The Scientific Basis of Myofascial Trigger Points

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Etiology of Myofascial Trigger Points

- Acute Overuse
- Direct Trauma
- Persistent Muscular Contraction (emotional or physical cause), i.e., poor posture, repetitive motions, stress response
- Prolonged Immobility
- Systemic Biochemical Imbalance
Etiology of MTrPs (updated)

low level muscle contractions


uneven intramuscular pressure distribution
direct trauma
unaccustomed eccentric contractions
eccentric contractions in unconditioned muscle
maximal or submaximal concentric contractions
Other Contributing Factors

- Associated MTrP
- Afferent Input from Joints
- Afferent Input from Internal Organs
- Stress / Tension
Radiculopathy? MTrP referred pain? Both?
Diagnostic criteria

spot tenderness within the taut band
Diagnosis criteria

- taut band
Muscle Fiber Direction

1. Quadratus – quadratus lumborum
2. Rhomboid – rhomboides major
3. Trapezius – trapezius
4. Biceps – biceps
5. Fusiform – biceps femoris
6. Digastric – digastric
7. Bipennate – rectus femoris
8. Multipennate (triangular) – deltoid
9. Unipennate – extensor digitorum longus
Palpation

two palpation techniques:
• Flat palpation
• Pincer palpation
Flat Palpation
Scientific Basis of Trigger Points

- Myofascial Trigger Points exhibit a number of characteristics that require explanation:
  - 1. Structural appearance (hardened muscle band)
  - 2. Biochemical features
  - 3. Nature of local and referred pain
  - 4. Response to treatment
The science of myofascial trigger points

- The anatomic basis of trigger points
- Electrical Activity of trigger points
- Sympathetic modulation
- Vascular changes
- Biochemical physiology of trigger points
- Sensitization
- Treatment effects
Trigger Point Structure
Hypothesis: Hypercontracted sarcomeres forming dense, contracted band

Visible nodule
This is a successful demonstration of utility of ultrasound imaging of taut bands in the management of myofascial pain syndrome.
Courtesy of Siddhartha Sikdar, PhD

Conclusion

The Trigger point zone is a densely contracted band of muscle that can be seen on ultrasound imaging.
Trigger Point
Electrophysiology
Trigger Point Endplate Noise
(SEA is EPN according to Simons)
Endplate Activity

- Simons, Hong, Simons found that there was a 5-fold increase in endplate noise regions in the trigger point taut band compared to normal muscle.

Conclusion: Increased endplate potential activity is associated with the myofascial trigger point.
Botulinum toxin attenuates endplate noise

Implication: Acetylcholine is essential for endplate noise

1) Specific inhibition of nerve-stimulated release of acetylcholine shows that ACh is critical for endplate noise and/or

2) Inhibition is of non-specific, non-quantal release of acetylcholine release

Sympathetic Modulation of Trigger Point Electrical Activity
Phentolamine
(alpha-adrenergic blocking agent)

Intravenous infusion of saline vs. phentolamine, 10mg, effect on needle EMG of trigger point and adjacent muscle fibers

Phentolamine

Phentolamine 10mg injected directly into trigger point in patient with myofascial pain

Conclusion

The electrical activity of the trigger point is maintained by the sympathetic nervous system to a large extent.
Sympathetic facilitation of hyperalgesia evoked from MTrPs and tender points in unilateral shoulder pain

Results: 1. **Pressure pain thresholds (PPT)** are lower at symptomatic MTrPs than tender points (non-painful side) with normal respiration.

2. PPT decreased at tender & TrPs & at referred pain sites at elevated intrathoracic pressures: local and referred pain intensity increased.

