

Heart Rate Variability Biofeedback in the Treatment of Chronic Muscle Pain: How the Vagus Governs Sympathetic Input to Muscle

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- ChristopherGordon, PT
- Frank Andrasik, Ph.D.



David Hubbard, MD
Neuro-epistimologist

Two journeys that merged in 1993



- Medical perspectives on chronic pain
 - If you have no diagnostic markers, its all in your head
- Psychological perspectives
 - Behavioral approach, Treat pain as a behavior
- Biofeedback Perspective
 - Chronically contracted muscles (need relaxing using surface EMG)
- Psychophysiological approach
 - Find the “mind” to body pathway, Autonomic Mediators

Central vs. Peripheral Pain:

A key differential diagnostic distinction



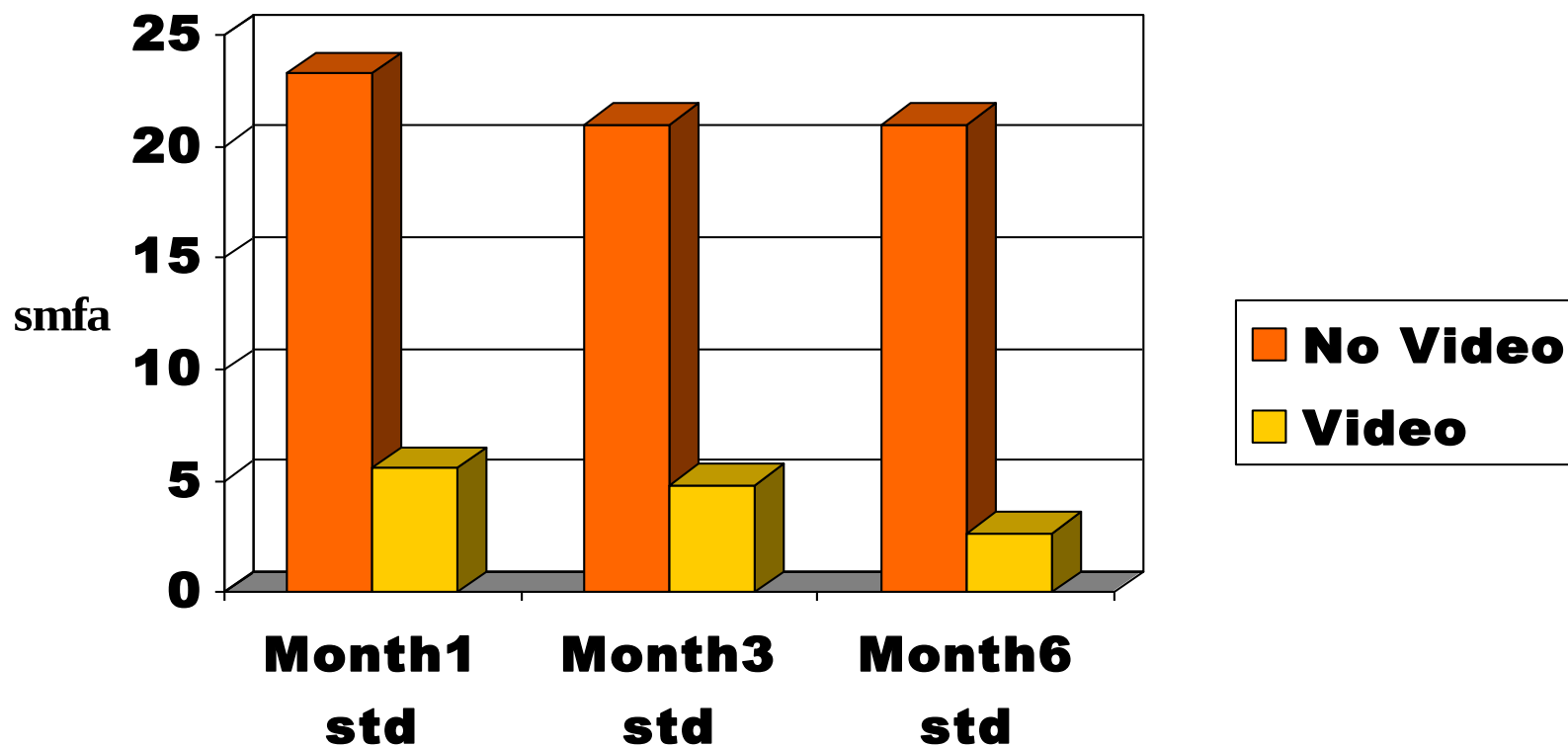
- All chronic pain is often lumped together
- It is necessary to form a hypothesis on the source or sources of pain
 - Clear Cut Central
 - FM- Central allodynia or sensitization
 - CRPS- pain in a limb
 - Phantom limb pain
 - Peripheral
 - Myofascial Pain
 - IBS (mixed)
 - Neuropathic Pain
 - Combination

The Effect of a Short Educational Trigger Point Management Video on Pain Outcomes

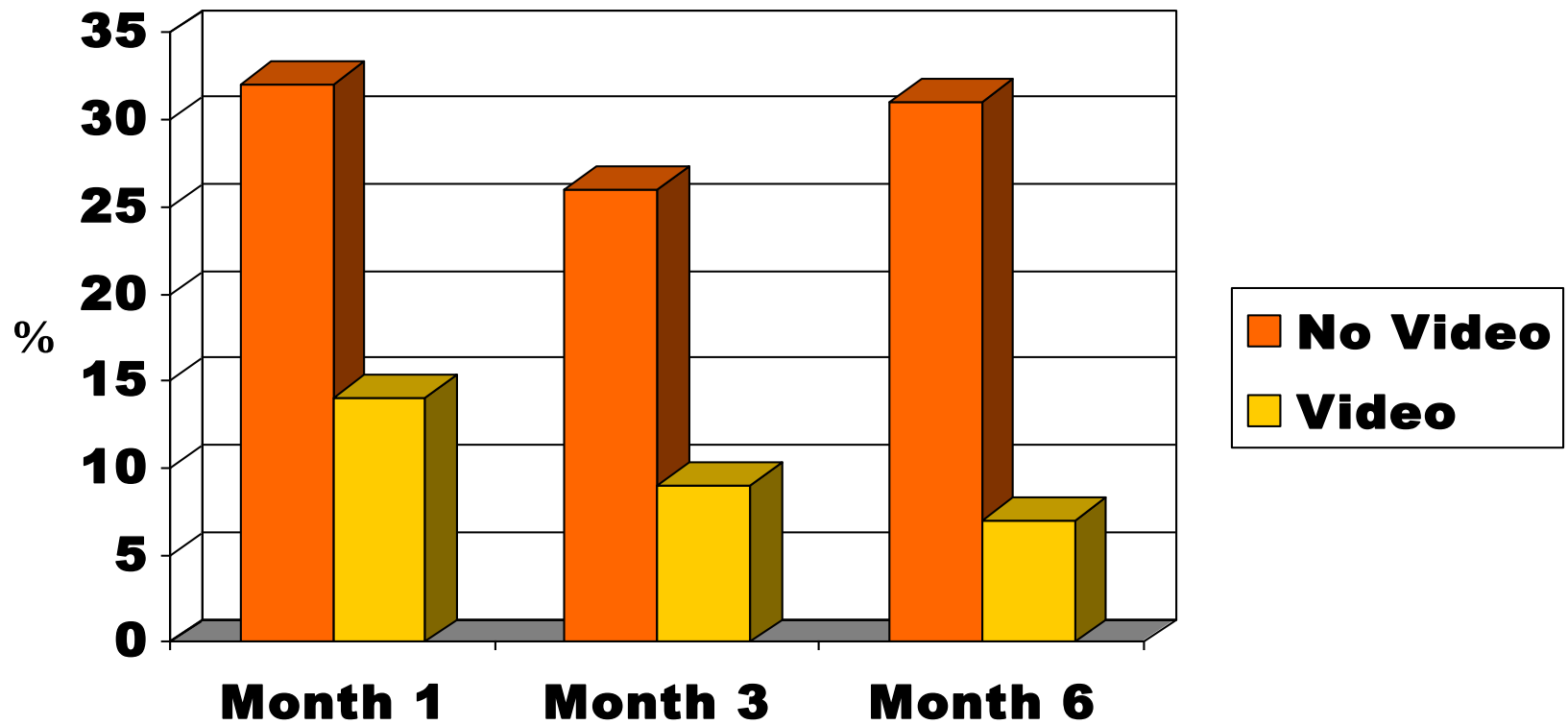
Oliveira, Gevirtz, & Hubbard (2005), *Spine*

- 126 Whiplash pts randomly assigned to video or normal ER tx
- Groups well matched
- Followed at 1,3 & 6 months
- Video group(as compared to controls) showed good mastery of a content test on TPs ($F_{(1,124)}=262.2$, $\text{Eta}^2=.9$)
- All ANOVAs and Chi^2 sig., $p<.001$

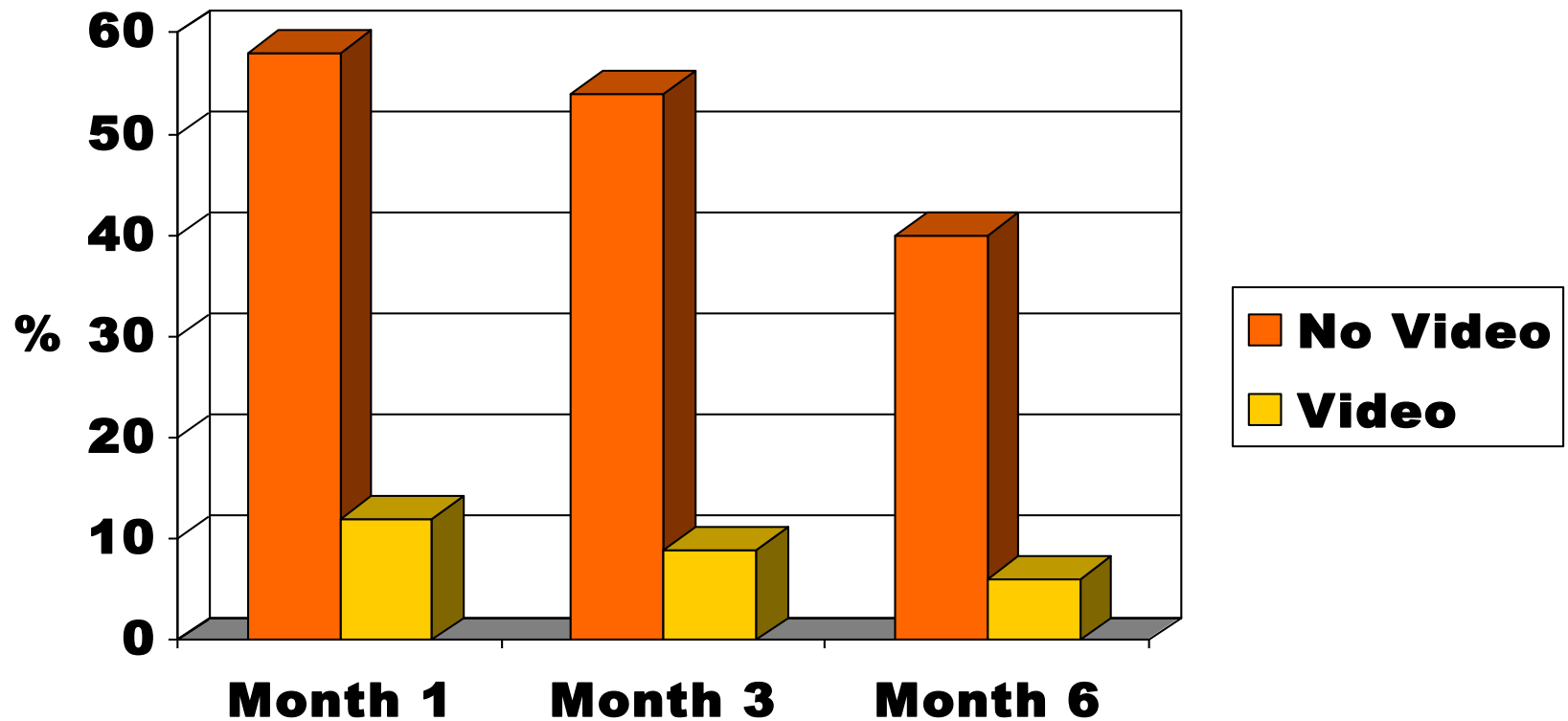
Short Form Musculoskeletal Function Assessment



