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The muscle twitch in myofascial pain relief: effects of acupuncture and other needling methods

J. Chu[1], **I. Schwartz**[2]

Abstract

Proposed is that needling methods such as acupuncture, primarily effect pain relief in myofascial pain through a local mechanism, elicitation of muscle twitches. Occasionally, diagnostic needling procedures such as electromyography (EMG) can relieve such pain through insertional intramuscular movements of the needle electrode. This results in stimulation of the motor end-plate zones (MEPZs), eliciting muscle twitches. As needle elicitation of muscle twitches is a common diagnostic technique to identify myofascial trigger points (MTrPs), muscle twitches elicited at such points may be therapeutic, not just diagnostic. Occasionally evoked small local muscle twitches are observed in pain relieving methods using needle penetration or manipulation, such as classical or electrical acupuncture and intramusclar stimulation (IMS). Twitch elicitation has been observed to be essential to obtain myofascial pain relief associated with the needling methods of automated and electrical twitch-obtaining intramuscular stimulation (ATOIMS and ETOIMS). These two methods facilitate the elicitation of larger force twitches by mechanical or electrical stimulation respectively at motor end-plate zones.

Acupuncture may have central, local and placebo effects. The central effect of acupuncture is attributed to the release of endogenous opioids, neurotransmitters and neurohormones. But these neuroactive chemicals are also associated with painful stimuli, vigorous exercise and relaxation training and are therefore not specific to acupuncture. On the contrary, vigorous exercise may aggravate rather than alleviate myofascial pain (6, 24). Information is sparse concerning the local mechanism of action of acupuncture specific to needle penetration and/or movement. A local electrophysiological explanation for the myofascial pain relief effects of acupuncture is presented.

Classical acupuncture describes *De Qi* as a subjective sensation of numbness, pressure, heaviness, soreness or distention resulting from needle placement at tender acupuncture (*ah shi*) points (26). As the same *De Qi*-like sensation may be elicited by needling myofascial trigger points (MTrPs) [localized, tender, hyper-irritable spots in muscle where local pressure elicits pain and also a local muscle contraction, i.e., twitch response (28)], possibly acupuncture points and MTrPs are identical (22). Therefore, the benefit of acupuncture in musculoskeletal pain relief would not be limited to classical acupuncture points.

Musculoskeletal pain relief can be obtained with procedures such as intramuscular stimulation [IMS] (10) and electromyographic (EMG) examinations (2, 3). Intramuscular movements of the needle cause insertional activity recordable on EMG. The insertional activity occurs from depolarization of innervated single muscle fibers. When the nerve is hyper-excitable, grouped single muscle fiber discharges occur which can also be recorded by EMG as micro-twitches (Fig. 1). Occasionally, needle penetration or manipulation in classical or electrical acupuncture may also evoke small local twitches.

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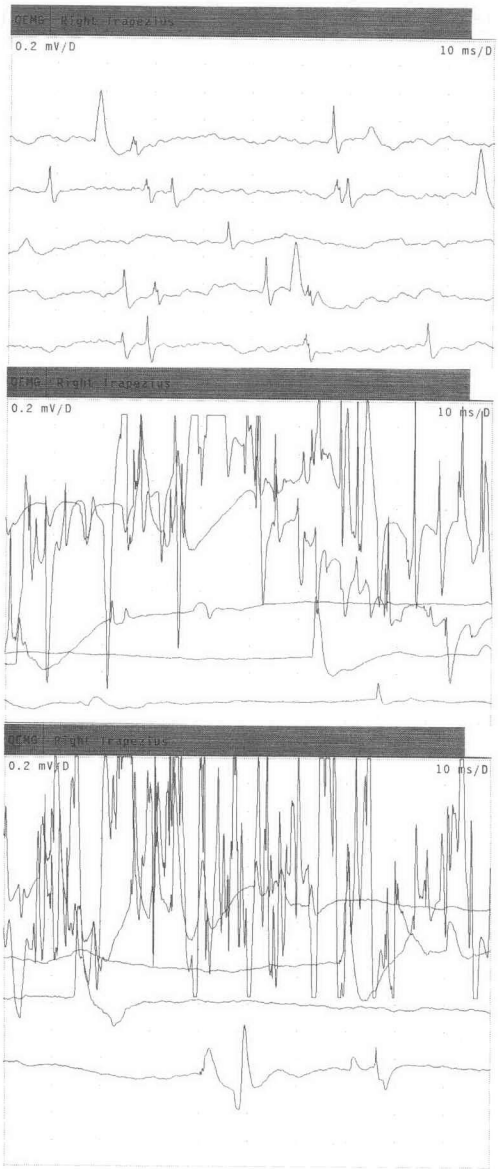

