Myofascial Trigger Points: Pathophysiology and Correlation with Acupuncture Points

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Summary

A review is made of recent studies on myofascial trigger points (MTrP) and their mechanism is discussed. Clinical and basic science studies have shown that there are multiple MTrP loci in a MTrP region. A MTrP locus contains a sensory component (sensitive locus) and a motor component (active locus). A sensitive locus is a point from which tenderness or pain, referred pain, and local twitch response can be elicited by mechanical stimulation. Sensitive loci (probably sensitised nociceptors) are widely distributed in the whole muscle, but are concentrated in the endplate zone. An active locus is a site from which spontaneous electrical activity can be recorded. Active loci appear to be dysfunctional endplates since spontaneous electrical activity is essentially the same as the electrical activity reported by neurophysiologists as that recorded from an abnormal endplate. A MTrP is always found in a taut band which is histologically related to contraction knots caused by excessive release of acetylcholine in abnormal endplates. Both referred pain and local twitch response are mediated through spinal cord mechanisms, as demonstrated in both human and animal studies.

The pathogenesis of MTrPs appears to be related to integration in the spinal cord of response to the disturbance of nerve endings and abnormal contractile mechanism at multiple dysfunctional endplates. There are many similarities between MTrPs and acupuncture points including their location and distribution, pain and referred pain patterns, local twitch responses (de qi), and possible spinal cord mechanism.

Key words

Acupuncture, Muscle Pain, Myofascial trigger points; Pain Mechanism.

Introduction

The myofascial trigger point (MTrP) has been defined as a highly localised and hyper-irritable spot in a palpable taut band of skeletal muscle fibres *(1-5)*. Important characteristics of a MTrP include local pain or tenderness, referred pain or referred tenderness, and local twitch response. Trigger point injection or dry needling of the MTrP appears to provide immediate relief of pain related to that MTrP *(3-22)*. It has been suggested that MTrPs are identical to some acupuncture points *(6,7)*, and that the mechanism of MTrP injection is the same as acupuncture *(6,7,14,15,23)*. The scientific basis for either MTrP injection or acupuncture is still unclear, although there is a body of evidence relating response in both cases to neuro-transmitter and neuro-hormone release, notably that of the endogenous opioids *(24,25)*.

Clinical

There has been a fairly general agreement *(3-5,26-34)* on the following common clinical characteristics of MTrPs:

i. Compression may elicit local pain or referred pain that is similar to the patient's usual clinical complaint (pain recognition), or may aggravate the existing pain.

ii. Snapping palpation (rapid compression across the muscle fibres) may elicit a local twitch response (LTR) which is a brisk contraction of the muscle fibres in or around the taut band. Rapid needling of the MTrP can also elicit a LTR.

iii. Restricted range of stretch, and increased sensitivity to stretch, of muscle fibers in a taut band may cause tightness of the involved muscle.

iv. The muscle with a MTrP may be weak due to pain, but usually no significant atrophy can be noticed. This may be due to a natural *waxing and waning* of the MTrP.

v. There may be associated autonomic phenomena including vasoconstriction, pilomotor response, ptosis, and hyper-secretion.

vi. An active MTrP is one with spontaneous pain

or pain in response to movement, while a latent MTrP is a sensitive spot with pain or discomfort only elicited in response to compression.

Pathophysiology

In the last 10-15 years, much clinical and basic science research into MTrPs has been published, including epidemiological, diagnostic, therapeutic, and pathophysiological studies. The development of an animal model *(35)* has facilitated further understanding so that the pathophysiology of a MTrP is now much clearer *(5,23,36-38)*. Clarification of the mechanism should be of help in treating MTrPs more appropriately and efficiently.

