# Neuropathic Pain in the Orthopedic Patient

Brad Keisling MSPT, CSCS, KBC level 1

" Instead of looking at your patients and thinking of them as having back or neck pain...instead see them as suffering with skepticism, nervousness- and being tentative about getting another decision wrong. Set your business up to help people overcome THOSE things and the rewards will undoubtedly come your way"

– unknown

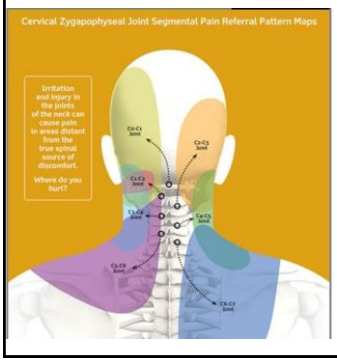
## Rehabilitation Philosophy

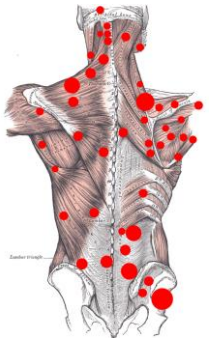
- What does every patient want/need?
  - What's wrong with me?
  - What can I do about it?
  - What can you do about it?
  - How long will it take?
- "Man is inert, sluggish, and averse from labour, unless compelled by necessity...."
  -Thomas Malthus

## Resources

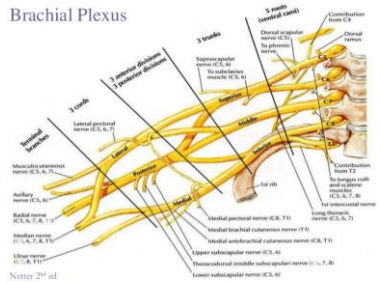
- Adriaan Louw, PT, PhD, CSMT
  https://www.ispinstitute.com
- Jack Stagge PT, OCS
- David Butler: Neuro Orthopaedic Institute NOI
- https://www.youtube.com/playlist?list=PLo4JklPFPNSQuItT9BORFzl3-4FAYdzgK
  - Youtube channel for Physical Therapy Nation

## Referred Sources of Pain



## The Neuro Nightmare

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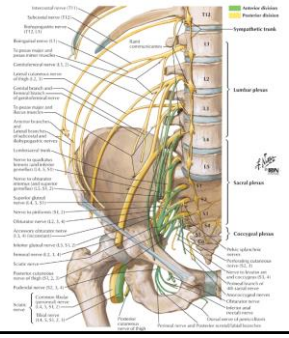

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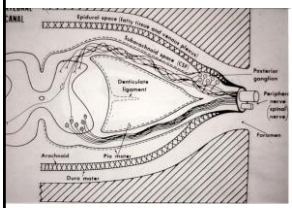
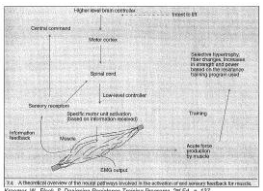



Kraemer, W., Fleck, S. Designing Resistance Training Programs, 2nd Ed., p. 137.

## The Ouch Button

- When you palpate and there is pain that must be the location of problem…
  - Or is it?

## The Ouch Button

"When pain from localized peripheral neural pathology becomes widespread, tenderness can be found along the course of the affected nerve."

- Devor, Lishman, Quitner, etc.

**Tender Points**

- Will be Found in Muscles Innervated by Involved Nerve The complaint of pain and demonstration of local tenderness may obscure the fact of offending pathological lesion is centrally placed
  - Keele C. A. Neile E (cds). 1971

## Neurogenic Rheumatica

- The usual diagnosis of arthritis, bursitis, neuritis, muscular rheumatism, fibrositis should not be made until cervical nerve root irritation has been considered. Joint swelling may be directly caused by inflamed nerve roots.
  - Jackson R 1966, Geppetti P 1996

## Types of Nerve "Injuries"

- Mechanical
  - Compressive
  - Traction
- Chemical
  - Inflammatory
- Combination

## Compressive

- External: Boney formations, cyst, scar tissue
  - Treatment of Externally Compressive Neuropathy
  - May include traction techniques ie manual or mechanical
- Internal: Swollen Nerve
  - Treatment may require injection, oral steroids, or direct intervention in addition to typical treatments for External compression

## Inflammatory

- Localized neuritis with distalization of symptoms.
- Examples : Herpes Zoster, Neuralgias including Sciatica etc.
- Treatment Techniques DO NOT involve stretching.
  - 15% elongation in NORMAL neural tissue causes microvascular stoppage
- Active – Ongoing – Inflammatory Condition
  - Very gentle oscillation of surrounding anatomical structures.

## Comparisson

| Compressive | Inflammatory |
|---|---|
| Loss of Reflex | Possible Hyper Reflexia |
| Hypoesthesia | Hyperesthesia |
| Loss of strength | |
| Irradiation with compressive positioning | Irradiation with provocation positions |
| Hair loss | Distal Tenderpoint, Mechanical hyperalgesia |
| Possible + electrodiagnostic tests | Negative Electrodiagnostic tests |
| | |

"E. M. G. will probably be negative if nerve is inflamed rather than compressed. Must lose 80% of conduction channels before tests are definitive."

- Haldeman S., SPINE Vol. 9, No. 1, 1984
- Sunderland S., Nerve and Nerve Injury, 1977
- Yoshizawa, H. SPINE Vol. 20. No. 4, 1995

Suprascapular neuropathy: diagnosis and management.
Freehill MT1, Shi LL, Tompson JD, Warner JJ. Phys Sportsmed. 2012 Feb;40(1):72-83.
doi: 10.3810/psm.2012.02.1953.

Electromyography and nerve conduction velocity studies remain the gold standard for confirmation of the diagnosis of suprascapular neuropathy; however, nerve pain may occur even in the setting of a negative electromyography

## Lesion Side

- Does it matter which side the nerve lesion is on?

**Contralateral neuropathic pain and neuropathology in dorsal root ganglion and spinal cord following hemilateral nerve injury in rats.**
Hatashita S[1], Sekiguchi M, Kobayashi H, Konno S, Kikuchi S. Spine (Phila Pa 1976). 2008 May 20;33(12):1344-51.