Fig. 1. – Top trace: EMG monopolar needle recording at the motor end-plate zone showing miniature end-plate potentials and end-plate spikes. Very minimal contraction elicited a motor unit action potential (MUAP). This MUAP is initially negative and diphasic in shape characteristic of recordings at the motor end-plate zone and is seen at the 1st, 2nd and 3rd traces.
Middle trace: The needle is moved at the motor end-plate zone to produce a micro-twitch which is comprised of grouped single muscle fiber discharges that are noted in the 1st and 2nd traces. When the needle movements stopped, no insertional discharges are noted in the following three traces. The initially negative, diphasic MUAP is noted in the 4th trace since the patient was instructed to continue with very minimal contraction.
Lowest trace: A micro-twitch with higher amplitude discharges is noted in the first trace on repeat movement of the needle at the motor end-plate zone. The initially negative, diphasic MUAP is noted in the last three traces.

The musculoskeletal pain relief with needling procedures such as acupuncture, IMS and EMG occurs in association with elicitation of micro-twitches. When the needle stimulates the motor end-plate zone or a large intramuscular nerve terminal, palpable or visible twitches can be observed. These observations suggest that procedures that involve needling of muscles induce local muscle twitches that produce a focal stretch on adjacent shortened muscle fibers. These stretch effects may mediate musculoskeletal pain relief.

Stretching tight muscles is commonly used in clinical rehabilitation to relieve pain, diminish muscle tension and tenderness as well as to enhance range of motion (15, 21). Muscle stretching exercises are also commonly applied in sports activities to gain flexibility (8). A reduction in passive stiffness of the muscle tendon unit may be the mechanism for the beneficial effects of stretching (17, 25, 27) although some studies have found no change in stiffness with long-term flexibility stretch training, as well as acute effects of single stretching maneuvers (11, 12, 18, 19). One of the chief difficulties in finding definitive changes in stiffness of the muscle after stretching may be related to factors that include the methods by which the muscle is stretched. External stretching procedures applied to muscle can provide stretch primarily to the most superficial muscle fibers, not deep muscle fibers, that may be shortened. Similarly, physical therapeutic measures that stimulate muscle using surface electrical stimulation such as faradic and interferential currents may have muscle stretching effects that will similarly occur to shortened muscle fibers on the surface, but not to the deep layers of the muscle. Surface stimulation does not provide sufficient electrical current to reach the deeply situated motor end-plate zones (MEPZs) to provide localized stimulation of deep muscle fibers. Methods such as transcutaneous electrical stimulation (TENS) achieve pain relief by stimulating large nerve fibers in the skin that close a "pain gate" in the spinal cord (23). Closing this gate prevents painful impulses from reaching the brain. As muscle has larger afferent nerve fibers than skin, stimulation of these nerves by percutaneous electrical nerve stimulation [PENS] (9) or electrical acupuncture may be more effective in closing the pain gate. Additionally, the electrical stimulation produces local tapping movements of the acupuncture needle which elicit insertional activity

and micro-twitches. However, there are limitations with PENS and electrical acupuncture since only very superficial MEPZs are electrically stimulated. This is due to the lack of strength of the acupuncture needle for deeper muscle penetration and stimulation. Also the stainless steel shaft of the acupuncture needle conducts electricity and stimulates tissues surrounding the needle shaft, rather than localizing stimulation to the MEPZs.

Gunn achieves stimulation of deep muscle fibers at tender motor points using intramuscular stimulation (IMS). In this method, an acupuncture needle is inserted into the depths of a muscle using a plunger and the mechanical stimulation is continued by manual oscillation of this needle (10). As movements of the needle cause insertional activity and micro-twitches, the pain relief afforded with IMS method may relate to micro-stretch effects on the adjacent shortened muscle fibers reducing the mechanical traction effect produced by these shortened fibers on pain sensitive structures, including intramuscular nerves and blood vessels (10, 16).

There is evidence that long-lasting, isometric force depression occurs following muscle shortening and long-lasting, isometric force enhancement follows muscle stretching (13). Contractile activity is important for the maintenance of normal muscle compliance (29). Therefore, methods that elicit larger force twitches may be more effective to involved shortened muscle fibers and in keeping the muscle compliant to produce efficient work. These factors may account for the superior pain relief from twitch obtaining intramuscular stimulation methods, especially when performed with electrical stimulation (5).