Animal model

In rabbit skeletal muscle, taut bands similar to that in human muscle can be identified by finger palpation. When a sensitive site in the palpable taut band is squeezed or compressed, the rabbit acts by screaming, kicking, or withdrawing as if it has suffered pain or discomfort. This behaviour is not observed when other sites are similarly irritated. When the sensitive site is stimulated mechanically with a needle or by snapping or tapping with a blunt metal probe, LTRs can be observed; these are elicited much more easily at the sensitive spot than other sites in the same muscle. This hyper-irritable spot has been defined as a myofascial trigger spot, similar to the human MTrP. Rabbit LTRs are similar to human LTRs, both in the characteristics of visible muscle twitching and in electromyographic (EMG) recording. Both human and rabbit LTRs are elicited by mechanical stimulation of the sensitive spot, but not of any other spot, even one closely adjacent. Both rabbit and human LTRs are diminished after repeated mechanical stimulation of the same sensitive spot or after transmission blockade of the innervating nerve *(35,39-41)*. Spontaneous electrical activity can be recorded from a minute locus of either a MTrP region *(42)* or a rabbit myofascial trigger spot *(43)*.

Multiple Loci

Travell and Simons *(3)* have suggested that, during clinical MTrP injection, the needle should be inserted into multiple sites over the entire region in order to eliminate tenderness in the whole MTrP region. When the needle tip encounters a sensitive locus, the patient may feel sharp pain, paraesthesia, or discomfort. The patient may also feel a referred pain with distribution patterns similar to that induced by finger-compression of the same MTrP *(44)*. If the needle is moved rapidly (strong stimulation of a sensitive locus), a brief contraction of muscle fibres (LTR) can be elicited *(14-16,21,22,45)*. When a LTR is produced during MTrP injection, it is always associated with sharp pain, paraesthesia, or discomfort, which may be quite severe. Based on these observations, a model of multiple small sensitive loci in a MTrP region has been proposed *(14,15)*.

Spinal cord mechanism

A *sensitive locus* is the site from which pain, referred pain, and LTR can be elicited by mechanical stimulation, especially needling *(14-16,23)*. Pain referred from muscle to muscle following noxious stimulation of the sensitive loci in a MTrP region is possibly due to central sensitisation in the spinal cord *(46-49)*. The EMG activity of a LTR can be recorded specifically from the muscle fibres of the taut band and in response to stimulation of its MTrP *(39,41)*. This has also been confirmed in an animal study *(35)*. The EMG activity of an LTR is diminished in the denervated muscle of a human subject *(50)* and in rabbit muscle after *lignocaine* block or transection of the innervating nerve *(35,40)*. In a rabbit study, this activity disappeared temporarily during the spinal shock period after spinal cord transection, but almost completely recovered later *(40)*. Therefore, like the mechanism of referred pain, the LTR is also mediated through the spinal cord, and it appears that sensitive loci in a MTrP region are closely related to spinal cord integration.

In a histological study of sensitive loci in rabbit skeletal muscle, a small nerve fibre was commonly found near the sensitive locus *(51)*. Therefore, the sensitive loci in the region of a muscle trigger spot are probably related to sensitised nerve fibres (nociceptors).

Referred pain can be elicited by stimulating sites outside a MTrP region *(52)*; however, it can be induced much more easily within an active MTrP region than at a latent MTrP or in normal muscle tissue, which are less irritable sites containing less sensitive loci *(53)*. Theoretically, referred pain can be elicited by sufficiently intense stimulation at any site containing nociceptors, but greater stimulation is required at a less sensitive site than at an active MTrP *(54)*. When pressure from an algometer is used to measure the referred pain threshold at a less sensitive site, the pain tolerance level may be

reached before referred pain is induced *(52,53)*. Sensitive loci are distributed throughout the whole muscle, but are highly concentrated in a MTrP region *(54)*. Similar findings mapping the sensitive loci have been confirmed in an animal study on rat biceps femoris muscle *(55)*.

Abnormal endplates

Hubbard and Berkoff first reported that spontaneous electrical activity (SEA) could be recorded from a MTrP region. SEA consists of continuous, low-amplitude, noise-like action potentials (10-50 microvolts, occasionally up to 80 microvolts). It may be accompanied by intermittent large-amplitude spikes (100-600 microvolts, biphasic, initially negative), especially from a more active MTrP *(36,42,43,56-59)*. The site from which SEA can be recorded is now defined as an *active focus*. In previous physiological studies on animals, electrical activity similar to SEA was recorded in the endplate zone when the endplate was irritated either mechanically or biochemically. This activity was shown to be a consequence of excessive acetylcholine release *(60-62)*.

