

OUT OF TUNE: A GUIDE TO UPPER EXTREMITY NERVE ENTRAPMENT SYNDROMES IN MUSICIANS

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Combined Sections Meeting - San Antonio, TX
February 15 – 18, 2017

DISCLOSURE STATEMENT OF FINANCIAL INTEREST

Janice Ying

I declare no funding or conflicts of interest related to this presentation

Adriaan Louw

I publish books for professionals and patients on pain and receive an honorarium for the sales. These are not being specifically promoted in the presentation. The intent is to share our research and not promote products

I teach for a seminar company offering continuing education for healthcare providers. The session is not designed to promote the attendance of the seminars

Erin Hayden

I declare no funding or conflicts of interest related to this presentation

LEARNING OBJECTIVES

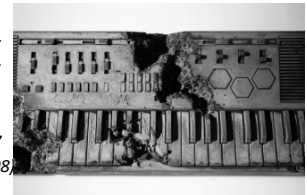
- Discuss trends of incidence/prevalence of injuries found among instrumental musicians.
- Develop a clinical understanding of altered mechanics, physiology and sensitivity of the nervous system as a source of upper extremity nerve entrapments
- Discuss, compare and contrast clinical presentations, differential diagnosis and interventions of peripheral neuropathies.
- Be able to apply and discuss various examination and treatment approaches for return to play amongst instrumental musicians.
- Discuss potential treatment interventions that are functionally applicable to instrumental musicians

PLAYING-RELATED INJURY

DEFINED

"Pain, weakness, lack of control, numbness, tingling, or other symptoms that INTERFERE with [a musician's] ability to play an instrument at a level that he/she is accustomed to."

(Zaza, et al. 1998)



THE FIGURES

- MSK -33% of all worker injury and illness cases (www.osha.gov - 2013)
- Musculoskeletal Disorders, Workforce Health and Productivity in the United States - June, 2015 - Center for Workforce Health and Performance
 - At any given time 30% American workforce living with pain
 - Lower income workers sustain greater injuries



PERCUSSION



COMMON PATHOLOGIES

Musculoskeletal (64%)

- Shoulder Impingement
- Ligament Sprain
- Tendinitis
- Arthritis
- Lateral Epicondylitis

Neurologic (20.2%)

- Thoracic Outlet Syndrome (TOS)
- Ulnar Neuropathy
- Carpal Tunnel Syndrome
- Cervical Radiculopathy

Focal Dystonia / Occupational Cramp (7.6%) (Lederman, 2003)

PREVALENCE

	C/S	T/S	L/S	Shoulder (R/L)	Elbow (R/L)	Wrist (R/L)
Fishbein (1988) n=2,212	21%	16%	22%	20% / 20%	10% / 8%	10% / 9%
Leaver (2011) n=243	56%	N/A	51%	51%	21%	33%
Kok (2013)	45.8%	19.3%	39.8%	30.1% / 27.7%	2.4% / 7.2%	16.9% / 15.7%
Steinmetz (2015) n=408	72.8%	23.5%	50.7%	52.2% / 55.1%	20.3% / 16.9%	23.5% / 55.1%

PREVALENCE: MUSICIAN VS. GENERAL POPULATION

	C/S	Shoulder (R/L)
Fishbein (1988) n=2,212	21%	20% / 20%
Leaver (2011) n=243	56%	51%
Steinmetz (2015) n=408	72.8%	52.2% / 55.1%
General Pop. (Fejer R 2006)	5.9-22.2*	6.9-26%* (Luime JJ 2004)

Out of Tune: A Guide to Upper Extremity Nerve Entrapment Syndromes in Musicians

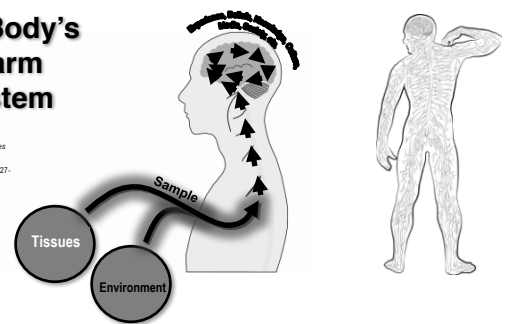
Normal and Abnormal Neurodynamics

Adriaan Louw, PT, PhD

Combined Sections Meeting - San Antonio, TX
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The Body's Alarm System


Gifford, L.S. Pain, the tissues and the nervous system. *Physiotherapy*, 1998, 84, p. 27-33.



MORE ACCURATELY...



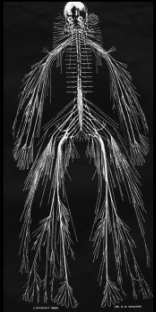
Lederman RJ. Peripheral Nerve Disorders in Instrumentalists. *Ann Neurol*. 1989;26:640-648.
 Storm SA. Assessing the instrumentalist interface modifications, ergonomics and maintenance of play. *Physical medicine and rehabilitation clinics of North America*. Nov 2006;17(4):893-903.
 Bejjani FJ, Kaye GM, Benham M. Musculoskeletal and neuromuscular conditions of instrumental musicians. *Archives of physical medicine and rehabilitation*. Apr 1996;77(4):406-413.