**RESULTS:**

- Mechanical withdrawal threshold of the ipsilateral hind paw was significantly decreased for 21 days. Conversely, mechanical withdrawal threshold of the contralateral hind paw was significantly decreased from 5 to 10 g for 7 days, and was <5 g at days 14 and 21. TNF-alpha expression and GFAP-positive satellite cells in the contralateral DRG significantly increased from day 7 to day 21. In the contralateral spinal dorsal horn, GFAP-positive astrocytes significantly increased for 21 days, but Iba-1 was not significant.

## Sleep effects

- Sleep depravation 36-48 hours
  - Pain pressure threshold decreases 23%
  - Max pain pressure threshold decrease 42%
  - Visual analog scale increases 50%
    - **Sleep deprivation and pain perception Stefan Lautenbacher.Bernd Kundermann. Jürgen-Christian Krieg. Sleep Medicine Reviews.** Volume 10, Issue 5, October 2006, Pages 357-369

Disturbances in sleep, pain behaviour and psychological distress influence return to work in workers who have suffered a soft tissue injury, e.g. low back pain. In conclusion, there is a reciprocal relationship between sleep quality and pain

- Sleep and pain. Harvey Moldofsky. Sleep Medicine Reviews Volume 5, Issue 5, October 2001, Pages 385-396

# Centralization

Not the McKenzie principle…

Bilateral widespread mechanical pain sensitivity in carpal tunnel syndrome: evidence of central processing in unilateral neuropathy. Fernández-de-las-Peñas C1, de la Llave-Rincón AI, Fernández-Carnero J, Cuadrado ML, Arendt-Nielsen L, Pareja JA. Brain. 2009 Jun;132(Pt 6):1472-9.

- The aim of this study was to investigate whether bilateral widespread pressure hypersensitivity exists in patients with unilateral carpal tunnel syndrome. A total of 20 females with carpal tunnel syndrome (aged 22-60 years), and 20 healthy matched females (aged 21-60 years old) were recruited. Pressure pain thresholds were assessed bilaterally over median, ulnar, and radial nerve trunks, the C5-C6 zygapophyseal joint, the carpal tunnel and the tibialis anterior muscle in a blinded design.
- **The results showed that pressure pain threshold levels were significantly decreased bilaterally over the median, ulnar, and radial nerve trunks, the carpal tunnel, the C5-C6 zygapophyseal joint, and the tibialis anterior muscle in patients with unilateral carpal tunnel syndrome as compared to healthy controls** (all, $P < 0.001$).
- Pressure pain threshold was negatively correlated to both hand pain intensity and duration of symptoms (all, $P < 0.001$). Our findings revealed bilateral widespread pressure hypersensitivity in subjects with carpal tunnel syndrome, which suggest that widespread central sensitization is involved in patients with unilateral carpal tunnel syndrome.

Widespread mechanical pain hypersensitivity as sign of central sensitization in unilateral epicondylalgia: a blinded, controlled study.Fernández-Carnero J1, Fernández-de-Las-Peñas C, de la Llave-Rincón AI, Ge HY, Arendt-Nielsen L.

- The aim of this study was to investigate whether generalized deep tissue hyperalgesia exists in patients with chronic unilateral lateral epicondylalgia (LE).
- A total of 26 LE patients (10 males and 16 females, aged 25 to 63 y) and 20 healthy comparable matched controls (aged 26 to 61 y) were recruited and pressure pain threshold (PPT) was assessed bilaterally over the median, ulnar, and radial nerve trunks, the lateral epicondyle, C5-C6 zygapophyseal joint, and the tibialis anterior muscle in a blind design.
- PPT was significantly decreased bilaterally over the median, ulnar, and radial nerve trunks, the lateral epicondyle, the C5-C6 zygapophyseal joint, and tibialis anterior muscle in patients with LE than healthy controls (all $P<0.001$). PPTs over those measured points was negatively related to current elbow pain intensity (all $P<0.05$)**. A more significant decrease in PPTs were present in females (all $P<0.05$).**
- This revealed a widespread mechanical hypersensitivity in patients with LE, which suggest that central sensitization mechanisms are involved in patients with unilateral LE. The generalized decrease in PPT levels was associated with elbow pain intensity, supporting a role of peripheral sensitization mechanisms in the initiation or maintenance of central sensitization mechanisms. In addition, females may be more prone to the development of generalized mechanical hypersensitivity.

Specific mechanical pain hypersensitivity over peripheral nerve trunks in women with either unilateral epicondylalgia or carpal tunnel syndrome. Fernández-de-Las-Peñas C1, Ortega-Santiago R, Ambite-Quesada S, Jiménez-Garcí A R, Arroyo-Morales M, Cleland JA. J Orthop Sports Phys Ther. 2010 Nov;40(11):751-60.

Sixteen women with unilateral LE (mean±SD age, 43±7 years), 17 women with unilateral CTS (43±6 years), and 17 healthy women (43±6 years) were included in this study. Pressure pain thresholds (PPT) were bilaterally assessed over the median, ulnar, and radial nerve trunks, as well as over the C5-6 zygapophyseal joints, by an examiner blinded to the subjects' condition. A mixed-model analysis of variance was used to evaluate differences in PPT among groups (LE, CTS, or controls) and between sides (affected/nonaffected or dominant/nondominant).

RESULTS:

- The individuals in both the LE and CTS groups demonstrated lower PPT bilaterally over the median (group, P<.001; side, P=.437), radial (group, P<.001; side, P=.556), and ulnar (group, P<.001; side, P=.938) nerve trunks as compared to controls.
- Additionally, radial (P<.001) and ulnar (P=.005) nerves were more sensitive bilaterally in patients with LE than in patients with CTS. The median nerve was more sensitive bilaterally in patients with CTS than patients with LE (P=.002). Lower PPT over the cervical spine (group, P<.001; side, P=.233) were found bilaterally in both the LE and CTS groups. Further, patients with CTS exhibited lower cervical PPT than patients with LE (P<.001). PPT was negatively correlated with both pain intensity and duration of symptoms in both the LE and CTS groups (P<.001).

CONCLUSIONS:

- Bilateral mechanical nerve pain hypersensitivity is related to specific and particular nerve trunks in women with either unilateral LE or CTS. Our results suggest the presence of central and peripheral sensitization mechanisms in individuals with either LE or CTS.

