The Scientific Basis of Myofascial Trigger Points

- Robert Gerwin MD, FAAN
- Johns Hopkins University, Baltimore, MD

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

Gerwin RD, Dommerholt J, Bron C, and Franssen J: Myofascial trigger points: an evidence-informed review. *J Manual & Manipulative Ther*, 2006;14(4):203-221.

Gerwin RD, Dommerholt J, and Shah J: An expansion of Simons' integrated hypothesis of trigger point formation. *Curr Pain Headache Rep*, 2004; 8:468-475.

uneven intramuscular pressure distribution

direct trauma

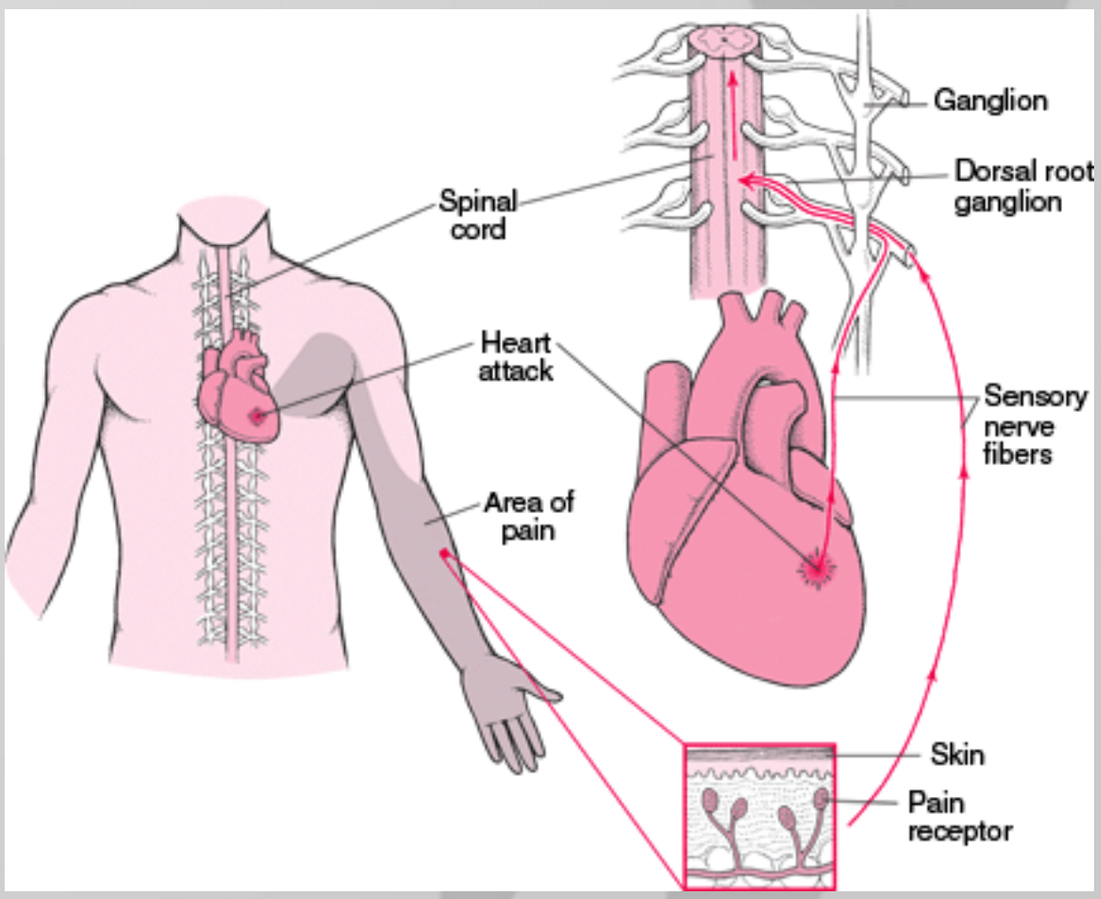
unaccustomed eccentric contractions

eccentric contractions in unconditioned muscle

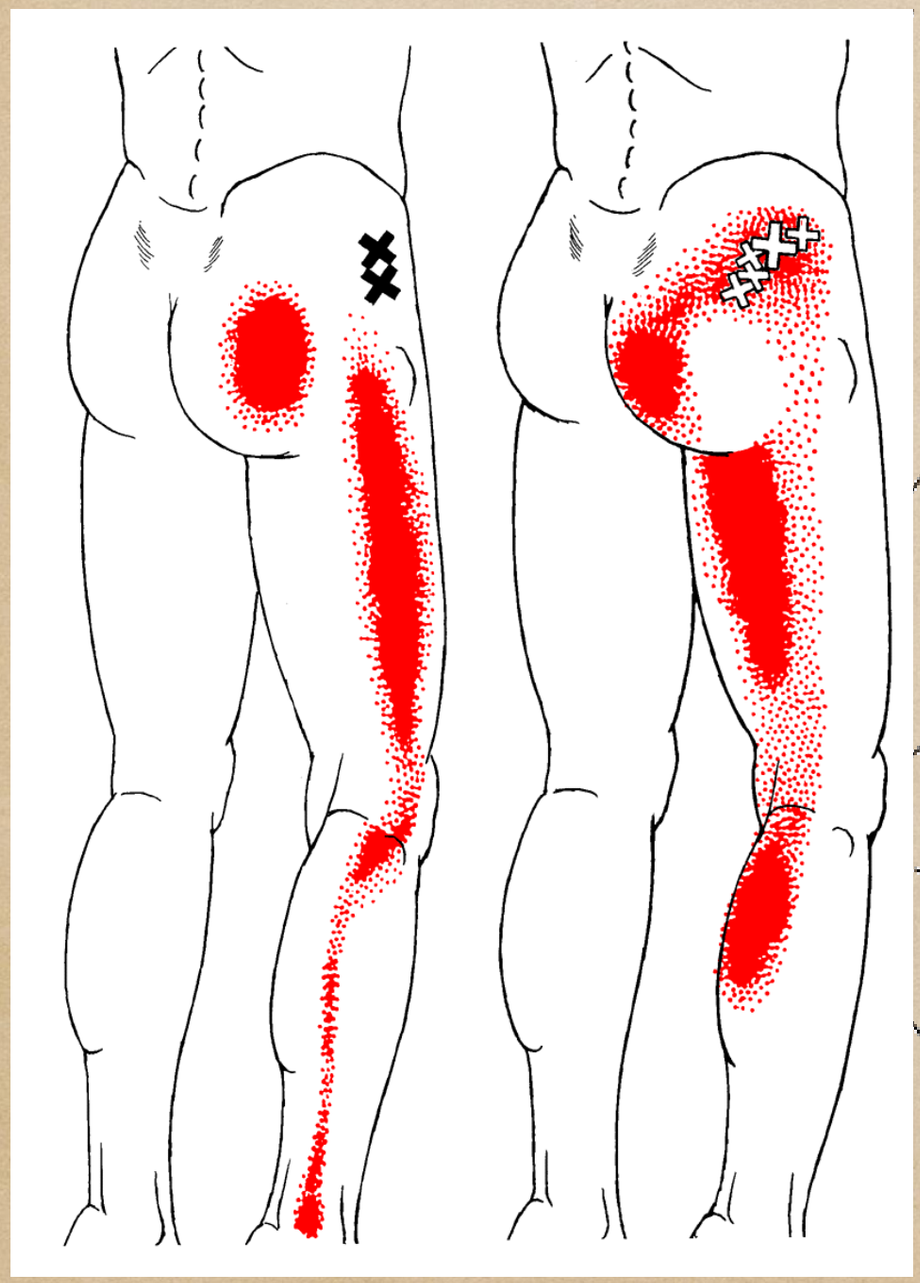
maximal or submaximal concentric contractions

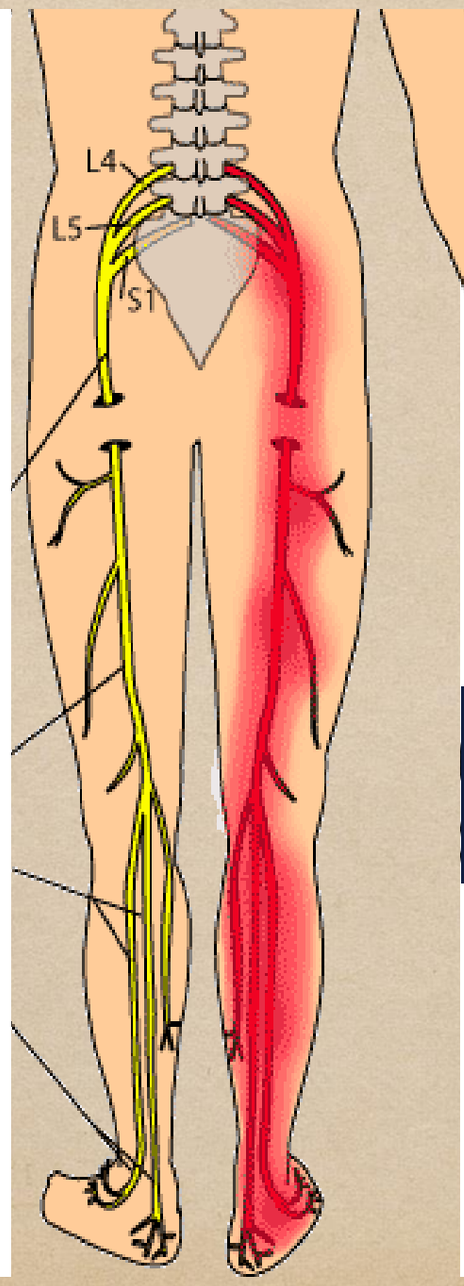
Other Contributing Factors

- Associated MTrP
- Afferent Input from Joints
- Afferent Input from Internal Organs
- Stress / Tension



Radiculopathy? MTrP referred pain? Both?



