPs, since taut bands can also be found in the pain-free muscles [51,52]. However, pain-free muscle may be tender. The degree of pain or tenderness is probably related to the amount of sensitized nociceptors [1]. Therefore, a pain-free muscle may still contain sensitive loci. In a normal muscle, different degree of tenderness can be found at different sits of the muscle. In our opinion, this "chicken-egg" puzzle is still unresolved.

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肌筋膜引痛點的基本單元

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本文總結最近關於肌筋膜引痛點的研究。肌筋膜引痛點是位於骨骼肌肉上可觸摸的緊繃肌帶中的過度敏感小點。觸痛點、固定型式的疼痛、及緊繃肌帶目前已被用來做爲肌筋膜引痛點的可靠診斷標準，而引傳痛與局部抽搐反應則是肌筋膜引痛點的確認病徵。每個肌筋膜引痛點區域內含有多個小點，這些肌筋膜引痛小點就是構成肌筋膜引痛點的基本單元，它們都包含有感覺部分(感覺小點 sensitive locus)與運動部分(活動小點 active locus)。感覺小點的所在就是經由針刺激而能產生局部疼痛、引傳痛與局部抽搐反應的部位，感覺小點很可能就是敏感化的神經纖維(疼痛感受器)。它們廣泛地分佈於肌肉當中，但多集中在肌筋膜引痛點區域裡。近年來在人類與兔子的骨骼肌上所做的電生理學研究顯示，引傳痛與局部抽搐反應兩者皆和脊髓整合機制有關聯。活動小點就是自發性電位活動(spontaneous electrical activity; SEA)可以被紀錄到的地方，自發性電位活動是一種終末板不正常的電位，可能來自於過度的釋放乙醯膽素(acetylcholine)，並且會導致緊繃肌帶的產生。最近的組織學研究顯示，在兔子骨骼肌中的感覺小點或活動小點附近可以找到神經纖維的存在。肌筋膜引痛點的病理機轉可能與激化的神經纖維和不正常的終末板有關，再經由脊髓的整合機制產生而成。（中華復健醫誌 1998; 26(4): 161 - 168）

關鍵詞：電生理學(electrophysiology)，注射(injection)，肌肉(muscle)，疼痛(pain)，引痛點(trigger points)

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