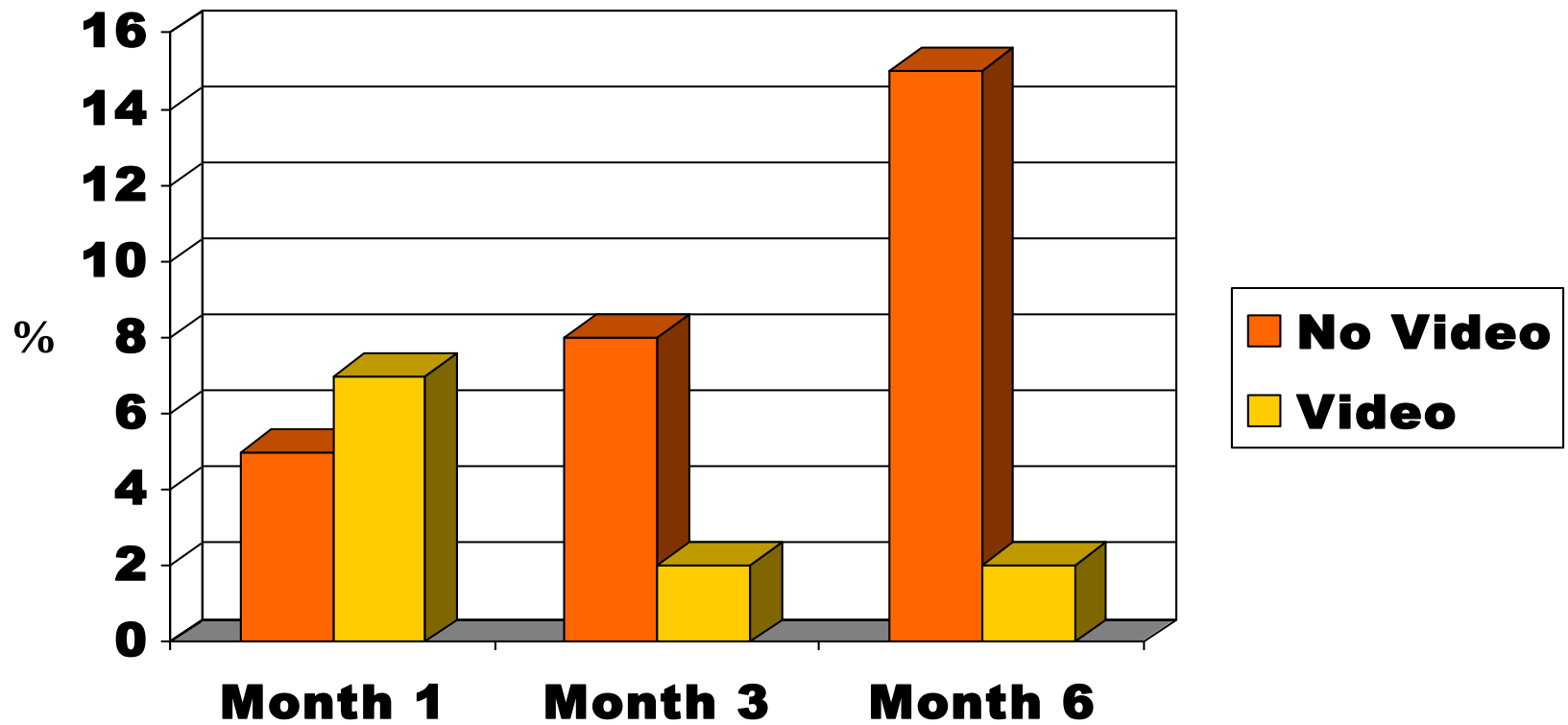
Chiropractic Visits



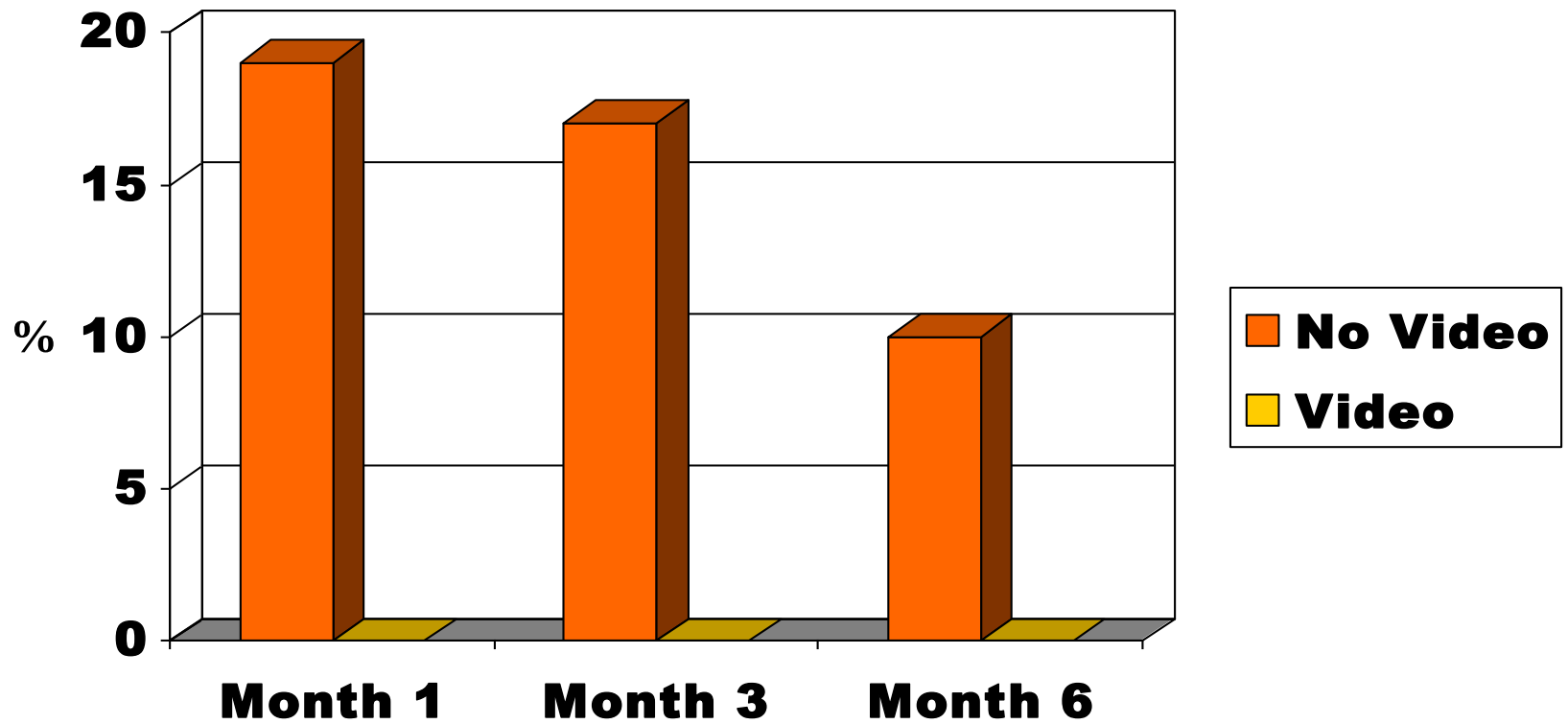
Physical Therapy Visits



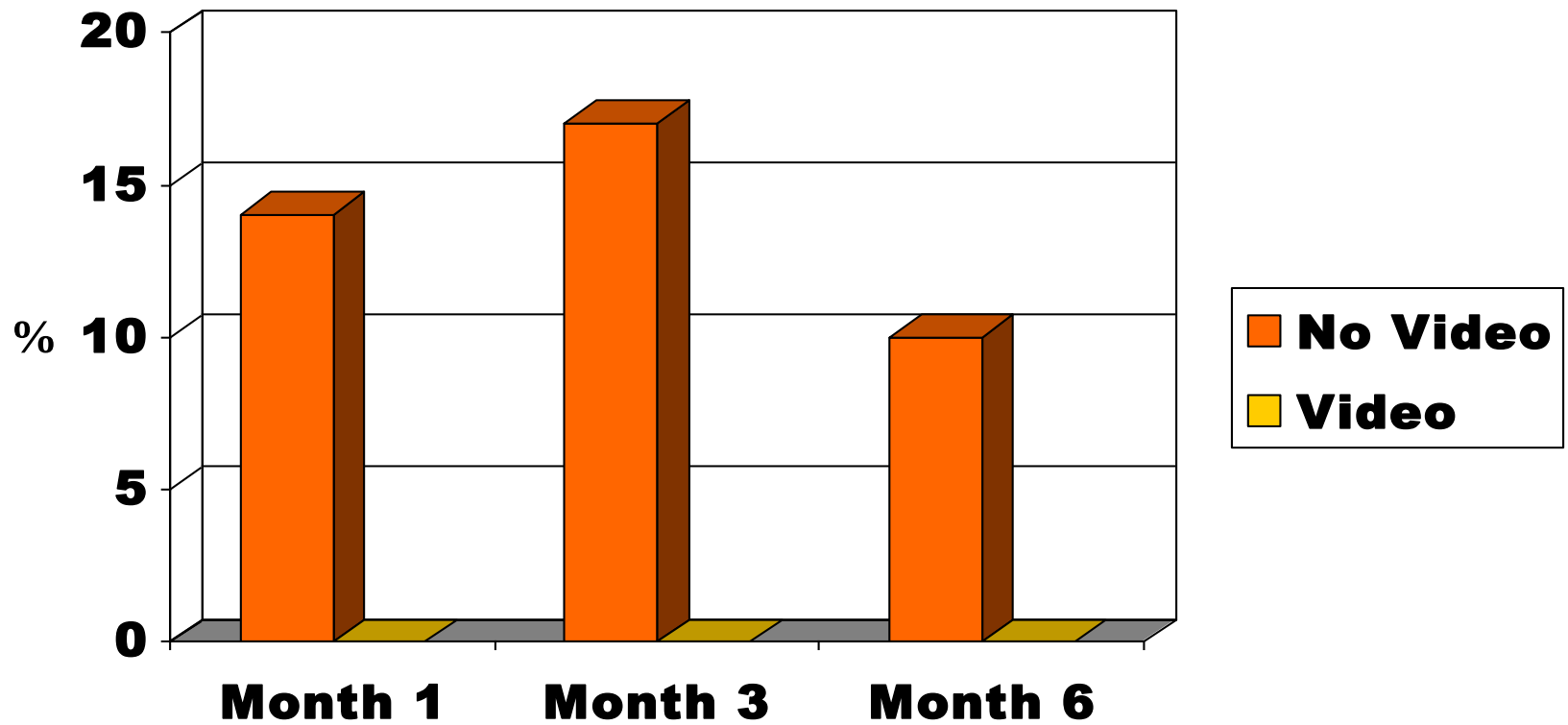
MRIs



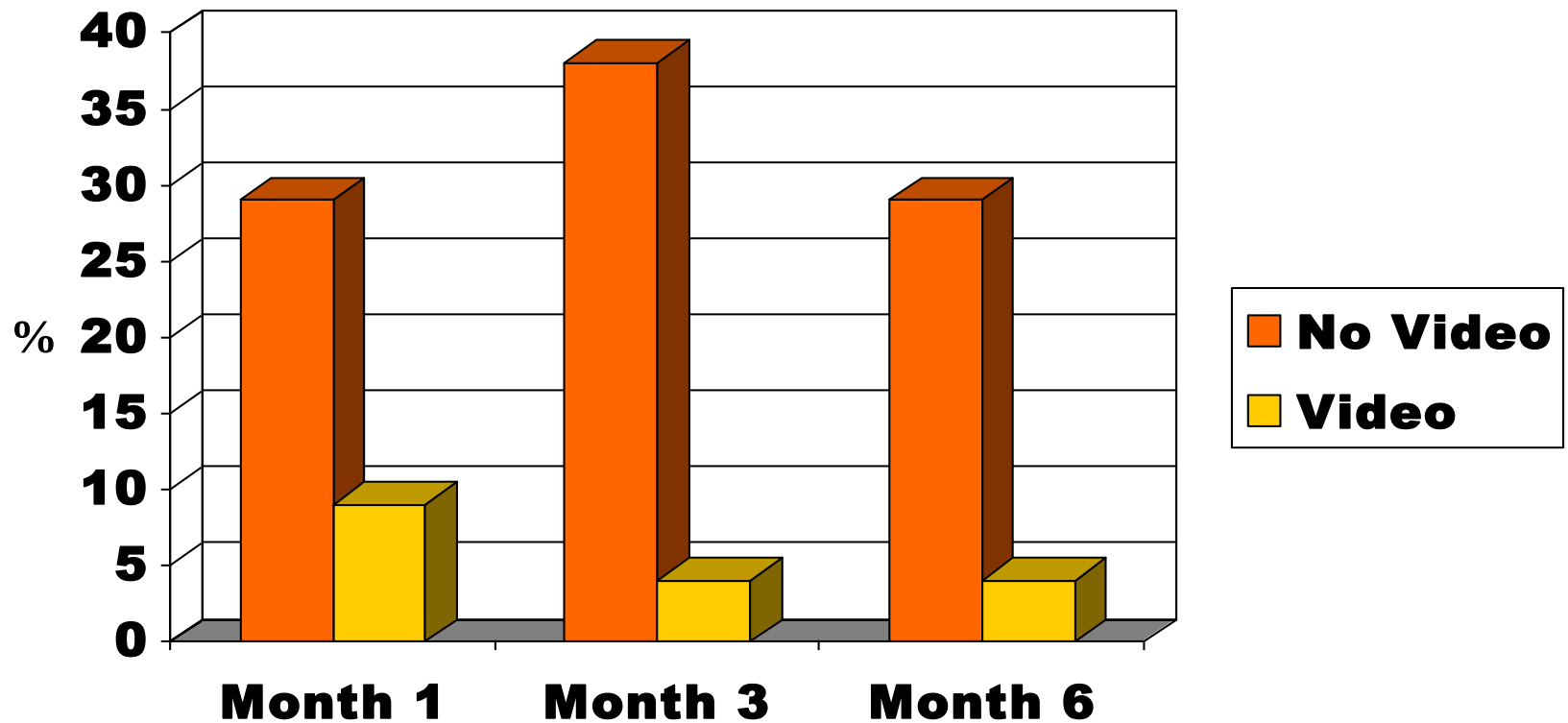
ER Visits



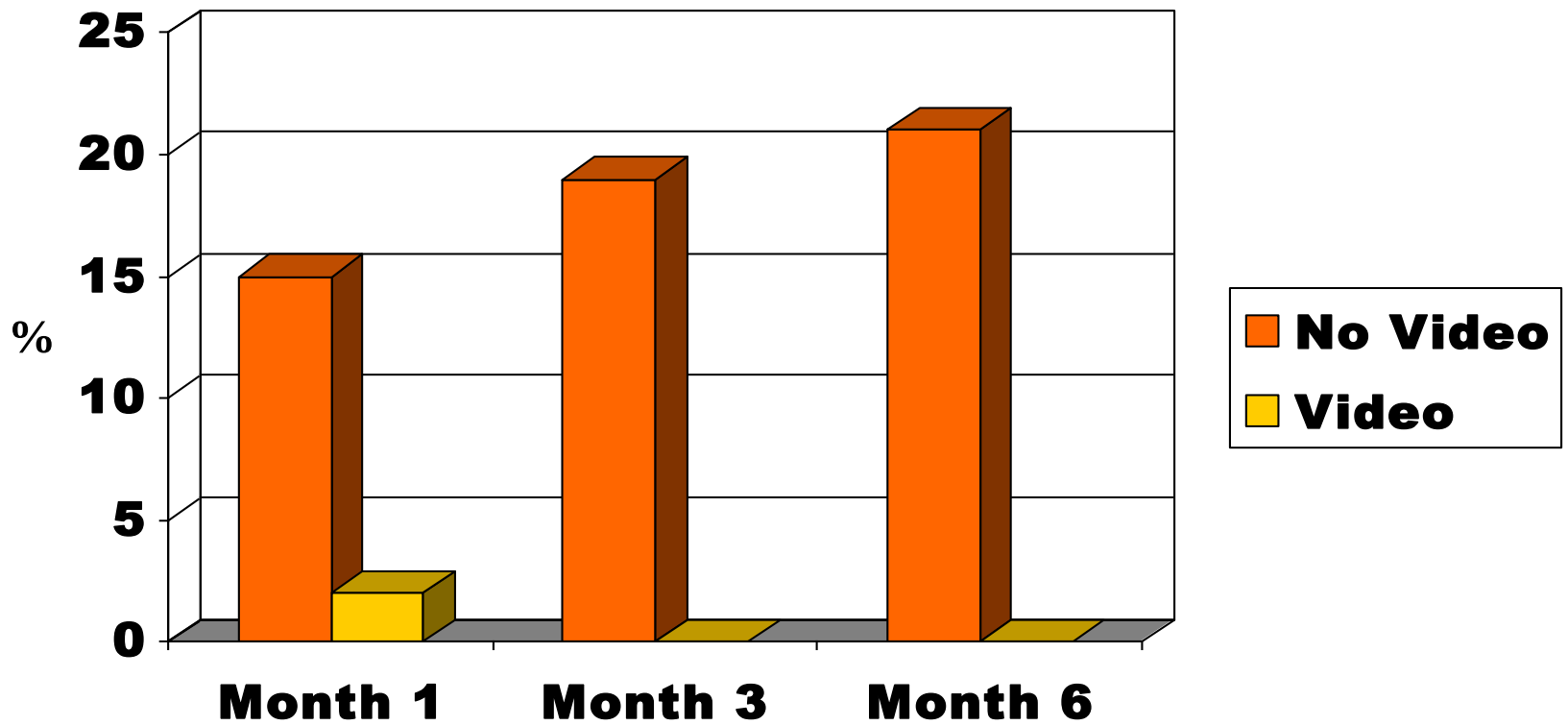
Urgent Care Visits



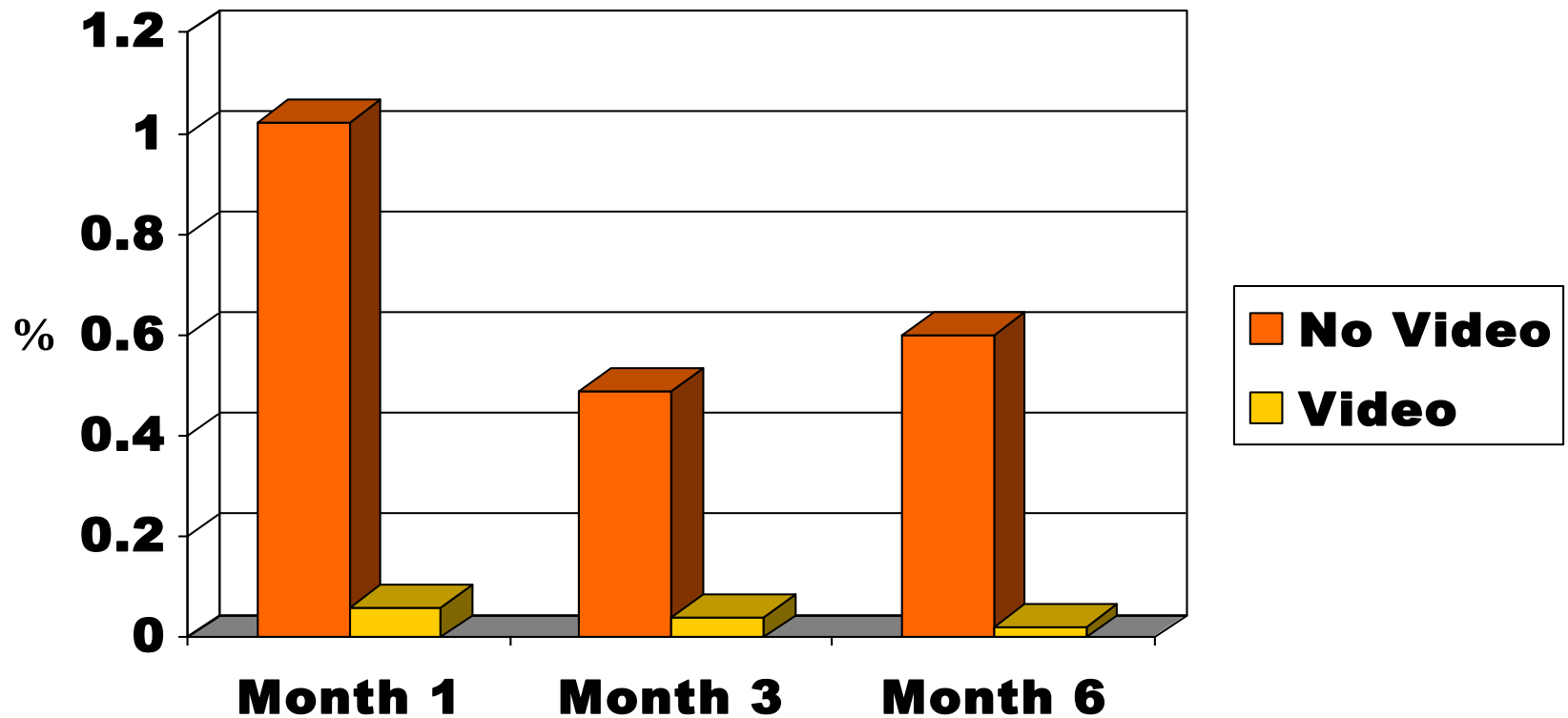
Taking Muscle Relaxant



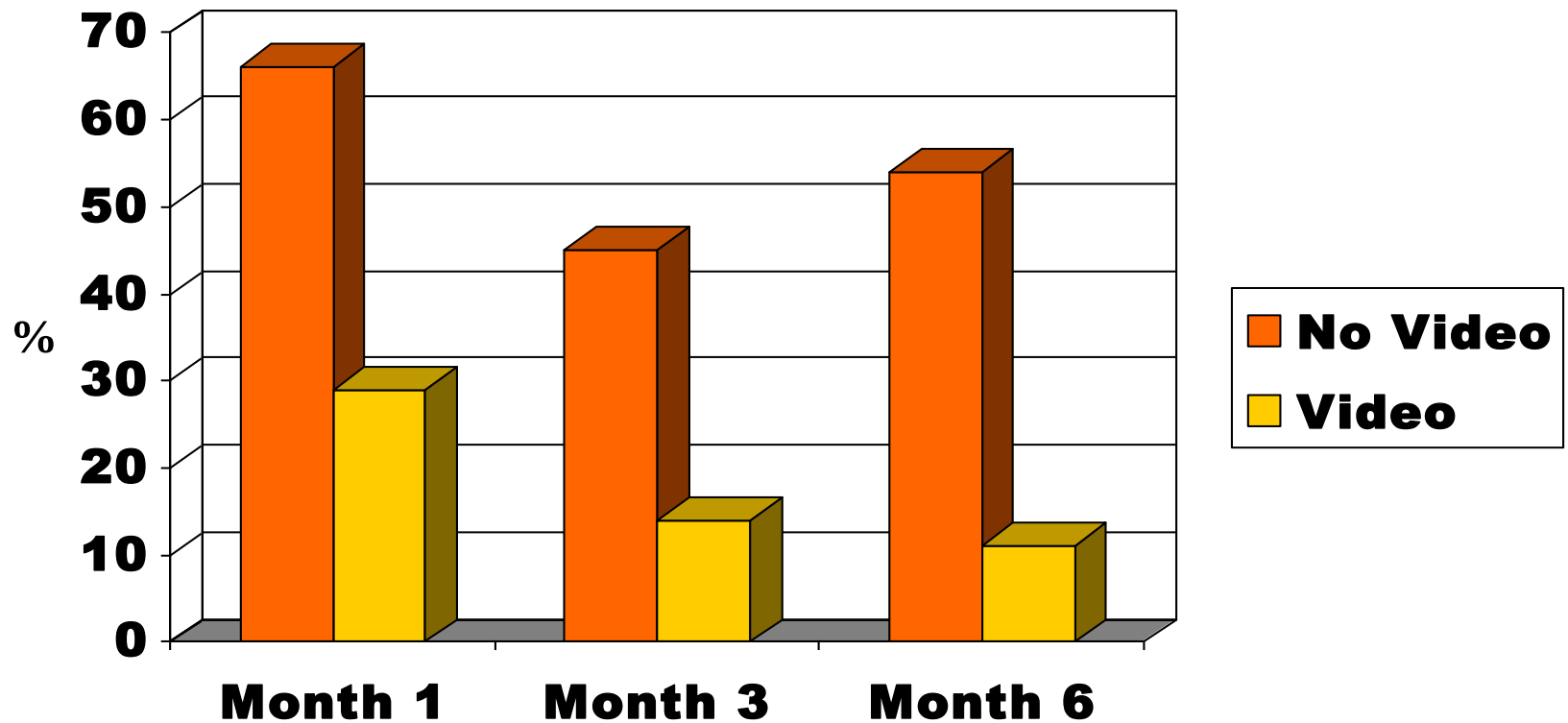
Surgical Consultation



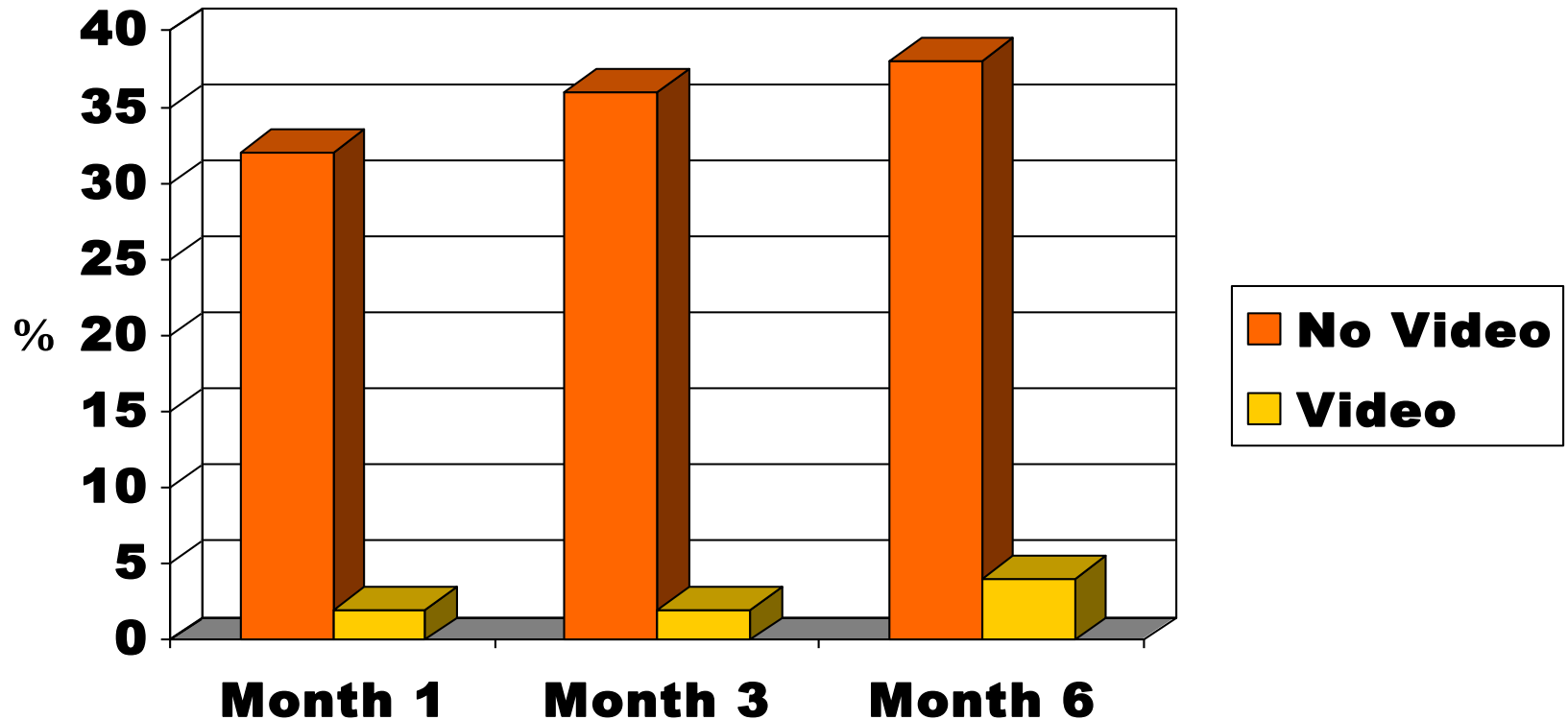
Number Missed Workdays Due to Injury



Primary Care Doctor Office Visits

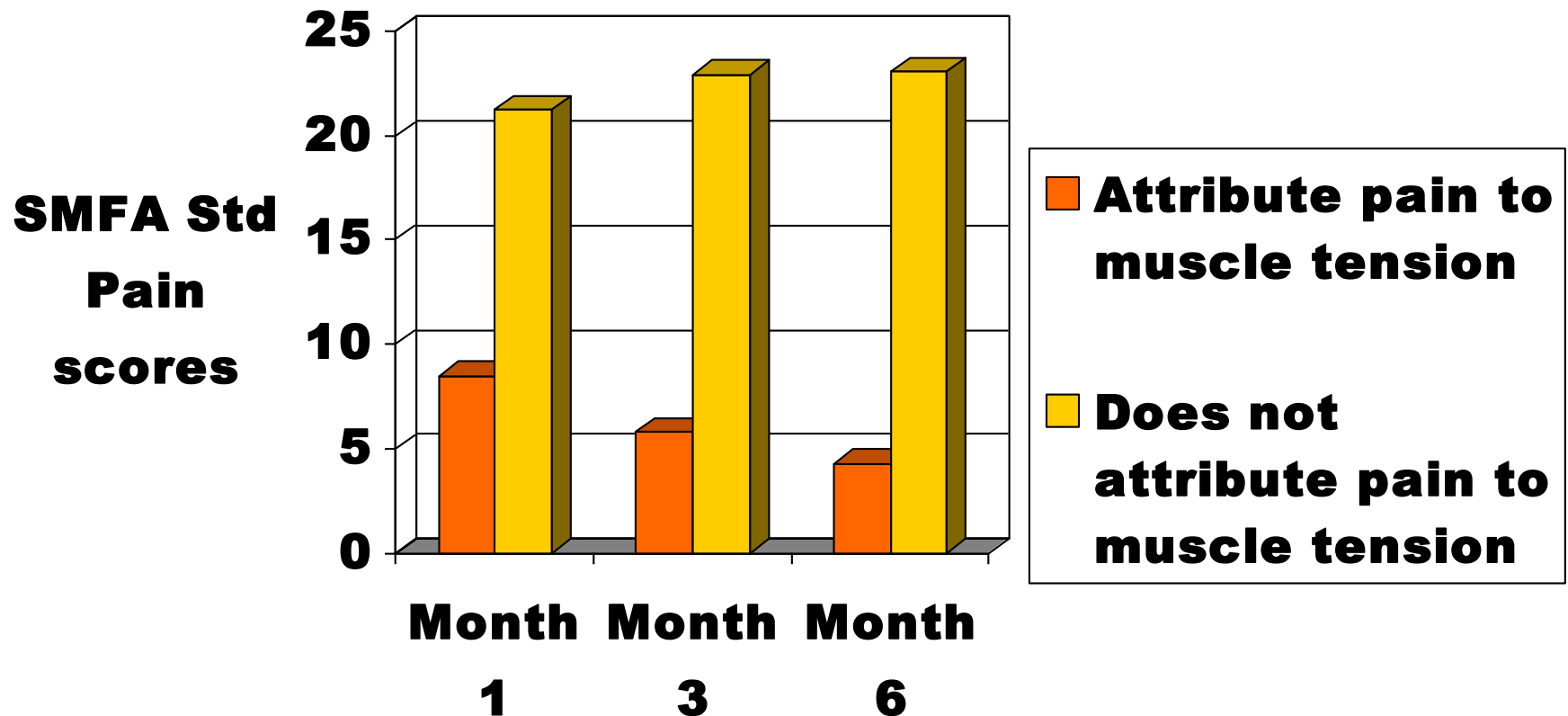


Taking Narcotics



Note: 37% of the control were still using opioids at the 6 month mark. Omen of the coming epidemic.

Relationship between attribution of pain etiology and pain improvement



Why was a 12-minute video so effective in preventing chronic neck/head pain?

- Answer is the core of this talk
- Video link:

<http://www.youtube.com/watch?v=FsmqHHrGas>

Where Does the Pain Come From?

- Key question-seldom asked
- Is there a strong central component?
 - Is the pain a neurological construction absent peripheral mechanisms?
 - Evidence of central factors
 - Seratonergric systems
 - Dopaminergic systems
 - Antidepressant medication
 - Imaging studies
 - Small % of the variance
- Muscle Fatigue
 - No evidence for byproducts which would indicate fatigue
- Peripheral Mechanisms- Trigger Points

Typical Diagnosis

- Cervical Strain
- Lumbar Strain
- Repetitive Strain Injury
- Tension Headache
- TMJ or TMD
- Myofascial Pain Syndrome

Typical Misdiagnoses

- ❑ Ruptured or bulged disc
- ❑ Pinched nerve
- ❑ Carpal tunnel syndrome
- ❑ Tennis elbow
- ❑ Bursitis
- ❑ Thoracic Outlet Syndrome
- ❑ Depression (or other Psychiatric diagnosis)
- ❑ Fibromyalgia