# Peripheral Nerve Reaction to Injury

| Insult | Physiologic Status | Etiology | Electrophysiology |
|---|---|---|---|
| Minimal | Conduction block, rapidly reversible | Focal ischemia, mild compression | Focal conduction block |
| | | | |
| Intermediate | Conduction block, prolonged | Focal demyelination | Focal conduction block and slowing |
| | | | |
| Severe | Wallerian degeneration | Loss of axon and myelin sheath | Absent response |

# Fibers and Functions

| Fiber category | Size (microns) | Speed (meters/second) | Function |
|---|---|---|---|
| Aα Group IA and IB afferents | 15 | 60-100 | Large motor axons Muscle stretch and tension sensory axons |
| Aβ Group II afferents | 12-14 | 30-60 | Touch, pressure, vibration and joint position sensory axons |
| Aγ | 8-10 | 15-30 | Gamma efferent motor axons |
| Aδ Group III afferents | 6-8 | 10-15 | Sharp pain, very light touch & temperature sensation |
| B | 2-5 | 3-10 | Sympathetic preganglionic motor axons |
| C Group IV afferents | <1 | <1.5 | Dull, aching, burning pain and temperature sensation |


Symptom involved indicates severity

This can be helpful for diagnosis and education of the patient

"Orthopedic" Patient Diagnosis That May Have Neurogenic Causation or in whom symptoms are maintained by Neurogenic Input.

Lower Extremity

- Failed Back Syndrome
- Chronic Hamstring Strain
- Chronic Plantar Fascitis
- Compartment Syndrome
- Persisting pain Post op Knee
- Chronic Trochanteric Bursitis
- Chronic Peroneal Tendonitis
- Chronic Achilles Tendonitis

Upper Extremity

- Chronic Biceps tendonitis
- Arthritic "_____"
- Adhesive capsulitis
- Chronic Lateral Epicondylitis
- Chronic Medial Epicondylitis
- RTC tear
- Failed RTC repair
- Non specific arm pain

## Evaluation

Lower extremity nerve entrapments in athletes. Meadows JR1, Finnoff JT. Curr Sports Med Rep. 2014 Sep-Oct;13(5):299-306.

- A high index of suspicion for nerve entrapments enables the clinician to identify these conditions in a timely manner and institute an appropriate management program, thus improving patient outcomes.

Lower extremity nerve entrapments in athletes. Meadows JR1, Finnoff JT. Curr Sports Med Rep. 2014 Sep-Oct;13(5):299-306.

Signs and symptoms suggestive of nerve entrapment include anesthesia, dysesthesias, paresthesias, or weakness in the distribution of a peripheral nerve. The physical examination may reveal an abnormal neurologic examination finding in the distribution of a peripheral nerve, positive nerve provocative testing, and positive Tinel sign over the area of entrapment. Electrodiagnostic studies, radiographs, magnetic resonance imaging studies, and sonographic evaluation may assist with the diagnosis of these disorders.

## Subjective Findings

## Common Complaints

- “feels like a hot poker”
- “burning intense pain”
- “feels dead”
- “feels weird” “not right”
- “Can’t really describe it”
- “Can’t pin point what aggravates”
- Intolerance to hot/cold
- Hypersensitivity to clothing/bedsheets
- Don’t like ESTIM

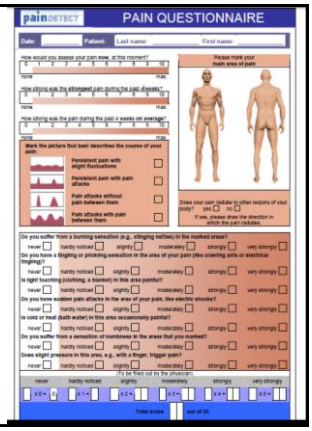
## Pain Detect

Total Score

**0-12 A neuropathic pain component is unlikely (< 15%)**

**13-18 Result is ambiguous, however a neuropathic pain component can be present**

**19-38 A neuropathic pain component is likely (> 90%)**

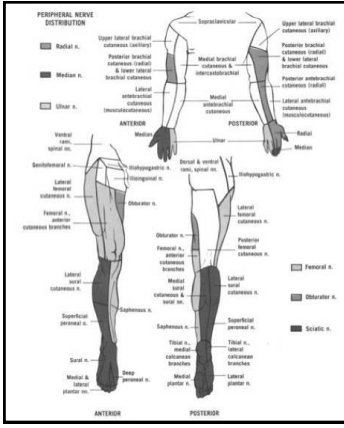


# Objective Findings

# Objective Findings

- Compensated Postures
- Atrophy
- Compensated Cervical motion with UE AROM
- Compensated Elbow ROM with UE AROM
- Compensated Knee/ankle ROM with Lumbar ROM
- Palpable tenderspots
- Potential weakness
- Diminished sensation
- Abnormal/assymetrical ULNT or LLNT signs
- Hyper/hyporeflexive

| Movement tested | Main muscles | Nerve root levels | Peripheral nerve |
|---|---|---|---|
| **Shoulder** | | | |
| Shrug (elevation) | Trapezius | C2-5 | Spinal accessory |
| Abduction | Deltoid/supraspinatus | C5 (6) | Axillary/suprascap. |
| External rotation | Infraspinatus/teres | C5 (6) | Suprascapular |
| Internal rotation | Pectoralis major | C5-7 | Lateral pectoral |
| Adduction | Latissimus/Pectoralis | C6-8 | Subscapular/pectoral |
| Flexion | Deltoid/coracobrac. | C5-6 | Axillary/musculocut. |
| **Elbow** | | | |
| Flexion | Biceps/brachialis<br>Brachioradialis | C5-6<br>C5-6 | Musculocutaneous<br>Radial |
| Extension | Triceps | C6-7 | Radial |
| **Wrist** | | | |
| Flexion | Flexor carpi uln. | C6-7 | Median/ulnar |
| Extension | Extensor carpi radialis<br>Ext. carpi ulnaris | C6-7<br>C7-8 | Radial<br>Radial |
| Pronation | Pronator teres | C6-7 | Median |
| Supination | Supinator | C5-6 | Radial |
| **Finger** | | | |
| Flexion | Flexor digitorum sum. | C7-8 | Median (ulnar) |
| Extension | Extensor digitorum | C7-8 | Radial |
| Ab- & adduction | Interosseus muscles | C8-T1 | Ulnar |
| Thumb abduction | Abductor pollicis | C8-T1 | Median |
| **Hip** | | | |
| Flexion | Iliopsoas | L2-3 (L4) | Lumbar plexus |
| Extension | Gluteus | L5-S2 | Inferior gluteal |
| Abduction | Gluteus medius | L5-S1 | Superior gluteal |
| Adduction | Adductor mm. | L2-4 | Obturator |
| **Knee** | | | |
| Flexion | Hamstring | L5-S1 | Sciatic |
| Extension | Quadriceps | L2-4 | Femoral |
| **Ankle** | | | |
| Dorsiflexion | Tibialis anterior | L4-5 (S1) | Peroneal (Fibular) |
| Plantar flexion | Gastroc/soleus | S1 (S2) | Tibial |
| Inversion | Posterior tibial | L5 (S1) | Tibial |
| Eversion | Peroneal (fibular) mm. | L5 (S1) | Peroneal (Fibular) |
| **Great toe** | | | |
| Dorsiflexion | Extensor hallucis | L5 (S1) | Peroneal (Fibular) |
| Plantar flexion | Flexor hallucis | (S1) S2 | Tibial |