Functional and Structural Changes in the CNS and Brain

Physical Properties of the Nervous System Neurodynamics

Louw A. Treating the brain in chronic pain. In: C FdiP, J C, Dommerholt J, eds. *Manual Therapy for Musculoskeletal Pain Syndromes*. Vol 1. London: Churchill Livingstone; 2015.
 Schmid AB, Nee RJ, Coppeters MW. Reappraising entrapment neuropathies—mechanisms, diagnosis and management. *Manual therapy*. Dec 2013;18(6):449-457.
 Nee RJ, Vicenzino B, Jull GA, Cleland JA, Coppeters MW. Neural tissue management provides immediate clinically relevant benefits without harmful effects for patients with nerve-related neck and arm pain: a randomised trial. *Journal of Physiotherapy*. 2012;92(1):29-31.
 Nee RJ, Butler D, S. Management of peripheral neuropathic pain: integrating neurobiology, neurodynamics and clinical evidence. *Physical Therapy in Sport*. 2006;7:36-49.
 Fior H. The functional organization of the brain in chronic pain. In: Sandkühler J, Bromm B, Gehring GF, eds. *Progress in Brain Research*. Vol 129. Amsterdam: Elsevier; 2000.
 Fior H, Elbert T, Muhnickel W, Pantev C. Cortical reorganisation and phantom phenomena in congenital and traumatic upper-extremity amputees. *Experimental Brain Research*. 1998;119:205-212.

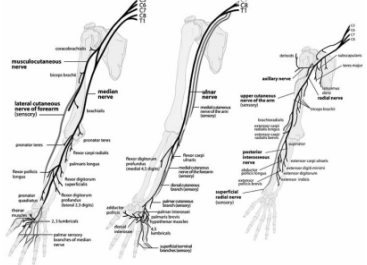


NEUROBIOLOGICALLY AND NEUROPHYSIOLOGICALLY...

1. Space
2. Movement
3. Blood

Louw A, Mintken P, Puentedura L. Neuophysilogic Effects of Neural Mobilization Maneuvers. In: Fernandez-De_Las_Penas C, Arendt-Nielsen L, Gerwin RD, eds. *Tension-type and Cervicogenic Headache*. Boston: Jones and Bartlett; 2009:231-245.
 Nee RJ, Butler D, S. Management of peripheral neuropathic pain: integrating neurobiology, neurodynamics and clinical evidence. *Physical Therapy in Sport*. 2006;7:36-49.

1. SPACE



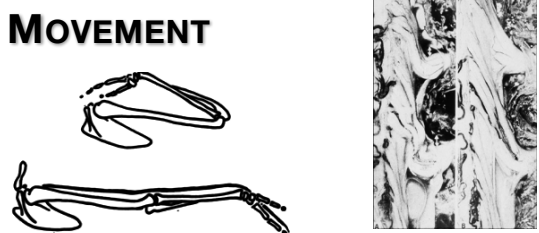
Louw A, Mintken P, Puentedura L. Neuophysilogic Effects of Neural Mobilization Maneuvers. In: Fernandez-De_Las_Penas C, Arendt-Nielsen L, Gerwin RD, eds. *Tension-type and Cervicogenic Headache*. Boston: Jones and Bartlett; 2009:231-245.
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1. SPACE



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 Nee RJ, Butler D, S. Management of peripheral neuropathic pain: integrating neurobiology, neurodynamics and clinical evidence. *Physical Therapy in Sport*. 2006;7:36-49.

2. MOVEMENT



Milesi H, Zoch G, Reihnsner R. Mechanical properties of peripheral nerves. *Clin Orthop Relat Res*. May 1995(314):76-83.
 Greening J, Smart S, Leary R, Hall-Craggs M, O'Higgins P, Lynn B. Reduced movement of median nerve in carpal tunnel during wrist flexion in patients with non-specific arm pain. *Lancet*. Jul 17, 1999;354(9174):217-218.
 Breig A. Adverse Mechanical Tension in the Central Nervous System. Stockholm: Almqvist and Wiksell; 1973.

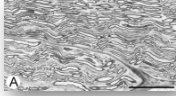
2. MOVEMENT

Greening J, Lynn B, Leary R, Warren L, O'Higgins P, Hall-Craggs M. The use of ultrasound imaging to demonstrate reduced movement of the median nerve during wrist flexion in patients with non-specific arm pain. *J Hand Surg [Br]*. Oct 2001;26(5):401-406; discussion 407-408.



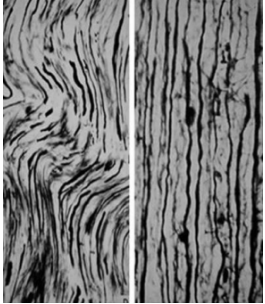
2. MOVEMENT

Nerves do not stretch
Axonal folding and unfolding



Breig A. *Adverse Mechanical Tension in the Central Nervous System*. Stockholm: Almqvist and Wiksell; 1978.

Li J, Shi R. A device for the electrophysiological recording of peripheral nerves in response to stretch. *J Neurosci Methods*. Jun 30 2006;154(1-2):102-108.

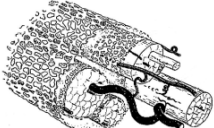


3. BLOOD SUPPLY

Neuroanatomy

- The brain and spinal cord are estimated to only account for 2% of the total body mass, yet they consume 20-25% of the available oxygen in the circulating blood
- If a nerve is "lengthened:"
 - 6-8%: Slow blood flow
 - 15%: Stop blood flow
 - 20%: Cells die in the dorsal horn

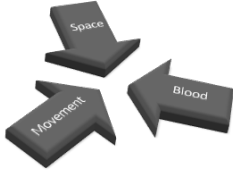

: Demyelination



Domisse GF, ed. *The blood supply of the spinal cord and the consequences of failure*. 2nd ed. Edinburgh: Churchill Livingstone; 1994. Boyling JD, Palastanga N, eds. *Grieve's Modern Manual Therapy*. London G, Rydevik B. Effects of stretching the tibial nerve of the rabbit. A preliminary study of the intraneural circulation and the barrier function of the perineurium. *J Bone Joint Surg Br*. May 1973;55(2):390-401.