Etiological Theories

- Central Pain Sensitization
- Fatigue/Posture models
- Inflammation models
- Micro-lesion
- Subtle metabolic abnormality
- **Trigger Points**

Book

Zoom -

Zoom +

Help

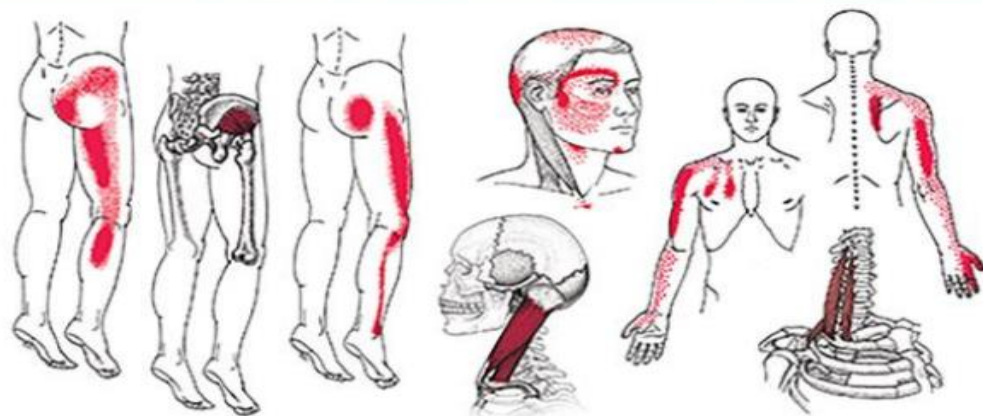
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TRAVELL, SIMONS & SIMONS'

Myofascial Pain and Dysfunction

THE TRIGGER POINT MANUAL

THIRD EDITION



Joseph M. Donnelly

César Fernández-de-las-Peñas

Michelle Finnegan

Jennifer L. Freeman



Wolters Kluwer

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Travell & Simons'

Myofascial Pain and Dysfunction: The Trigger Point Manual

VOLUME 1. Upper Half of Body

Second Edition

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Electromyography and Electrodiagnosis Section
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Consultant, Myofascial Pain and Dysfunction

Illustrations by Barbara D. Cummings

with contributions by Diane Abeloff and Jason Lee



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[†] Dr. Janet Travell's genius and medical insight identified in the first edition the clinical picture of individual myofascial pain syndromes and many perpetuating factors. In addition, we were most fortunate to have had the benefit of her advice in preparing some of this edition. She emphasized the importance of including a new chapter that covers the respiratory muscles and supplied unique pearls of clinical wisdom that sprinkle this revision.

- 
- Simons, acknowledging the lack of attention paid to the muscle has stated:
 - “Muscle is the orphan organ. No medical specialty claims it.”
 - There are signs, however, that Simons’ comments along with Travell's myofascial pain concepts are gaining ground in mainstream medicine.