SENSATION

## Neural Irritation Tests

Passive by Clinician

- Femoral
- Saphenous
- SLR (use IR and Add)
- ULNT 1-3
  - Median
  - Radial
  - Ulnar

Active

Slump (use lumbar sidebending)

Obturator

Axillary

## Neural Irritation Tests

The test modified becomes the treatment

-Gary Gray

When you find a test that is positive consider how you can modify it to become a manual technique.

Often will see objective improvement in the test before there is a change in subjective symptoms

-EDUCATE THE PATIENT ON THIS!!!

Strain in the median and ulnar nerves during upper-extremity positioning. Byl C1, Puttlitz C, Byl N, Lotz J, Topp K. J Hand Surg Am. 2002 Nov;27(6):1032-40.

The purpose of this study was to quantify the strain of the median nerve and the ulnar nerve throughout upper-extremity positioning sequences used by clinicians to evaluate nerve dysfunction.

Median

- nerve tension test caused a maximum summative strain in the median nerve at the carpal tunnel of 7.6%,
- **with the largest increase in strain during elbow extension (3.5%).**

Ulnar

- Nerve tension test caused a maximum summative strain in the ulnar nerve of 2.1%,
- **with the largest increase in strain during shoulder abduction (0.9%).**

Ulnar nerve excursion and strain at the elbow and wrist associated with upper extremity motion. Wright TW1, Glowczewskie F Jr, Cowin D, Wheeler DL. J Hand Surg Am. 2001 Jul;26(4):655-62.

Significant excursion of the ulnar nerve is required for unimpeded upper extremity motion.

The 2 most common sites of nerve entrapment, the cubital tunnel and the entrance of Guyon's canal, were studied.

SHOULDER ABD 30 degrees to 110 degrees

An average of 4.9 mm ulnar nerve excursion was required

ELBOW FLEXION 10 degrees to 90 degrees.

5.1 mm was needed

WRIST EXT was moved from 60 degrees of extension to 65 degrees of flexion,

13.6 mm excursion of the ulnar nerve was required at the wrist.

COMBINED

21.9 mm at the elbow

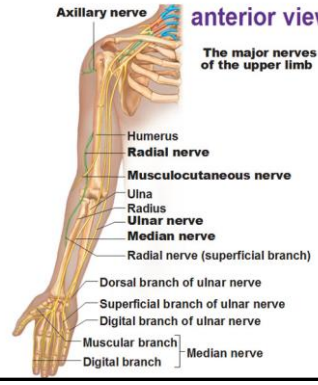
23.2 mm at the wrist.

Ulnar nerve strain of 15% or greater was experienced at the elbow with elbow flexion and at the wrist with wrist extension and radial deviation.

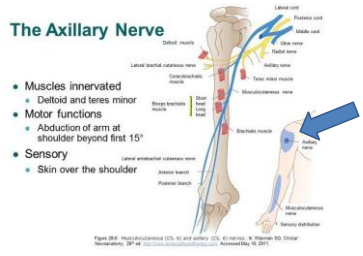
Any factor that limits excursion at these sites could result in repetitive traction of the nerve and possibly play a role in the pathophysiology of cubital tunnel syndrome or ulnar neuropathy at Guyon's canal.

# Upper Extremity Review

## Nerves of the Upper Limb

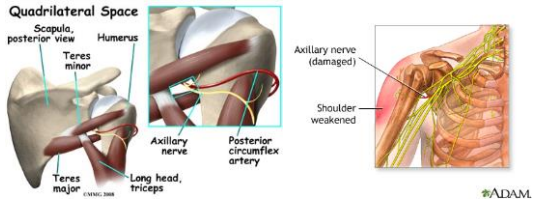



## Axillary

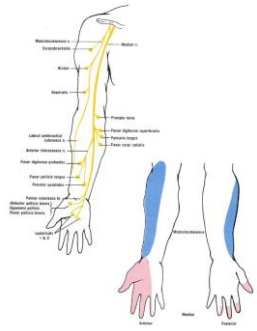



## Quadrilateral Space Syndrome

Symptoms of quadrilateral space syndrome usually include vague shoulder pain, numbness or tingling in the arm, and tenderness to pressure over the area of the quadrilateral space. A dull ache in the shoulder may worsen when the arm is moved **overhead** repeatedly.




## Median



- Golfer's Elbow

The use of ultrasound imaging to demonstrate reduced movement of the median nerve during wrist flexion in patients with non-specific arm pain. Greening J1, Lynn B, Leary R, Warren L, O'Higgins P, Hall-Craggs M. J Hand Surg Br. 2001 Oct;26(5):401-6; discussion 407-8.

Following clinical screening, we examined movement of the median nerve at the wrist using high-resolution (10-22 MHz) ultrasound in 16 controls and 12 patients with non-specific arm pain (also referred to as repetitive strain injury).

Imaging was performed just proximal to the carpal tunnel with the wrist in neutral, 30 degrees of extension and 30 degrees of flexion.

In control subjects the position of the median nerve was 4.8 (SE=0.4) mm more radial with the wrist flexed than with the wrist extended.

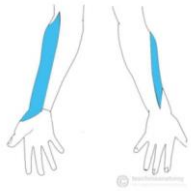
In the twelve arm pain patients the average change was only 1.2 (SE=0.5) mm.

It appears that ultrasound imaging may be helpful in diagnosing non-specific arm pain, a condition for which there are no well-defined diagnostic tests at present. The reduced nerve movement seen with ultrasound imaging confirms previous work with magnetic resonance imaging.