Ogata K, Naito M. Blood flow of peripheral nerve effects of dissection, stretching and compression. *J Hand Surg [Br]*. Feb 1986;11(1):10-14.

ENTRAPMENT NEUROPATHIES






Schmid AB, Nee RJ, Coppeters MW. Reappraising entrapment neuropathies—mechanisms, diagnosis and management. *Manual therapy*. Dec 2013;18(6):449-457.

Oskay D, Meric A, Kirdi N, Firat T, Ayhan C, Leblebicioğlu G. Neurodynamic mobilization in the conservative treatment of cubital tunnel syndrome: long-term follow-up of 7 cases. *J Manipulative Physiol Ther*. Feb 2010;33(2):156-163.

TUNNEL PRESSURE

Positions similar to ulnar nerve biased ULNT cause at least 15% strain and **quadruple** intraneural pressure in this nerve at the elbow

Wright TW, Glowczweskie F, Jr., Cowin D, Wheeler DL. Ulnar nerve excursion and strain at the elbow and wrist associated with upper extremity motion. *J Hand Surg [Am]*. Jul 2001;26(4):655-662.

Pechan J, Julius I. The pressure measurement in the ulnar nerve. A contribution to the pathophysiology of the cubital tunnel syndrome. *J Biomech*. Jan 1975;8(1):75-79.

COMPARTMENT SYNDROMES

Where nerves run through tunnels they have pressure gradients to help nourish the nervous system

- Blood pressure is needed to "pump" blood to nerves
- Blood is diffused from the arteriole (PA) to the capillary (PA) and ultimately the nerve fascicle (PF)
- This allows nerves to have adequate blood supply

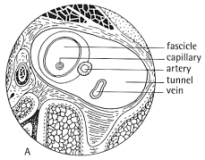


Image from Butler DS. *Mobilisation of the Nervous System*. Melbourne: Churchill Livingstone; 1991

P Arteriole > P Capillary > P Fascicle

COMPARTMENT SYNDROMES

Where nerves run through tunnels they have pressure gradients to help nourish the nervous system

- Once the nerve fascicle has nourished, it need to get out of the area
- Blood has to flow into the neighboring vein
- Ultimately the lowest pressure need to be in the tunnel

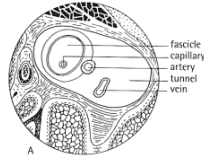


Image from Butler DS. Mobilisation of the Nervous System. Melbourne: Churchill Livingstone; 1991

P Arteriole > P Capillary > P Fascicle > P Vein > P Tunnel

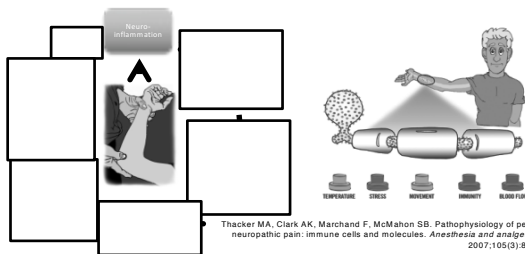
COMPARTMENT SYNDROMES

Repetitive motions...

Neuroinflammation Tendon Swelling Bony Changes	Increased Tunnel Pressure Back up blood in the Vein Back up blood in the Fascicle	Ischemia Edema Scarring Axonal Compression and Degeneration
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Lederman RJ. Peripheral Nerve Disorders in Instrumentalists. *Ann Neurol*. 1989;26:640-644.
 Dilley A, Odeyinde S, Greening J, Lynn B. Longitudinal sliding of the median nerve in patients with non-specific arm pain. *Man Ther*. Oct 1 2007;12(4):275-281.
 van Tulder M, Malmivaara A, Koes B. Repetitive strain injury. *Lancet*. May 26 2007;369(9575):1815-1822.
 Schmid AB, Nee RJ, Coppiters MW. Reappraising entrapment neuropathies: mechanisms, diagnosis and management. *Manual Therapy*. Dec 2013;18(6):449-457.

IMMUNE CHANGES AND NERVE SENSITIVITY



Thacker MA, Clark AK, Marchand F, McMahon SB. Pathophysiology of peripheral neuropathic pain: immune cells and molecules. *Anesthesia and analgesia*. Sep 2007;105(3):838-847.

VIBRATION SENSITIZATION

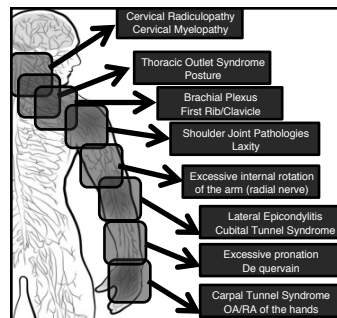
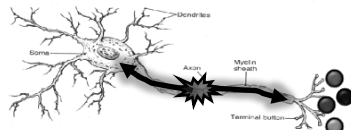
Dysfunction of A-beta fibers and Pacini corpuscles have shown increased sensitivity in neuropathic pain



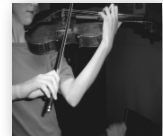
Greening J, Lynn B, Leary R. Sensory and autonomic function in the hands of patients with non-specific arm pain (NSAP) and asymptomatic office workers. *Pain*. Jul 2003;104(1-2):275-281.
 Tyros I, Soundy A, Heneghan NR. Vibration sensibility of the median nerve in a population with chronic whiplash associated disorder: Intra- and inter-rater reliability study. *Manual therapy*. Sep 2016;25:81-86.