Trigger Points (TrPs) I

- Trigger point is the sine qua non of Myofascial Pain Syndrome (MPS)
- Associated stiffness
- Localized point tenderness in muscle
- Stimulation produces local and referred pain
- Often with a palpable taut band

TrPs II

- Twitch
- Trigger because like a gun trigger is initiated with pressure
- Produces pain in another place-(target)

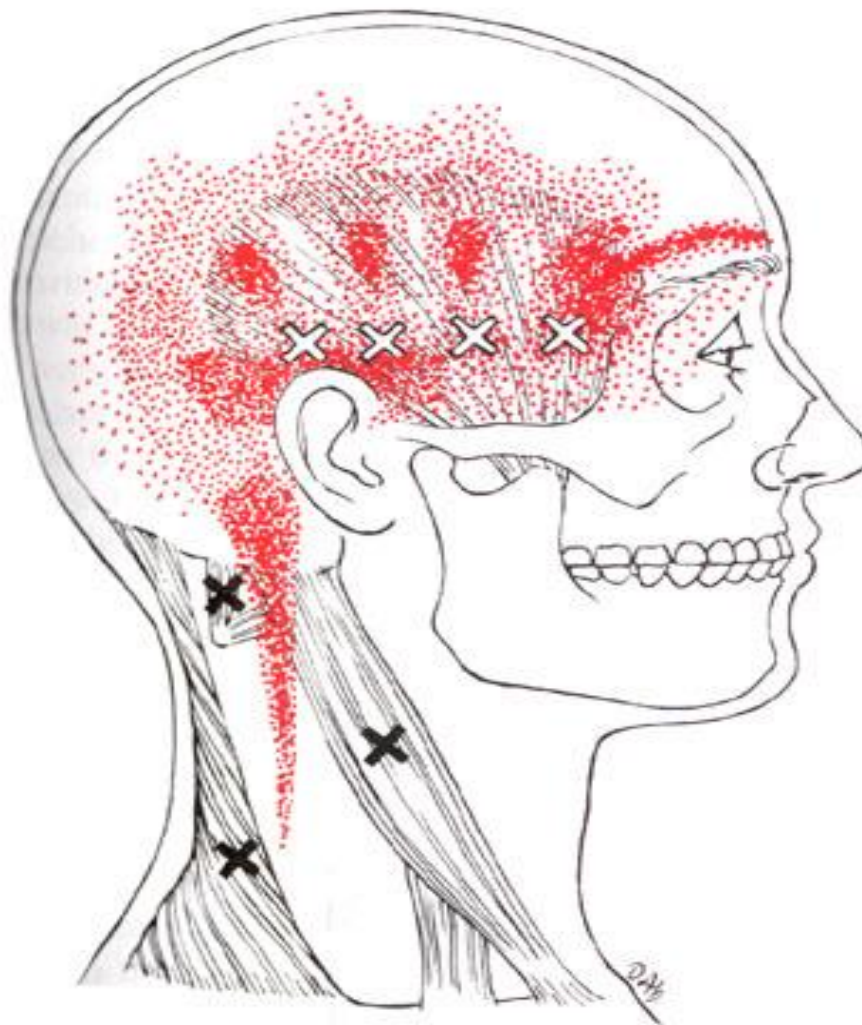
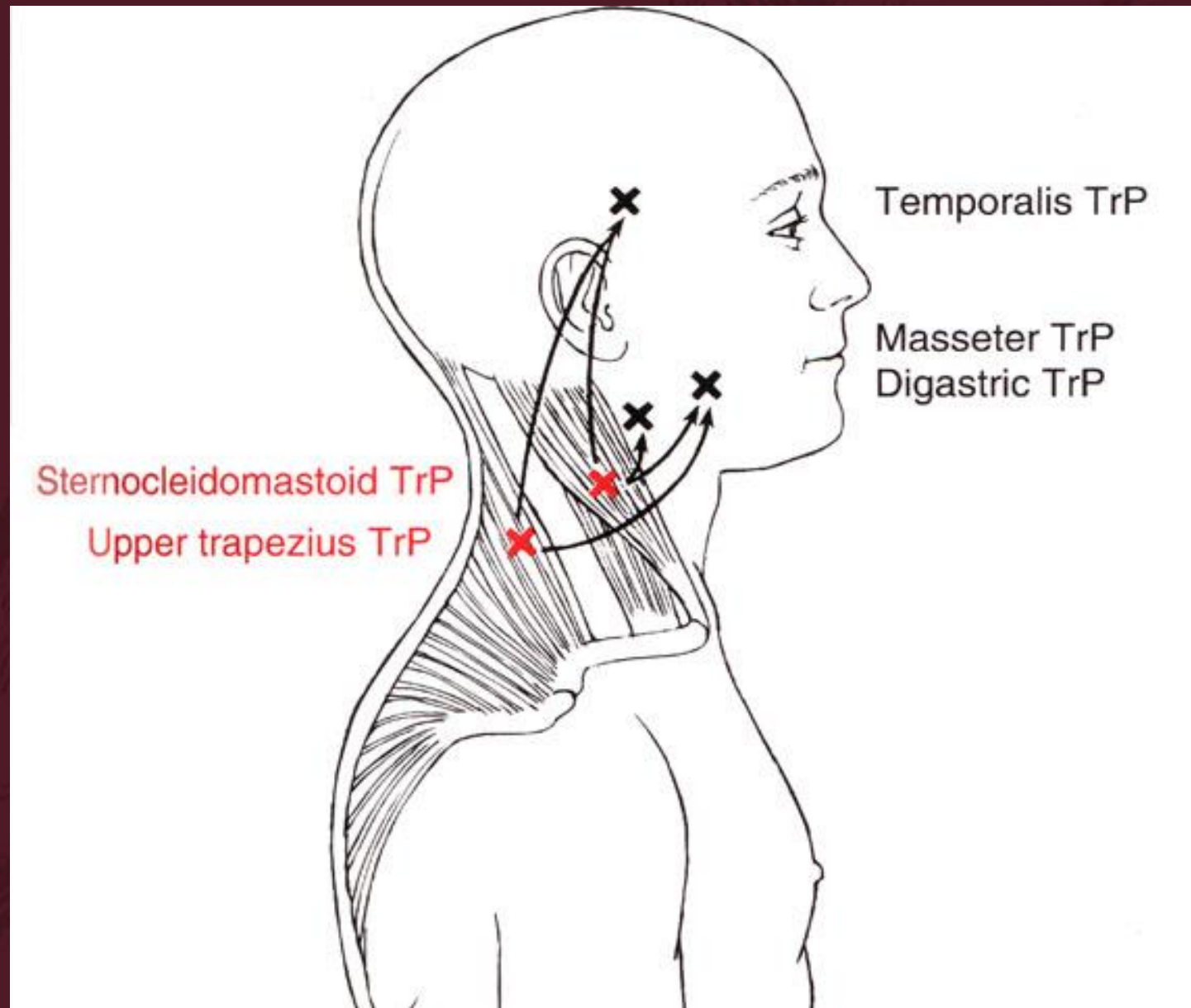


Figure 5.2. Overlapping pain referral patterns (red) from myofascial trigger points (Xs) in various masticatory and cervical muscles produce typical unilateral or bilateral migraine or tension-type headache pictures.



cle

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toid attachment of the sternocleidomas-
toid. They reported inducing referred head
pain by applying digital pressure to these
tender muscles and by injecting hyper-
tonic salt solution into them, location un-
specified.

Sternal Division (Fig. 7.1A)

An active TP in the lower end of the
sternal division refers pain downward
over the upper portion of the sternum (Fig.
7.1A). This is the only downward refer-
ence of pain from this muscle.^{49,53} True
trigeminal facial neuralgia is not accom-
panied by sternal pain, which, when also
present, suggests the sternocleidomastoid
myofascial syndrome.

When an unusual TP is activated in the
lowest part of the sternal division, where
that division may merge with a slip of the
inconstant sternalis muscle, the TP is as-
sociated with a paroxysmal dry cough that
can be precipitated by mechanical stimu-
lation of the TP.

At the mid-level of the sternal division,
TPs refer pain homolaterally, arching
across the cheek (often in finger-like pro-
jections) and into the maxilla, over the
supraorbital ridge and deep within the or-
bit.⁵¹ Pain may be referred on the same
side to the external auditory canal.^{56,62} The
quality of the pain is described by patients

to be aching as in the deep pain defined
by Kellgren.²³ The TPs along the inner
margin at the mid-level of this division
refer pain to the pharynx and to the back
of the tongue during swallowing,⁵ which
causes "sore throat," and to a small round
area at the tip of the chin.⁵³ Marbach²⁸
shows a similar pattern that includes the
cheek, temporomandibular joint and mas-
toid areas.

In the upper end of the sternal division,
TPs refer pain to the occipital ridge behind,
but not close to the ear, and to the vertex
of the head like a skull cap, with scalp
tenderness in the pain reference zone.

Autonomic concomitants of TPs in the
sternal division relate to the homolateral
eye and nose.^{49,53} Eye symptoms include
excessive lacrimation, reddening (vascular
engorgement) of the conjunctiva, apparent
"ptosis" (narrowing of the palpebral fis-
sure) with normal pupillary size and re-
actions, and visual disturbances. The
"ptosis" is due to spasm of the orbicularis
oculi muscle, rather than to weakness of
the levator palpebrae muscle. The spasm
is caused by increased excitability of mo-
tor units within the reference zone of ster-
nal division TPs. The patient may have to
tilt the head backward to look up, because
of inability to raise the upper eyelid. Visual
disturbances include not only blurring of
vision,^{47,49} but also dimming of perceived

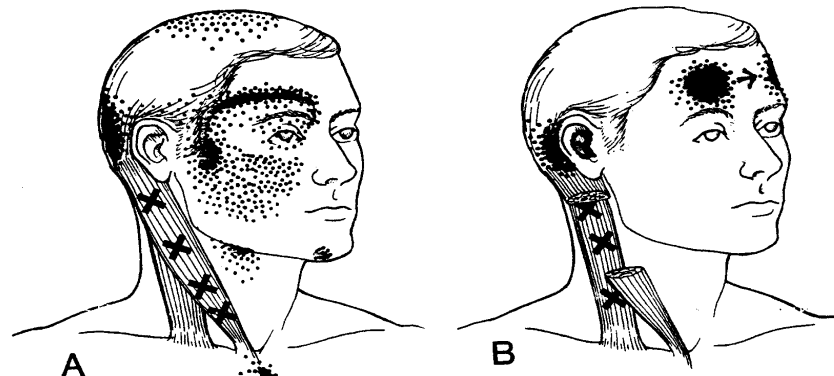


Figure 7.1. Referred pain patterns (solid red shows essential zones and stippling shows the spillover areas) with location of corresponding trigger points (Xs) in the right sternocleidomastoid muscle. A, the sternal (superficial) division. B, the clavicular (deep) division.

Unlike "Tender Points", Trigger Points have been shown to be a reliable and valid sign/symptom.

reported a study part of which involved the

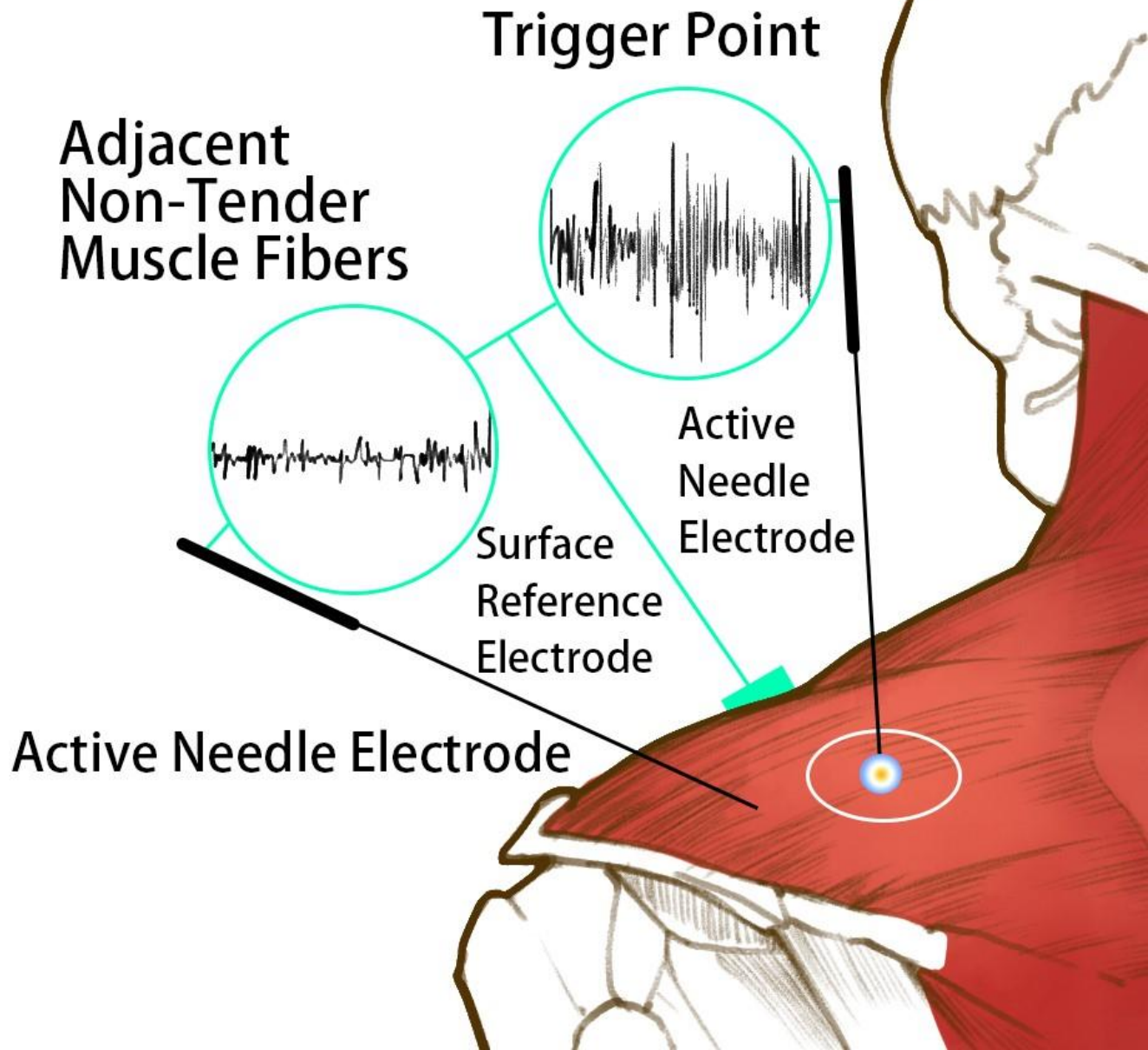
picked from a pool of one general practitioner and four medical students. Each

Table 8-2 *Interrater Reliability of Examinations for Trigger Point Characteristics, Kappa Values*

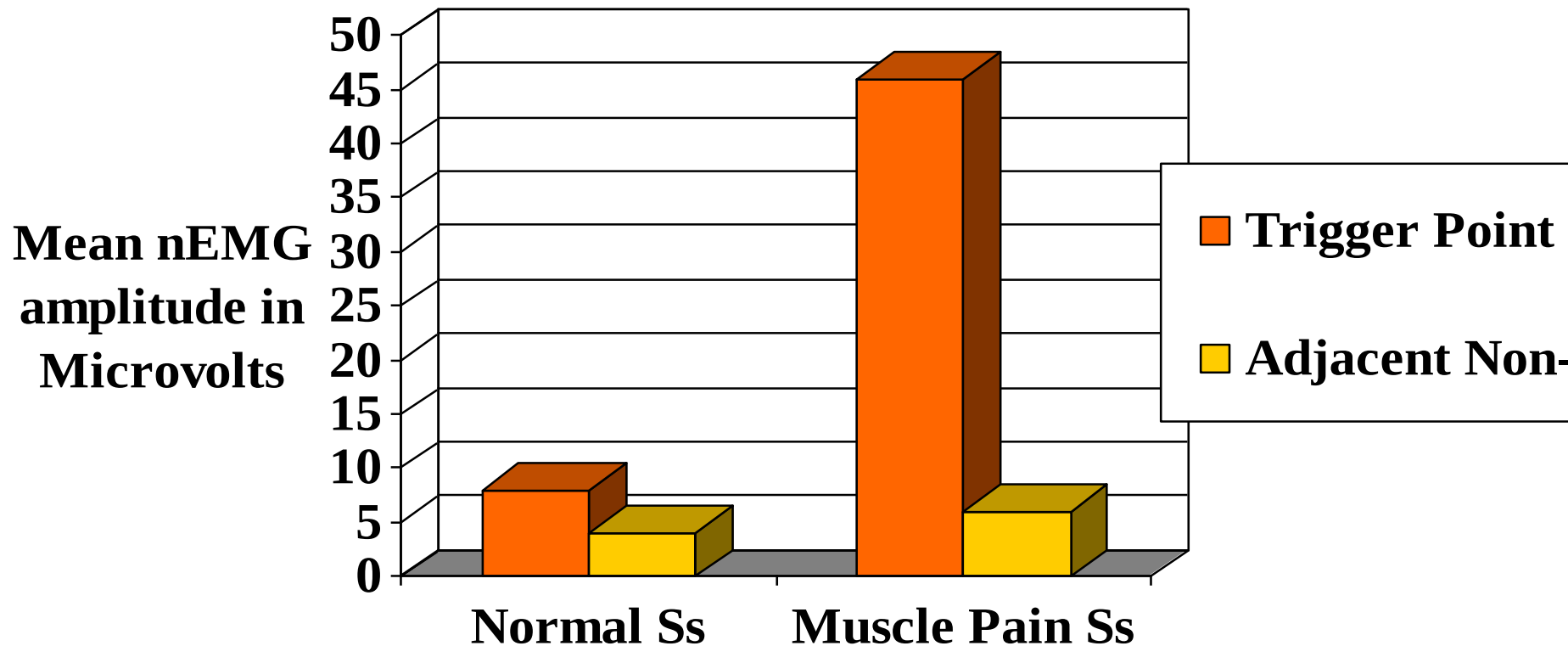
Examination	Wolfe et al. ³⁰⁰	Nice et al. ²⁰⁷	Njoo et al. ²¹⁰	Gerwin et al. ⁹⁷	Mean
Spot tenderness	0.61		0.66	0.84	0.70
Jump sign			0.70		0.70
Pain recognition	0.30		0.58	0.88	0.59
Palpable band	0.29		0.49	0.85	0.54
Referred pain	0.40	0.38	0.41	0.69	0.47
Twitch response	0.16		0.09	0.44	0.23
Mean	0.35	0.38	0.49	0.74	

Gerwin, R., Shannon, S., Hong, C., Hubbard, D. & Gevirtz, R. (1997) Interrater reliability in myofascial trigger point examination. *Pain*, 69, 65-73.