Conclusion: sympathetic facilitation of

1. mechanical sensitization and 2. local and referred muscle pain

Vascular changes at the trigger point
Retrograde Blood Flow at the Trigger Point

B Ascending branch of transverse cervical artery in upper trapezius

C Blood vessel passing through an active MTrP in the upper trapezius
Biochemical Features of the Trigger Point
Changes in pH, neurotransmitters, kinins in Trapezius muscle trigger point zone

**What about ACh?**

\[ \text{Trapezius vs Gastrocnemius} \]

What about ACh?

Sub P


O$_2$-tissue saturation in TrPs

Conclusion

1. Neurotransmitters and cytokines are increased or altered at the trigger zone
2. The Trigger point is ischemic and hypoxic
Referred Pain
Referred Pain

Selected neuron responds only to deep pressure in biceps femoris muscle from one receptive field site.

Expansion of Receptive Field

5 min after Bradykinin injection in tibialis anterior, the neuron can now be excited by additional RF sites located in deep muscle

(RF: receptive field)

Hoheisel U, Mense S, Simons DG. Appearance of new receptive fields in rat dorsal horn neurons following noxious stimulation of skeletal muscle: a model for referral of muscle pain?

Neurosci lett 153:9-12, 1993
15 min after Bradykinin injection the neuron responds to moderate (less) pressure in the original receptive field - biceps femoris

Hoheisel U, Mense S, Simons DG. Appearance of new receptive fields in rat dorsal horn neurons following noxious stimulation of skeletal muscle: a model for referral of muscle pain?

*Neurosci lett* 153:9-12, 1993
Expansion of Receptive Field:
Receptive fields have expanded and respond to a milder noxious stimulus

Expansion of Receptive Field

Sensitization

- Hypersensitivity
- Allodynia
- Referred pain
Peripheral Mechanisms

- Muscle tenderness is mainly due to muscle nociceptor sensitization:
  - acidic pH
  - prostaglandins
  - bradykinin and serotonin

all found at the trigger zone
Sensitization

- Continuous peripheral nociceptive input:
  - neuroplastic changes in the PNS and CNS
  - Activation of dormant synapses

Result: Transition
- acute to chronic pain
Peripheral Sensitization: Inflammatory mediators (kinins, H+) Restricted to site of injury;

- Lowers threshold to activation;
- Alters heat sensitivity, not mechanical sensitivity (centrally mediated);

Second messenger systems increase sensitivity and output of nociceptor cell.
Central Sensitization

Includes dorsal horn changes and glial cell mediators; increased synaptic efficacy
Central Sensitization: Activation of dormant synapses increases synaptic efficiency.
Cerebral as well as Spinal

- Extent of neuroplastic changes in the CNS
- Dorsal horn neurons
- CN V nucleus caudalis of the brainstem
- Thalamus, Amygdala
- Anterior cingulate gyrus
- Periaqueductal gray matter inhibitory centers
- Prefrontal cortex
- Cortical Atrophy

Thalamus
Animal Models of Trigger Points

- Models in rodents showing contraction knots, studying electrophysiology and histology
- Huang (Shanghai, China) and Mayoral del Moral (Toledo, Spain)
- Hong CZ (Taiwan): rabbit model

Summary
Muscle injury (overuse)

- Substance P
- CGRP
- Low pH
- Kinins
- Interleukins

Edema

Vasoconstriction

- Increased ACh release
- Increased AChR at endplate
- Decreased ACh-esterase activity

Increased ACh activity at endplate

Localized sarcomere contraction under the endplate

ASIC3 activation

Nociceptive receptor activation
TREATMENT
A Study of the Effect of Treating Trigger Points on the Number & Intensity of Attacks in Migraine Headache

Pain Sensitivity: determined by electrical stimulation of skin, subcutaneous and muscle layers at days 3, 10, 30, and 60
Grp 1: Injection of trigger points in neck and shoulders
Grp 2: no treatment
Normal (no headache) controls

All migraineurs showed lower than normal thresholds in trigger points and referred pain areas in all tissues (p<.001).

60 days after trigger point treatment: Pain threshold at trigger points and at referred pain sites normalized in all three tissue layers.