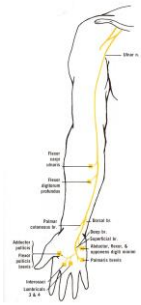
## Musculocutaneous

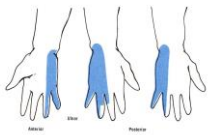
The Musculocutaneous Nerve

- **Nerve roots:** C5-C7.
- **Motor functions:** Innervates the muscles in the anterior compartment of the arm – the coracobrachialis, biceps brachii and the brachialis
- **Sensory functions:** Gives rise to the lateral cutaneous nerve of forearm, which innervates skin on the lateral surface of the forearm.



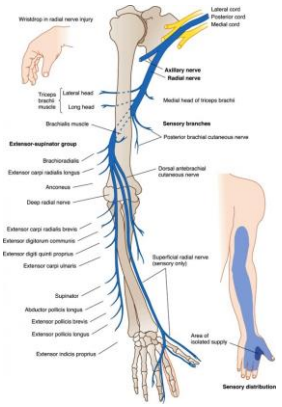
## Ulnar



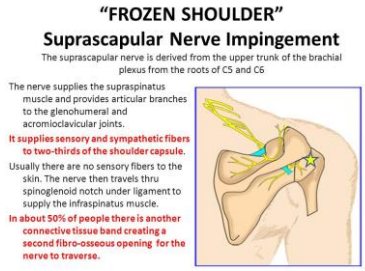


Consider when your post op shoulder patient struggles to regain OH motion

## Radial



## Suprascapular




The Shoulders of Professional Beach Volleyball Players High Prevalence of Infraspinatus Muscle Atrophy

- (PDF Download Available). https://www.researchgate.net/publication/24271006_The_Shoulders_of_Professional_Beach_Volleyball_Players_High_Prevalence_of_Infraspinatus_Muscle_Atrophy [accessed Jul 21, 2017]

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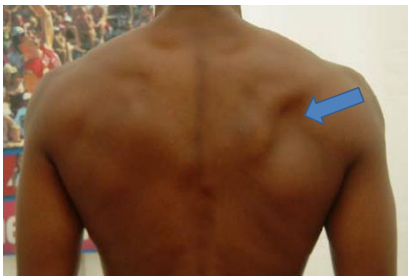


## The Shoulders of Professional Beach Volleyball Players High Prevalence of Infraspinatus Muscle Atrophy

- Atrophy of the infraspinatus muscle was found in 30% of the hitting shoulders, and it was not typically recognized by the players.
- Average external rotation strength was decreased in the hitting shoulder (8.2 versus 9.5 kg, P < .0001).
- Players with atrophy had significantly more loss of external rotation strength (2.3 kg) than did players without atrophy (0.8 kg)
- Average Abduction strength was decreased in the hitting shoulder (7.8 vs 8.5 kg, P <.001). The infraspinatus muscle substantially contributes to abduction strength (up to 40%).
- Pain in the hitting shoulder was present in 63% of the players, without clear correlations to the investigated clinical and imaging parameters.
- Compression of the suprascapular nerve was not observed.

## The Shoulders of Professional Beach Volleyball Players High Prevalence of Infraspinatus Muscle Atrophy

The literature well acknowledges that the reason for infraspinatus atrophy is overhead-shoulder activity, over-use, or trauma leading to a neuropathy of the suprascapular nerve.** Such neuropathy can be caused by direct compression of the suprascapular nerve at the level of the scapular notch or at the spinoglenoid notch, because of a ganglion cyst or a hypertrophied transverse scapular or spinoglenoid ligament, respectively.

But in volleyball players with infraspinatus atrophy and documented neuropathy, a compression of the suprascapular nerve by a ganglion or a ligament was not observed. This is in agreement with our findings: the 84 sonographies and 29 MRIs of the hitting shoulders showed neither a ganglion cyst nor a hypertrophied ligament in the course of the supra-scapular nerve. We therefore agree with Ferretti et al15,16 that the cause of infraspinatus atrophy in volleyball players is a **stretching neuropathy** of the suprascapular nerve caused by the repetitive hitting activity..

Martin SD, Warren RF, Martin TL, Kennedy K, O'Brien SJ, Wickiewicz TL. Suprascapular neuropathy: results of non-operative treatment. J Bone Joint Surg Am. 1997;79:1159-1165

We retrospectively reviewed the results of non-operative treatment of suprascapular neuropathy in fifteen patients seen between November 1983 and February 1991. The clinical diagnosis was confirmed with electrodiagnostic studies. The treatment consisted of a program of physical therapy to improve the range of motion of the shoulder and to strengthen the surrounding muscles. The average duration of follow-up was three years and eleven months (range, one year to eight years and ten months). The latest evaluation included electrodiagnostic studies of the affected extremity and dynamic isokinetic testing of both upper extremities. The result was excellent for five patients and good for seven. The three remaining patients had operative treatment because of persistent symptoms; one of these patients had an excellent result, one had a good result, and one had a poor result. The results suggest that, in the absence of a well defined lesion producing mechanical compression of the suprascapular nerve, suprascapular neuropathy should be treated non-operatively.

## What's this sound like?

- Have the patient bring his arm across the anterior portion of the body to bring the scapula maximally around the thorax. (This increases the distance of the suprascapular foramen from the cervical spine origin of the nerve, thereby stretching it). With this movement there is often increased irritation to the nerve and pain in related areas.

## What's this sound like?

Evaluation, treatment, and outcomes of suprascapular neuropathy: a 5-year review.
Hill LJ1, Jelsing EJ2, Terry MJ3, Strommen JA4.
PM R. 2014 Sep;6(9):774-80.

- **METHODS:**
- A 5-year retrospective chart review of patients with EMG-confirmed SSN.
- **MAIN OUTCOME MEASURES:**
- Descriptive statistics were used to summarize demographics, risk factors, causes, EMG findings, diagnostic evaluation, treatments, and self-reported outcomes. Exact Mantel-Haenszel $\chi(2)$ tests and Fisher exact tests were used to assess correlation between these measures.
- **RESULTS:**
- The 3 most common causes of SSN were trauma (32 patients), an inflammatory process (ie, brachial neuritis) (14), and the presence of a cyst (13). Remaining cases were related to a rotator cuff tear or were due to overuse. No cases were attributed to notch abnormalities. At the time of follow-up (a mean of 50 months [range, 15-84 months] after EMG), 50% of subjects returned to activity with no restrictions (excellent outcome) and 40% returned to activity with restrictions (good outcome), regardless of cause and treatment. EMG findings, specifically the presence/absence of fibrillation potentials, did not predict recovery.