NEUROGENIC INFLAMMATION

- Orthodromic impulses (to the CNS)
- Antidromic impulses (to the tissues)
 - Substance P (vasoactive)
 - Histamine
 - Cytokines, macrophages

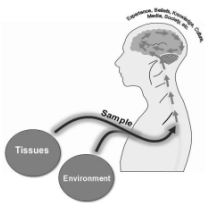


SO WHAT?



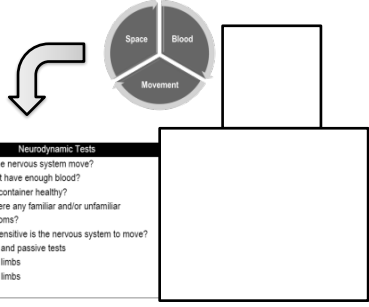
Lederman RJ. Peripheral Nerve Disorders in Instrumentalists. *Ann Neurol*. 1989;26:640-646.
 Storm SA. Assessing the instrumentalist interface: modifications, ergonomics and maintenance of play. *Physical medicine and rehabilitation clinics of North America*. Nov 2006;17(4):893-903.
 Bejjani FJ, Kaye GM, Benham M. Musculoskeletal and neuromuscular conditions of instrumental musicians. *Archives of physical medicine and rehabilitation*. Apr 1996;77(4):406-413.

IDENTIFYING NEUROPATHIC PAIN IN THE CLINIC



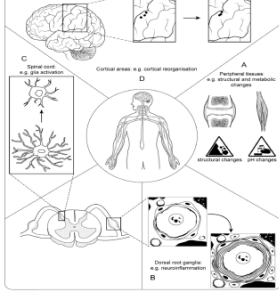
- Symptoms and sign clusters
- 150 times more likely to have a peripheral neurogenic pain states
 - Pain in dermatomal or cutaneous distribution
 - Positive neurodynamic and palpation (mechanical tests)
 - History of nerve pathology or compromise

Gifford, L.S., Pain, the tissues and the nervous system. Physiotherapy, 1998, 84, p. 27-33
 Smart KM, Blake C, Staines A, Thacker M, Doozy C. Mechanism-based classifications of musculoskeletal pain: Part 2 of 3: Symptoms and signs of peripheral neuropathic pain in patients with low back (+/leg) pain. Manual therapy, Aug 2012, 17(4):345-353
 Smart KM, Blake C, Staines A, Doozy C. Clinical indicators of 'hypoceptive', 'peripheral neuropathic' and 'central' mechanisms of musculoskeletal pain: A Delphi survey of expert clinicians. Man Ther. Feb 2009;15(1):80-87



Neurodynamic Tests

- Can the nervous system move?
- Does it have enough blood?
- Is the container healthy?
- Are there any familiar and/or unfamiliar symptoms?
- How sensitive is the nervous system to move?
- Active and passive tests
- Upper limbs
- Lower limbs
- Trunk



THERE IS MORE COMPLEXITY...

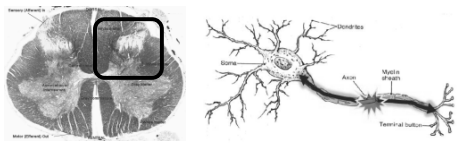
Adverse Mechanical Tension in the Nervous System: A Model for Assessment and Treatment

David G. Butler, PhD, David D. Grimmer, PhD, and a panel of practitioners in Australia, and a panel on the epidemiology, diagnosis, and treatment of entrapment neuropathies. South Australian Institute of Technology, North York, Australia.

The Australian Journal of Physiotherapy, Vol. 35, No. 4, 1989

Schmid AB, Nee RJ, Coppiters MW. Reappraising entrapment neuropathies—mechanisms, diagnosis and management. Manual therapy, Dec 2013;18(4):449-457.

BARRAGE INTO THE CNS...




Woolf CJ. Central sensitization: uncovering the relation between pain and plasticity. Anesthesiology, Apr 2007;106(4):864-867
 Vardeh D, Mannion RJ, Woolf CJ. Toward a Mechanism-Based Approach to Pain Diagnosis. The Journal of Pain: official Journal of the American Pain Society, Sep 2016;17(9 Suppl):T50-69

END-RESULT

Process	Consequence
• Death of the inhibitory neurons	• Decreased gating from the periphery

Woolf CJ. Central sensitization: uncovering the relation between pain and plasticity. Anesthesiology, Apr 2007;106(4):864-867
 Vardeh D, Mannion RJ, Woolf CJ. Toward a Mechanism-Based Approach to Pain Diagnosis. The Journal of Pain: official Journal of the American Pain Society, Sep 2016;17(9 Suppl):T50-69

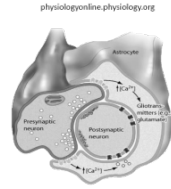
BUT THE CNS CONTAINS A LOT MORE THAN JUST NEURONS



Microglia...