Needle EMG Activity

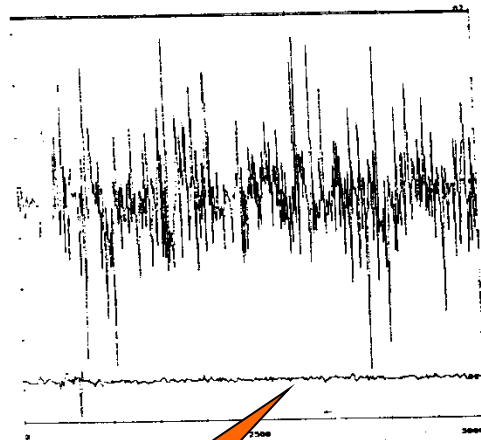


Myofascial Trigger Points Show Spontaneous Needle EMG Activity (Hubbard & Berkoff, 1993)

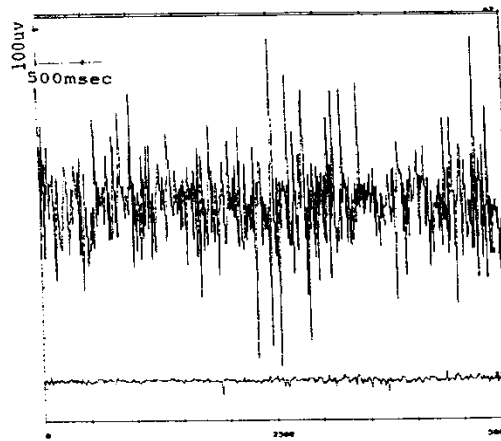


Effects of Curare on nEMG in TPs and Adjacent, (Non-tender) Sites

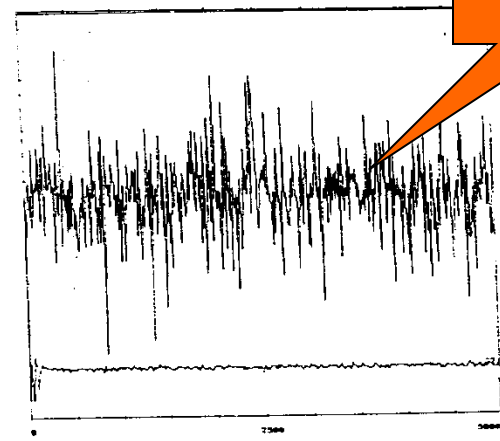
Pre



Injection



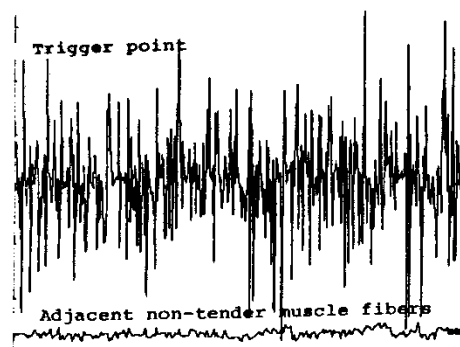
Post



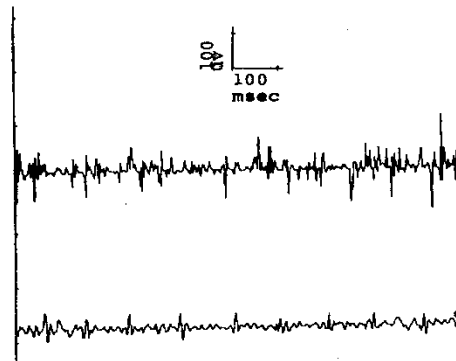
Adjacent nEMG

TP nEMG

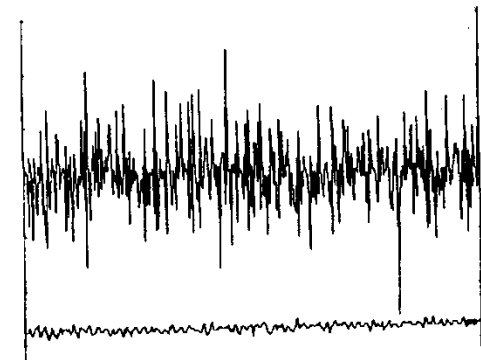
The Effect of Phentolamine Injection on TP & Adjacent nEMG



BEFORE



20 MINUTES AFTER



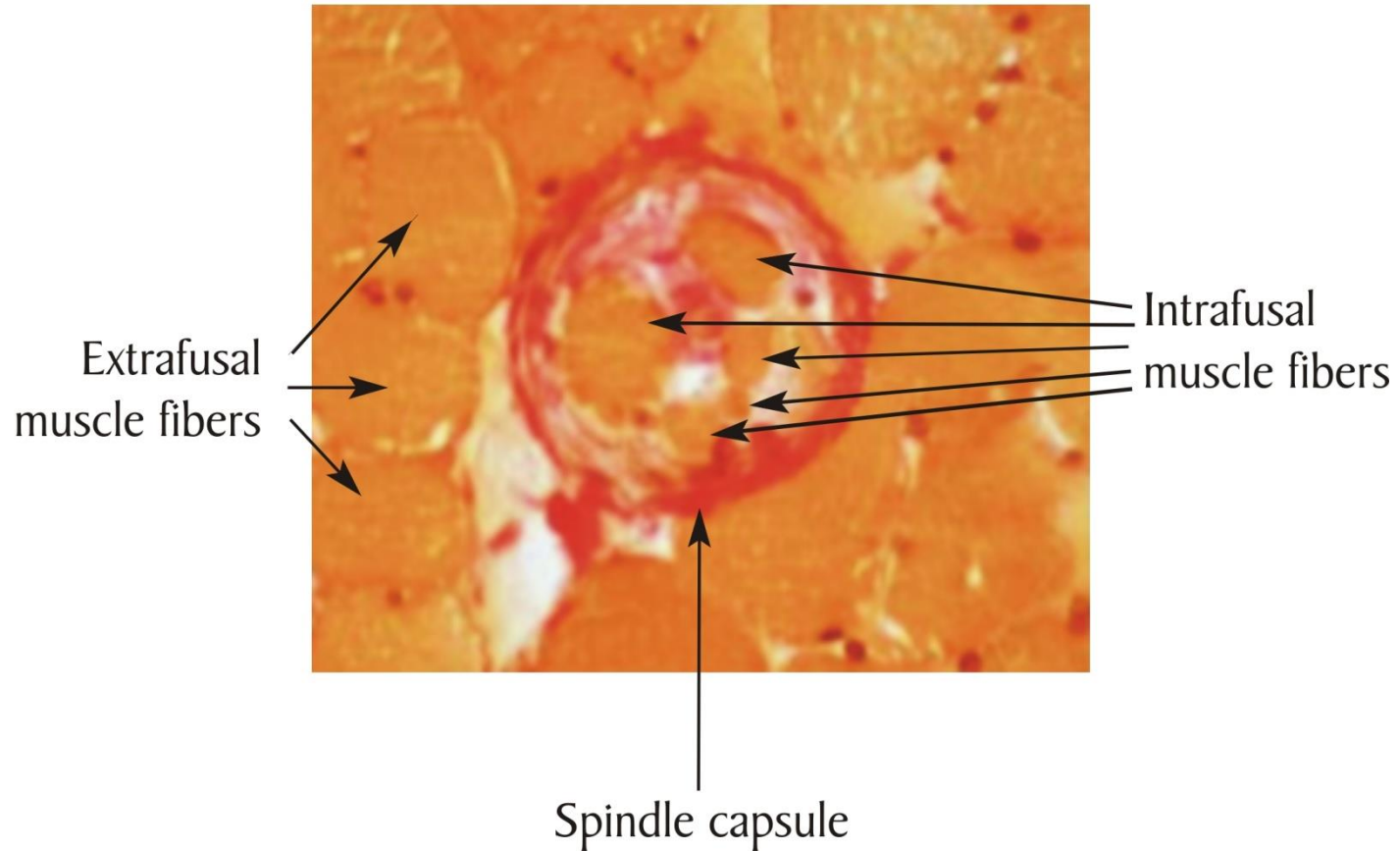
50 MINUTES AFTER

PHENTOLAMINE 2.5MG INJECTED DIRECTLY INTO TRIGGER POINT IN PATIENT WITH MYOFASCIAL PAIN
David Hubbard, MD, Dpt Neurology, University of California, San Diego

Italian Spindle Studies

- Passatore, Deriu, Grassi, & Raotta (1996), *J.Auton N.S.*
- Grassi, Deriu, & Passatore (1993) *J. Physiology*
- Grassi, Deriu, Artusio, & Passatore (1993) *Arch Ital Biol*
- Grassi & Passatore(1990) *Functional Neurology*
 - Found strong response in spindle could be elicited by sympathetic cervical nerve stimulation, abolished by alpha-adrenergic blockade, unaffected by sympathetically induced vasomotor changes.
 - “These data suggest that, when the sympathetic nervous system is activated under physiological conditions, there is a marked depression of the stretch reflex which is independent of vasomotor changes and is probably due to decrease in sensitivity of muscle spindle afferents” (Grassi, Deriu, & Passatore, 1993, p.163)

Needle EMG-Guided Biopsy of a Trigger Point



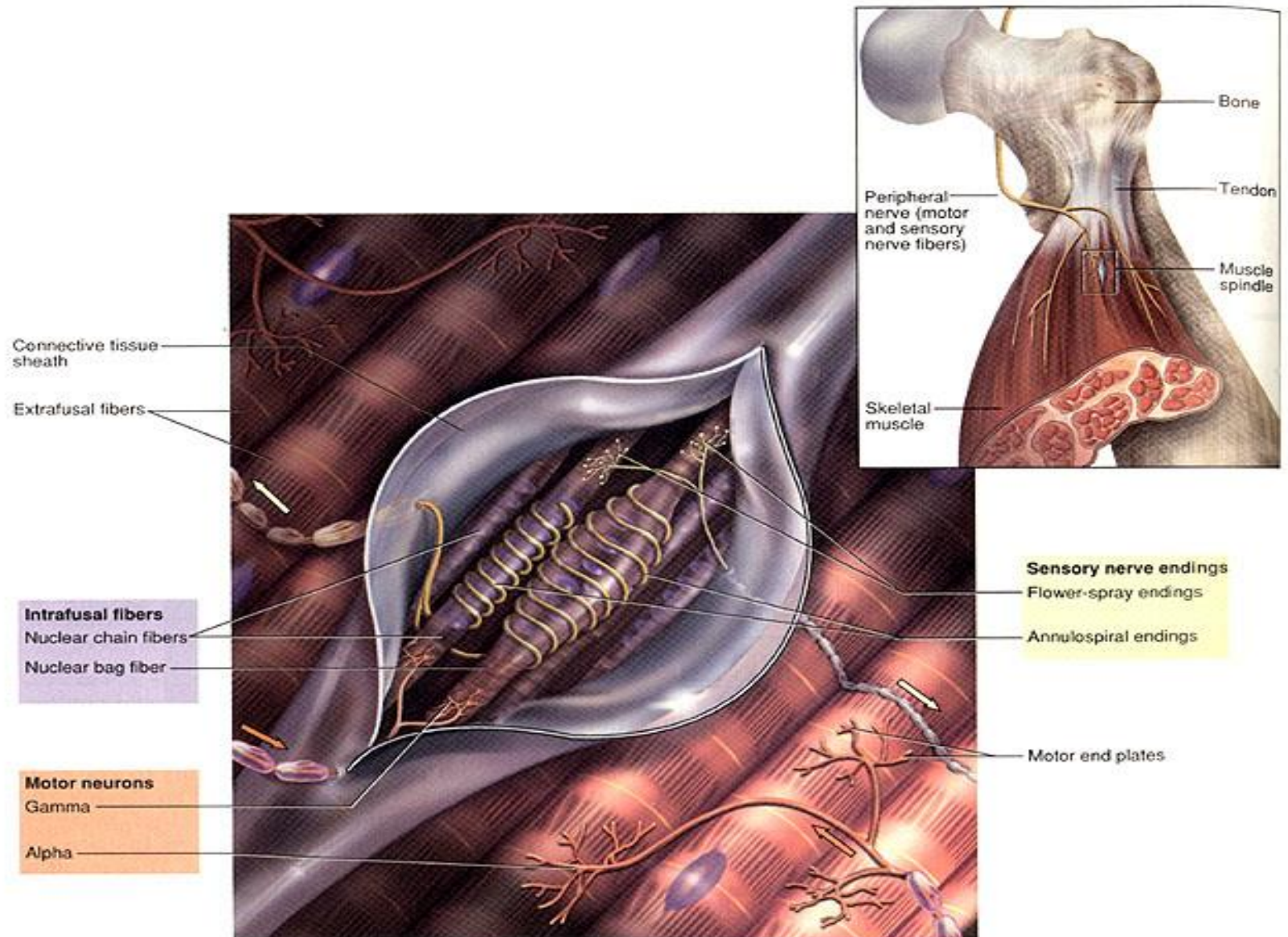
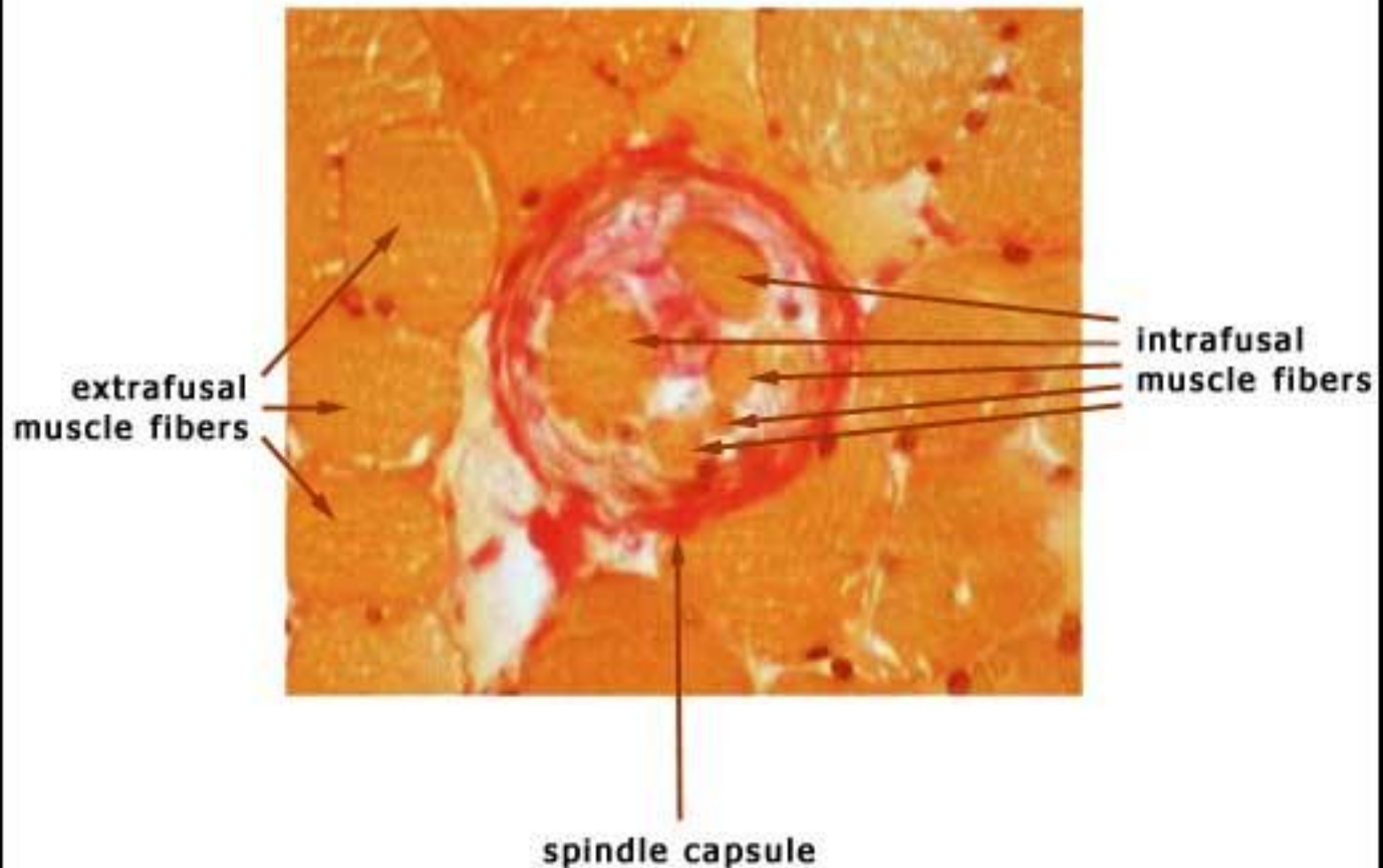