Complete Fatty infiltration of intact rotator cuffs caused by suprascapular neuropathy. Leclere LE1, Shi LL2, Lin A3, Yannopoulos P4, Higgins LD5, Warner JJ6.Arthroscopy. 2014 May;30(5):639-44.

- **Abstract**
- Suprascapular neuropathy is generally considered to be a diagnosis of exclusion, although it has been described in association with several activities and conditions. To our knowledge, this is the first description of suprascapular neuropathy with complete neurogenic fatty replacement in patients with intact rotator cuff tendons in the absence of traction or compression mechanisms. We present 4 cases of patients who presented with complete fatty infiltration of the supraspinatus (1 patient), infraspinatus (2 patients), and both (1 patient) resulting from suprascapular neuropathy. Each of these patients underwent arthroscopic suprascapular nerve decompression and subsequently had immediate improvement in pain and subjective shoulder value.

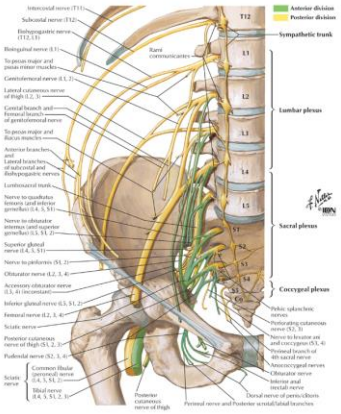
J Shoulder Elbow Surg. 2013 Nov;22(11):1537-46. doi: 10.1016/j.jse.2013.01.028. Epub 2013 May 2.

**A comparative analysis of fatty infiltration and muscle atrophy in patients with chronic rotator cuff tears and suprascapular neuropathy.**

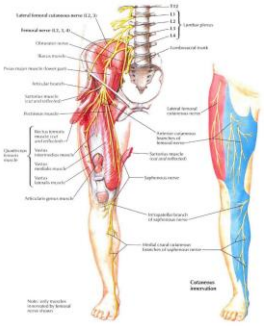
Beeler S[1], Ek ET, Gerber C

- We have observed that the magnetic resonance imaging (MRI) appearance of fatty infiltration (FI) and muscle atrophy (MA) differ between chronic cuff tears and suprascapular neuropathy, suggesting different pathophysiology

# Lower Extremity Review




## Femoral Nerve



Lateral Femoral Cutaneus…
ITB syndrome

[Peripheral neuropathic pain relieved by somatosensory rehabilitation]. Mathis F1, Desfoux N, Sprumont P, Hecker E, Rossier P, Spicher C. Rev Med Suisse. 2007 Nov 28;3(135):2745-8.

The femoral neuralgia is a rather frequent and invalidating clinical disorder.

**It takes on many clinical forms because of the anatomical variations of the cutaneous branches of saphenous and femoral nerves**.

Bilateral femoral neuropathy after massive toxic ingestion in a suicide attempt. Mathis S1, du Boisguéheneuc F, Godenèche G, Ansquer S, Neau JP. Neurologist. 2012 Mar;18(2):70-2

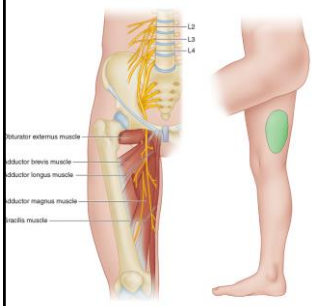
Bilateral femoral nerve injury can occur after various surgical and nonsurgical processes, but has rarely been reported.

We describe a case of bilateral femoral neuropathy after a suicide attempt in a 41-year-old woman. We suggest a stretch mechanism to explain this observation. We also discuss the other causes of bilateral nerve palsy, usually secondary to a compressive injury, with a review of the medical literature.

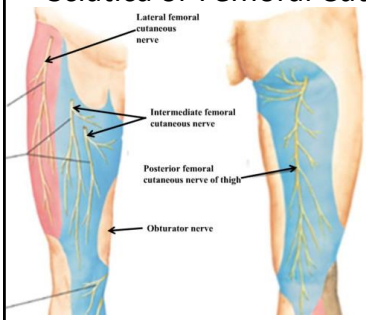
CONCLUSIONS:

Half of the reported cases are secondary to a surgical process (particularly abdominopelvic surgery). If a compressive origin is most frequent, a stretch mechanism may at times explain a bilateral femoral neuropathy.

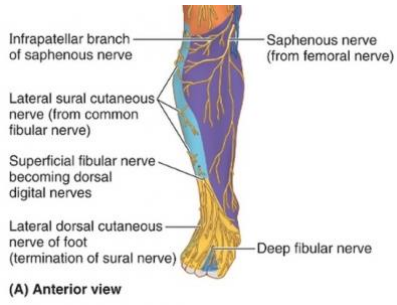
## Obturator




## Sciatica or Femoral Cutaneousa ☺



## Saphenous




**Entrapment of the saphenous nerve at the adductor canal affecting the infrapatellar branch – a report on two cases** Jason Porr, BSc (Hons) HK, DC, FRCCSS(C), Karen Chrobak, Hons. BHSc, DC,[a,b] and Brad Muir, BSc (Hons), DC, FRCCSS(C) J Can Chiropr Assoc. 2013 December; 57(4): 341–349.

Saphenous nerve entrapment has been reported within the literature to be associated with or mimic a number of conditions including lumbar radiculopathy, patellofemoral disorders, suprapatellar plica, tear of medial meniscus, tibial stress fracture, pes anserine tendonopathy or bursitis, osteochondritis dissecans, nonspecific synovitis and reflex sympathetic dystrophy.

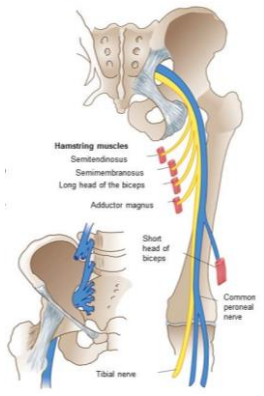
## Saphenus

- On historical examination patients will typically present with complaint of medial knee and or leg pain, pain with kneeling, and there may be an associated trauma to the saphenous nerve via blunt trauma or previous surgical procedures.
- The distribution of pain in saphenous nerve entrapment patients has been reported as at the knee (90%), thigh (7%) and calf (3%),[35] and it may also be present at night.
- Physical examination may elicit hypoesthesia or dysesthesia in the absence of any motor weakness and a positive Tinel's test at the site of injury.
- Patients may also present with pain on gait and resisted adduction or flexion at the hip, as well as pain on palpation at the adductor canal or the medial femoral condyle where the saphenous nerve pierces or wraps around the sartorius muscle.
- Pain may also be elicited with prone hip extension (reversed Lasegue's sign) due to an increase in neural tension along the saphenous nerve

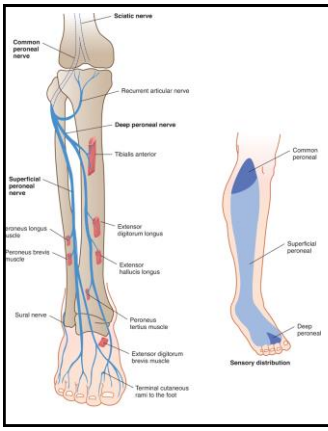
Saphenous neuropathy in a patient with low back pain. Ahadi T1, Raissi GR, Togha M, Nejati P. J Brachial Plex Peripher Nerve Inj. 2010 Jan 16;5:2. doi: 10.1186/1749-7221-5-2.