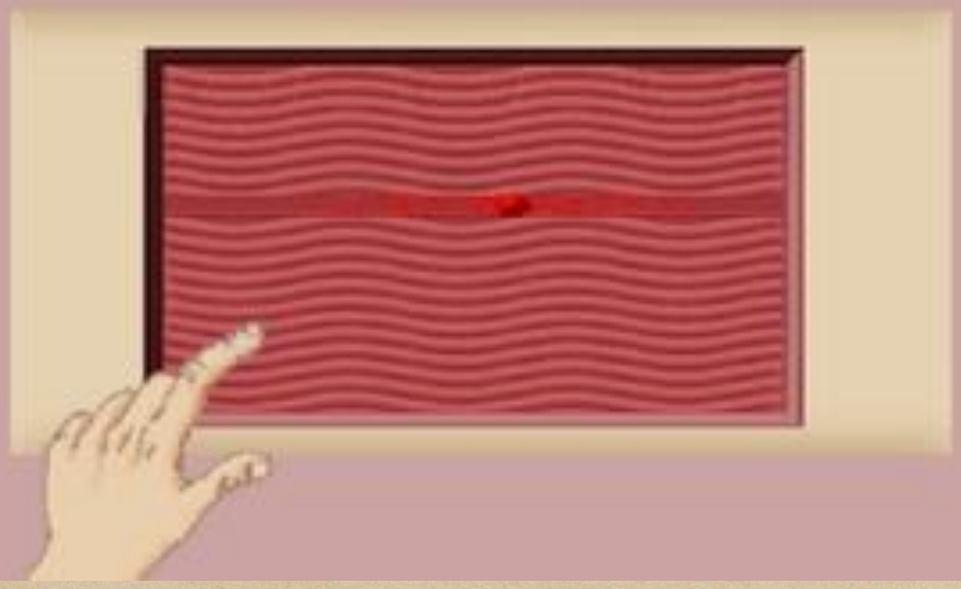


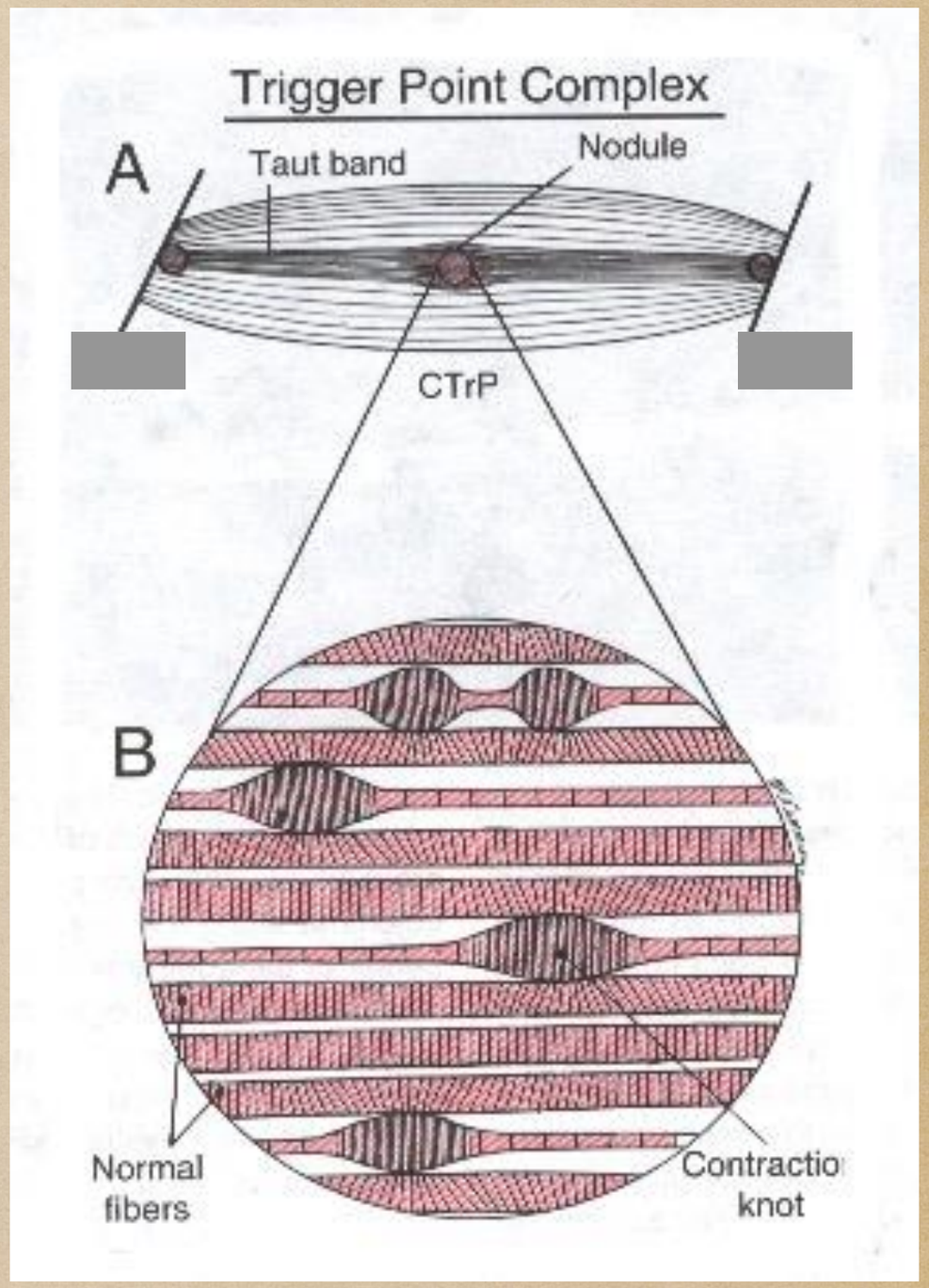
Diagnostic criteria

spot tenderness within the taut band

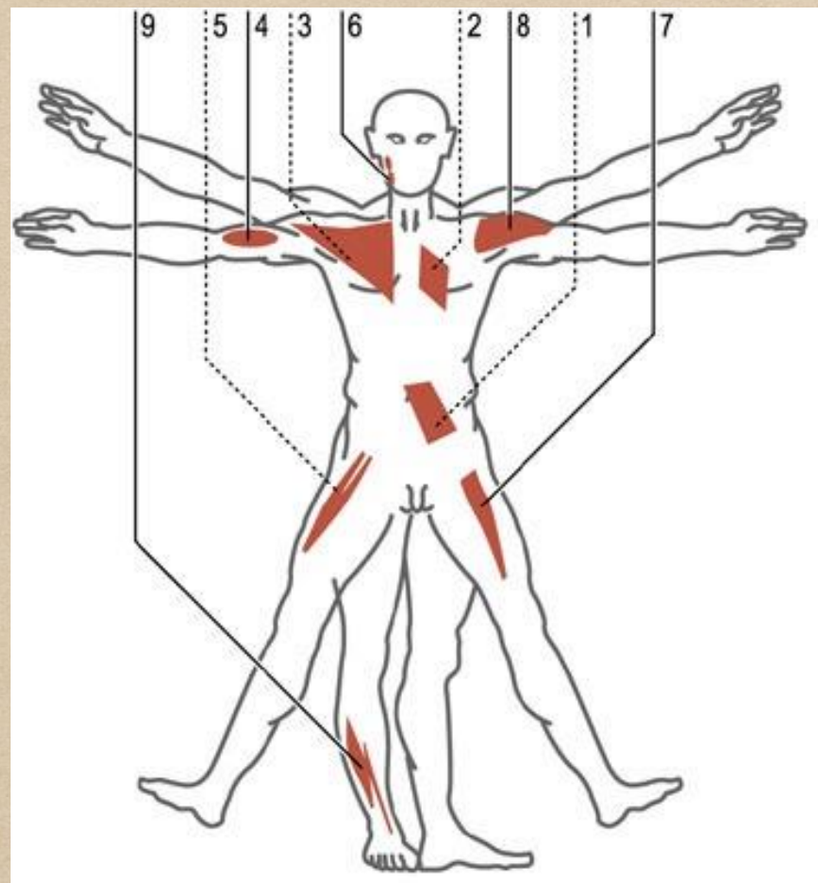
Diagnostic criteria

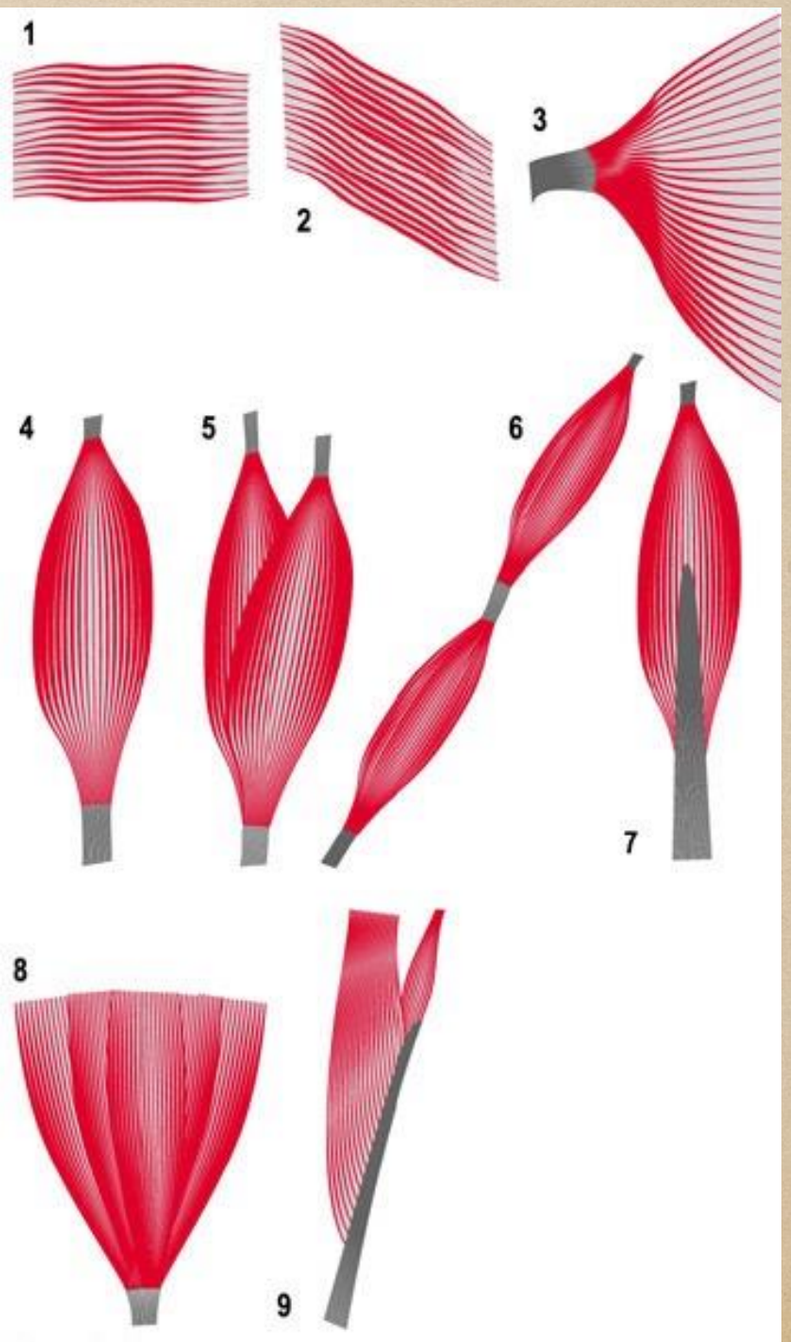
- taut band





Muscle Fiber Direction





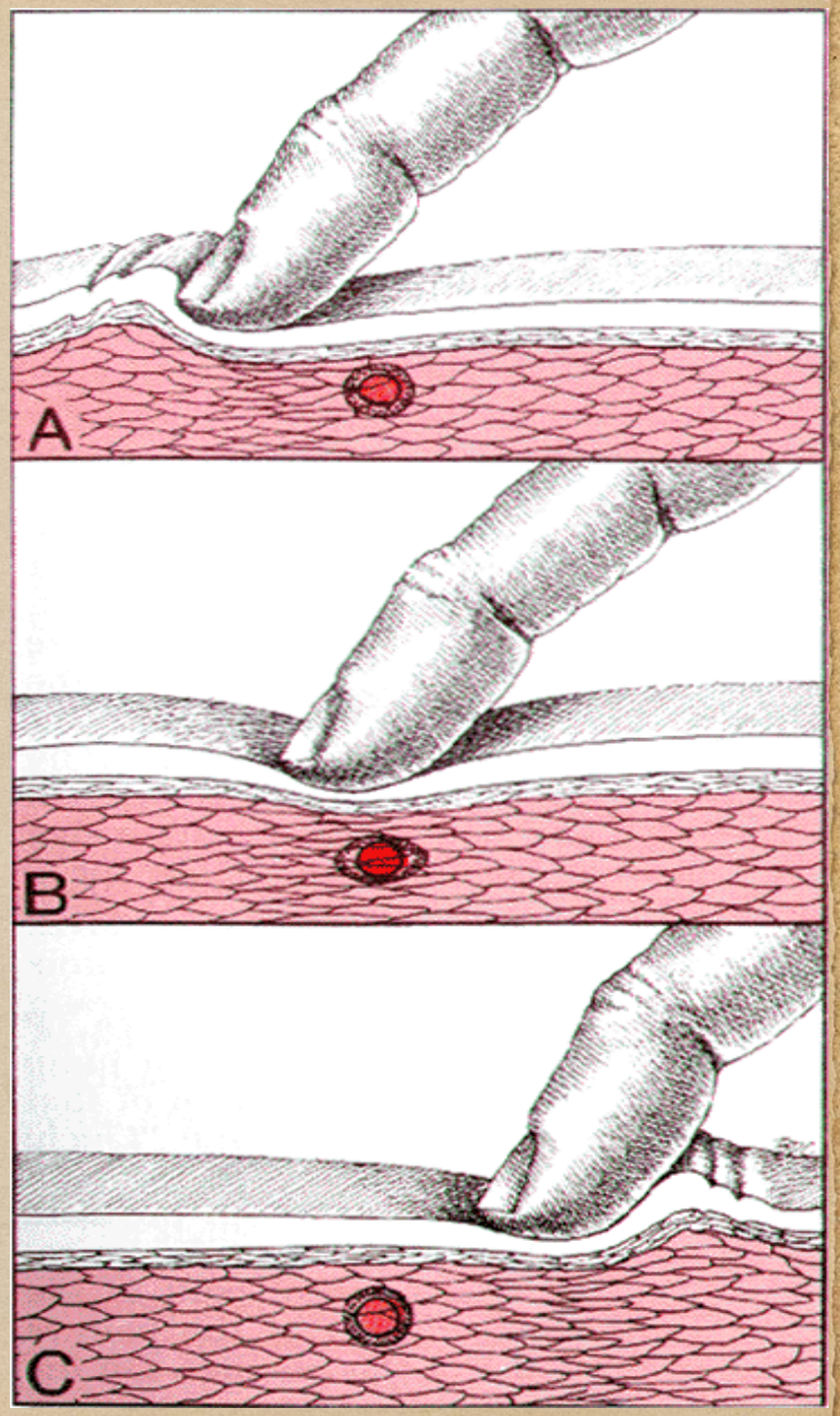
1 Quadrate – quadratus lumborum
2 Rhomboid – rhomboideus major
3 Trapezoid – trapezius
4 Bicipital – biceps
5 Fusiform – biceps femoris
6 Digastric – digastric
7 Bipennate – rectus femoris
8 Multipennate (triangular) – deltoid
9 Unipennate – extensor digitorum longus

Palpation

two palpation techniques:

- Flat palpation
- Pincer palpation

Flat Palpation



Scientific Basis of Trigger Points

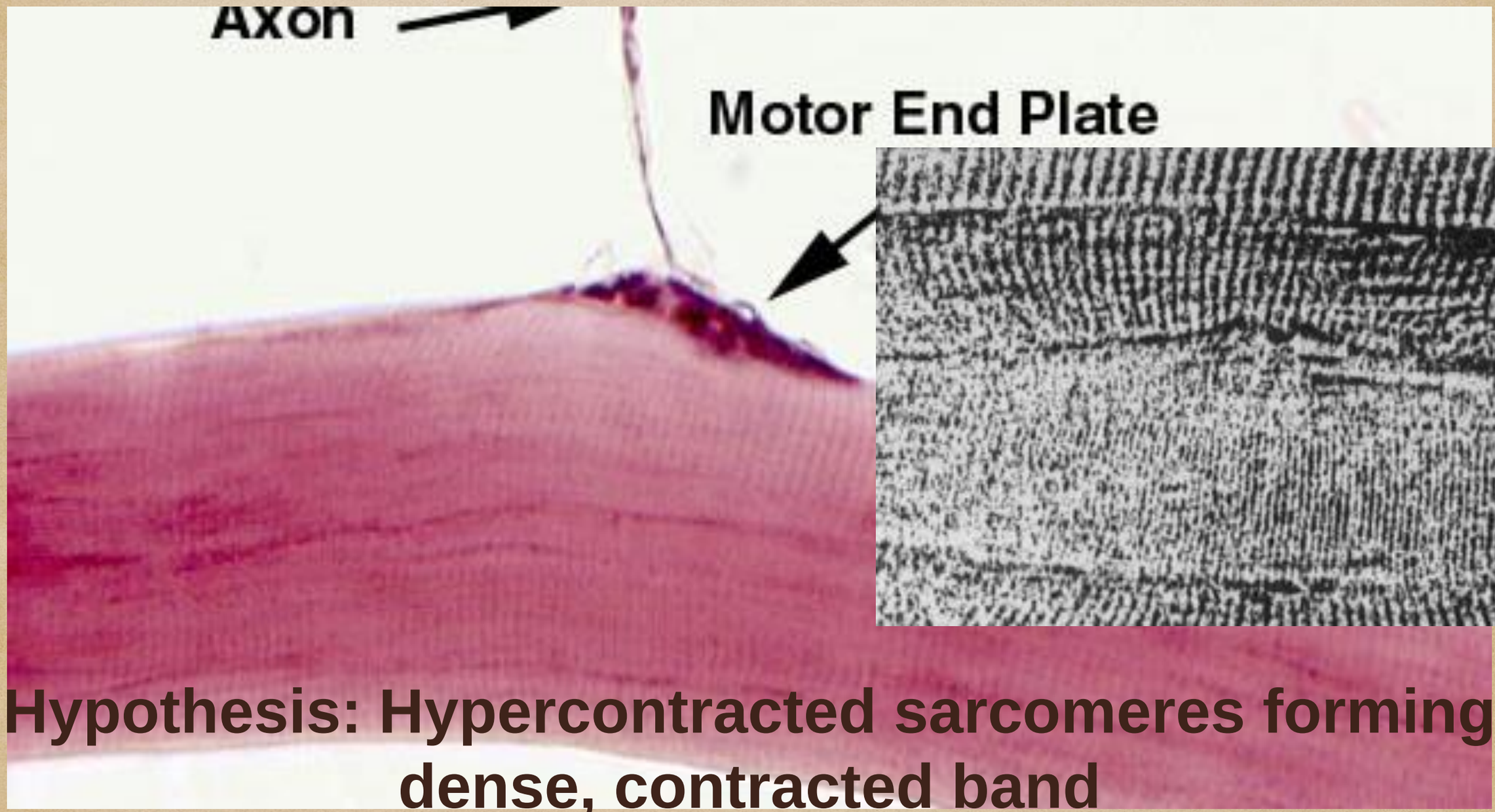
- Myofascial Trigger Points exhibit a number of characteristics that require explanation:
  - 1. Structural appearance (hardened muscle band)
  - 2. Biochemical features
  - 3. Nature of local and referred pain
  - 4. Response to treatment

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

Motor End PLate



Hypothesis: Hypercontracted sarcomeres forming dense, contracted band

Sikdar S, et al. Novel Applications of Ultrasound Technology

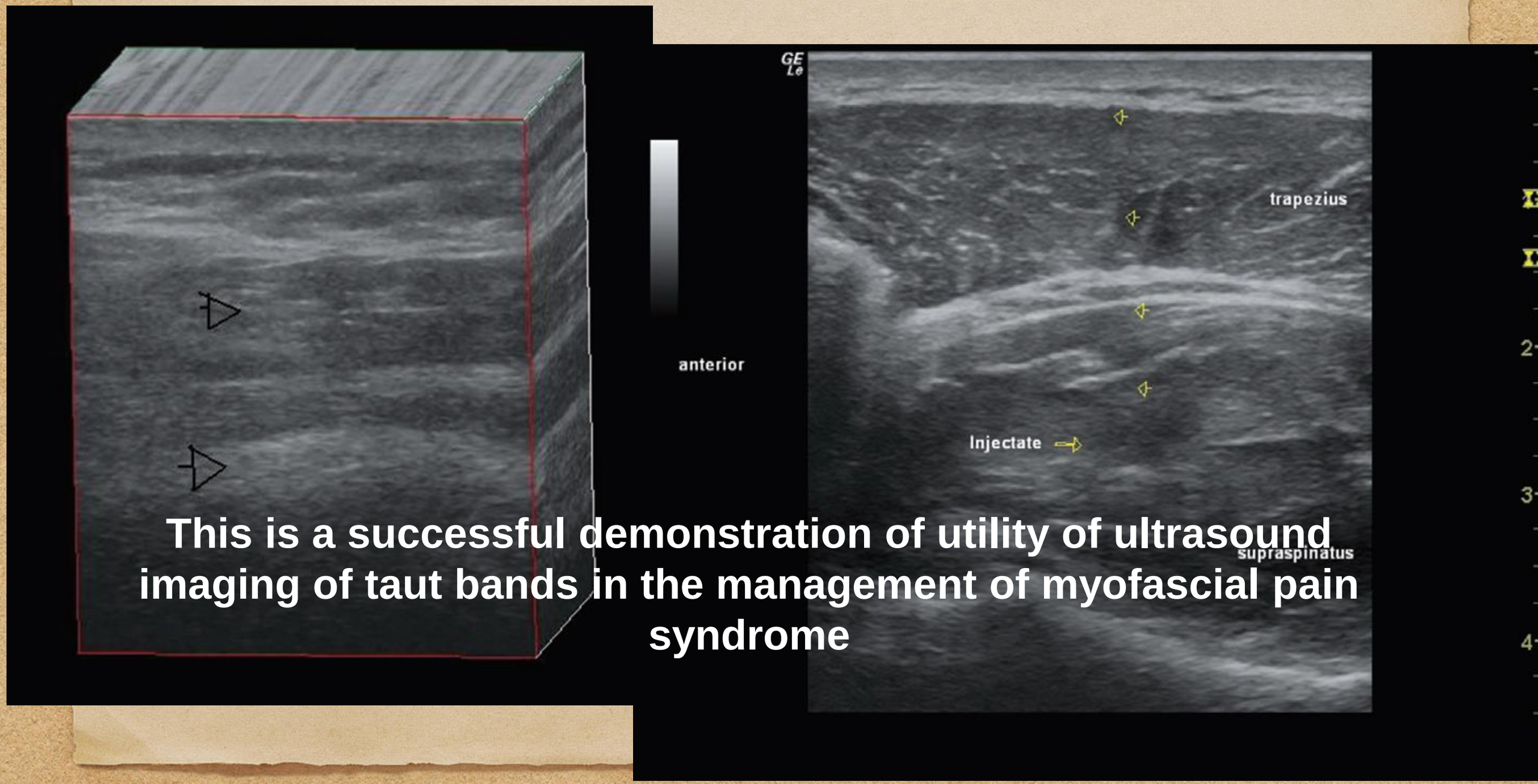
to Visualize and Characterize Myofascial Trigger Points

and Surrounding Soft Tissue. *Arch Phys Med Rehabil.* 2009;90:1829-38

Visible nodule

Two- and Three-Dimensional Ultrasound Imaging to Facilitate Detection and Targeting of Taut Bands in Myofascial Pain Syndrome

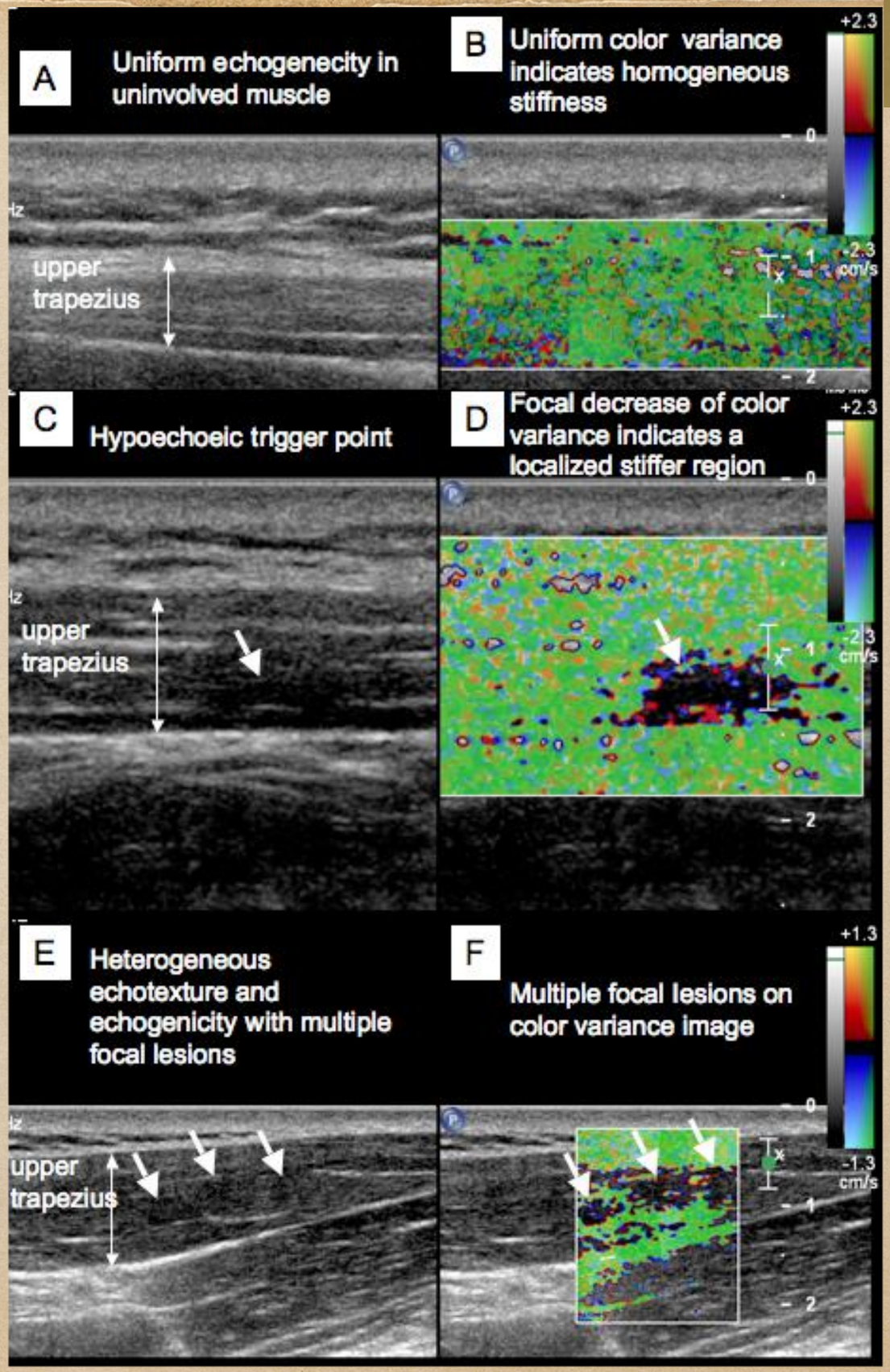
Hariharan Shankar and Sapna Reddy *Pain Medicine 2012*



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

Exerc Sport Sci Rev 2014;42(3):126-35
Sikdar et al. *Arch. Phys. Med.,* 2009



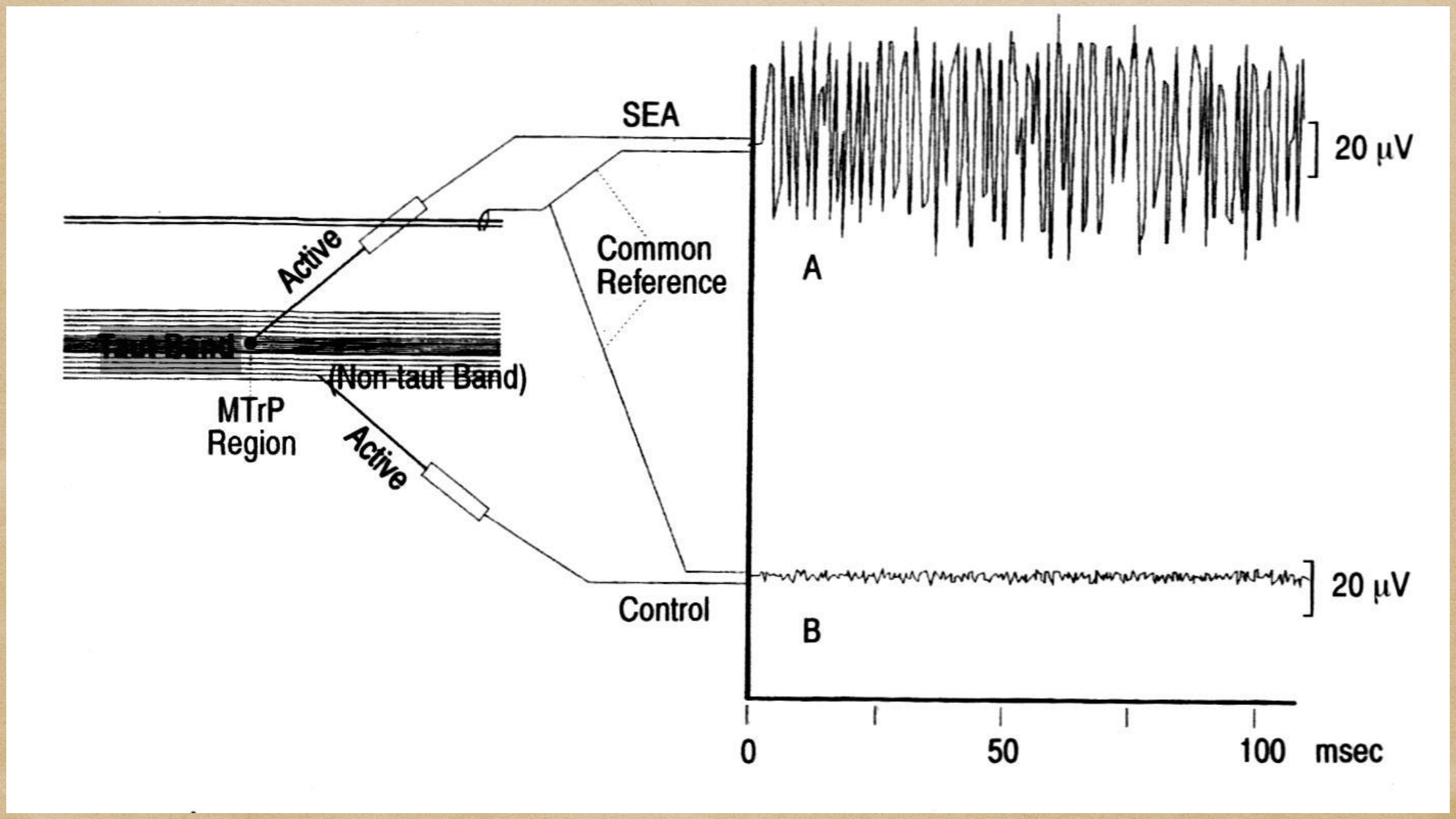
Archives of Physical Medicine and Rehabilitation 2009 90, 1829-1838DOI: (10.1016/j.apmr.2009.04.015)