GLIA IN THE SPINAL CORD

- Neuroglia (Greek for "glue"), classically = cells that provide metabolic and structural support, but also:
 - Establish and maintain synapses
 - Regeneration and plasticity
 - Myelin formation and repair
 - Immune function
- Outnumber neurons >10 to 1

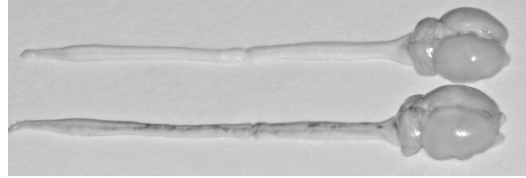


Watkins LR, Hutchinson MR, Milligan ED, Maier SF. "Listening" and "talking" to neurons: implications of immune activation for pain control and increasing the efficacy of opioids. *Brain Res Rev.* Nov 2007;56(1):148-169

Watkins LR, Milligan ED, Maier SF. Immune and glial involvement in physiological and pathological exaggerated pain states. In: Dostrovsky JO, Carl DB, Kolzenburg M, eds. *Progress in Pain Research and Management.* Vol 24. Seattle: IASP Press; 2003:369-386

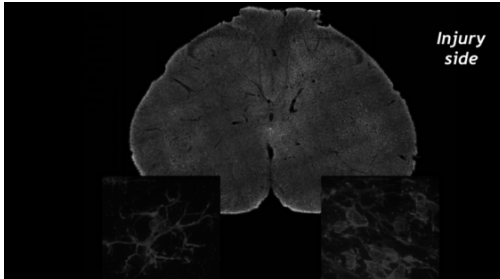
Ji RR, Berta T, Nedergaard M. Glia and pain: is chronic pain a gliopathy? *Pain.* Dec 2013;154 Suppl 1:S10-28

Injury to a peripheral nerve and electrical stimulation of C-fibers each cause an increase in the permeability of the blood-spinal cord barrier and blood-brain barrier



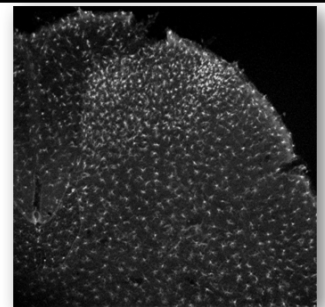
Beggs S, Liu Xi, Kwan C, Salter MW. Peripheral nerve injury and TRPV1-expressing primary afferent C-fibers cause opening of the blood-brain barrier. *Mol Pain.* 2010;6:74.

RESPONSE OF MICROGLIA IN THE SPINAL CORD AFTER PERIPHERAL NERVE INJURY



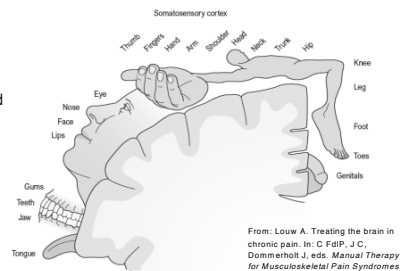
A CASCADE OF IMMUNE CHANGES START TO OCCUR...

Beggs S, Liu Xi, Kwan C, Salter MW. Peripheral nerve injury and TRPV1-expressing primary afferent C-fibers cause opening of the blood-brain barrier. *Mol Pain.* 2010;6:74.



PLASTIC MAPS

- Biologically coded
- Environmentally sculpted
- Changes occur in minutes...



From: Louw A. Treating the brain in chronic pain. In: C FdP, J C, Dommerholt J, eds. *Manual Therapy for Musculoskeletal Pain Syndromes.* Vol 1. London: Churchill Livingstone; 2015

Movement and use

Maihöfner C, Handwerker HD, Neundörfer B, Birken F. Patterns of cortical reorganization in complex regional pain syndrome. *Neurology.* December 23, 2003;61(12):1707-1715.

Flor H. The functional organization of the brain in chronic pain. *Prog Brain Res.* 2000;129:31-3-322.



Mahlöner C, Handwerker HO, Neundörfer B, Birklein F. Patterns of cortical reorganization in complex regional pain syndrome. *Neurology*. December 23, 2003; 61(12): 1707-1715.

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Flor H. The functional organization of the brain in chronic pain. *Prog Brain Res*. 2000; 129:31-3-322.

Movement and use

NEGLIGENCE AND PAIN

Disrupted Working People With Back Pain
Helen Bray and G. L. ...
Br J Sports Med publishing ...

Neuroscience Letters ...

Role of Distorted Body Image in Pain
Martin Lotze, MD, and G. Lorimer Moseley

Neglect-like tactile dysfunction in chronic back pain

Why do people with chronic pain syndrome ...

Pain and the body schema movement: Evidence for peripheral effects on movement

John Schwenker, Richard Franklin, Nancy Oatis, and H. Bruce ...

Cortical ...

IT HAPPENS FAST

Moseley GL, Othof N, Venema A, et al. Psychologically induced cooling of a specific body part caused by the illusory ownership of an artificial counterpart. *Proc Natl Acad Sci U S A*. Sep 2 2008; 105(35): 13169-13173.

Stavrinou ML, Della Penna S, Pizzella V, et al. Temporal dynamics of plastic changes in human primary somatosensory cortex after finger webbing. *Cereb Cortex*. Sep 2007; 17(9):2134-2142.

Where is it?
Left or right?
Looks bigger
Movement
What am I feeling?

Low Threat → High Threat

Moseley GL. Reconceptualising pain according to modern pain sciences. *Physical Therapy Reviews*. 2007; 12:169-178

Louw A. Treating the brain in chronic pain. In: C FdIP, J C, Dommerholt J, eds. *Manual Therapy for Musculoskeletal Pain Syndromes*. Vol 1. London: Churchill Livingstone; 2011

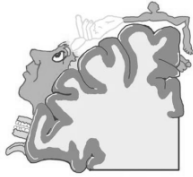
THE BRAIN: "TELL ME MORE..."