In rabbit skeletal muscle active loci were found mainly in the endplate zone *(43)*, and there were more in a MTrP region than at other sites such as: a taut band without MTrP, or normal muscle tissue. Recent animal studies with intra-arterial infusion of neuromuscular or calcium blocking agents have further confirmed that active loci have abnormal endplate potentials *(63,64)*. However, based on a single fibre EMG study,' the abnormal endplate activity did not cause a neuromuscular transmission defect in the endplate itself *(65)*. SEA was not directly related to spinal cord activity, since in an animal study transection of peripheral nerves or spinal cord did not induce any obvious change in SEA over a period of an hour *(66)*.

Simons has suggested that excessive acetylcholine release is related to the taut band formation and that the contraction knots in a MTrP region appear to be directly responsible for the palpable nodule and the taut band of a MTrP *(5,36,38)*. The resulting increased energy consumption, together with reduced energy supply, produces a local energy crisis evidenced by severe localised hypoxia *(67)*.

As small nerve fibres were seen in the histological study on sensitive loci, so they were noted in the vicinity of active loci *(68)*. This finding can be related to an earlier histological study of *insertion activity*, morphologically similar to the waveform of SEA *(69)*. Thus both sensitive and active loci are related to nerve fibres, probably nociceptive nerve endings.

Autonomic function

Autonomic phenomena have been observed to develop as a result of activity in MTrPs *(3)*. Hooshmand considered MTrP activity to be a complication, or manifestation, of reflex sympathetic dystrophy (RSD); MTrP injection can effectively treat muscle pain in some RSD patients *(70,71)*, however this may be due to concomitant development of RSD and MTrPs which have common aetiological factors *(72)*. Hubbard found that the electrical amplitudes and number of spikes recorded from a MTrP region were significantly reduced after injection of *phentolamine*, either locally or systemically, and a similar result was found in a study on rabbit myofascial trigger spots *(56,73)*.

Overview

In summary: there are multiple MTrP loci (basic units), each consisting of a sensitive locus and an active locus, in a MTrP region. Sensitive loci are probably nociceptors, *sensory structures*, and active loci are probably dysfunctional motor endplates, *motor structures*. Either SEA or LTR, or both, can be observed at different loci in a MTrP region, and both are often associated with sharp pain similar to the patient's usual complaint. Therefore a sensitive locus is probably in the immediate vicinity of an active locus. It is likely that the sensitive loci are widely distributed in the entire muscle, or even outside the muscle in subcutaneous tissues, ligaments, *etc*. Sensitive loci can be sensitised either locally or centrally *(74)*, and can also be found in some tender points in fibromyalgia patients. When a sensitive locus is associated with an active locus, a MTrP locus can develop: this may be the basic difference between a MTrP and a fibromyalgic tender point.

The pathophysiology of MTrPs has now been well described *(5,23,36,54,75)*. A significant number of normal adults have latent MTrPs. Sola *et al*, in a study on fit American Air Force personnel, found latent MTrPs in 45 out of 100 males and 54 out of 100 females *(76)*. A latent MTrP may become active in response to any noxious lesion, generally trauma to muscle. It has been suggested that this is a phenomenon of central sensitisation in the spinal cord, but it may be that the central sensitisation is a response to peripheral activation and sensitisation of MTrP nociceptors. The newborn express a pain

reaction in response to noxious stimuli at all sites in a muscle. However, as they grow up, they develop a stronger reaction to painful stimuli in a MTrP region than at other non-MTrP sites in the same muscle. Thus, latent MTrPs appear to develop gradually as the child gets older. It has been suggested that a peripheral nerve lesion (particularly radiculopathy) is the cause of MTrP formation *(9-11,77,78)*. This may be true for the formation of some MTrPs; however, there is clinical evidence to suggest that activation of a latent MTrP (to become an active MTrP) can be induced by a variety of other causes, such as trauma and ischaemia, in addition to peripheral nerve lesion *(79-83)*.