Conclusion

The Trigger point zone is a densely contracted band of muscle that can be seen on ultrasound imaging

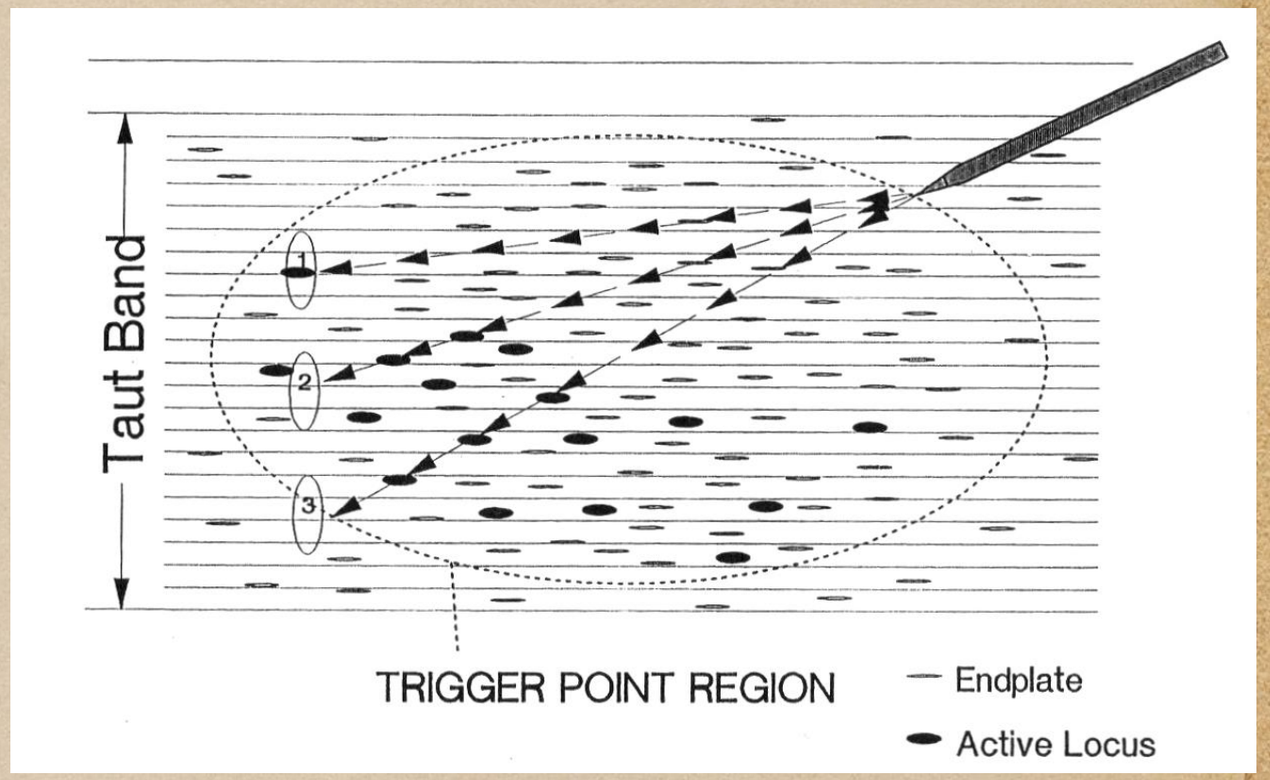
Trigger Point Electrophysiology

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

Attenuation of Endplate Noise by Botulinum Toxin

- 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

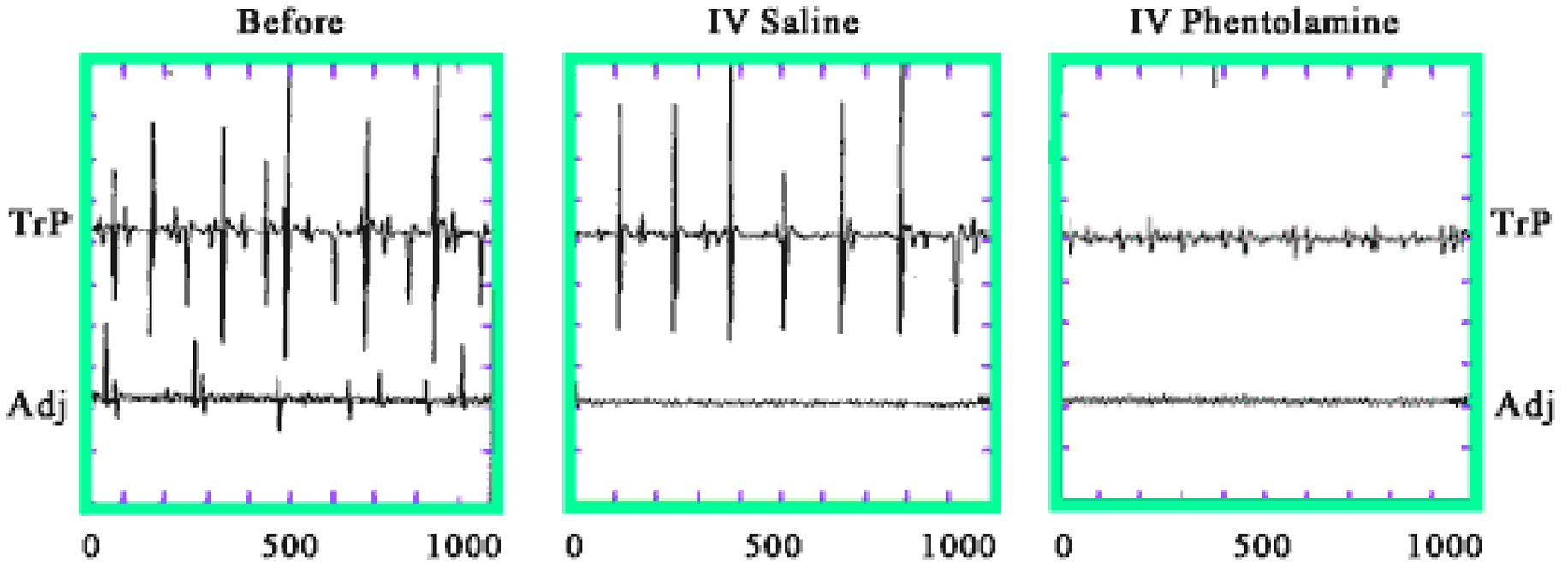
Kuan et al. Am J Phys Med Rehabil 2002;81:512-520

Sympathetic Modulation of Trigger Point Electrical Activity

Phentolamine

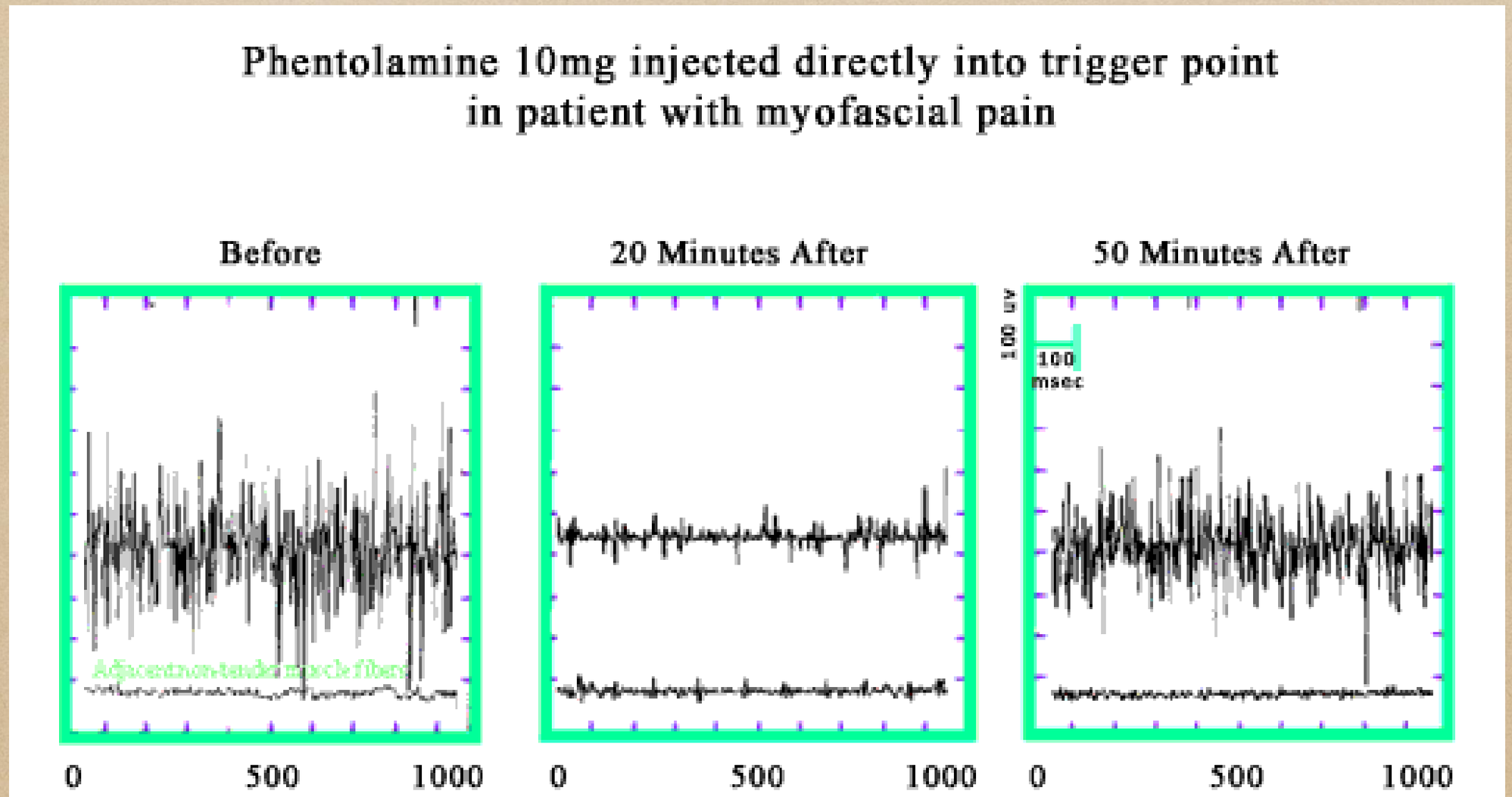
(alpha-adrenergic blocking agent)

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



Chen JT et al. Arch Phys Med Rehabil 1998; 79:790

Phentolamine



Chen JT et al. Arch Phys Med Rehabil 1998; 79:790

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 MTrP and tender points in unilateral shoulder pain

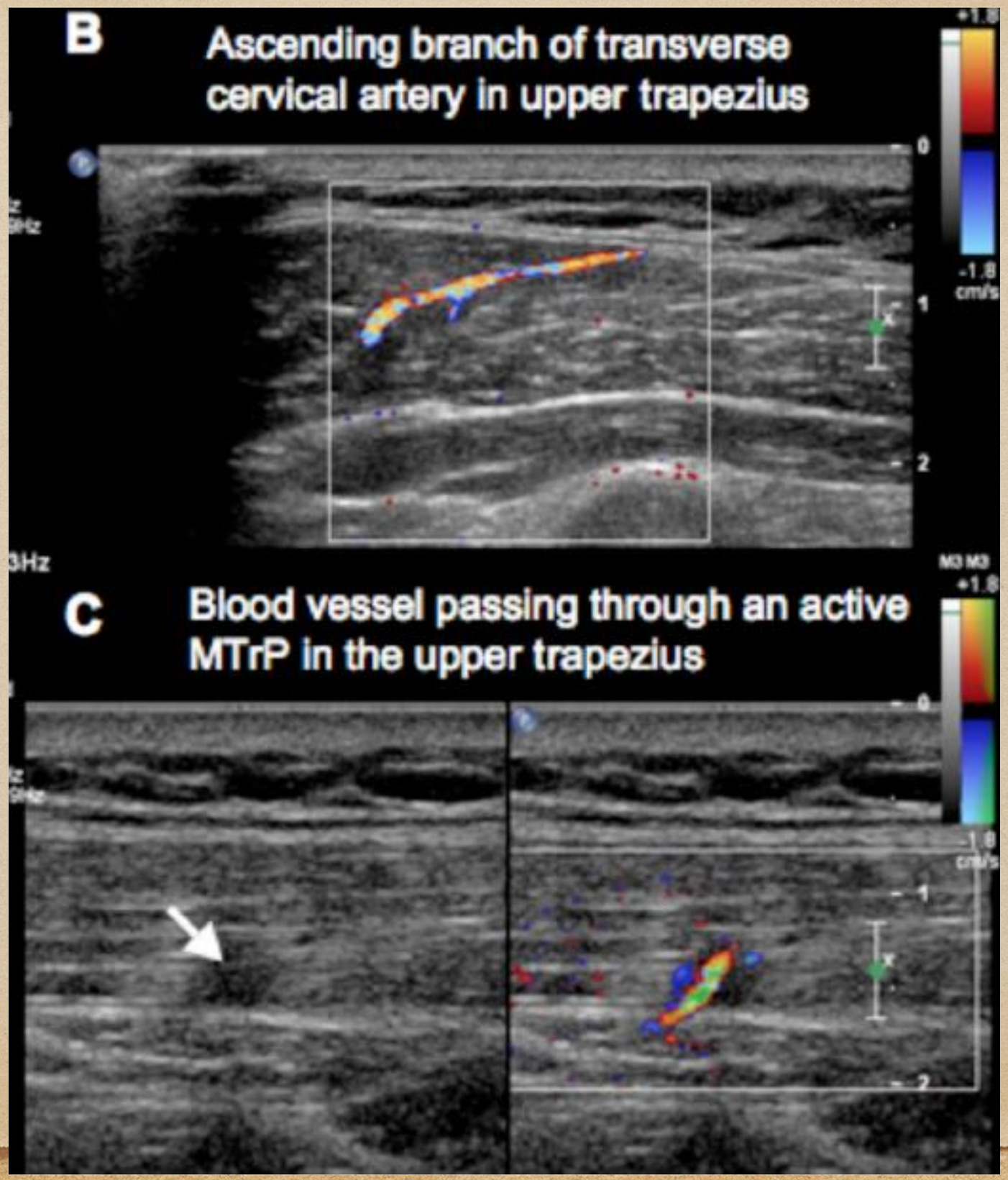
- Results: 1. *Pressure pain thresholds (PPT)* are lower at symptomatic MTrPs than tender points (non-painful side) with normal respiration.
- 2.*PPT* decreased at tender & TrPs & at referred pain sites at elevated intrathoracic pressures: local and referred *pain intensity* increased.
- Conclusion: sympathetic facilitation of
  - 1. mechanical sensitization and 2. local and referred muscle pain

Ge HY, Fernandez de-las-Penas C, Arendt-Nielsen L. Clin Neurophysiol 2006; 117:1545-50

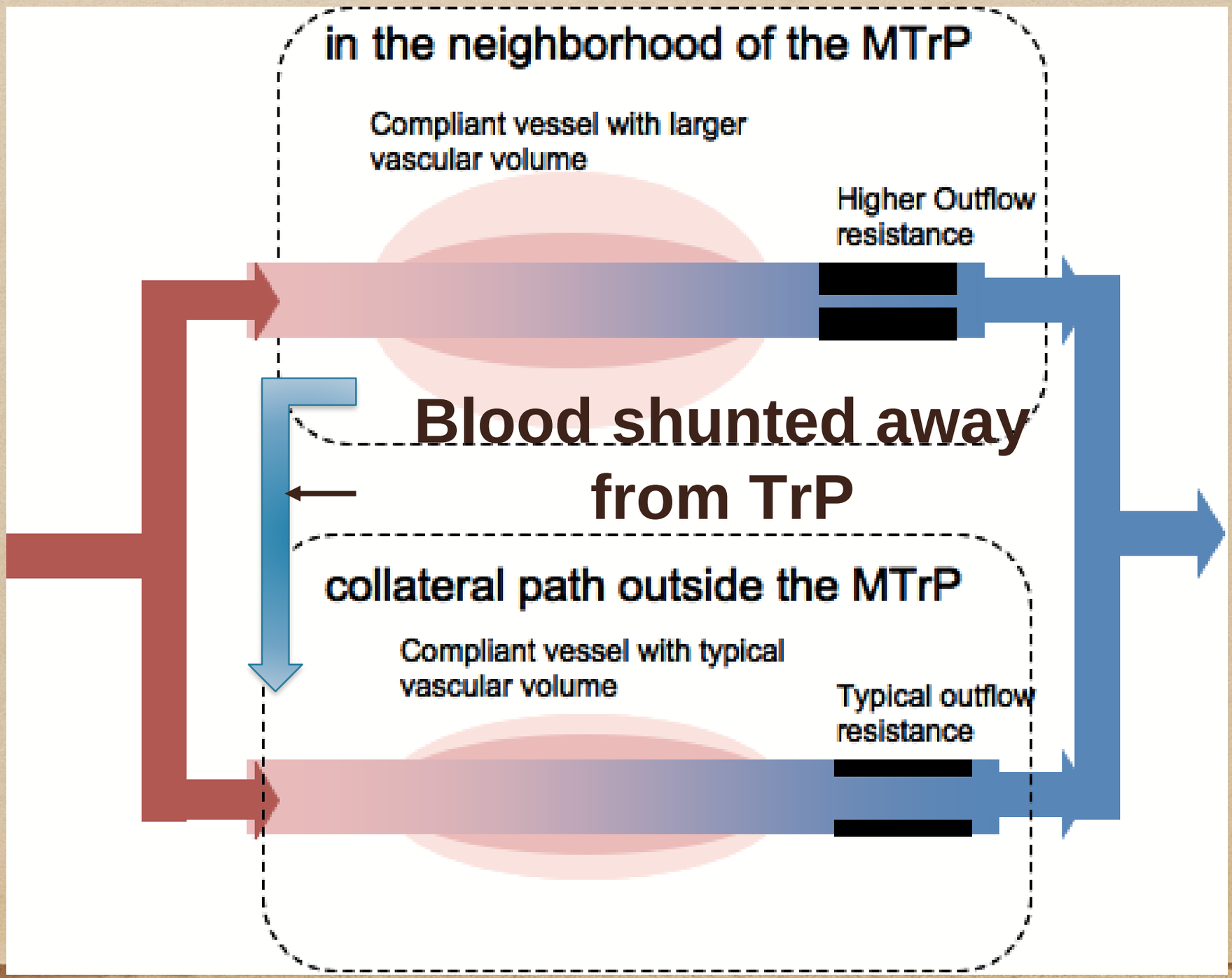
Vascular changes at the trigger point

Retrograde Blood Flow at the Trigger Point

Ballyns JJ, Shah JP, Hammond J, Gebreab T, Gerber LH, Sikdar S. Objective Sonographic Measures for Characterizing Myofascial Trigger Points Associated with Cervical Pain. *J Ultrasound Med* 2011; 30:1331-1340.


B
Ascending branch of transverse cervical artery in upper trapezius
C
Blood vessel passing through an active MTrP in the upper trapezius

Sikdar S, Ortiz R, Gebreab T, Gerber LH, Shah JP, Understanding the vascular environment of myofascial trigger points using ultrasonic imaging and computational modeling. Conf Proc IEEE Eng Med Biol Soc 1: 5302-5, 2010.



Biochemical Features of the Trigger Point

Changes in pH, neurotransmitters, kinins in Trapezius muscle trigger point zone

What about ACh?

Trapezius vs Gastrocnemius

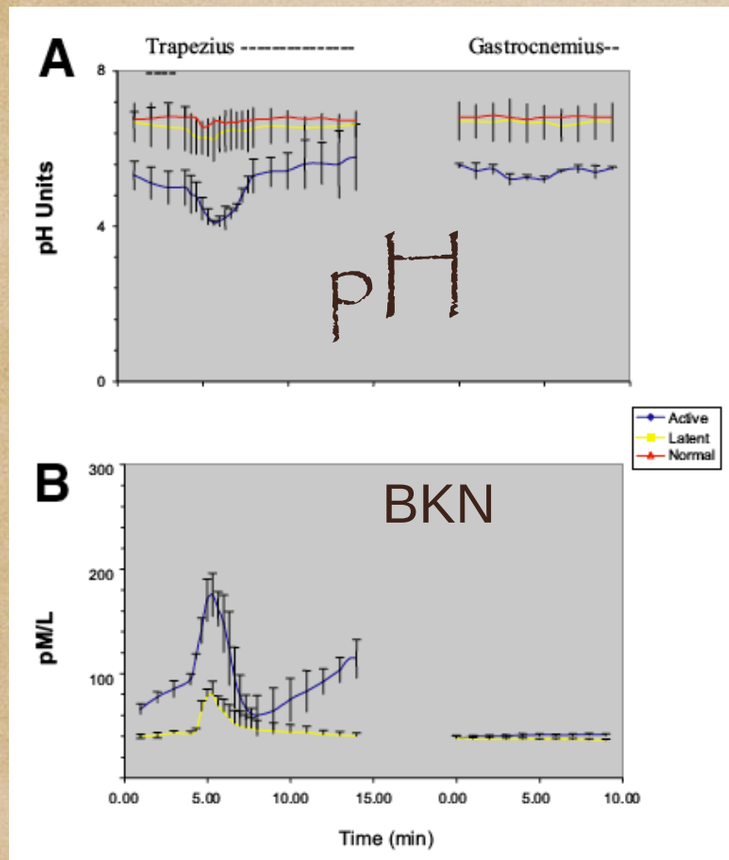


Fig 7. Analyte concentrations in the trapezius compared with the gastrocnemius for (A) pH and (B) bradykinin.