Before Pain: Lots of room for activities, NORMAL EXCITED LEVEL

After Pain: Little room for activities, EXTRA SENSITIVE, NORMAL EXCITED LEVEL

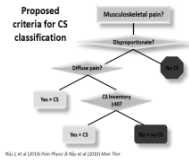
Louw A. Treating the brain in chronic pain. In: C FdIP, J C, Dommerholt J, eds. *Manual Therapy for Musculoskeletal Pain Syndromes*. Vol 1. London: Churchill Livingstone; 2011

IDENTIFYING ALTERED MAPS...SUBJECTIVELY



- Allodynia
- Difficulty with laterality
- Neglect
- Spreading pain
- Mirror pains
- Body chart

CENTRAL SENSITIZATION INVENTORY



Central Sensitivity Inventory
 Scale range is 0-100
 Answers and scoring method
 • Never = 0
 • Rarely = 1
 • Sometimes = 2
 • Often = 3
 • Always = 4

1. I feel exhausted when I walk in the morning
2. My muscles feel stiff and achy
3. I have trouble sleeping
4. I have trouble with thinking and/or concentration
5. I have trouble with shortness of breath
6. I have trouble with my bladder
7. I have trouble with my stomach
8. I have trouble with my eyes
9. I have trouble with my ears
10. I have trouble with my nose
11. I have trouble with my mouth
12. I have trouble with my throat
13. I have trouble with my skin
14. I have trouble with my hair
15. I have trouble with my nails
16. I have trouble with my teeth
17. I have trouble with my joints
18. I have trouble with my bones
19. I have trouble with my muscles
20. I have trouble with my nerves
21. I have trouble with my organs
22. I have trouble with my blood
23. I have trouble with my lymphatic system
24. I have trouble with my immune system
25. I have trouble with my endocrine system

Nijls J, Van Houdenhove B, Oostendorp RA. Recognition of central sensitization in patients with musculoskeletal pain: Application of pain neurophysiology in manual therapy practice. *Man Ther.* Apr 2010;15(2):135-14

Mayer TG, Neblett R, Cohen H, et al. The development and psychometric validation of the central sensitization inventory. *Pain Pract.* Aug 2012;12(4):276-288

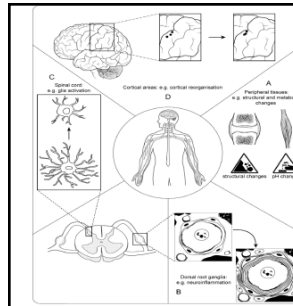
TESTING A SENSITIVE NERVOUS SYSTEM

Overview of the clinical examination of patients with suspected central sensitization.⁴

Clinical tests

1. Assessment of pressure pain thresholds at sites remote from the symptomatic site
2. Assessment of sensitivity to touch during manual palpation at sites remote from the symptomatic site
3. Assessment of sensitivity to vibration at sites remote from the symptomatic site
4. Assessment of sensitivity to heat at sites remote from the symptomatic site
5. Assessment of sensitivity to cold at sites remote from the symptomatic site
6. Assessment of pressure pain thresholds during and following exercise
7. Assessment of joint end feel
8. Brachial plexus provocation test

Nijls J, Van Houdenhove B, Oostendorp RA. Recognition of central sensitization in patients with musculoskeletal pain: Application of pain neurophysiology in manual therapy practice. *Manual therapy.* Apr 2010;15(2):135-144



WITHIN THIS FRAMEWORK...



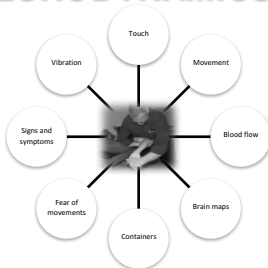
Schmid AB, Nee RJ, Coppiters MW. Reappraising entrapment neuropathies—mechanisms, diagnosis and management. *Manual therapy.* Dec 2013;18(6):448-457.

NEURODYNAMICS

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Out of Tune: A Guide to Upper Extremity Nerve Entrapment Syndromes in Musicians

Clinical Examination of the Instrumentalist

Janice Ying, PT, DPT, OCS

Combined Sections Meeting - San Antonio, TX
 February 15 – 18, 2017



COMMON PATHOLOGIES

<p>Musculoskeletal (64%)</p> <ul style="list-style-type: none"> • Regional Pain Syndrome • Shoulder Impingement • Ligament Sprain • Tendinitis • Arthritis • Lateral Epicondylitis 	<p>Neurologic (20.2%)</p> <ul style="list-style-type: none"> • Thoracic Outlet Syndrome (TOS) • Ulnar Neuropathy • Carpal Tunnel Syndrome • Cervical Radiculopathy
---	---

Focal Dystonia/Occupational Cramp (7.6%)

(Lederman, 2003)

RED FLAG SCREENING

<p style="text-align: center;">C/S</p> <ul style="list-style-type: none"> • Metastatic lesions • Cervical bone tumors • Cervical cord tumors • Lung cancer/Pancoast's tumor • Esophageal cancer • Thyroid Cancer • C/S myelopathy 	<p style="text-align: center;">Shoulder</p> <ul style="list-style-type: none"> • Metastatic lesions • Myocardial infarction • Lung cancer/Pancoast's tumor • Spinal accessory nerve entrapment • Kidney dysfunction • Liver/gallbladder dysfunction • Splenic dysfunction • Ectopic pregnancy 	<p style="text-align: center;">Elbow</p> <ul style="list-style-type: none"> • Myocardial Infarction • Angina • Pleuro/pulmonary
---	--	---

RED FLAG SCREENING

(Sueki, D. 2010)

PATHOPHYSIOLOGY: NEURAL ENTRAPMENT

- **Radiculopathy:** Impingement and inflammation of a nerve root induced by a space-occupying lesion that reduces the size of the intervertebral foramen
- **Peripheral entrapment:** Compression of the peripheral nerve along its path