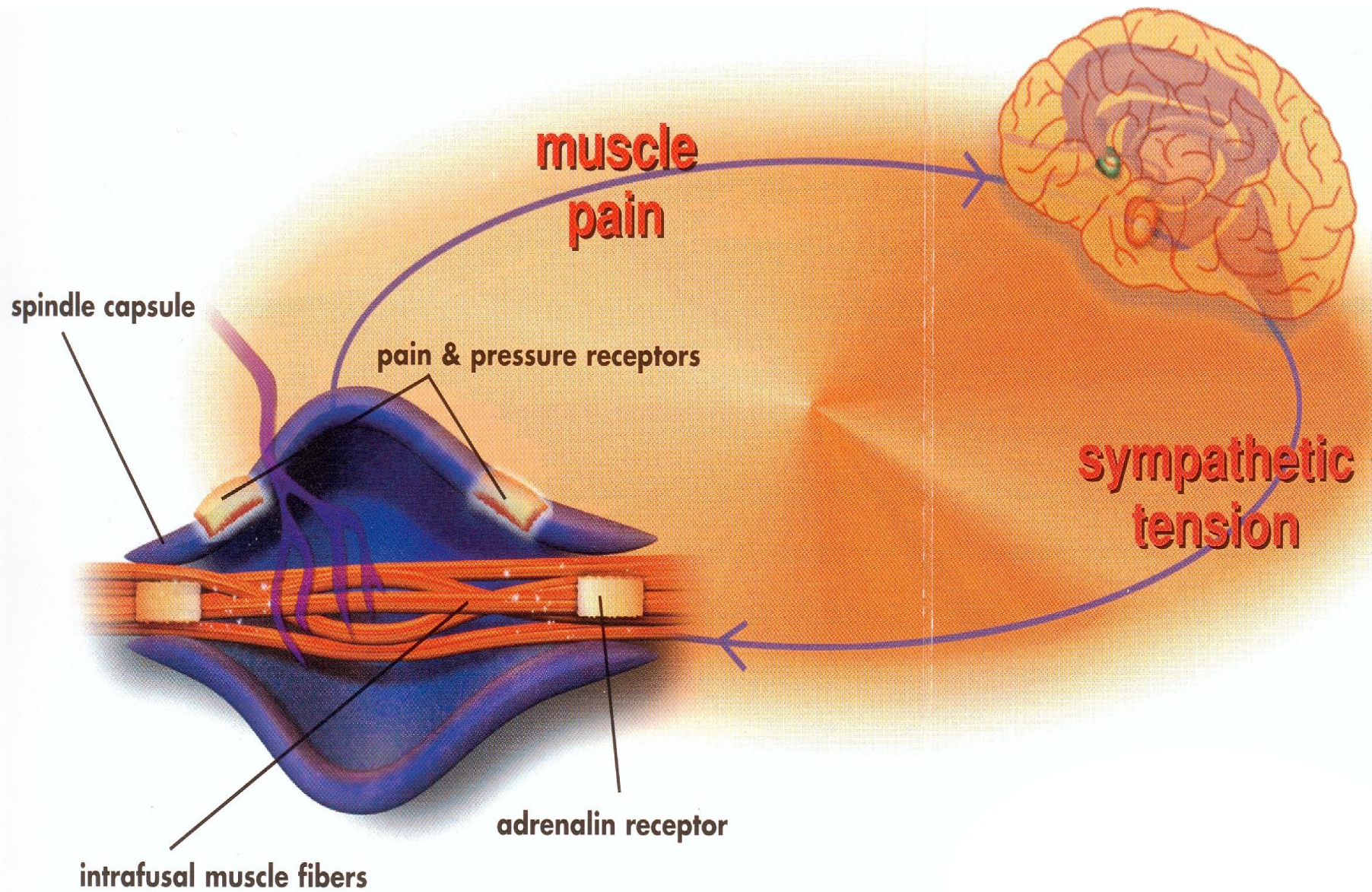
Figure 15.11 A muscle spindle and its innervation.

Needle EMG-Guided Biopsy of a Trigger Point

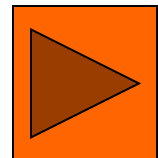
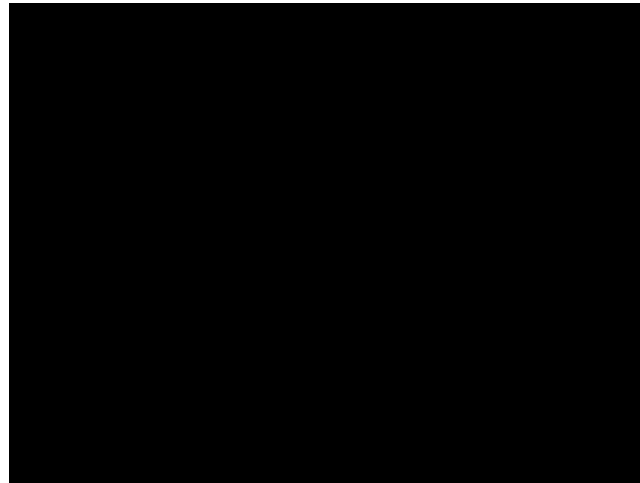


Spindles are
sympathetically
preparing for
motor action

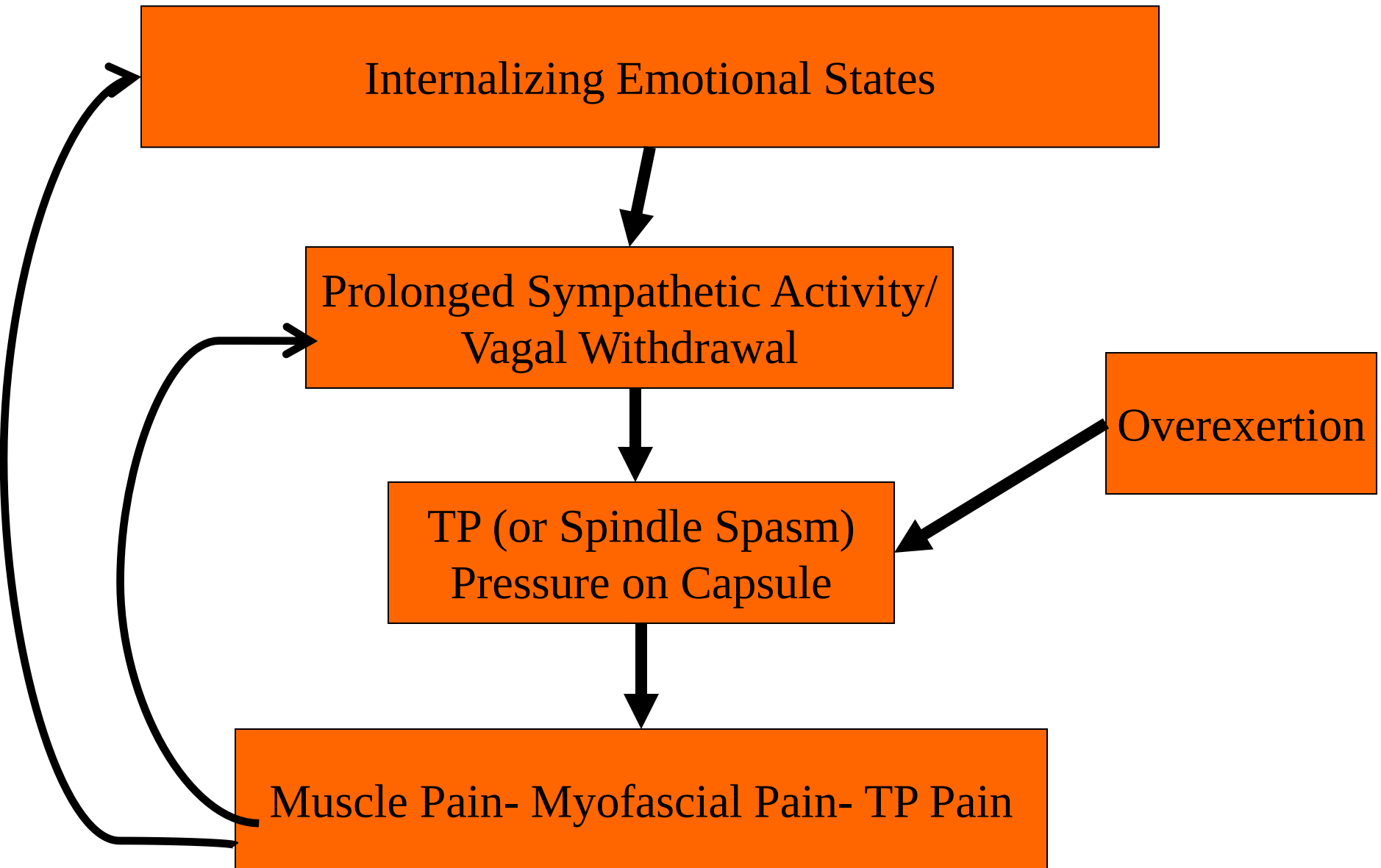




Video showing the TP EMG response
During resting, relaxation, and stressful states.
Available: E-mail me at Rgevirtz@alliant.edu



Mediation Model of Muscle Pain



Myofascial TPs and Migraine(Do, T. P., Heldarskard, G. F., Kolding, L. T., Hvedstrup, J., & Schytz, H. W. (2018). Myofascial trigger points in migraine and tension-type headache. *The journal of headache and pain*, 19(1), 84.



- Most studies support the existence of Tps in Tension Type HA
- “Myofascial trigger points are prevalent in both migraine and tension-type headache, but the role they play in the pathophysiology of each disorder and to which degree is unclarified.”

Alaca, N. (2019). The impacts of internet addiction on depression, physical activity level and trigger point sensitivity in Turkish university students. *Journal of Back and Musculoskeletal Rehabilitation*, (Preprint), 1-8.



- Internet addicted group had lower pain thresholds in trapezius TPs.
- Either prolonged SNS, Vagal withdrawal, or both, sensitize TPs

Chronic pain is associated with low HRV(InHF)

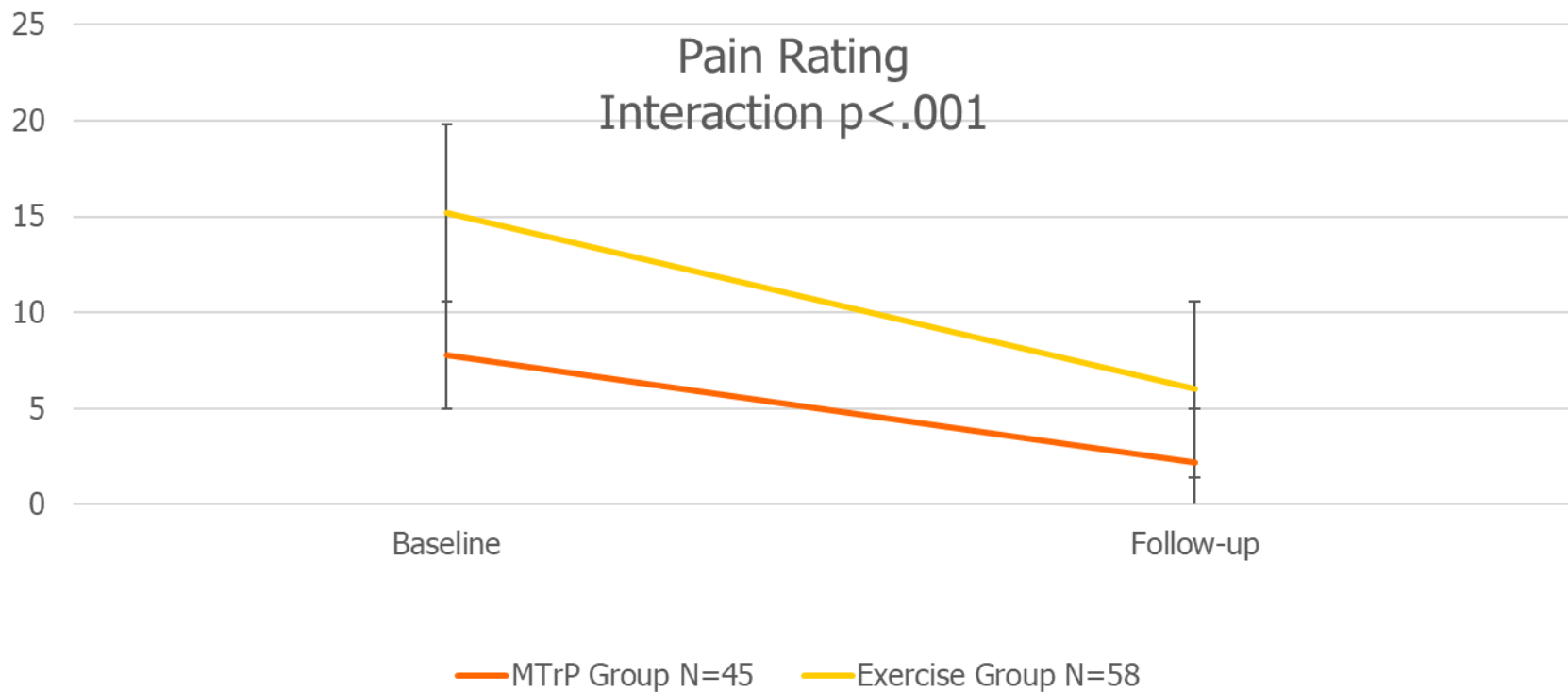


- "...significant differences in HRV were reported for fibromyalgia (HF-HRV, LF/HF ratio, SDNN, and RRI), neuropathic pain (SDNN), head and/or orofacial pain (SDNN), and chronic musculoskeletal pain (RRI)."
- Tracy, L. M., Ioannou, L., Baker, K. S., Gibson, S. J., Georgiou-Karistianis, N., & Giummarra, M. J. (2016). Meta-analytic evidence for decreased heart rate variability in chronic pain implicating parasympathetic nervous system dysregulation. *Pain*, 157(1), 7-29.