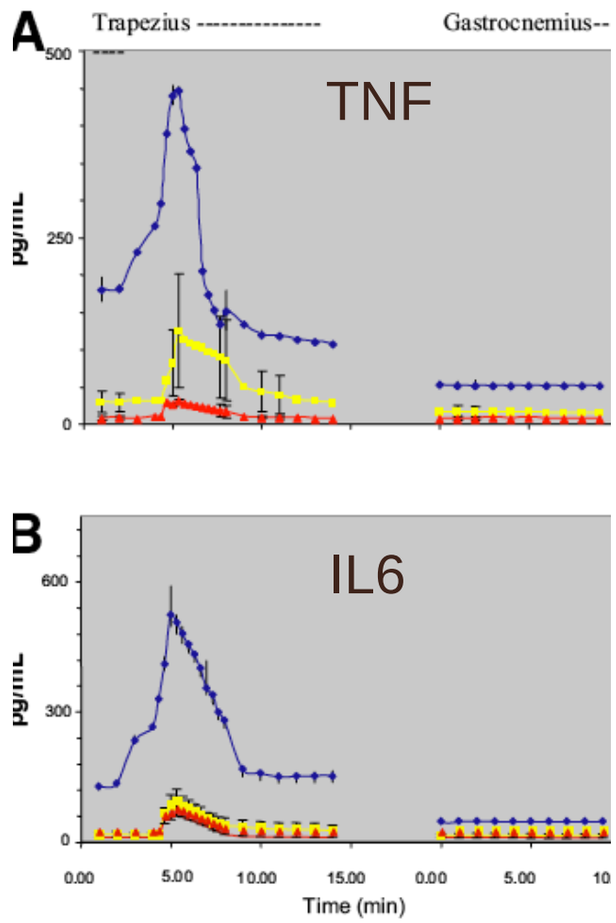


Fig 9. Analyte concentrations in the trapezius compared with the gastrocnemius for (A) TNF-α and (B) IL-6.

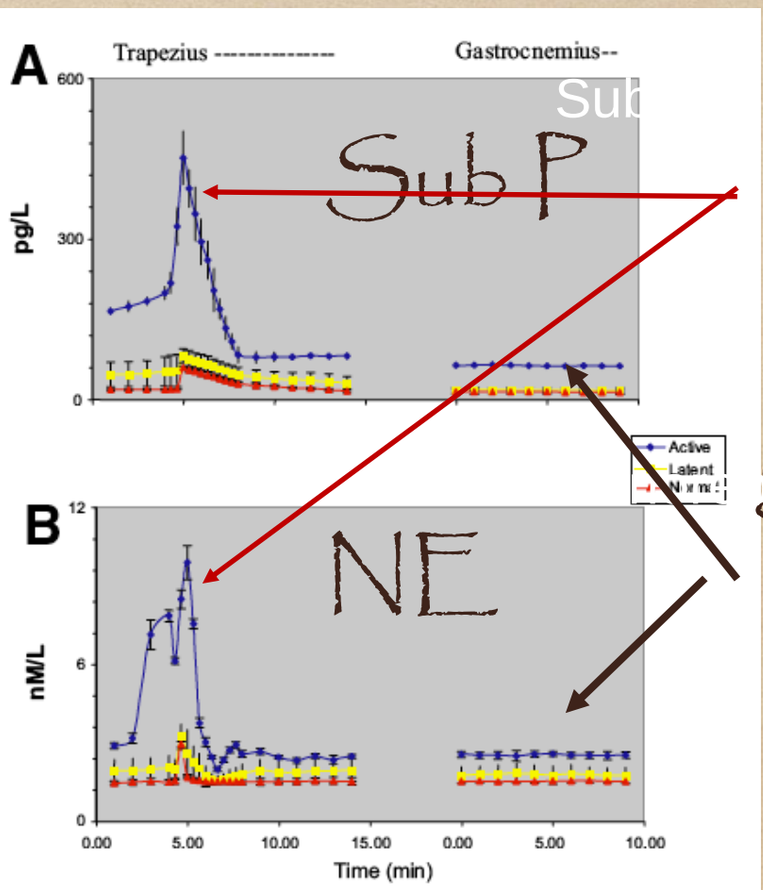


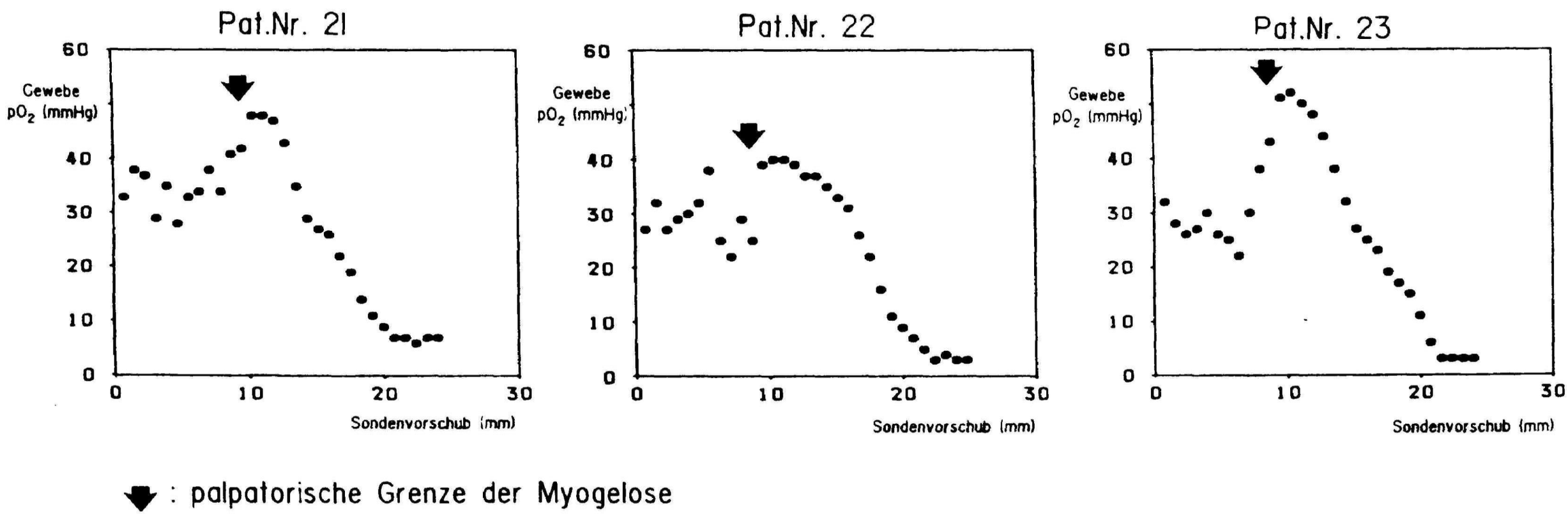
Fig 8. Analyte concentrations in the trapezius compared with the gastrocnemius for (A) SP and (B) norepinephrine.

Tra p gastro c

Shah, J.P., et al., An in-vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. J Appl Physiol, 2005. 99: p. 1980-1987

Shah JP, Danoff JV, Desai MJ, Parikh S, Nakamura LY, Phillips TM, and Gerber LH, Biochemicals associated with pain and inflammation are elevated in sites near to and remote from active myofascial trigger points. Arch Phys Med Rehabil. **89**(1): 16-23, 2008

O_2- tissue saturation in TrPs



Brückle, W., et al., Gewebe-pO2-Messung in der verspannten Rückenmuskulatur (m. erector spinae). Z. Rheumatol., 1990. 49: p. 208-216.

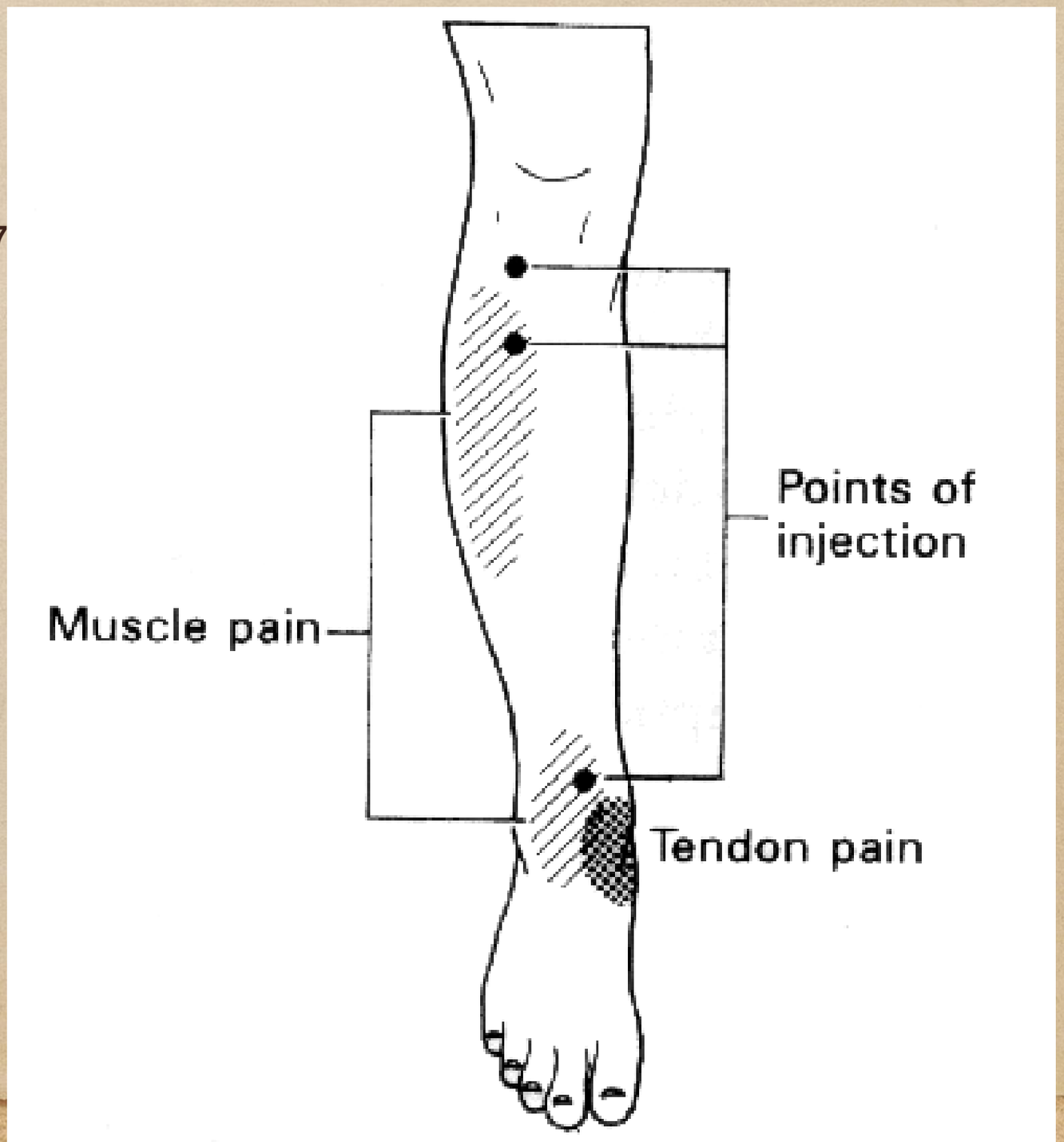
Conclusion

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

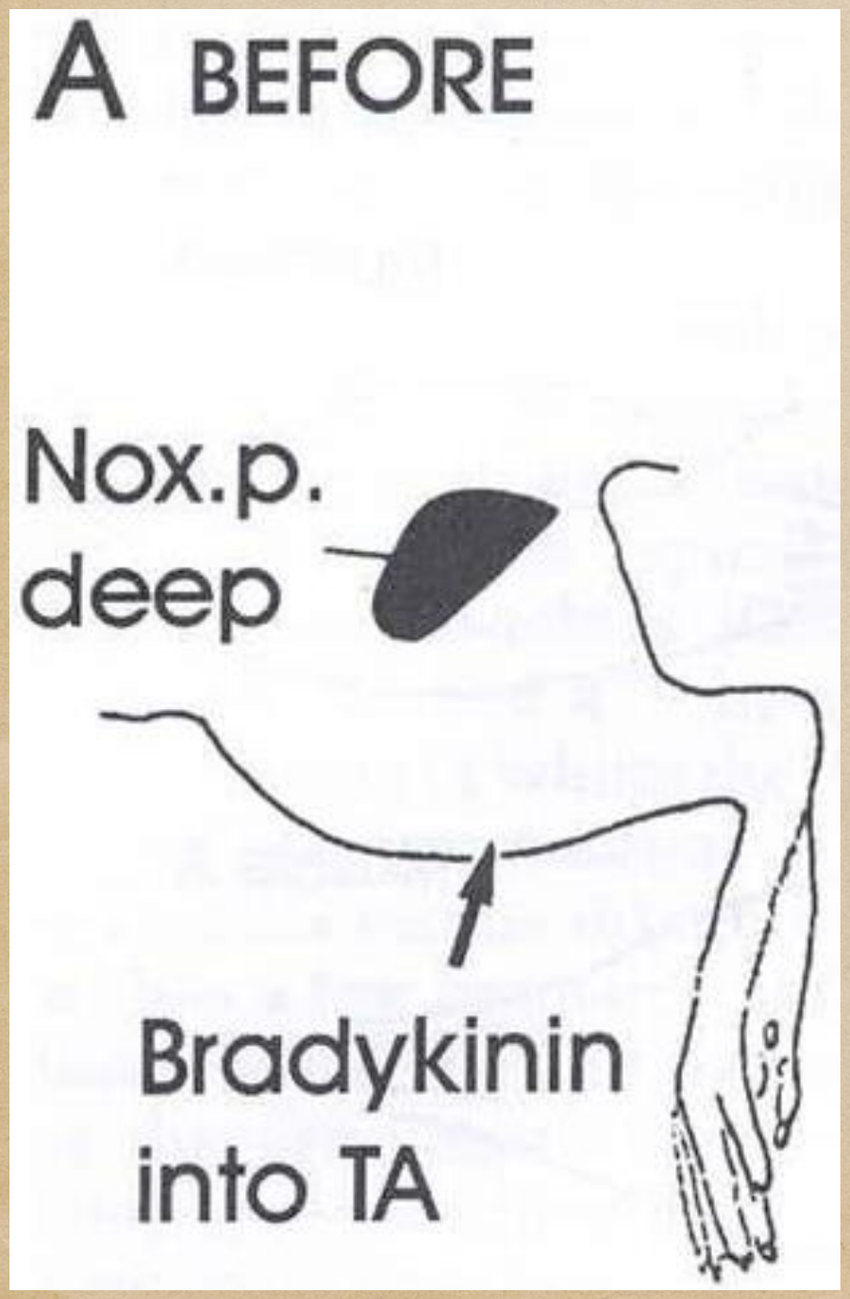
Referred Pain

Referred Pain

J.H. Kellgren, Clinical Science, vol.3.pp 17
190© 1938



Expansion of Receptive Field

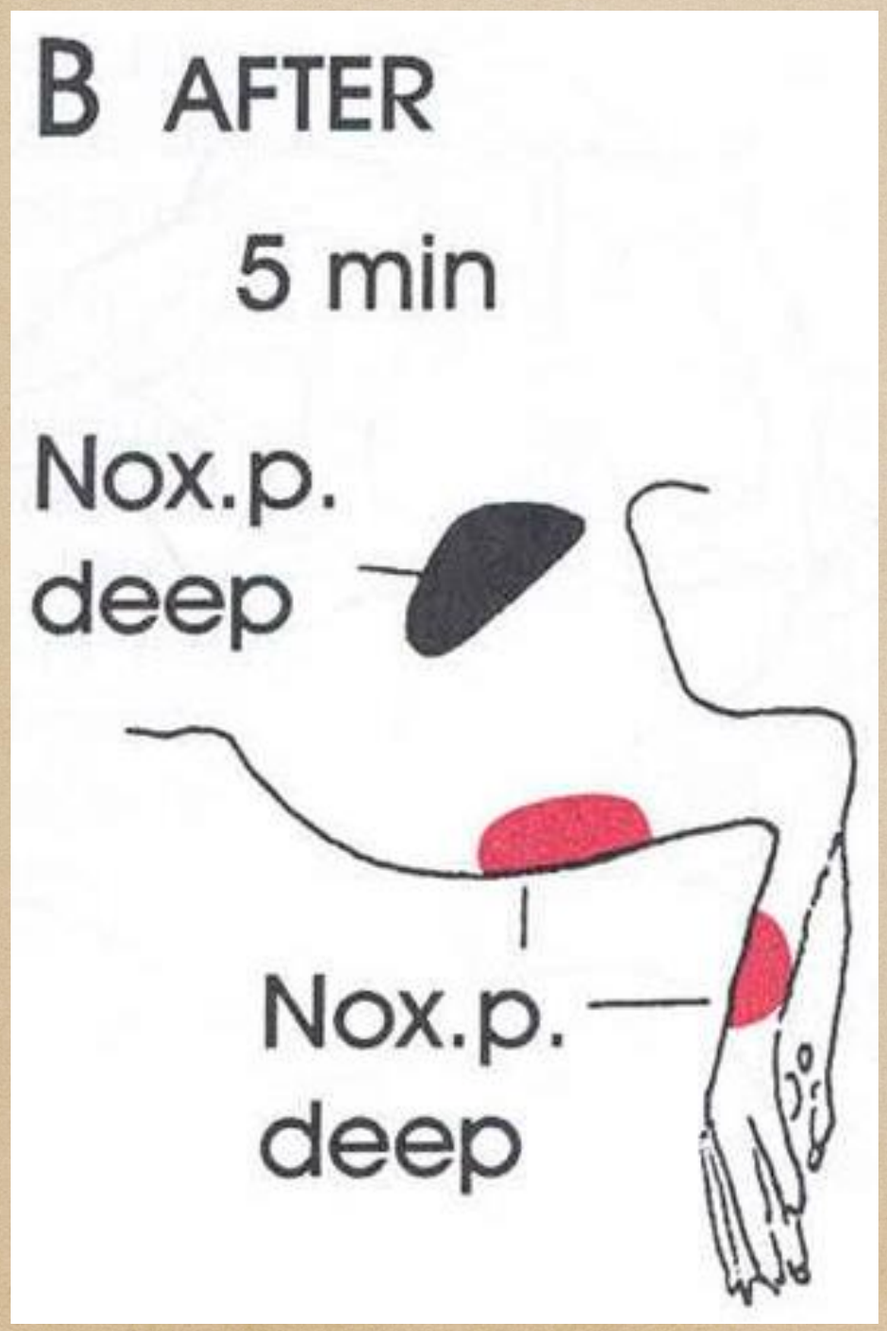


Selected neuron responds only to deep pressure in biceps femoris muscle from one receptive field site