CERVICALGIA

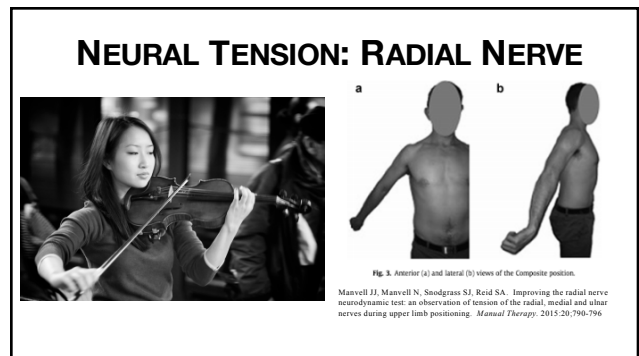
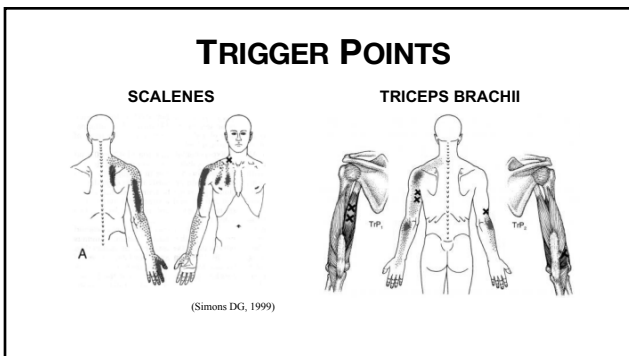
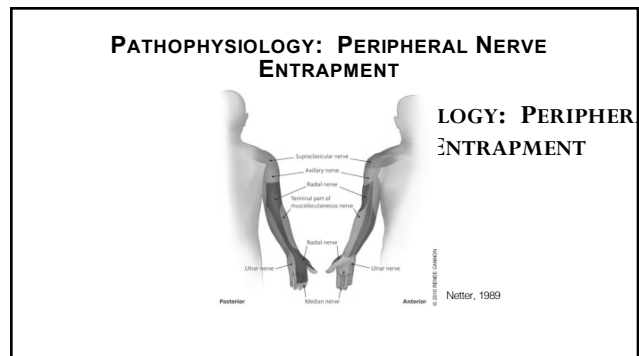
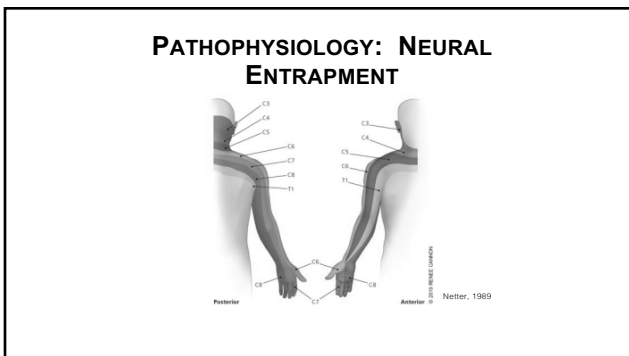
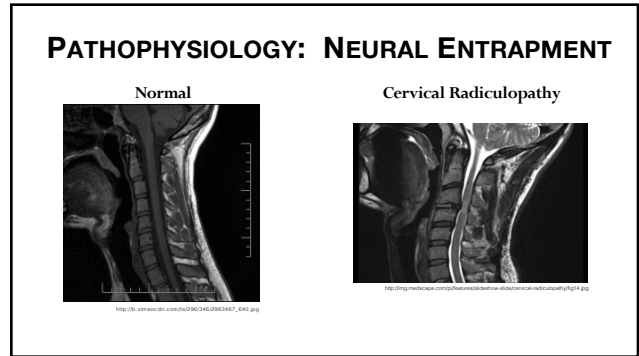
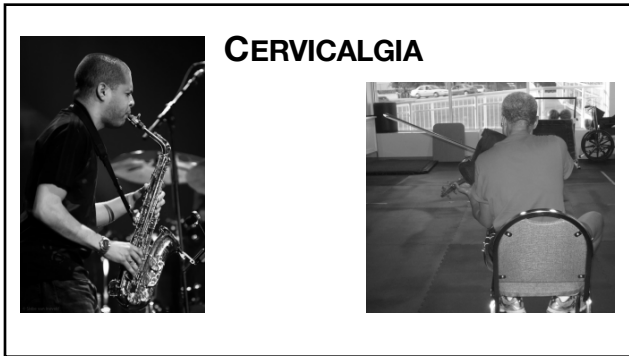
CLINICAL GUIDELINES

JOHN D. CHOLETS, PE, PhD • JOSHUA A. COLLARD, PE, PhD • JAMES H. ELLOTT, PE, PhD • DEBBIE L. TETTER, PE, PhD
ROBERT S. HARRIS, PE, PhD • JAMES R. HUSTON, PE, PhD • DEBRA L. RUPPEL, MD
JOSelyn A. SOOLES, DPT • TERRY R. FRYER, PE, PhD

Neck Pain:

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health From the Orthopaedic Section of the American Physical Therapy Association

J Orthop Sports Phys Ther 2008;38(6):414-416. doi:10.2519/jospt.2008.0303



NEURAL TENSION: ULNAR NERVE



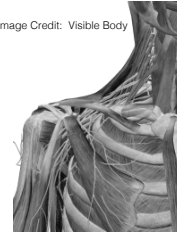
Manvell N, Manvell JJ, Snodgrass SJ, Reid SA. Tension of the ulnar, median and radial nerves during testing: observational cadaveric study. 2015;95(6)