Based on the above, mechanisms to elicit larger force twitches were invented. Presence of muscle macro-twitches allow the objective recording of the number, frequency and force of the twitches. This eliminates subjective confirmation of acupuncture point localization based upon patient *De Qi* impression or acupuncturist tactile sensation, such as "sticky points" and "needle grab". An optimal treatment point twitch is obtained in 2 seconds using 2 Hz automated monopolar needle movement. Therefore, leaving needles stationary in tissue to obtain pain relief in classical acupuncture appears without physiologic basis or therapeutic benefit.

Muscle relaxation resulting from stretching shortened muscle fibers, leads to improved circulation (1, 7). These mechanisms may contribute to twitch induced pain relief at the local level and also have central effects on the pain gate in the spinal cord. Therefore, by postulated mechanism of action and associated therapeutic pain relief, the twitch may be the local key to pain relief, not just a diagnostic sign for the localization of MTrPs (14).

A stronger, more durable, Teflon coated, monopolar EMG needle electrode that prevents tissue sticking to its shaft during oscillation, with a conical tip that causes little tissue trauma (20), is better suited for stimulating superficial and deep MEPZs. This type of needle has a known exposed tip area and thus permits better localization of the electrical stimulus. More important for identification of the treatment points is the clinician's ability to palpate for tender points along the intramuscular bands and nodes and to follow the intramuscular/intermuscular grooves that become delineated and visible when the twitches are elicited.

Classical acupuncture points or meridians in the trunk and limbs in myofascial pain relief may not be necessarily memorized or used for treatment, unless they can be identified as tender MEPZs. Presence of palpable or visible muscle twitches allow objective recording of the number, frequency, and force of twitches. Since one can recognize elicited muscle twitches, acupuncture point localization becomes objective. No longer is an observer dependent upon memory, a patient's subjective *De Qi* impression, or the acupuncturist's tactile sensation of "sticky points" and "needle grab". The most effective twitch points are clustered as zones, debunking the notion of a single acupuncture point. The depth of penetration required for acupuncture needle placement is simplified and objectified by eliciting twitch confirmation. Although muscle should twitch at all levels, with nerve and/or muscle pathology, twitches may become difficult to elicit, especially in deeper layers. Leaving needles stationary over prolonged periods during classical acupuncture may inadvertently induce occasional twitches when needles move due to patient's movements from difficulty in maintaining a position or from significant body movements associated with respiration, coughing or sneezing. Therefore, for stationary needles to cause additional musculoskeletal pain relief in the absence of needle movements appears without significant physiologic basis.

To facilitate twitch elicitation and to obtain larger force twitches, localized intramuscular electrical stimulation using electricity applied via the EMG machine to the Teflon coated monopolar EMG needle appears more efficient. Electrical twitch obtaining intramuscular stimulation (ETOIMS) produces more rapid production of many larger force twitches from stimulation of more MEPZS per stimulus and produces better pain relief than using mechanical stimulation alone (4, 5). More MEPZs deep within the muscle are stimulated to twitch due to stimulation of larger nerve terminals/trunks. ETOIMS elicited twitch force often is forceful enough to move a joint in the direction of action of the treated muscle, producing a greater stretch effect on the muscle. Such twitches zones are carefully sought during ETOIMS treatments to produce significant pain relief. The treatment is focused on eliciting twitches that must be strong enough to shake or move the joint The duration of the electrical stimulation with ETOIMS is only for 2 seconds, which is sufficient to fatigue immature or abnormal MEPZs related to degeneration or regeneration of nerves. The chance of tissue injury is further reduced when macro-twitch induced movement changes the muscle position of the needle, preventing repetitive electrical stimulation of the same tissue even when the same skin insertion point is re-used.

The proposed local mechanism of action of acupuncture permits speculation that *Yin* may pertain to muscle (skeletal or smooth), *Yang* may correspond to the nervous system (somatic and autonomic), and *Qi* may represent neuromuscular transmission and blood circulation. The balancing of excess and deficient *Yin* and *Yang* for maintenance of *Qi* may be understood as homeostasis, involving muscle, nerve, and circulatory inter-relationships.

Relaxation of muscle spasm with immediate relief of muscle pain, as in the case with muscle cramps, is a well-experienced phenomenon. Similar association is noted with intramuscular twitch mediated reduction of muscle pain. Therefore, enhanced twitch-obtaining methods were developed from acupuncture to improve therapeutic efficacy. The ability to objectify the method of application with enhancement of therapeutic efficacy provides more scientific creditability to acupuncture.

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