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



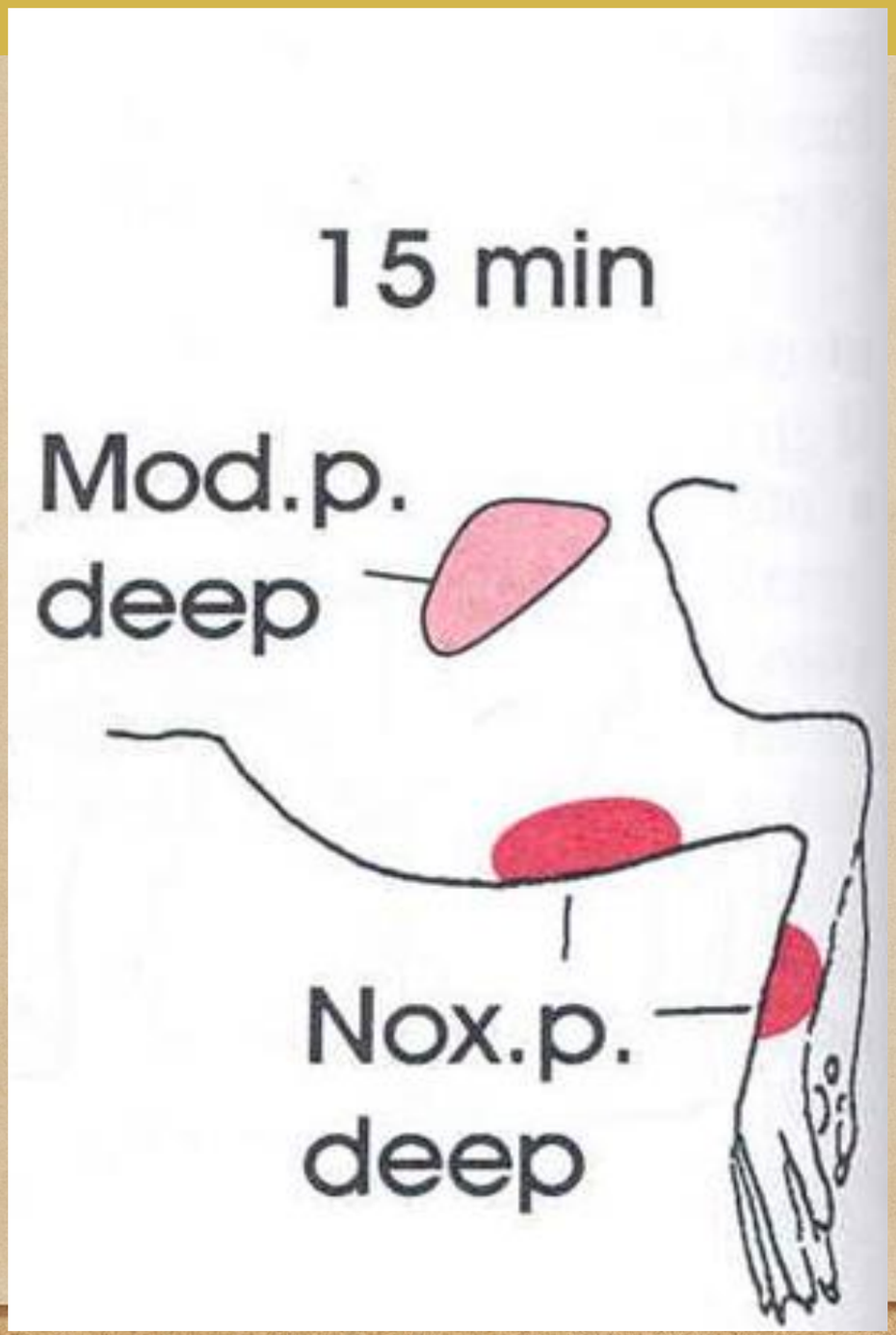
5 min after Bradykinin injection in tibialis anterior, the neuron can now be excited by additional RF sites located in deep muscle

(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

Expansion of Receptive Field



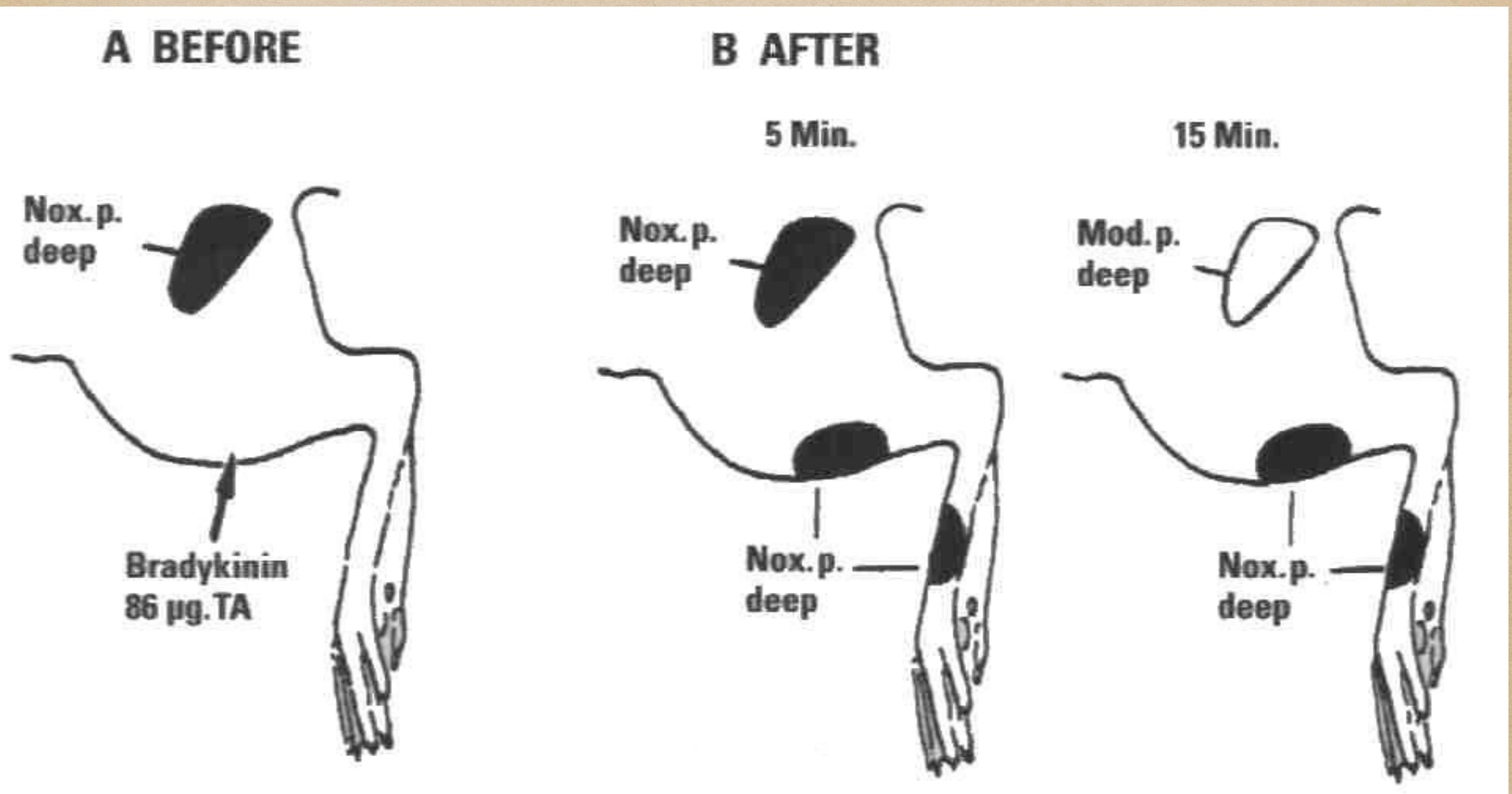
15 min after Bradykinin injection the neuron responds to moderate (less) pressure in the original receptive field - biceps femoris

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

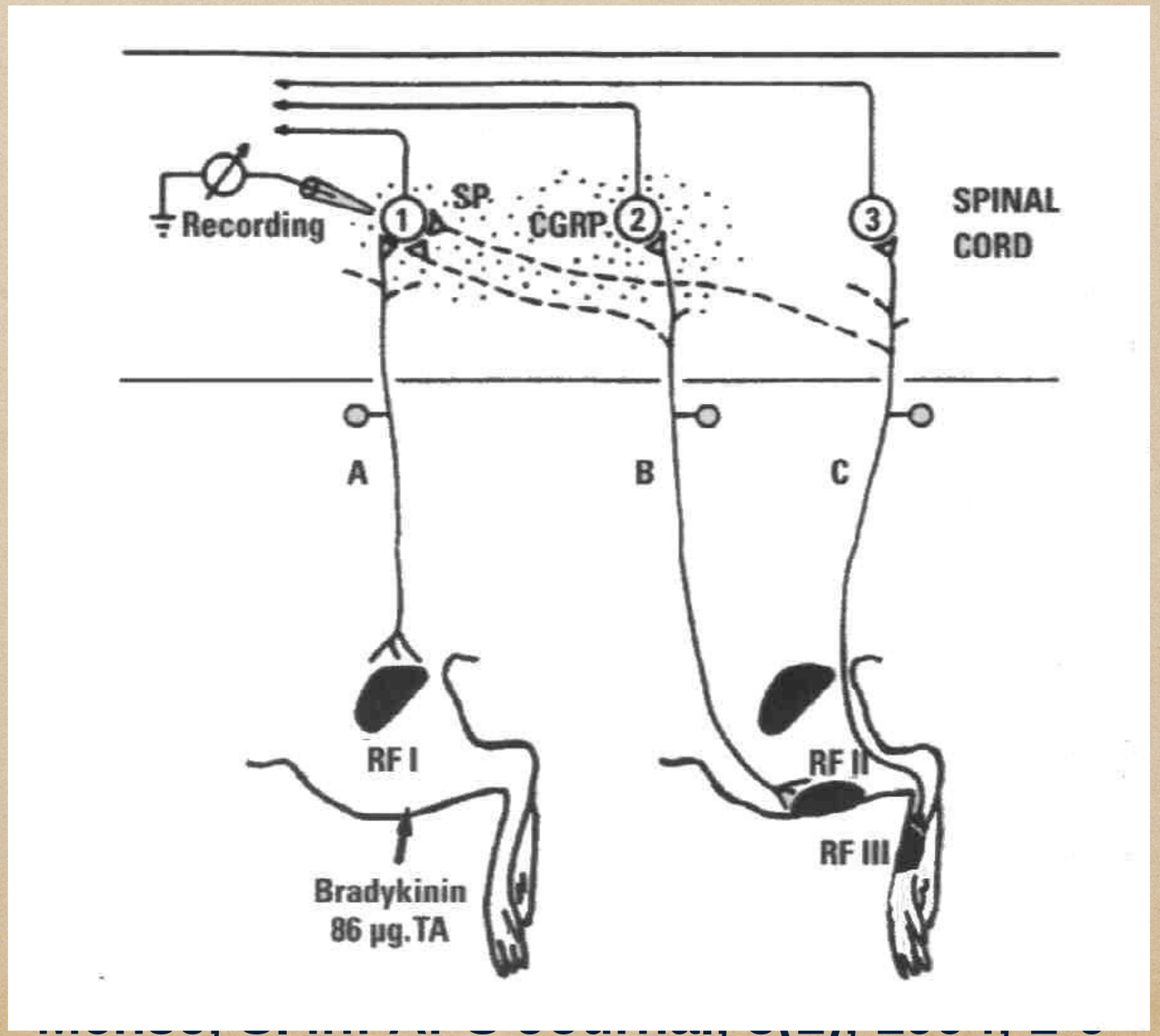
Expansion of Receptive Field:

Receptive fields have expanded and respond to a milder noxious stimulus



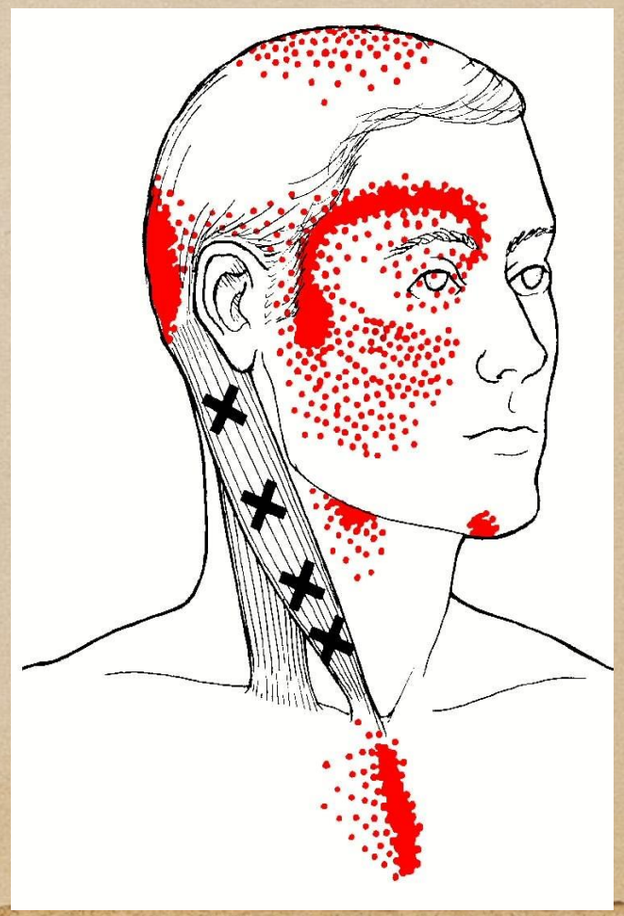
Mense, S. in: APS Journal, 3(1), 1994, 1-9

Expansion of Receptive Field



Sensitization

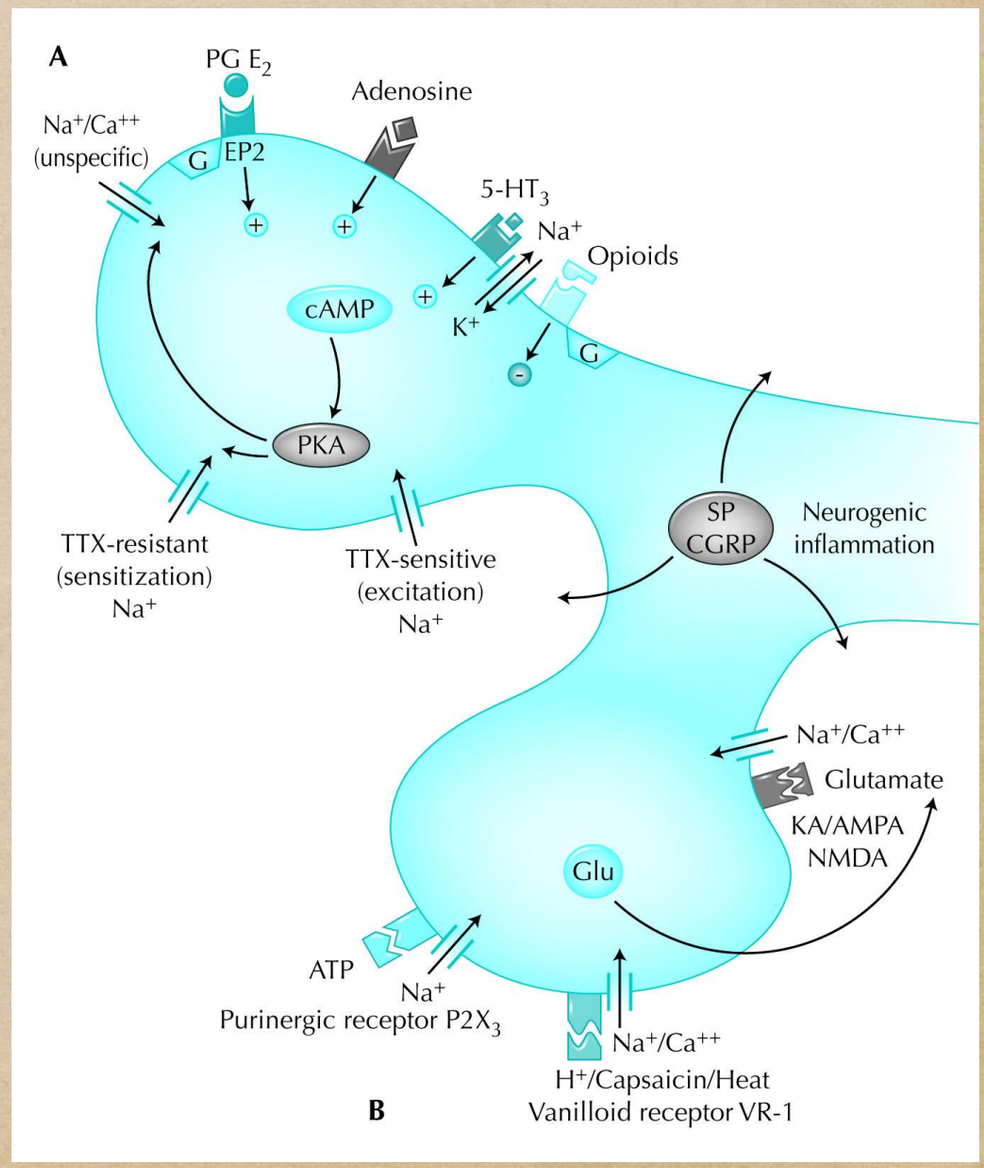
- **Hypersensitivity**
- **Allodynia**
- **Referred pain**



Peripheral Mechanisms

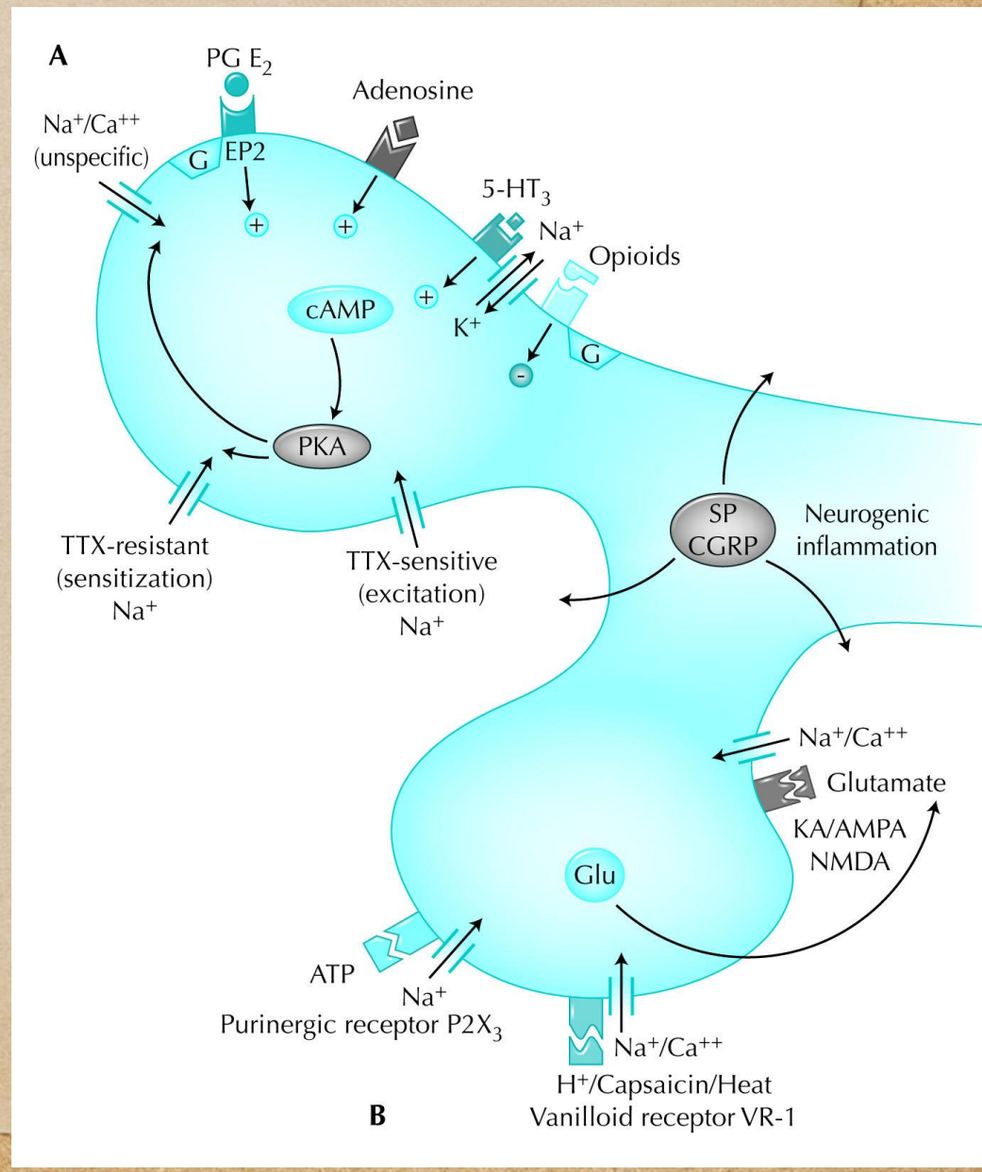
- Muscle tenderness is mainly due to
- muscle nociceptor sensitization:
  - acidic pH
  - prostaglandins
  - bradykinin and serotonin