Comparison of acupuncture points and myofascial trigger points

Location

MTrPs are always identified in the endplate zone. Some acupuncture points can be identified in the endplate zone, but some may not be in muscle. Melzack *(6)* has reported a high degree (71%) of correspondence between MTrPs and acupuncture points, and it is very likely that all MTrPs are *Ah-Shi* acupuncture points.

Characteristics

Tenderness

All active and latent MTrPs, but not all acupuncture points, are tender. Tender, and clinically relevant acupuncture points are called *Ah-Shi* points. In Chinese, *Ah-Shi* means *Oh Yes!* (that's the right spot). So, when the point is pressed, the patient feels pain and says *Oh Yes! That's it.*

Referred pain

With high-pressure stimulation, referred pain can be elicited in most active and some latent MTrPs. Clinically we observed that twisting the needle during acupuncture may cause referred pain in some patients. Further observation showed that referred pain patterns of some MTrPs are similar to the traditional meridian connections of acupuncture points. The consistent pattern of referred pain in a specific MTrP suggests that there are fixed connections between certain sensory neurons in the spinal cord. These are probably the same as the connections between acupuncture points along a meridian. Thus, the mechanism of MTrP injection may be similar to that of acupuncture in terms of pain relief.

Local twitch response

During fast movement (high-pressure stimulation) of the needle, LTRs should always be elicited in active MTrPs. In our clinical observations, a needle sensation *(de-qi)*, similar to LTRs can be elicited during acupuncture treatment at some points. The best therapeutic effects obtained with either MTrP injection or acupuncture seem to be related to the production of LTR or *de-qi (14,16,21-23,54,77)*.

Morphology

It has been suggested that the MTrP consists of multiple loci which are nociceptors and dysfunctional endplates *(14,16,23,54,75)*. Contraction knots can be observed in a MTrP region *(5,38)*; however, previous studies have failed to identify any specific structure at an acupuncture point. Morphologically, it is difficult to differentiate a normal from an abnormal (sensitised) sensory receptor, or to differentiate a normal from a dysfunctional endplate. It is likely that an acupuncture point in muscle consists of multiple sensory receptors or MTrP loci: sensory receptors plus dysfunctional endplates.

Pathophysiology

With the evidence of the studies mentioned above, I would suggest that the MTrP is related to interneuronal integration in the spinal cord, with the specific, referred pain patterns of a MTrP, the local twitch responses elicited by high pressure stimulation to MTrP loci, and autonomic phenomena. Acupuncture points probably also have a spinal relationship similar to that of the MTrP. I believe that the mechanism of acupuncture in pain relief is similar to that of MTrP injection, and is probably related to the spinal cord mechanism *(15)*. When an acupuncture point or MTrP is stimulated mechanically at high pressure, not only pain sensation, but also referred pain can be elicited. When the stimulation pressure is high enough to induce local twitch responses, spinal inhibitory effects may be induced that relieve pain. Strong stimulation may also influence the autonomic and endocrine systems, so it seems reasonable to expect that acupuncture should be effective in the treatment of metabolic or autonomic disease.

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The International Acupuncture Symposium will be held from 14th to 17th June. There will be a trade exhibition, historical exhibition, poster sessions and a full social programme. The scientific meeting will comprise sections on:

Research
Basic research
Clinical research
Evidence based medicine
Acupuncture in health care
Quality assurance
University practice
Related techniques
Neural therapy

Brandenburg Gate

The congress fee will be discounted to 500.DM for members of BMAS or ICMART if booking and payment is made by 28th February 2001. This fee will include daily lunch at the conference centre and the "Get Together Party".

Free papers and poster presentations are requested. The new ICMART prizes of $1500, $1000 and $500 are now available to be awarded for free papers delivered at the symposium detailing new research.

Prior to the international symposium there will be the Anniversary Congress for DÄGfA and DGfAN; the 15th DÄGfA Acupuncture Week and 13th DGfAN Congress will run from June 9th to 14th.

Further information is on the association web sites <www.daegfa.de> and <www.dgfan.de>, or the ICMART web site <www.icmart.org>, or contact the following for details:

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