- Saphenous nerve, a pure sensory nerve, may compromise as a result or complication of a surgical procedure or secondary to trauma or insidiously.
- We present a male patient with low back pain concomitant with pain in medial portion of left thigh in addition to pain and numbness in medial part of leg and inferior part of patella after a strenuous activity.
- Preliminary diagnosis suggested that the patient had radiculopathy but electrodiagnostic tests revealed the absence of left saphenous response both in medial leg and infrapatellar region, while normal findings were recorded from right side.
- Needle electromyography in L4 innervated muscles were normal. The patient had saphenous nerve entrapment in left thigh.
- Two months later symptoms relieved with conservative therapy.

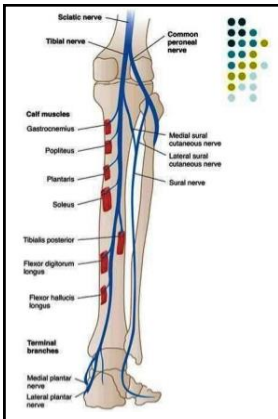
## Sciatic




## Peroneal




Shin Splints
Peronal tendonitis



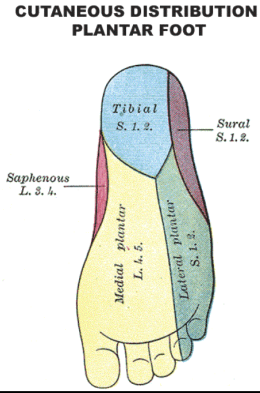

## Tibial

Nerve entrapment and calf atrophy caused by a Baker's cyst: case report. DiRisio D1, Lazaro R, Popp AJ. Neurosurgery. 1994 Aug;35(2):333-4; discussion 334.

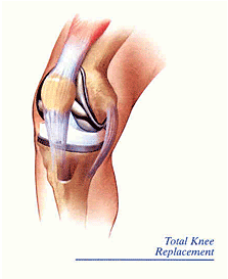
An unusual case of leg pain and atrophy in a patient with gastrocnemius due to tibial nerve branch compression by a Baker's cyst.

The clinical findings and electrodiagnostic studies were supportive of isolated medial gastrocnemius denervation.

Treatment by synovectomy along with decompression of the branch of the posterior tibial nerve to the medial head of the gastrocnemius muscle resulted in clinical improvement.



# Post Op Patients





## Intraoperative nerve monitoring during total shoulder arthroplasty surgery. Malik AA1, Aresti N1, Plumb K1, Cowan J1, Higgs D1, Lambert S1, Falworth M1. Shoulder Elbow. 2014 Apr;6(2):90-4

- BACKGROUND:
- Nerve injury is an acknowledged complication of total shoulder arthroplasty (TSA). Although the incidence of postoperative neurological deficit has been reported to be between 1% and 16%, the true incidence of nerve damage is considered to be higher. The present study aimed to identify the rate of intraoperative nerve injury during total shoulder arthroplasty and to determine potential risk factors.
- METHODS:
- A prospective study of nerve conduction in 21 patients who underwent primary or revision TSA was carried out over a 12-month period. Nerve conduction was monitored by measuring intraoperative sensory evoked potentials (SEP). A significant neurophysiological signal change was defined as either a unilateral or bilateral decrease in SEP signal of ≥50%, a latency increase of ≥10% or a change in waveform morphology, not caused by operative or anaesthetic technique.
- RESULTS:
- Seven (33%) patients had a SEP signal change. The only significant risk factor identified for signal change was male sex (odds ratio 15.00, 95% confidence interval). The median nerve was the most affected nerve in the operated arm. All but one signal change returned to normal before completion of the operation and no patient had a persisting postoperative clinical neurological deficit.
- CONCLUSIONS:
- The incidence of intraoperative nerve damage may be more common than previously reported. However, the loss of SEP signal is reversible and does not correlate with persisting clinical neurological deficits. The median nerve appears to be most at risk. Monitoring SEPs in the operated limb during TSA may be a valuable tool during TSA.

## The risk of nerve injury during anatomical and reverse total shoulder arthroplasty: an intraoperative neuromonitoring study. Parisien RL1, Yi PH2, Hou L3, Li X1, Jawa A4. J Shoulder Elbow Surg. 2016 Jul;25(7):1122-7. doi: 10.1016/j.jse.2016.02.016.

BACKGROUND:

- This study compared the incidence and pattern of potential nerve injuries between reverse shoulder (RSA) and total shoulder arthroplasty (TSA) using intraoperative neuromonitoring. Our hypothesis was that RSA has a greater risk of nerve injury than TSA due to arm lengthening.

METHODS:

- We reviewed 36 consecutive patients who underwent RSA (n = 12) or TSA (n = 24) with intraoperative neuromonitoring. The number of nerve alerts was recorded for each stage of surgery. Neurologic function was assessed preoperatively and postoperatively at routine follow-up visits. Predictive factors for increased intraoperative nerve alerts and clinically detectable neurologic deficits were determined.

RESULTS:

- There were nearly 5 times as many postreduction nerve alerts per patient in the RSA cohort compared with the TSA cohort (2.17 vs. 0.46). There were 17 unresolved nerve alerts postoperatively, with only 2 clinically detectable nerve injuries, which fully resolved by 6 months postoperatively. A preoperative decrease in active forward flexion and the diagnosis of rotator cuff arthropathy were independent predictors of intraoperative nerve alerts.