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



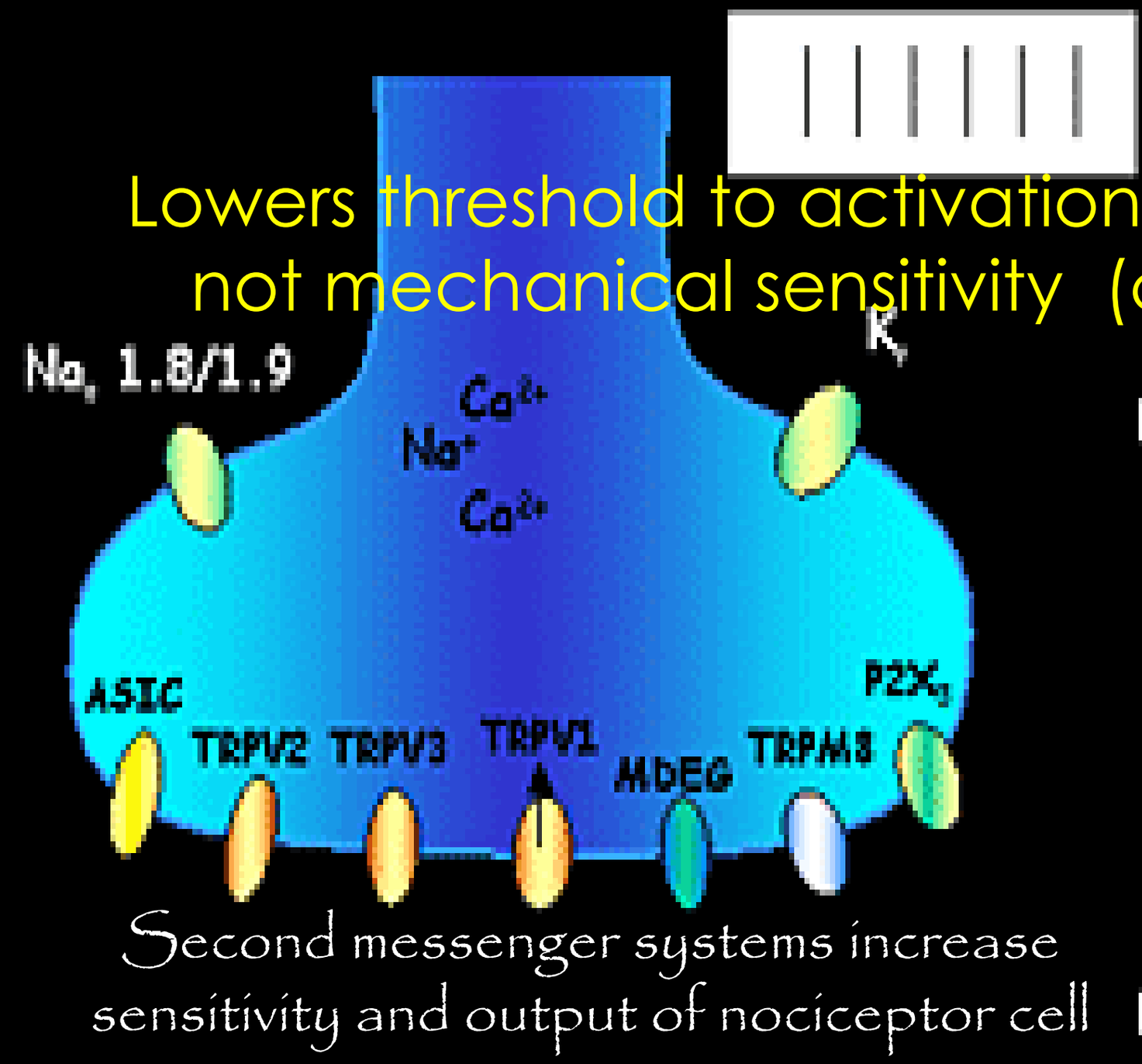
NOCICEPTIVE PAIN

PERIPHERAL SENSITIZATION

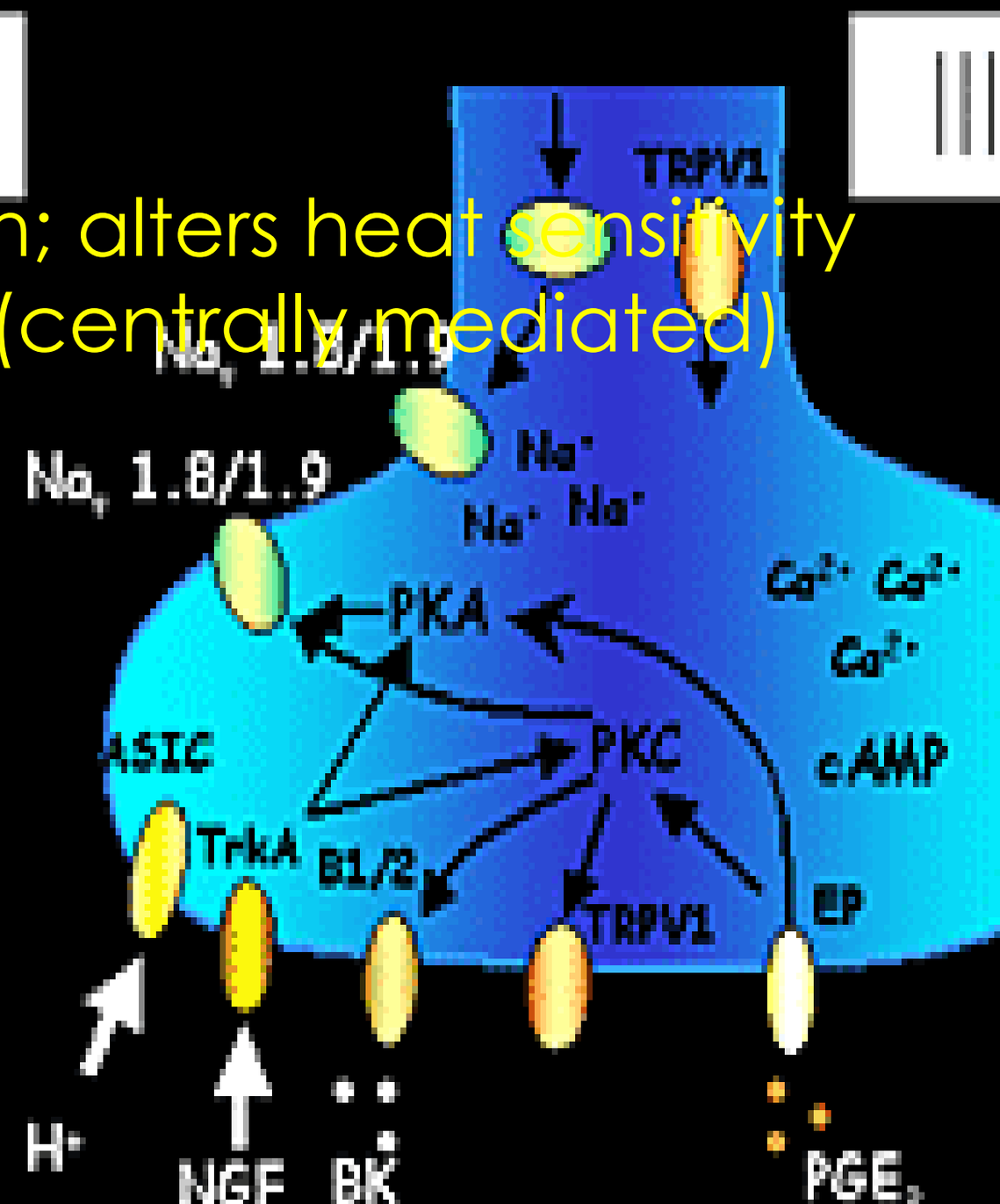
Peripheral Sensitization: Inflammatory mediators (kinins, TH+)

Restricted to site of injury;

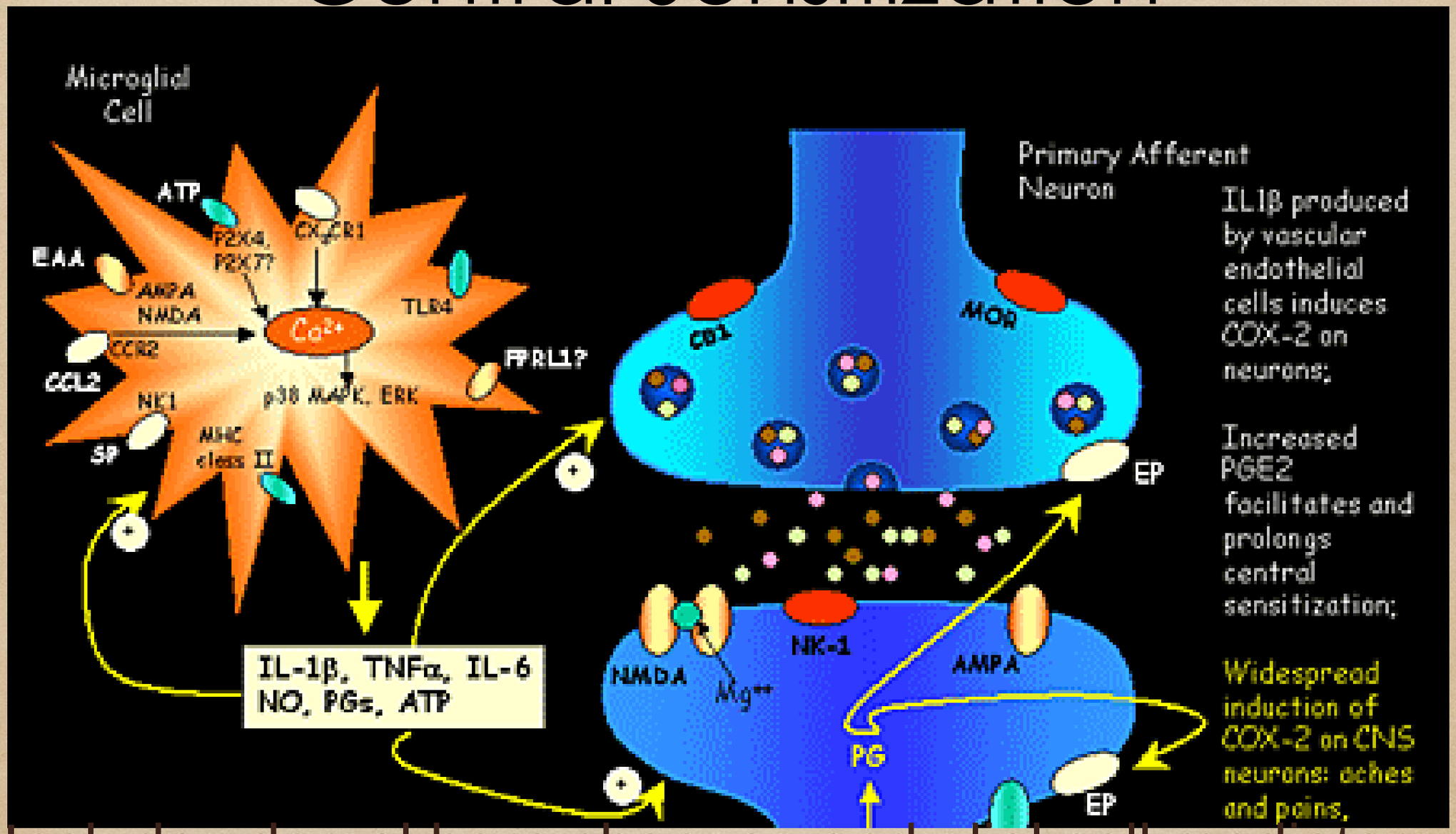
Lowers threshold to activation; alters heat sensitivity not mechanical sensitivity (centrally mediated)



Second messenger systems increase sensitivity and output of nociceptor cell



Central Sensitization



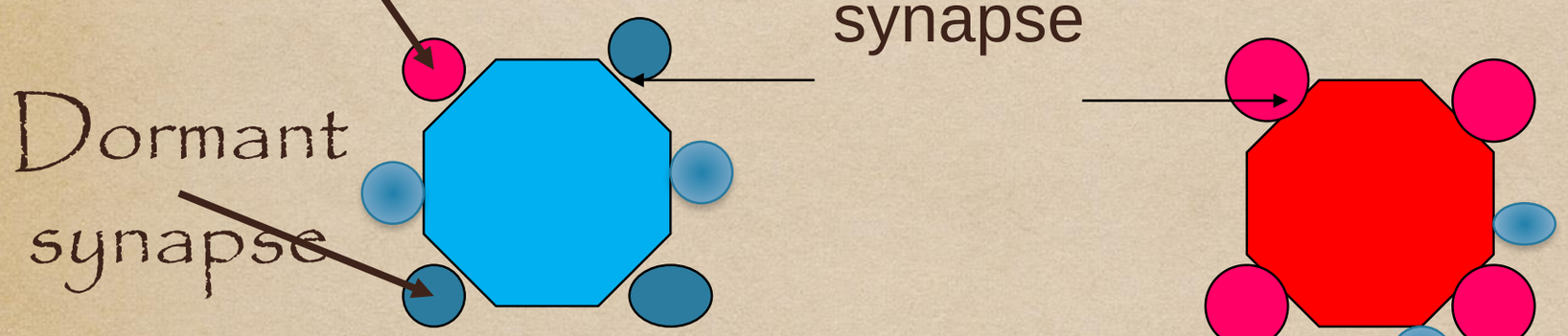
Includes dorsal horn changes and glial cell mediators; increased synaptic efficacy

Central Sensitization: Activation of dormant synapses increases synaptic efficiency

Excited or active synapse

Nerve axons

Increase in excited or active synapses results in more excitable nociceptive neuron

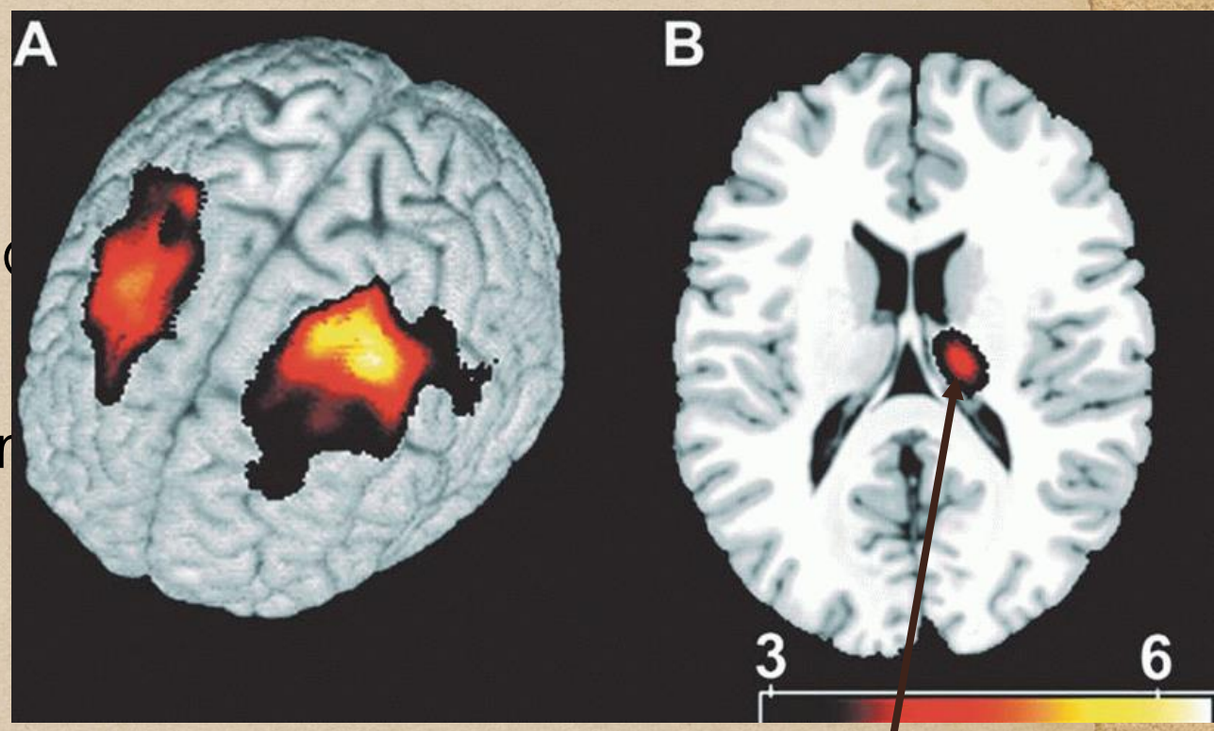


non-activated cell

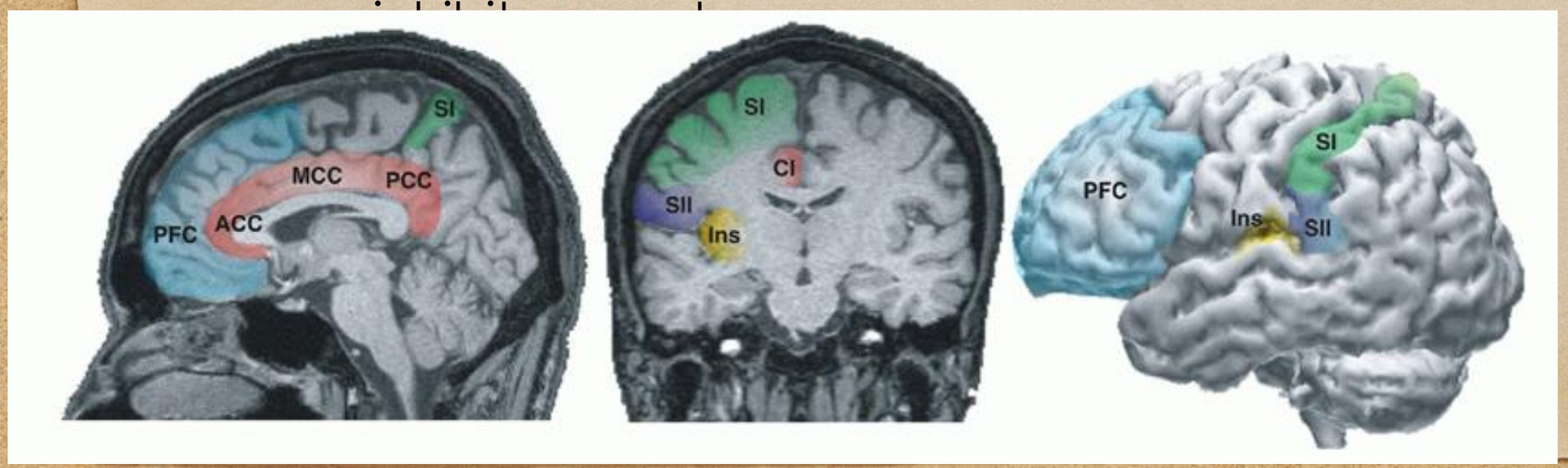
Activated cell

Cerebral as well as Spinal

- Extent of neuroplastic changes in the C
- Dorsal horn neurons
  CN V nucleus caudalis of the br
  Thalamus, Amygdala
  Anterior cingulate gyrus
  Periaqueductal gray matter



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

- Huang QM et al. Acupunct MEd 2013;31:65-73; Huang QM et al. Acupunct Med 2015;33:319-24

Summary

Muscle injury (overuse)