Needling Trigger Points

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Needling Trigger Points

- Needling (dry needling or trigger point injection) is a skilled intervention using a thin filiform or hypodermic needle to penetrate the skin and subcutaneous tissues to stimulate fascial tissue, muscle, and myofascial trigger points to manage neuromuscular disorders

  adapted from APTA 2013
Needling Trigger Points

- Needling (dry needling or trigger point injection) is used to diminish persistent peripheral nociceptive input, to restore function, leading to improved activity

  adapted from APTA 2013
Needling (dry needling or trigger point injection) by itself is seldom sufficient to restore normal function, but is part of a comprehensive program of rehabilitation and correction of underlying mechanical, medical, and functional disorders.
Osler practiced dry needling in the 1870s

"Observe, record, tabulate, communicate. Use your five senses. Learn to see, learn to hear, learn to feel, learn to smell, and know that by practice alone you can become expert."

William Osler
Sir William Osler and Dry Needling

Mr. Redpath (a wealthy board member of Montreal General Hospital arrived exhausted after mounting the stairs. They proceeded to treat him with acupuncture (for Lumbago), thrusting a long needle into the muscles of the back. At each jab the old gentleman ripped out a string of oaths. He hobbled out no better for his pain. No millions for McGill.

Courtesy of Dr. Robert Woody
Sir William Osler textbook of medicine 1892: For lumbago...acupuncture is the most efficient treatment. Needles 3-4 inches in length (ordinary bonnet needles, sterilized, will do), are thrust into the lumbar muscles at the seat of the pain.

courtesy of Dr. Robert Woody
Why Needle?

- Diagnostic
- Treatment
  - to relieve pain
  - to facilitate physical therapy and rehabilitation
What is needled: The most firm or hardest part of the taut band, that is usually also the most tender part.
How do you know you are there? The local twitch response!

Hong, C. Z.; Torigoe, Y. in: Journal of Musculoskeletal Pain, 2(2), 1994, 17-43
When are you done? When there are no more twitch responses.

The trigger point region can be a hornet's nest of trigger points.
Lidocaine injections of trigger points produced significant pain reduction.

Effects of treatment of peripheral pain generators in fibromyalgia patients

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Comparison of Superficial and Deep Acupuncture in the Treatment of Lumbar Myofascial Pain: A Double-Blind Randomized Controlled Study

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Conclusions: Clinical results show that deep stimulation has a better analgesic effect when compared with superficial stimulation.

Deep dry needling is more effective than superficial needling
Deep dry needling reduced pain, improved sleep, and improved mobility
Contribution of Myofascial Trigger Points to Migraine Symptoms

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Inactivation of trigger points in the neck and shoulder muscles that referred pain to headache regions reduced local and referred pain, decreased headache days and reduced headache intensity.
Efficacy of myofascial trigger point dry needling in the prevention of pain after total knee arthroplasty: a randomized, double-blinded, placebo-controlled trial.

Mayoral O1, Salvat I, Martín MT, Martín S, Santiago J, Cotarelo J, Rodríguez C.
Acupuncture needling versus lidocaine injection of trigger points in myofascial pain syndrome in elderly patients – a randomised trial

Hyuk Ga, Ji-Ho Choi, Chang-Hue Park, Hyeon-Jung Yoon

Abstract

Aim To compare the efficacy of acupuncture needling and 0.5% lidocaine injection of trigger points in myofascial pain syndrome of elderly patients.

Methods Thirty-nine participants with myofascial pain syndrome of one or both upper trapezius muscles were randomised to treatment with either acupuncture needling (n=18) or 0.5% lidocaine injection (n=21) at all the trigger points on days 0, 7, and 14, in a single-blinded study. Pain scores, range of neck movement, pressure pain intensity and depression were measured up to four weeks from the first treatment.