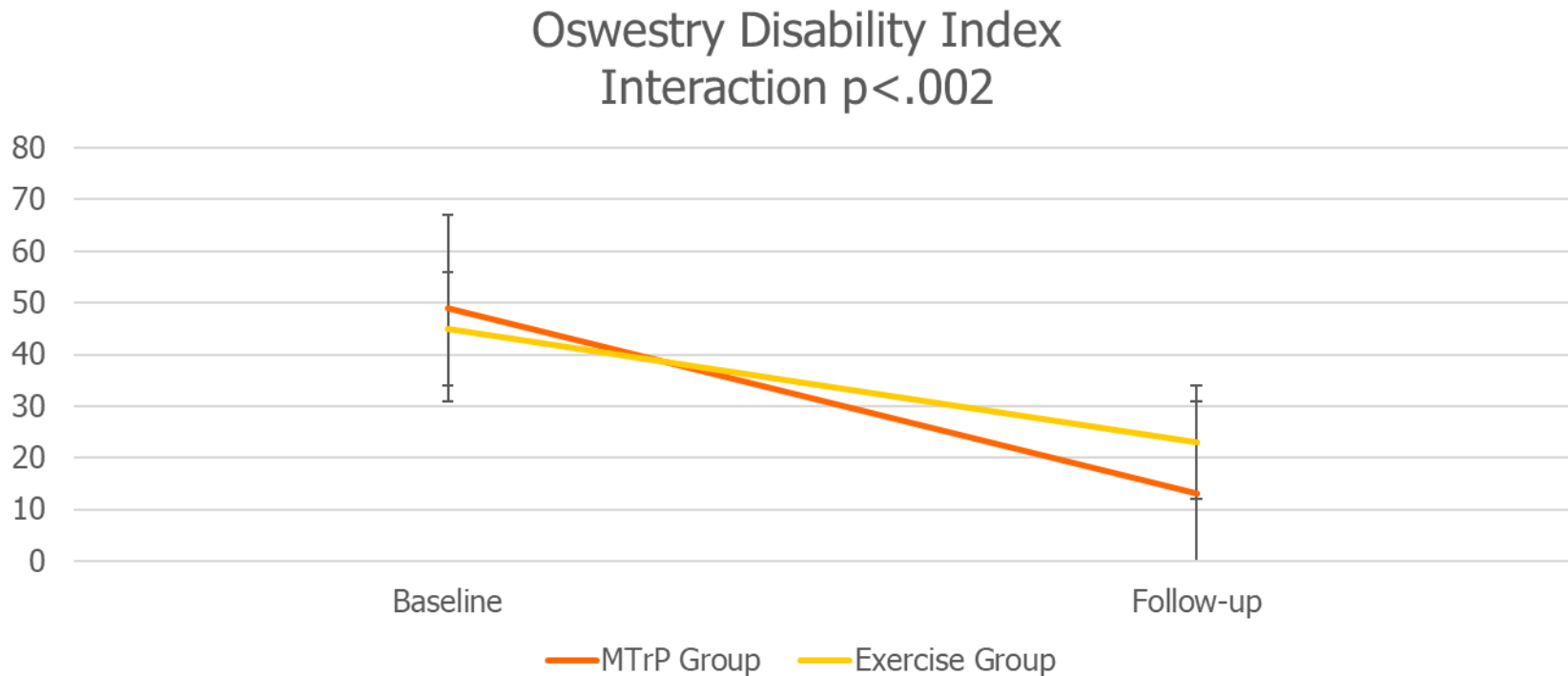


MTrP Treatment Appears Superior to TAU, Exercise, or Muscle Stabilization Exercises

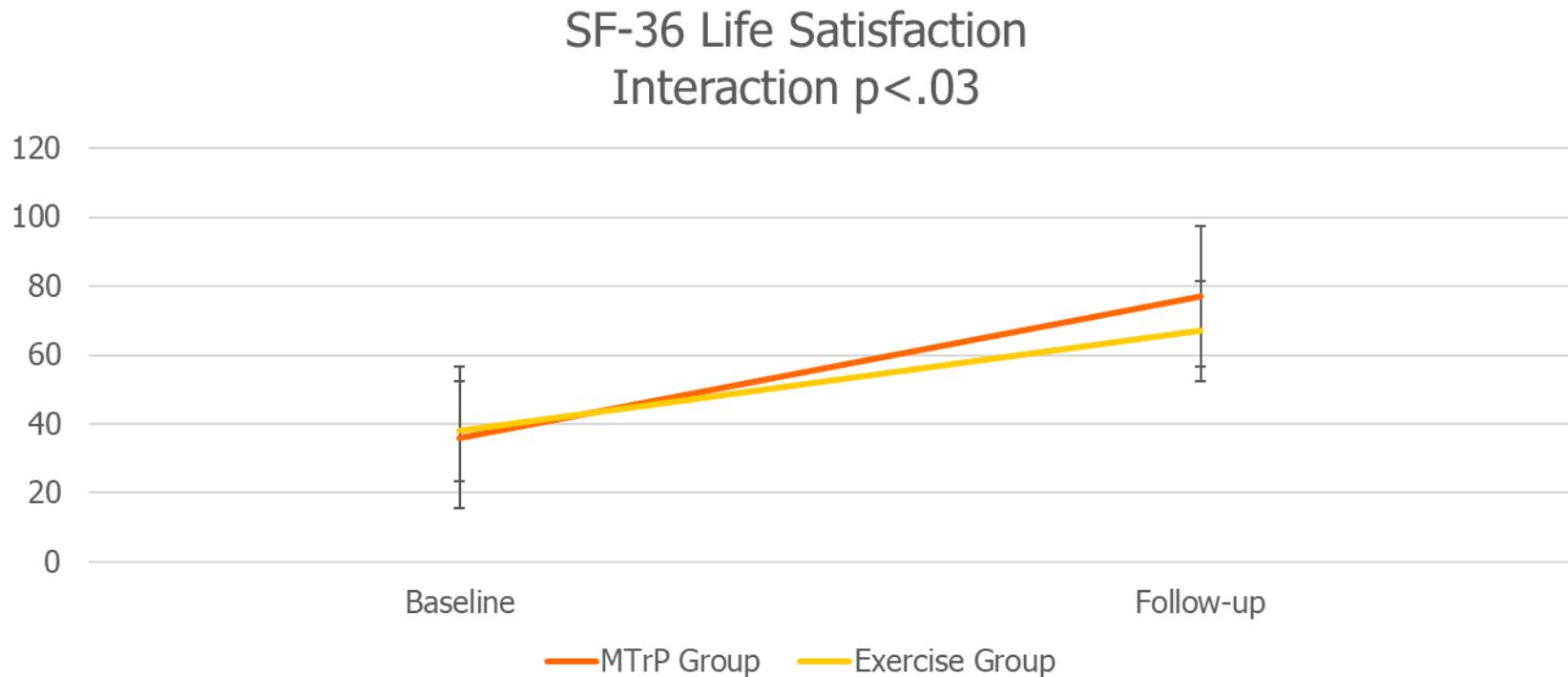
Rawan et al., 2020, Myofascial trigger-point compression therapy as an adjunct to exercise program is superior in alleviating chronic low back pain compared to exercise program alone, *BMC Musculoskeletal disorders*



Rawan et al., 2020, Myofascial trigger-point compression therapy as an adjunct to exercise program is superior in alleviating chronic low back pain compared to exercise program alone, *BMC Musculoskeletal disorders*



Rawan et al., 2020, Myofascial trigger-point compression therapy as an adjunct to exercise program is superior in alleviating chronic low back pain compared to exercise program alone, *BMC Musculoskeletal disorders*

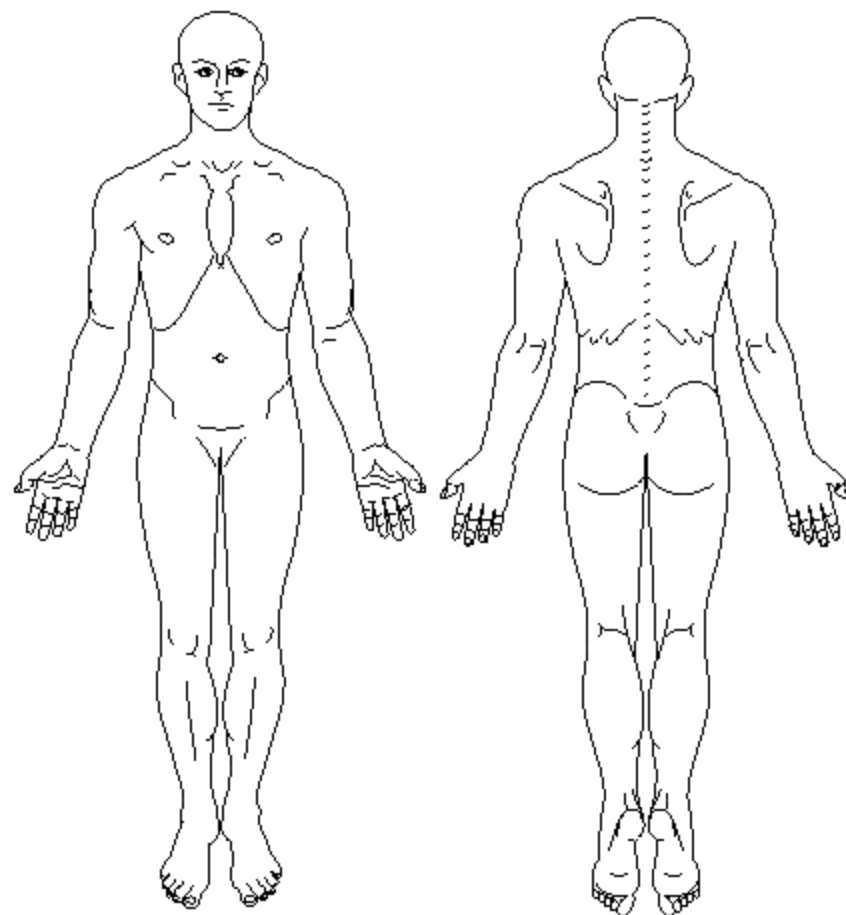


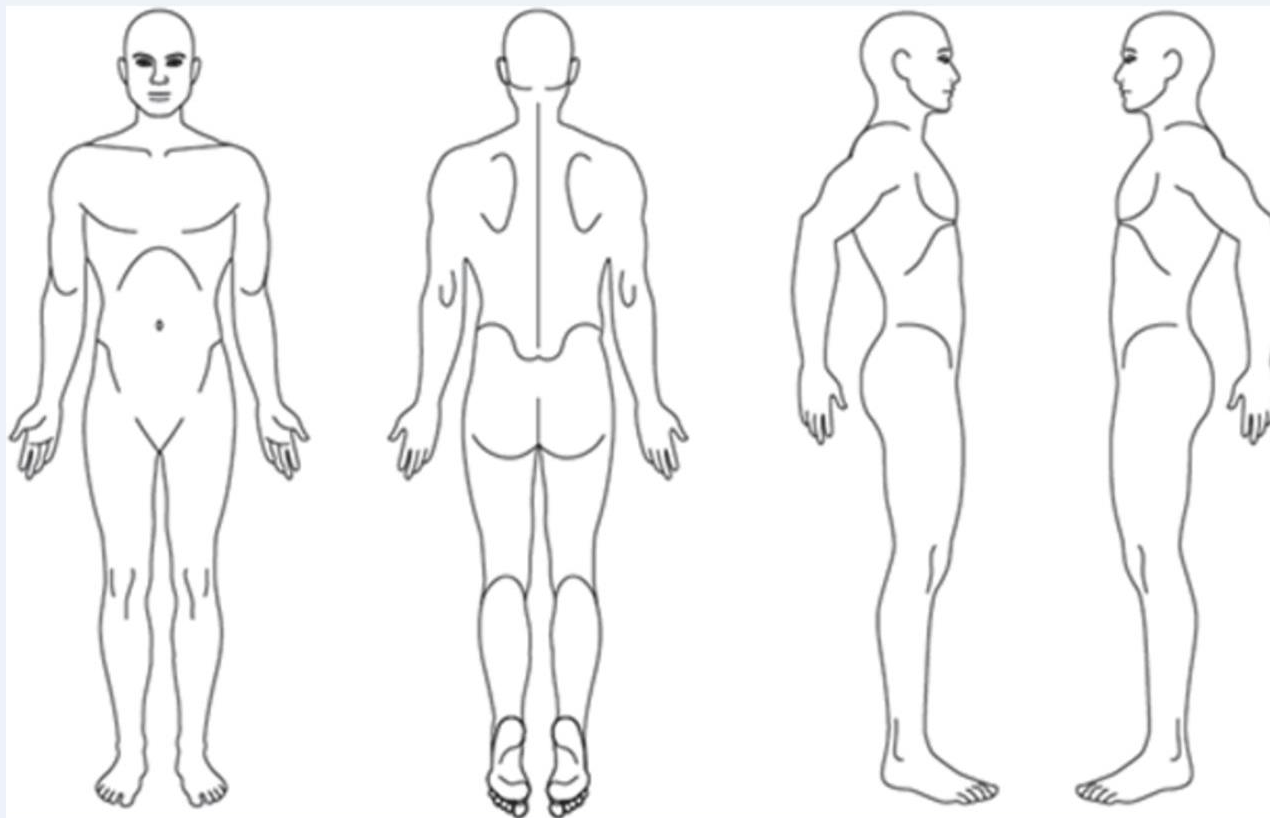
PAIN DRAWING

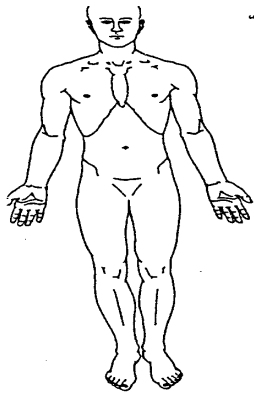
SHADE IN WITH A PENCIL ALL AREAS YOU HAVE PAIN.

(Don't forget to include the head or areas of lesser pain).

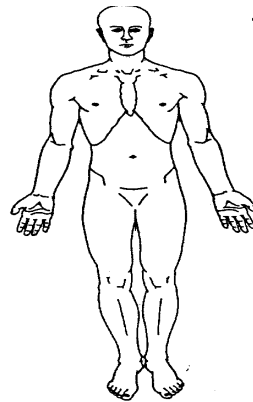
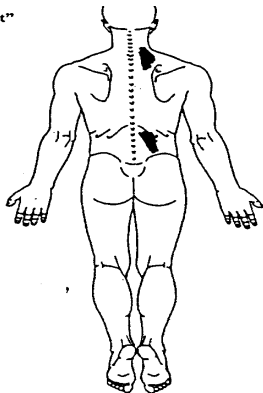
Use small x's to show any areas of numbness or tingling



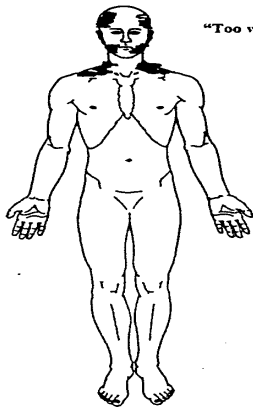
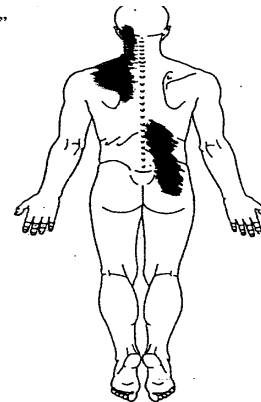




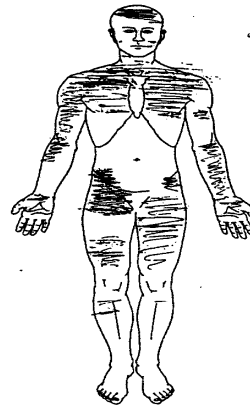
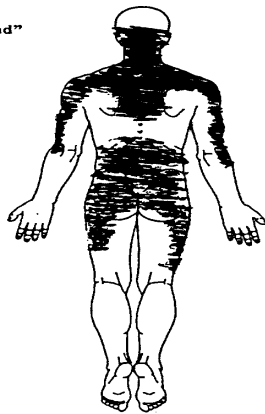
"Excellent"



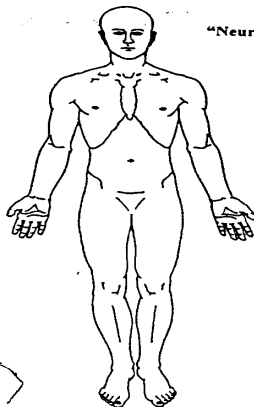
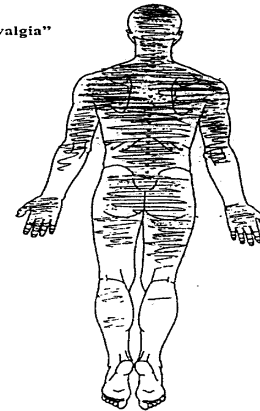
"Typical"



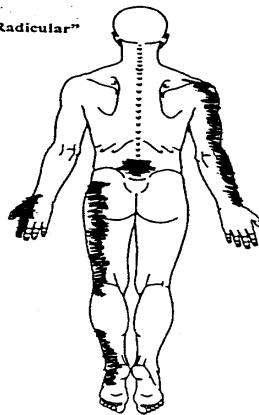
"Too widespread"



"Fibromyalgia"



"Neuropathic/Radicular"