Substance P
CGRP

Edema

Vasoconstriction

Low pH

~~Ischemia~~

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

Kinins
Interleukins

Increased ACh activity at endplate

Localized sarcomere contraction under the endplate

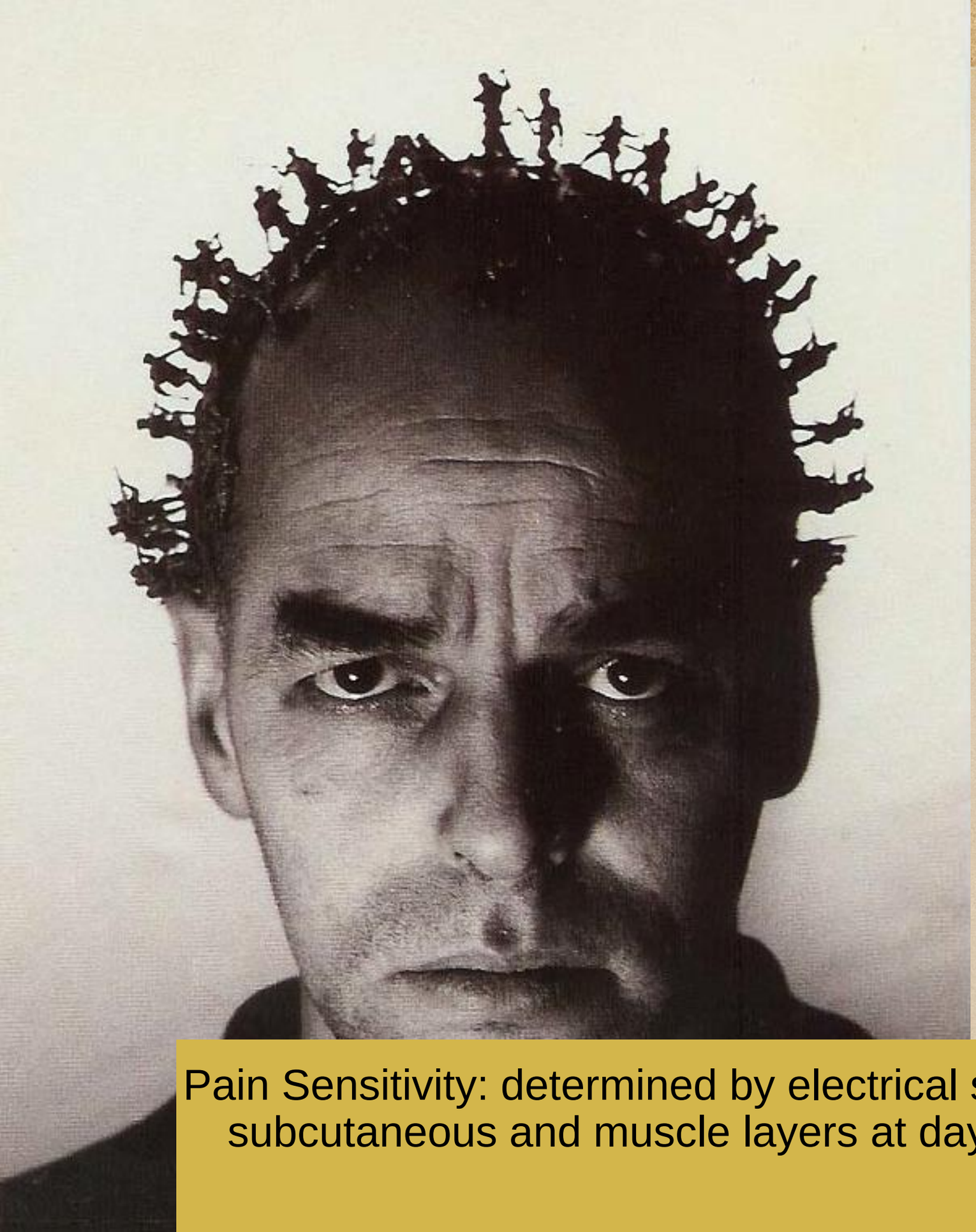
ASIC3 activation

Nociceptive receptor activation

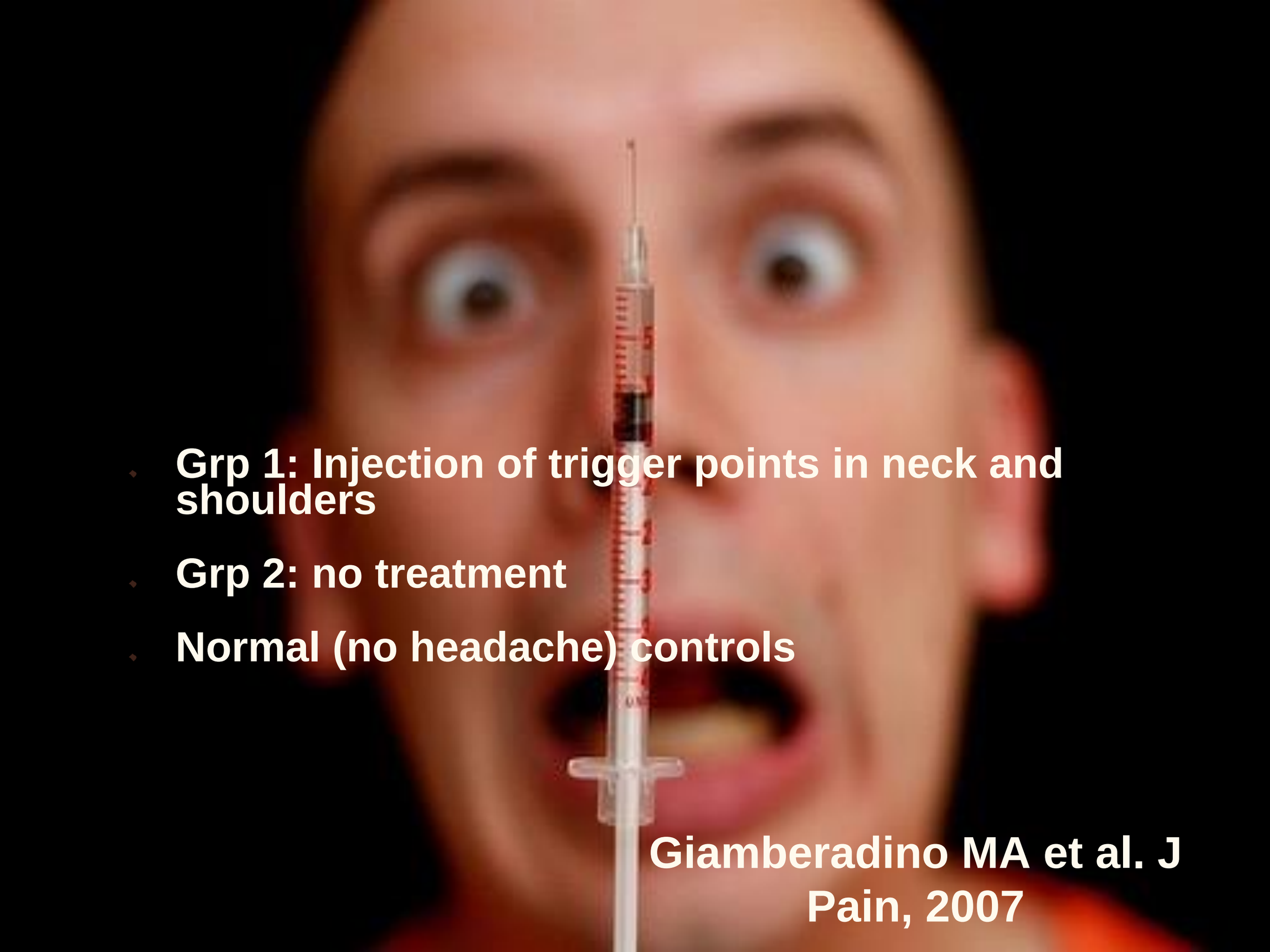

TREATMENT

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

Giamberadino MA et al. J Pain, 2007

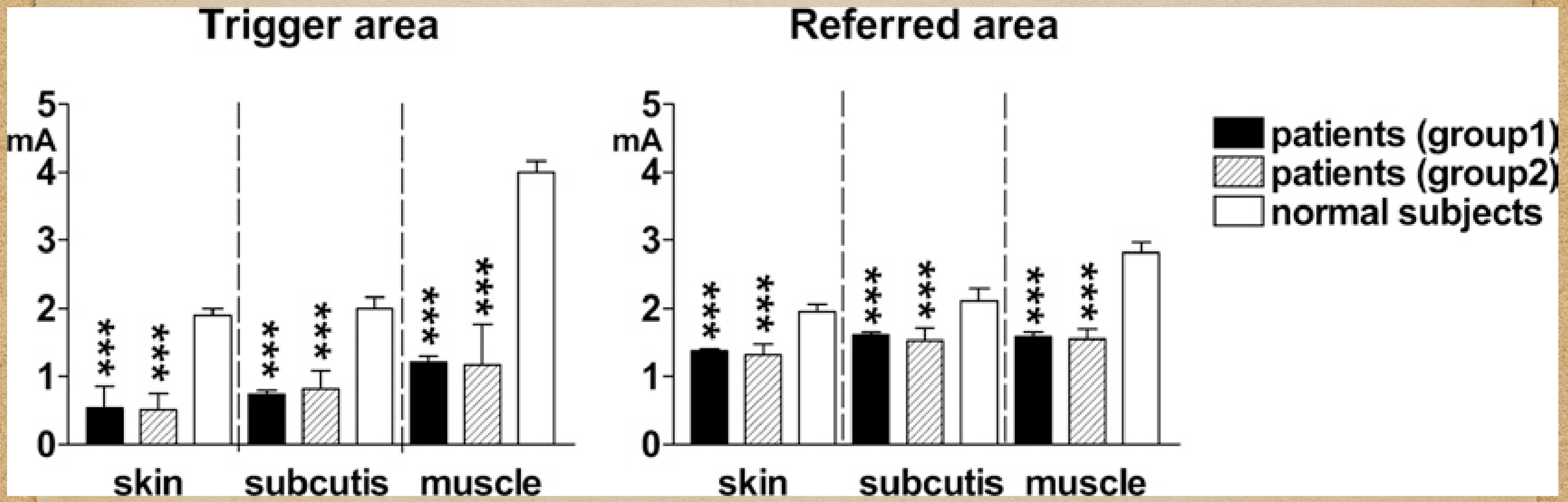


Pain Sensitivity: determined by electrical stimulation of skin, subcutaneous and muscle layers at days 3, 10, 30, and 60



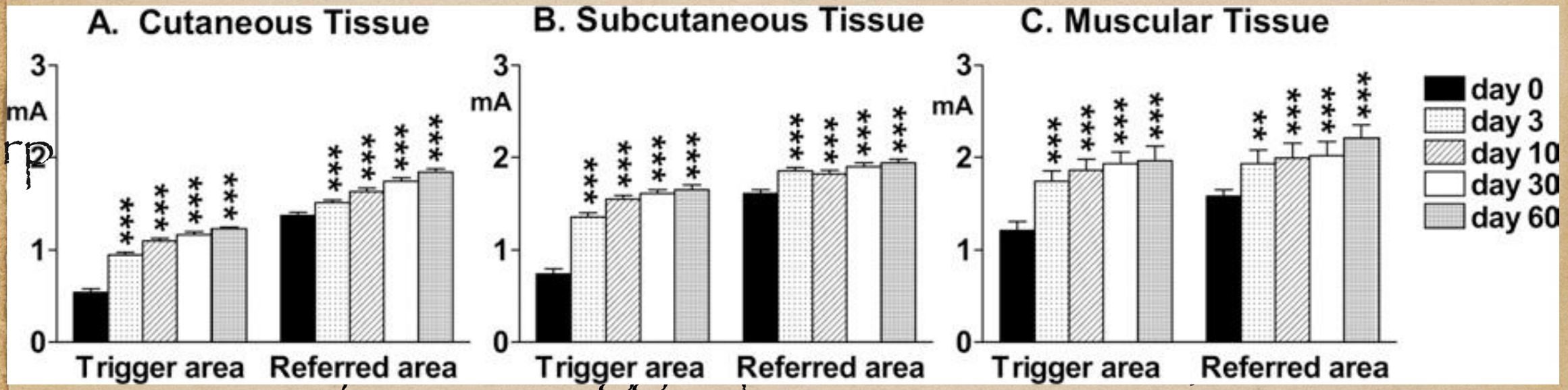
- Grp 1: Injection of trigger points in neck and shoulders
- Grp 2: no treatment
- Normal (no headache) controls

Giamberadino MA et al. J Pain, 2007



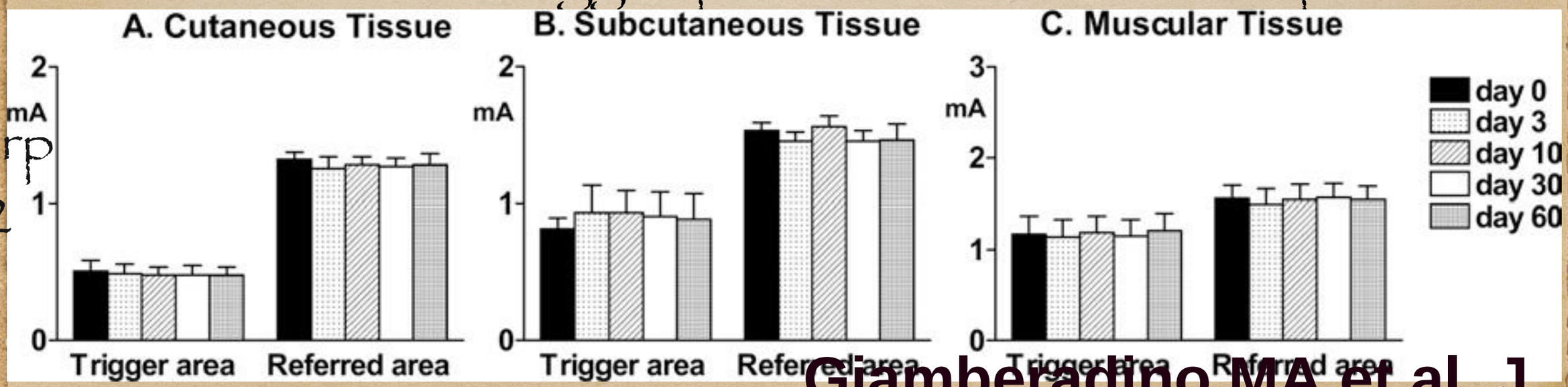
Giamberadino MA et al. J Pain, 2007

Grp 1



threshold at trigger points and at referred pain

Grp 2



Giamberadino MA et al. J Pain, 2007

Needling Trigger Points

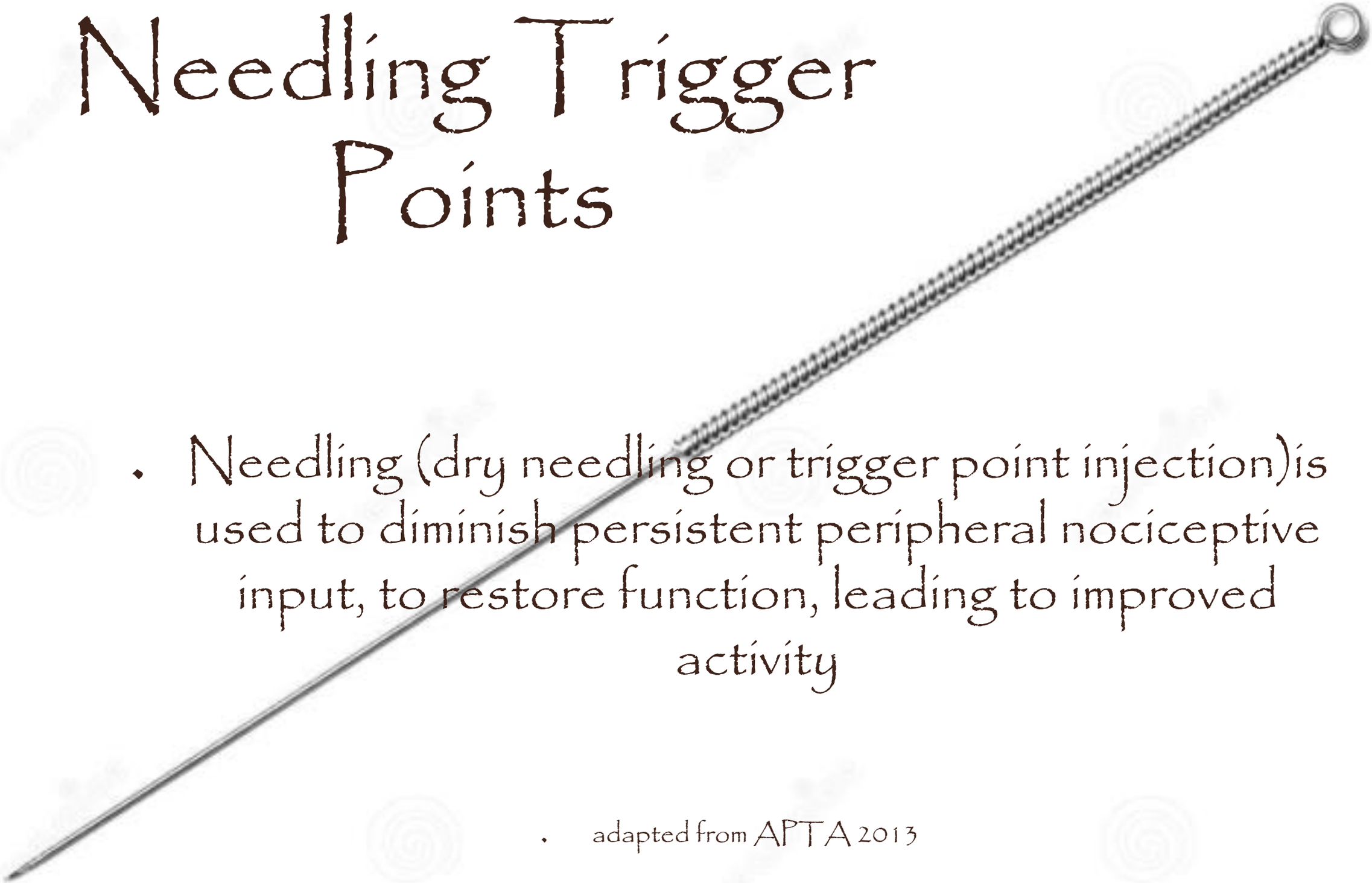
Robert D. Gerwin, M.D., FAAN
Johns Hopkins University
Baltimore, MD

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



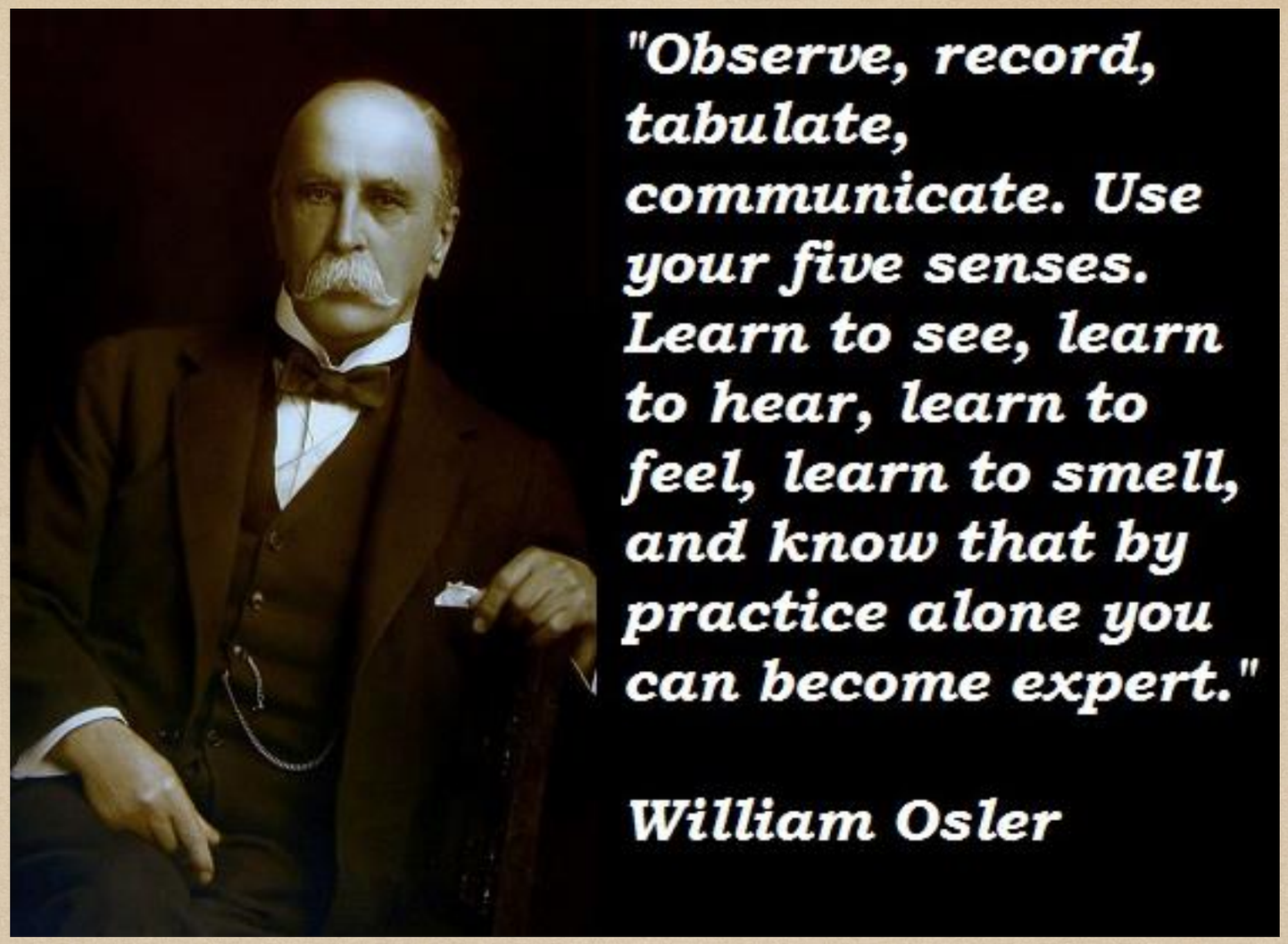
- Needling (dry needling or trigger point injection)is used to diminish persistent peripheral nociceptive input, to restore function, leading to improved activity

- adapted from APTA 2013

Needling Trigger Points

- 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.


Trigger Point
Dry Needling
An evidenced and clinical-based approach
Jan Dommerholt
César Fernández-de-las-Peñas
Leon Chaitow
Robert D. Gerwin



Osler practiced dry needling in the 1870s

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.