Results Local twitch responses were elicited at least once in 94.9% of all subjects. Both groups improved, but there was no significant difference in reduction of pain in the two groups at any time point up to one month. Overall, the range of cervical movement improved in both groups, apart from extension in the acupuncture needling group. Changes in depression showed only trends.

Conclusion There was no significant difference between acupuncture needling and 0.5% lidocaine injection of trigger points for treating myofascial pain syndrome in elderly patients.

Keywords

Acupuncture, lidocaine injection, trigger points, myofascial pain syndrome, elderly patients.

Introduction

Myofascial pain syndrome (MPS) is a common cause of musculoskeletal pain characterised by trigger points (MTPs), that is tender nodules in taut bands of skeletal muscle, limited range of motion in joints, referred pain and local twitch responses (LTRs) during mechanical stimulation of the MTPs.1

Inactivation of MTPs is essential in managing MPS and several methods have been recommended. The treatments most commonly used for this purpose are dry needling of the MTPs, injection treatments with local anaesthetics or salins, sprays, and stretching. According to the results of several studies, injection continues to be the most effective choice for treatment. The superiority of local injection or dry needling for the inactivation of MTPs is controversial,2 and hollow needles were used for dry needling in these studies.3 Yann suggests that the "hollow needle" induces more tissue injury and is more painful than a "pointed-tip needle".4

In this single-blinded randomised trial, we compared the efficacies and adverse events of acupuncture needling and 0.5% lidocaine injection of trigger points in myofascial pain syndrome.

Method

Participants

We obtained retrospective ethical approval from the institutional review board of Inha University Hospital. We selected 40 subjects with chronic MPS of the upper trapezius from volunteers at four community-based facilities; one further subject proved unable to complete the necessary forms. Subjects were selected on the basis of physical examination and interview, and signed informed consent was obtained. Participants were randomised into two groups by coin-toss: 1) ACU (acupuncture needling) group and 2) TPI (trigger point injection with 0.5% lidocaine) group.

Inclusion criteria (for the trial were: 1) aged more than 60 years old; 2) complaining of chronic shoulder...
The effect of dry needling in the treatment of myofascial pain syndrome: a randomized double-blinded placebo-controlled trial

Levent Tekin · Selim Akarsu · Oğuz Durmuş · Engin Çakar · Ümit Dinçer · Mehmet Zeki Kıralp

Dry needling compared to sham needling reduced pain (VAS) and improved SF 36 score
Conclusions

- The Trigger point is a densely contracted band of muscle with increased electrical activity.
- The taut band is maintained to a large extent by sympathetic nervous system input.
- Neurotransmitters and cytokines activate and sensitize peripheral nociceptors.
- Referred pain is the result of activation of dormant synaptic connections (Central sensitization).
- Inactivation of trigger points decreases local pain and reverses central sensitization, eliminating referred pain.
Rules of Needling
If you do not know where you are going, don’t go
PLEASE DO NOT GO BEYOND THIS POINT
INTERDICTIO DE DÉPASSE
CE PANNEAU
BITTE ABSEHEN
Universal Precautions:

Gloves
Nitrile, not latex
CAUTION

THIS SIGN HAS SHARP EDGES

DO NOT TOUCH THE EDGES OF THIS SIGN

ALSO, THE BRIDGE IS OUT AHEAD
HIKERS and BIKERS
Move to the side of the road when a vehicle approaches
If you do not know where you are going, don’t go
Needling: For all Muscles

- Identify landmarks
- prepare the needle or injection material
- recheck landmarks every time
Injection Materials

- lidocaine 0.25% (4 cc’s of lidocaine 2% in 30 cc of normal saline)
- Botox
- Nothing else
If you do not know where you are going, don’t go
Complications

- Allergy to nickel, to local anesthetic (epinephrine)
- local soreness
- bleeding
- nerve injury
- syncope
Pneumothorax
Pregnancy is not a contraindication
If you do not know where you are going, don’t go