PATHOPHYSIOLOGY: NEURAL ENTRAPMENT - THORACIC OUTLET



Image Credit: Visible Body



OUT OF TUNE: A GUIDE TO UPPER EXTREMITY NERVE ENTRAPMENT SYNDROMES IN MUSICIANS

Epidemiology of Upper Extremity Nerve Entrapments in Musicians

Combined Sections Meeting - San Antonio, TX
February 15 - 18, 2017



SUBJECTIVE EXAM

- Chief complaint
- Mechanism of Injury
- Aggravating/Easing Factors
- Past Medical History
- Severity/Irritability/Nature/Stage of Symptoms
- Medical Screening/Red flags

SUBJECTIVE EXAM

- Rehearsal/Practice/Performance schedule
- Practice Techniques
- Changes in Playing Technique
- Current Repertoire
- **Changes in instrument**



OCCUPATION: FROM PRACTICE TO PERFORMANCE

- Level of difficulty
- Motor Learning
- Rates of >800 notes/minute for 3-30 minutes
- High demands of both proximal and distal segments
- Practice duration - rest breaks
- Rehearsal
- Studio Recording
- Performance

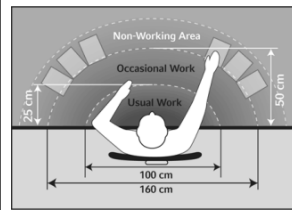
ORTHOPEDIC OBJECTIVE EXAM

- Resting Posture
- Functional Assessment
- A/PROM
- Strength (MMT)
- Neuro Screen
- Joint Accessory Motion
- Special Tests

PLAYING POSTURE



ERGONOMIC ANALYSIS



PLAYING TECHNIQUE / MOVEMENT ANALYSIS



<https://youtu.be/W1Bvent3A1M>

OUT OF TUNE: A GUIDE TO UPPER EXTREMITY NERVE ENTRAPMENT SYNDROMES IN MUSICIANS

Case-based Approach to Treatment

Erin Hayden, PT, DPT, OCS

Combined Sections Meeting - San Antonio, TX
February 15 – 18, 2017

TREATMENT STRATEGIES SIMILAR TO GENERAL PATIENT POPULATION

- Patient Education
- Manual Therapy
 - Joint mobilizations, HVLA
 - STM
 - Cervical Manual Traction
- Nerve Gliding Exercises
- Stretching
- Taping
- Aerobic Exercise

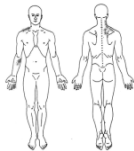
WHAT'S UNIQUE

- Total playing time
- High demand
- Instrument position
- High variability of tasks
- Multiple instruments for same musician
- Difficult to rest



NECK PAIN WITH RADIATING PAIN

Participation Restrictions:
Playing, working @ computer



- Practice Schedule: > 4 hrs/day, 2-3 sessions/day
- Rehearsal Schedule: weekly ensembles, lessons
- Upcoming Performances: recital in 8 weeks
- Teaches 4-6 lessons per week
- No significant changes in technique/style
- Preparing new pieces for recital - varied



PLAYING ANALYSIS – 3 VIEWS

Sagittal - Left



PLAYING ANALYSIS – 3 VIEWS

Posterior



PLAYING ANALYSIS – 3 VIEWS

Sagittal - Right



BODY FUNCTION & STRUCTURE IMPAIRMENTS

- Limited ROM of the cervical spine
- Neural mobility deficits
- Hypomobility thoracic spine
- Pectoralis muscular tightness
- Decreased scapulothoracic strength & endurance
- Poor postural awareness
- Poor trunk control

TREATMENT: THERAPEUTIC EXERCISE & HOME EXERCISE PROGRAM

- Stretching & T/S mobility exercises
- Strengthening of the DNFs
- Strengthening of proximal stabilizers
- Functional exercises - simulating playing position
- Development and integration of warm-up routine
- Education
 - Practice schedules, stress management, cross training, warm up routine

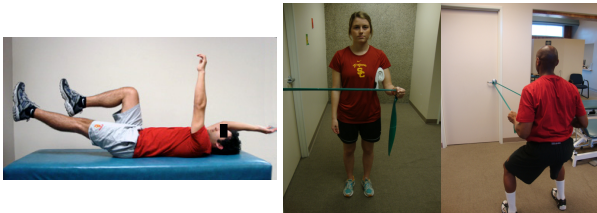
STRETCHING & MOBILITY



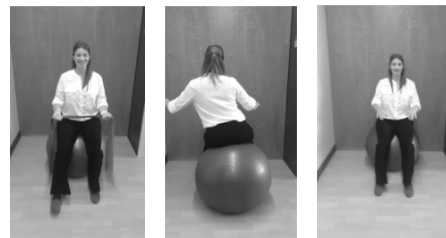
DNF STRENGTHENING



STRENGTHENING PROXIMAL STABILIZERS



DYNAMIC EXERCISES



INSTRUMENT SPECIFIC DYNAMIC EXERCISES

How would you vary exercises based on instrument?



OTHER CONSIDERATIONS

- Analyze lifting mechanics instrument
- Analyze instrument case & carrying mechanics
- Analyze position of the music stand
- Inquire about ensemble set up
- Inquire about lighting in practice room

SUMMARY TREATMENT STRATEGIES

- Utilize individual assessment + practice guidelines to address the nerve entrapment
- Perform postural & movement analysis with instrument
 - Collaborate with musician on necessary ergonomic modifications
- Develop dynamic exercise interventions based on their instrument and occupational demands
- Keep musicians playing whenever possible

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