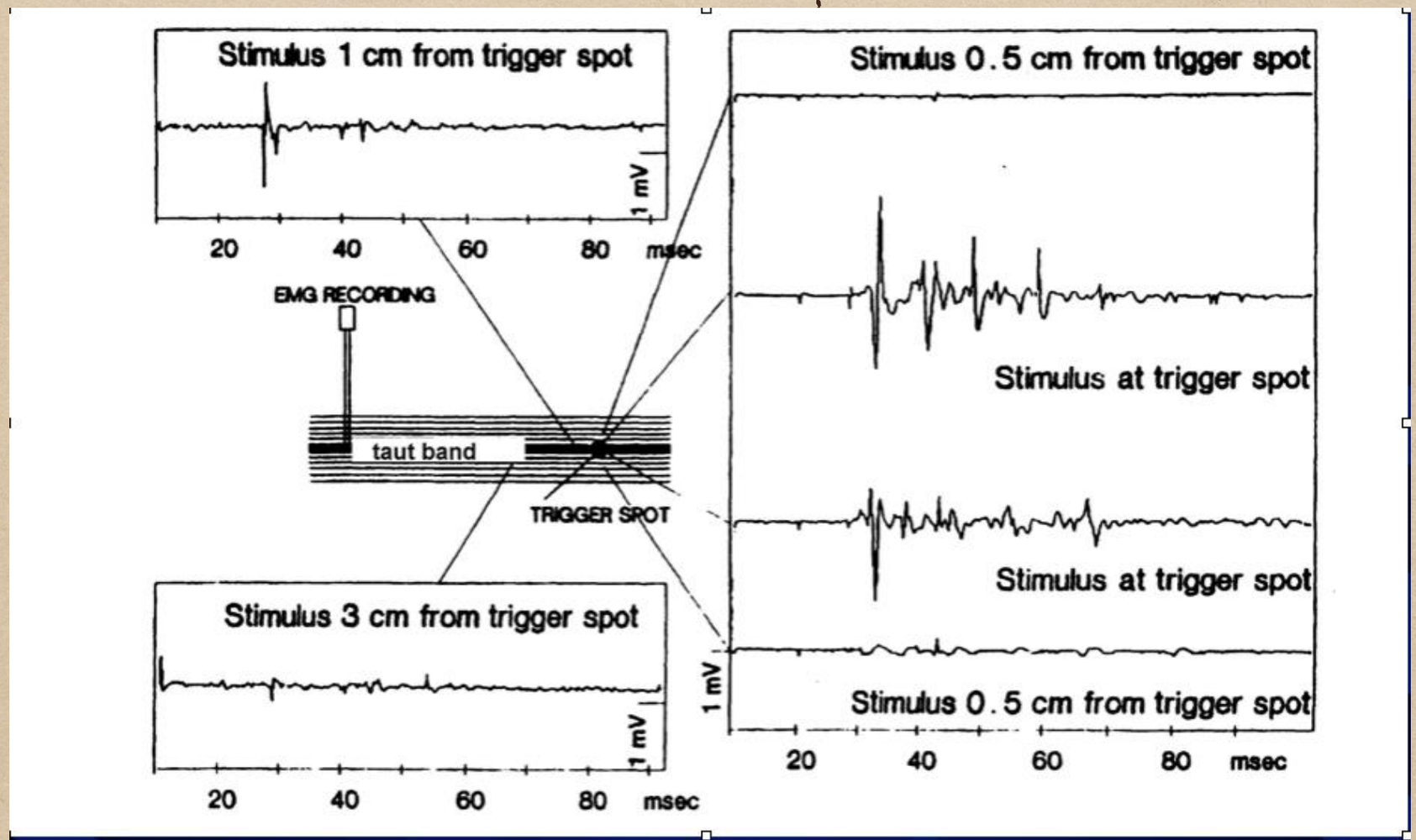
courtesy of Dr. Robert Woody

Why Needle?

- Diagnostic
- Treatment
  - to relieve pain
  - to facilitate physical therapy and rehabilitation

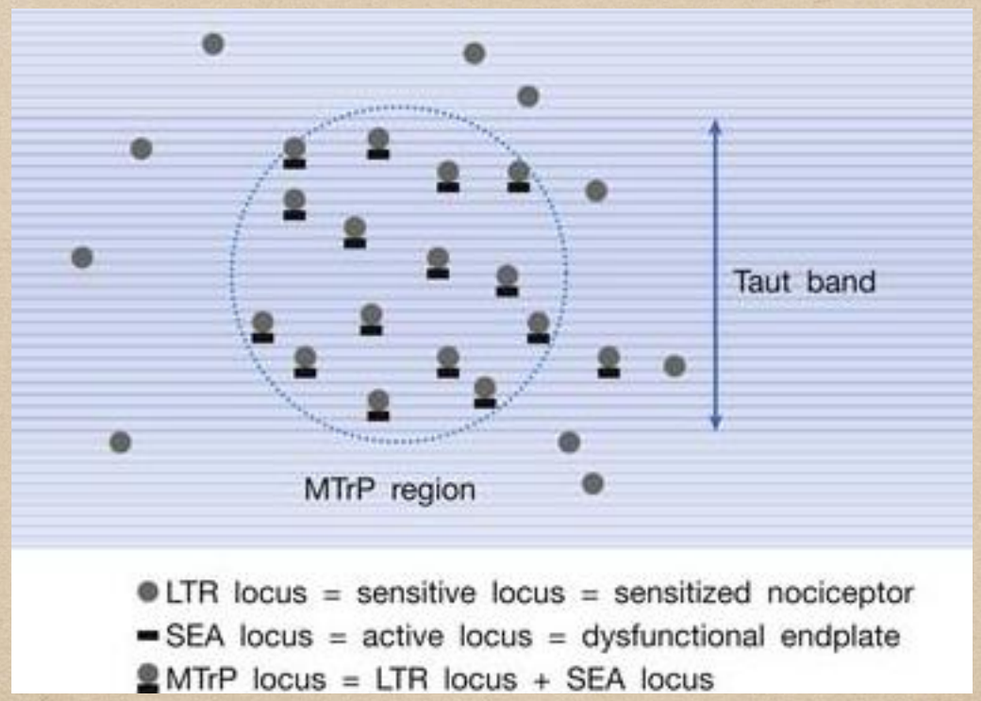
- What is needled: The most firm or hardest part of the taut band, that is usually also the most tender part.

- 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.

Contents lists available at ScienceDirect

European Journal of Pain

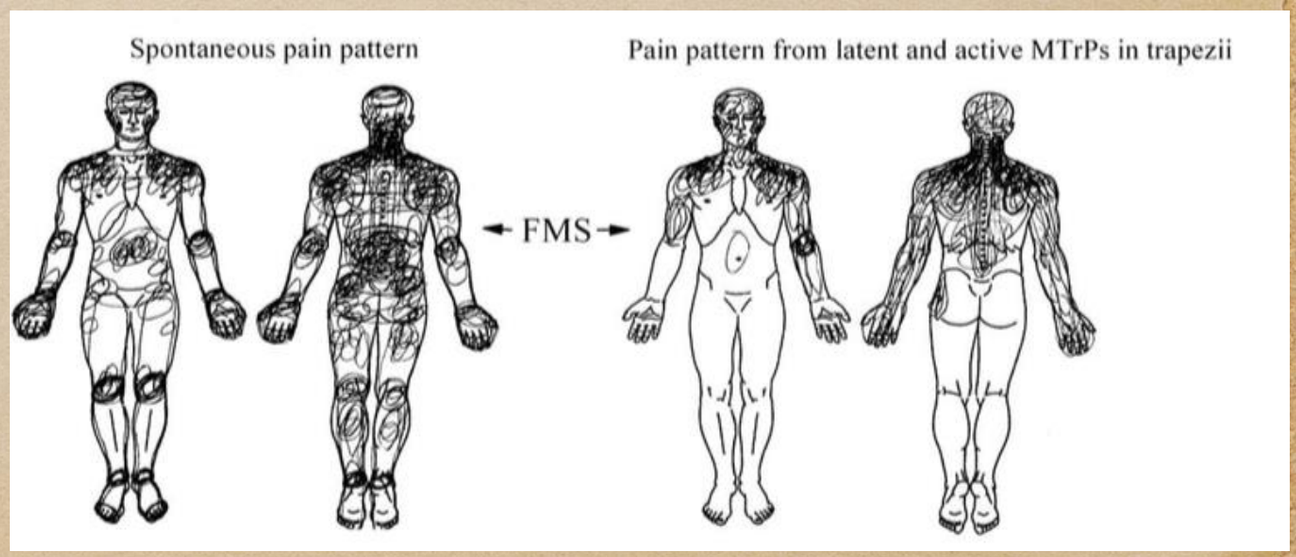
journal homepage: www.EuropeanJournalPain.com

Effects of treatment of peripheral pain generators in fibromyalgia patients

Giannapia Affaitati [a], Raffaele Costantini [b], Alessandra Fabrizio [a], Domenico Lapenna [a], Emmanuele Tafuri [a], Maria Adele Giamberardino [a,*]

[a] *Pathophysiology of Pain Laboratory, Ce.S.I., "G. D'Annunzio Foundation", Department of Medicine and Science of Aging, Chieti University, Italy*
[b] *Institute of Surgical Pathology, Chieti University, Italy*

Lidocaine injections of trigger points produced significant pain reduction



The Clinical Journal of Pain
18:149–153 © 2002 Lippincott Williams & Wilkins, Inc., Philadelphia

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

*†Francesco Ceccherelli, M.D., †Maria Teresa Rigoni, M.D., *†Giuseppe Gagliardi, M.D., and

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

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

Hemiparetic Shoulder Pain Syndrome Treated with Deep Dry Needling During Early Rehabilitation: A Prospective, Open-Label, Randomized Investigation

L. DiLorenzo
M. Traballesi
D. Morelli
A. Pompa
S. Brunelli
M. G. Buzzi
R. Formisano

Deep dry needling reduced pain, improved sleep, and improved mobility

Contribution of Myofascial Trigger Points to Migraine Symptoms

Maria Adele Giamberardino, Emmanuele Tafuri, Antonella Savini, Alessandra Fabrizio, Giannapia Affaitati, Rosanna Lerza, Livio Di Ianni, Domenico Lapenna, and Andrea Mezzetti

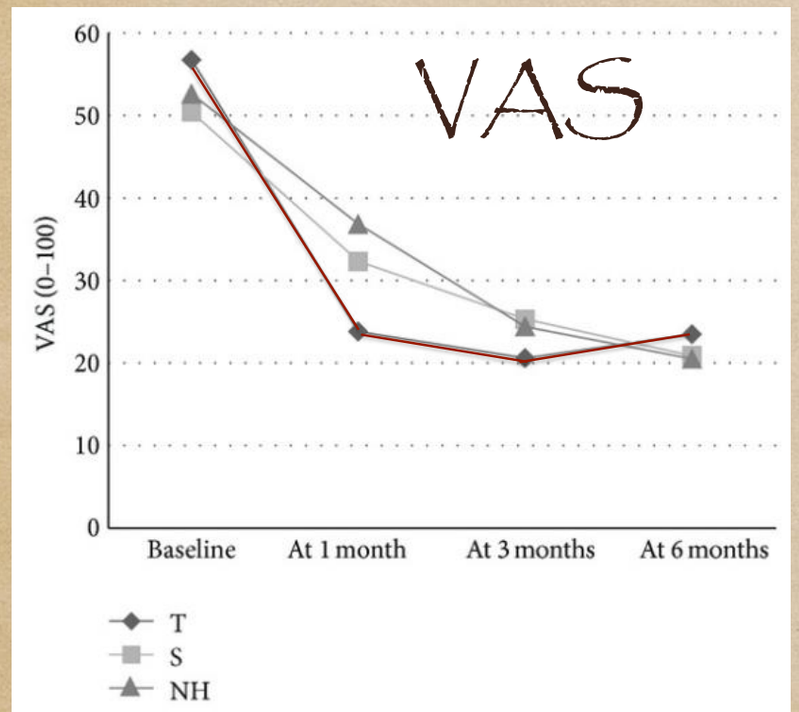
Headache Center, Department of Medicine and Science of Aging, "G. D'Annunzio" University; Ce.S.I., "G. D'Annunzio" Foundation, Chieti, Italy.

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

Evid Based Complement Alternat Med. 2013;2013:694941.
doi: 10.1155/2013/694941. Epub 2013 Mar 27.

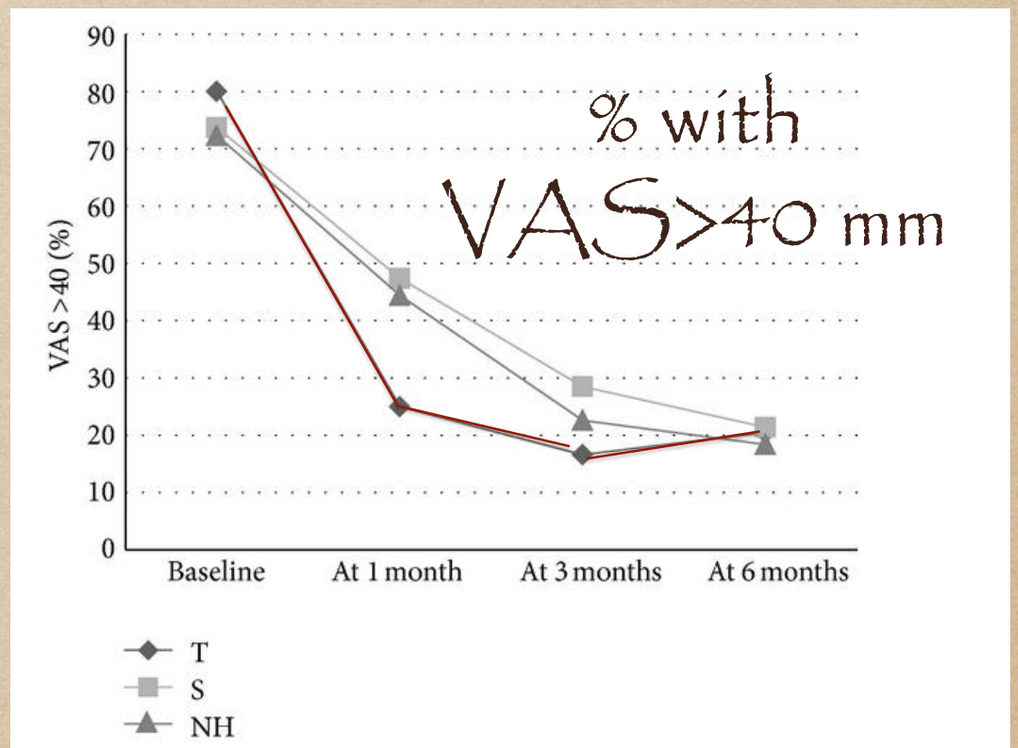
Efficacy of myofascial trigger point dry needling in the prevention of pain after total knee arthroplasty: a randomized, double-blinded, placebo-controlled trial.

Mayoral O1, Salvat I, Martín MT, Martín S, Santiago J, Cotarelo J, Rodríguez C.



igure 2

he graph shows average pain scores (VAS) at baseline, and at 1, 3, 6 months in the T group (true dry



The graph shows percentage of patients with significant pain (VAS > 40) at baseline, and at 1, 3, 6 months

Acupuncture needling versus lidocaine injection of trigger points in myofascial pain syndrome in elderly patients – a randomised trial

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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.

There was no significant difference between [dry needling] and lidocaine 0.5%

Introduction

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

Inactivation of MTrPs is essential in managing MPS and several methods have been recommended. The treatments most commonly used for this purpose are dry needling of the MTrPs, injection treatments with local anaesthetics or saline, sprays, and stretching.[2] 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 MTrPs is controversial,[2-4] and hollow needles were used for dry needling in these studies.[3-5] Gunn suggests that the 'hollow needle' induces more tissue injury and is more painful than a 'pointed-tip needle'.[6]

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

Clin Rheumatol
DOI 10.1007/s10067-012-2112-3

ORIGINAL ARTICLE

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


BULL
KEEP
OUT

PLEASE DO NOT GO
BEYOND THIS POINT
NTERDICTION DE DÉPASSE
CE PANNEAU

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


KEEP
GATE
CLOSED

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


DROP, DON'T FORCE SHARPS
INTO CONTAINER. FORCING,
COMPRESSION OR OVERFILLING
CAN CAUSE CONTAINER PUNCTURE
AND RESULT IN INJURY.
SHARPS
REGULATED
MEDICAL WASTE
Single Use
BIOHAZARD
UN
3291
tyco /Healthcare
KENDALL
Tyco Healthcare Group LP
Mansfield, MA 02048
In U.S. 1-800-962-9888
www.tycohealthcare.com
REF
8909
R4157C
(01) 00694393004013

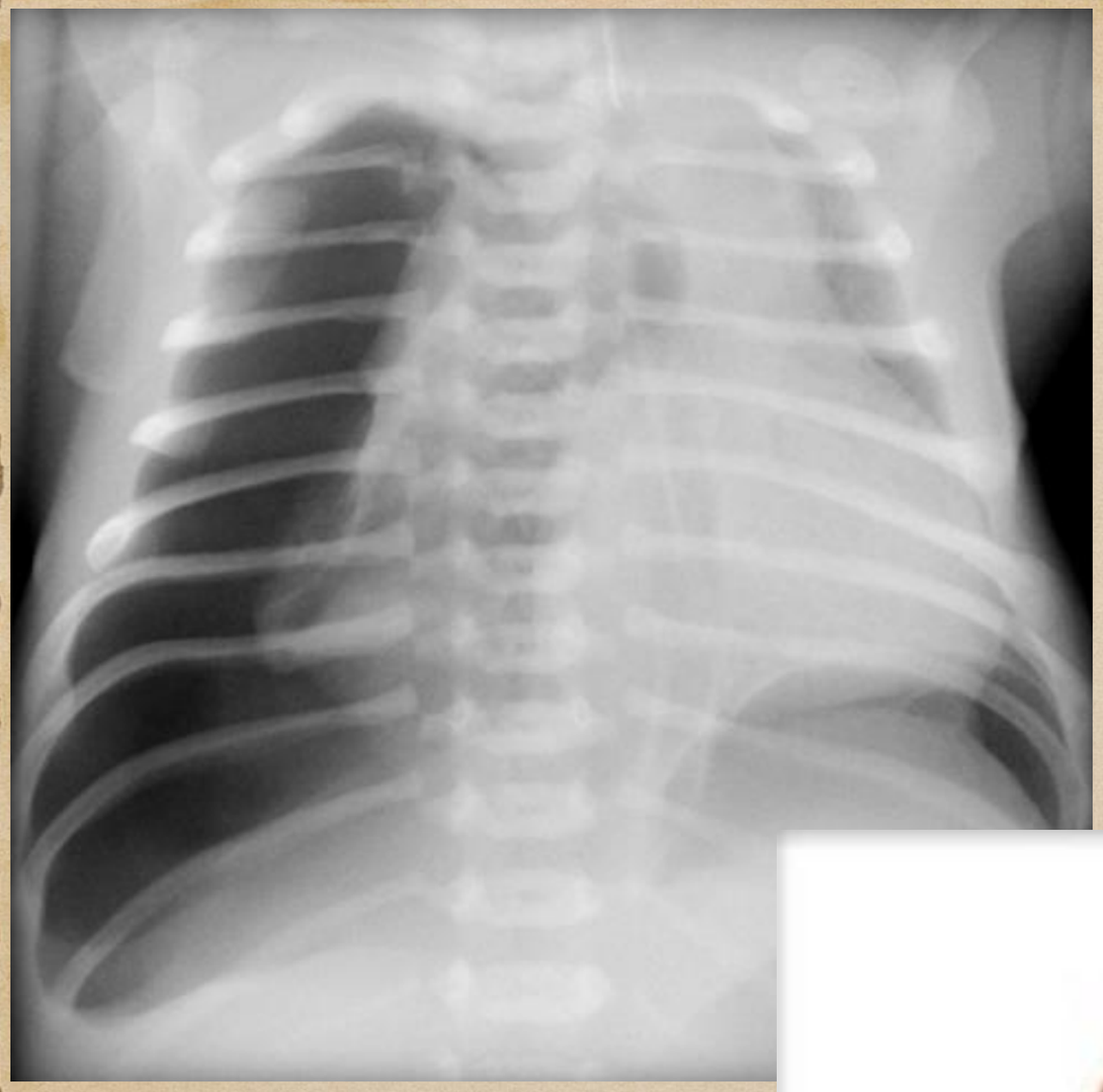

If you do not know
where you are going,
don't go

Complications

- Allergy to nickel, to local anesthetic (epinephrine
- local soreness
- bleeding
- nerve injury
- syncope

Implants

Pneumothorax



Pregnancy is not a
contraindication


If you do not know where you are
going, don't go