Treatment Considerations



- Education/Attribution Shift



- Use grid, video, articles, persuasion, diagrams, etc. to achieve shift in causal attribution

- Physical management

- Acupressure, acupuncture, theracane, tennis balls, passive stretches, moist heat, spray and stretch

- Injections (Phenoxybenzamine, botulinum toxin type A, dry needling)

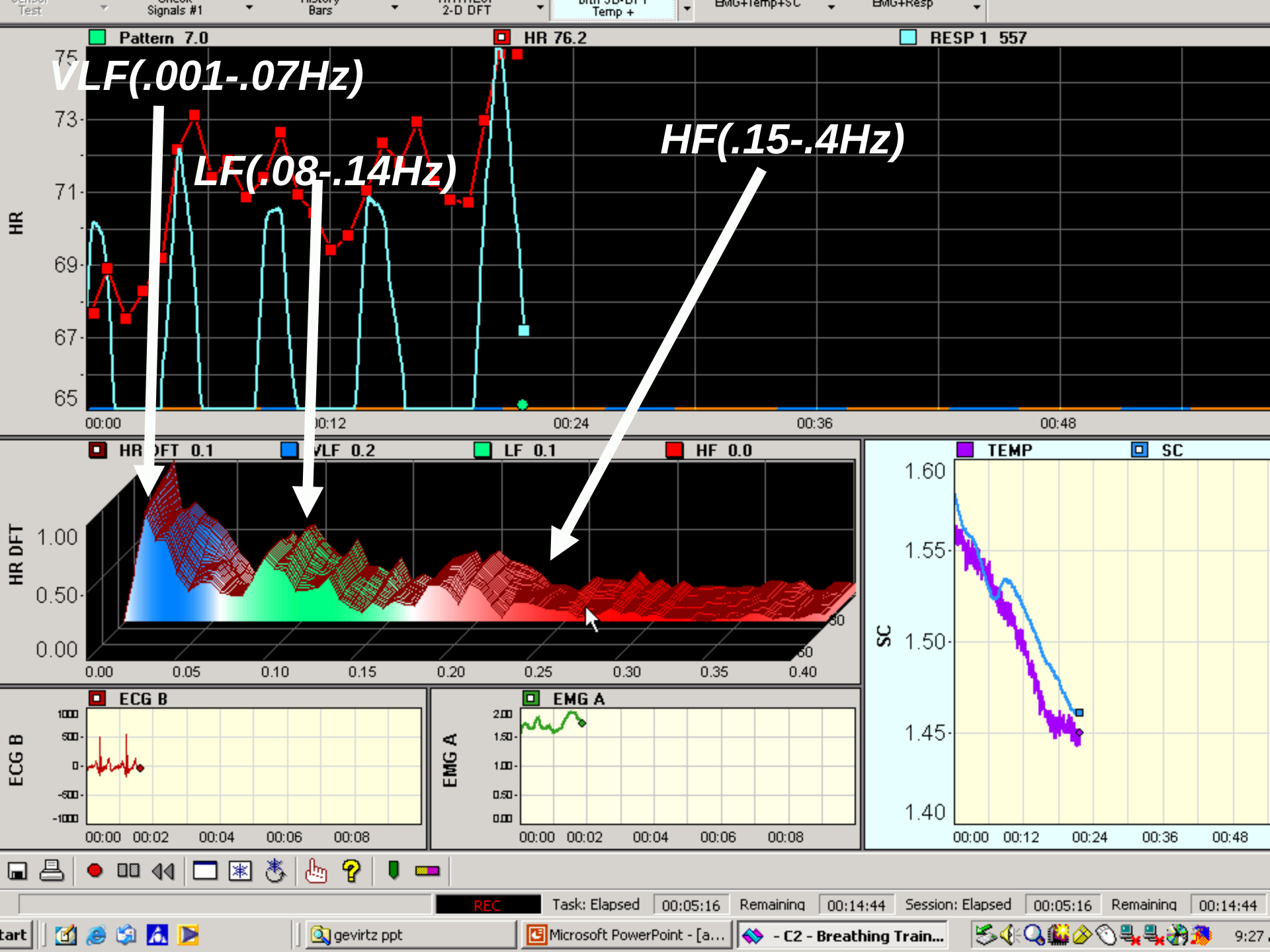
Parasympathetic

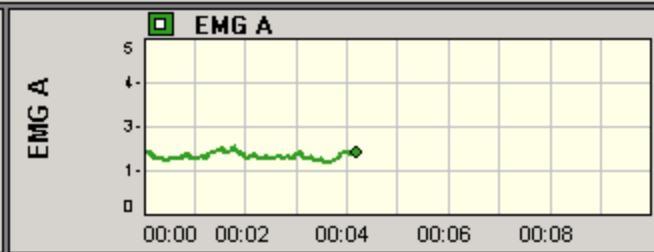
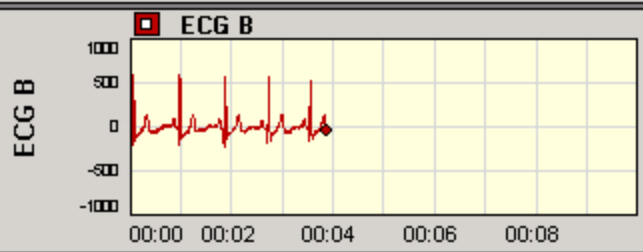
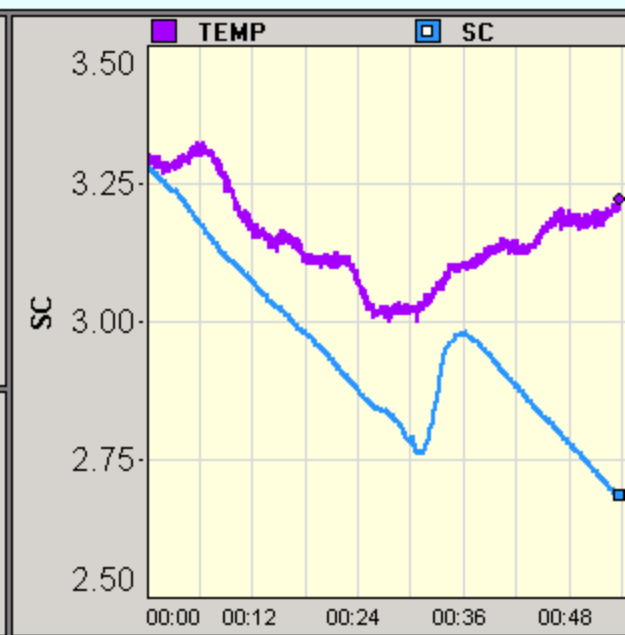
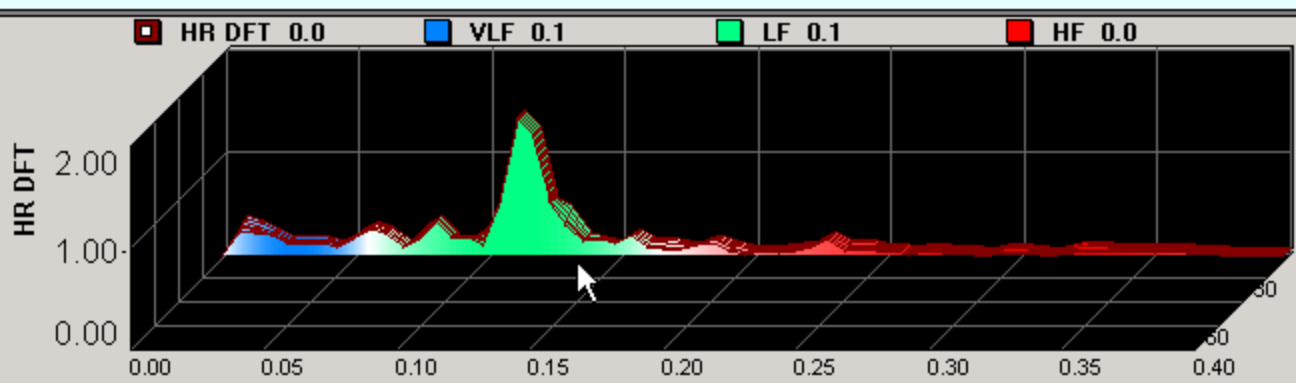
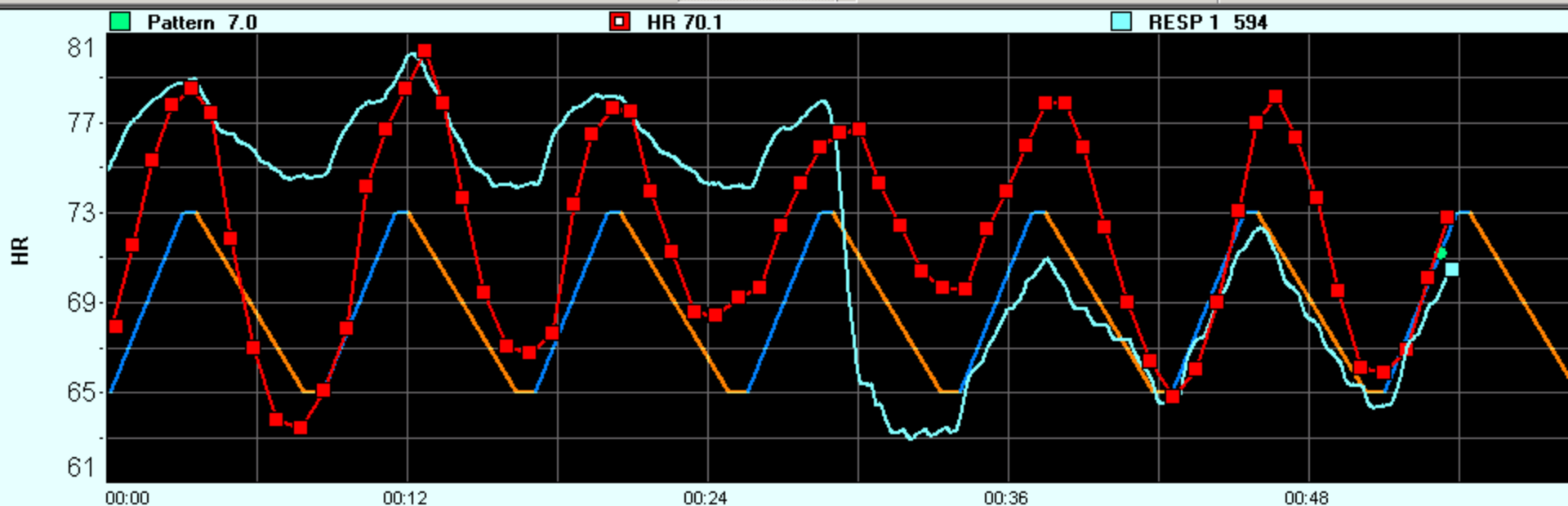
“Accentuated Antagonism”

- “Vagal ‘tone’ predominates over sympathetic tone at rest. Under normal physiological conditions, abrupt parasympathetic stimulation will inhibit tonic sympathetic activation and its effects at rest and during exercise. This response is known as ‘accentuated antagonism’” (Olshansky et al., 2011, p.863; Yang and Levy, 1984; Schwegler and Jacob, 1975; Levy, and Zieske, 1969)

Treatment II: sEmg Biofeedback Techniques

- Muscle awareness
 - Biofeedback, bilateral, symmetry, traps, frontal
- Frontal EMG
 - Cultivated Low Arousal
 - Facial Muscle Feedback
- Bi-lateral Trapezius Tx
 - For Bracing or Splinting
 - For Symmetry
 - For Breathing
- Specific Muscle Placement





Effects of HRVB regular practice



- Increase flexibility/balance of ANS
- Increase Baroreflex (by 20-30%)
- Produce activity in brain centers that control inhibition, depression, and anxiety
- Increase self efficacy

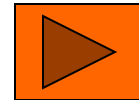
Treatment Considerations

III

□ Breathing/relaxation

- Cultivated low arousal, breathing retraining, mindfulness techniques, etc.

- Resonant Frequency Training



□ Problem solving

- Using awareness of muscle tension, try to remedy causal situation(seeing the big picture)

Treatment Considerations IV

□ Cognitive interventions

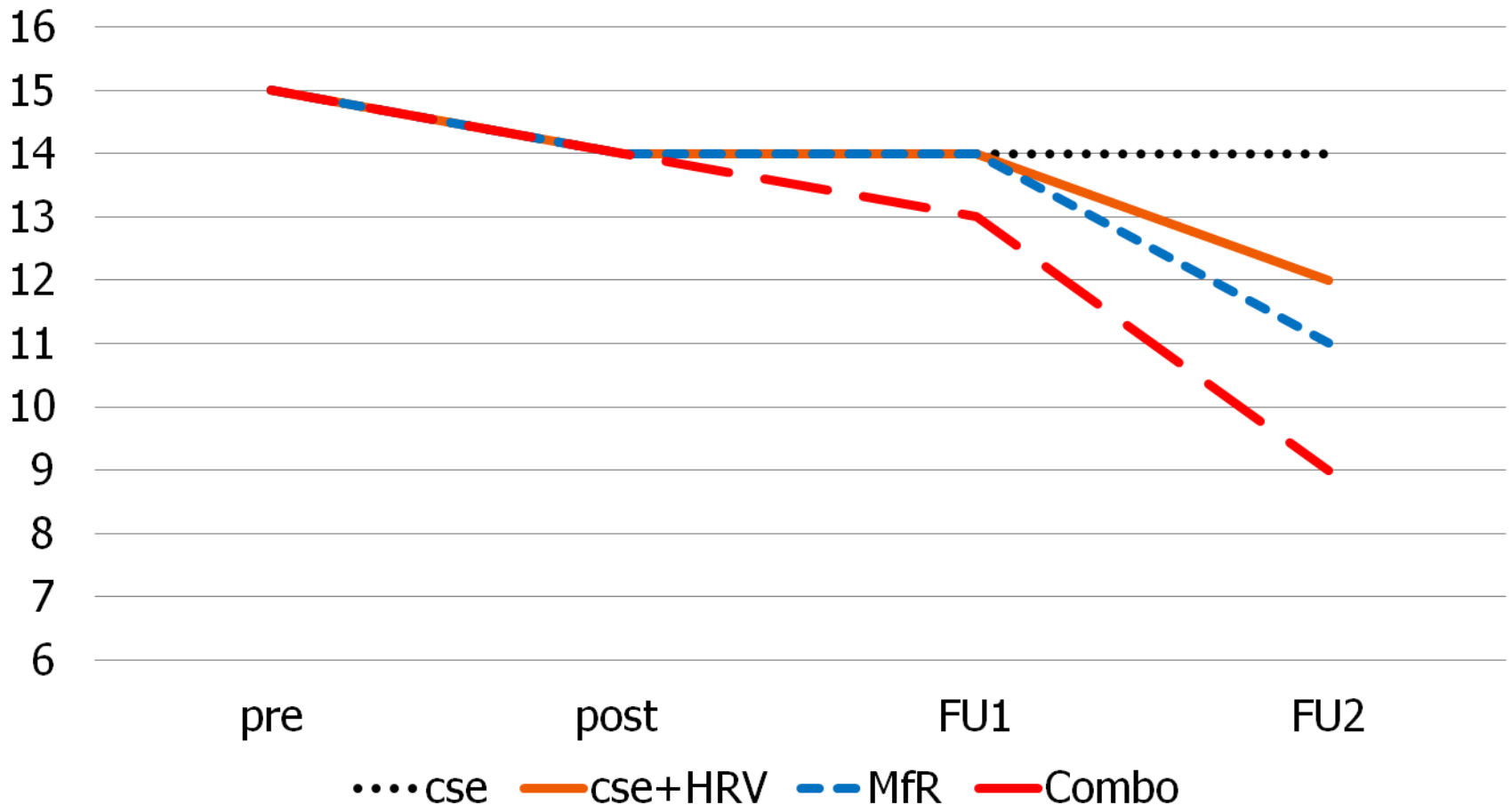
- Since the model hypothesizes that persistent sympathetic activity (even if low level) stimulates activity in the TrPs, we now look for the “smoking cognitive gun”. This is likely to center around distorted self-schema such as: “I’m only a valid person if I am pleasing others”, or “If I am not perfect, I am worthless”.

Wrap-Up

- Summary of the arguments presented today
 - Epidemiology
 - Pathophysiology
 - Treatment
- Implications: Mind/Body techniques should be the first line treatment for muscle pain disorders

Pain ratings across time

(Vagades, Gordon, Gevirtz, Andrasik (2013) N=124



Composite pain measure