CONCLUSION:

- RSA has a higher incidence of intraoperative nerve alerts than TSA during the postreduction stage due to arm lengthening. Decreased preoperative active forward flexion and the diagnosis of rotator cuff arthropathy are predictors of more nerve alerts. The clinical utility of routine intraoperative nerve monitoring remains in question given the high level of nerve alerts and lack of persistent postoperative neurologic deficits.

Femoral, saphenous nerve palsy after tourniquet use: a case report.cKornbluth ID1, Freedman MK, Sher L, Frederick RW. Arch Phys Med Rehabil. 2003 Jun;84(6):909-11.

- Patients with continued weakness may be perceived as lacking motivation by health care providers.
- Persistent motor and sensory abnormalities after surgery may affect the rehabilitation process.
- a case of a 20-year-old man who underwent surgical repair of multiple knee structures with the use of a pneumatic tourniquet. Several weeks after surgery, electromyographic evaluation was done because he was having difficulty in his rehabilitation because of persistent weakness.
- An electromyography and nerve conduction study (NCS) revealed femoral and saphenous nerve palsies.
- A review of the literature indicates that tourniquet-induced nerve palsies are not a rare event.
- Further evaluation should be considered if patients who are having persistent weakness or sensory findings after surgery have used a tourniquet.

2014 Neer Award Paper: neuromonitoring the Latarjet procedure. Delaney RA1, Freehill MT1, Janfaza DR2, Vlassakov KV2, Higgins LD3, Warner JJ4. J Shoulder Elbow Surg. 2014 Oct;23(10):1473-80

METHODS:

- Thirty-four patients with a mean age of 28.4 years were included. The Latarjet procedure was divided into 9 defined stages. Bilateral median and ulnar somatosensory evoked responses and transcranial motor evoked potentials from all arm myotomes were continuously monitored. A "nerve alert" was defined as averaged 50% amplitude attenuation or 10% latency prolongation of ipsilateral somatosensory evoked responses and transcranial motor evoked potentials. For each nerve alert, the surgeon altered retractor placement, and if there was no response to this, the position of the operative extremity was then changed.

RESULTS:

- Of 34 patients, 26 (76.5%) had 45 separate nerve alert episodes. The most common stages of the procedure for a nerve alert to occur were glenoid exposure and graft insertion. The axillary nerve was involved in 35 alerts; the musculocutaneous nerve, in 22. Of the 34 patients, 7 (20.6%) had a clinically detectable nerve deficit postoperatively, all correlated with an intraoperative nerve alert. All cases involved the axillary nerve, and all resolved completely from 28 to 165 days postoperatively. Prior surgery and body mass index were not predictive of a neurologic deficit postoperatively. However, total operative time (P = .042) and duration of the stage of the procedure in which the concordant nerve alert occurred (P = .010) were statistically significant predictors of a postoperative nerve deficit.

CONCLUSIONS:

- The nerves, in particular the axillary and musculocutaneous nerves, are at risk during the Latarjet procedure, especially during glenoid exposure and graft insertion.

Neer Award 2005: Peripheral nerve function during shoulder arthroplasty using intraoperative nerve monitoring. Nagda SH1, Rogers KJ, Sestokas AK, Getz CL, Ramsey ML, Glaser DL, Williams GR Jr. J Shoulder Elbow Surg. 2007 May-Jun;16(3 Suppl):S2-8.

- The incidence of neurologic injury after shoulder arthroplasty has been reported to be 1% to 4%. However, the true incidence may be higher, because injury is identified only clinically and examination of the post-arthroplasty shoulder is difficult.
- Continuous intraoperative monitoring of the brachial plexus was performed in 30 consecutive patients undergoing shoulder arthroplasty. Impending intraoperative compromise of nerve function was signaled by sustained neurotonic electromyographic activity or greater than 50% amplitude attenuation of transcranial electrical motor evoked potentials (or both). Arm and retractor positions were recorded and adjusted to relieve tension. Patients with intraoperative nerve alerts underwent diagnostic electromyography at least 4 weeks postoperatively. Of the patients, 17 (56.7%) had 30 episodes of nerve dysfunction (ie, nerve alerts) during surgery.
- None of these 30 nerve alerts returned to baseline with retractor removal alone. Of the 30 alerts, 23 (76.7%) returned to baseline after repositioning of the arm into a neutral position. Postoperative electromyography results were positive in 4 of 7 patients (57.1%) who did not have a return to baseline transcranial electrical MEPs intraoperatively and in 1 of 10 (10%) whose nerve function did return to baseline.
- In all cases of positive postoperative electromyographic results, the pattern of nerve involvement matched the pattern of intraoperative nerve dysfunction.
- The affected nerves included the following: combined (ie, mixed plexopathy) (46.7%), musculocutaneous (20%), axillary (16.7%), ulnar (10%), and radial (6.7%).
- Prior shoulder surgery and passive external rotation of less than 10 degrees were associated with an increased incidence of nerve dysfunction (P < .05).

# TREATMENT

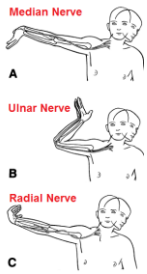
## Treatment

- Passive mobilizations, spine and peripheral soft tissue entrapments
- Initiate Active Nerve glides when objective change in neural tension noted and patient demonstrates proper technique
- Then Strengthen
- Patient's normally have developed loss of specific muscular strength and endurance. This is due to disuse atrophy, reflexive inhibition, or neural compression.

## Rub my feet please…

- Ankle joint mobilization reduces axonotmesis-induced neuropathic pain and glial activation in the spinal cord and enhances nerve regeneration in rats. Martins, Daniel, Pain vol. 152. pgs 2653-2661, 2011

# Nerve Sliders and Tensioners




Do 'sliders' slide and 'tensioners' tension? An analysis of neurodynamic techniques and considerations regarding their application. Coppieters MW1, Butler DS. Man Ther. 2008 Jun;13(3):213-21. Epub 2007 Mar 30.

- The aim of this cadaveric biomechanical study was to measure longitudinal excursion and strain in the median and ulnar nerve at the wrist and proximal to the elbow during different types of nerve gliding exercises.
- The results confirmed the clinical assumption that 'sliding techniques' result in a substantially larger excursion of the nerve than 'tensioning techniques' (e.g., median nerve at the wrist: 12.6 versus 6.1mm, ulnar nerve at the elbow: 8.3 versus 3.8mm), and that this larger excursion is associated with a much smaller change in strain (e.g., median nerve at the wrist: 0.8% (sliding) versus 6.8% (tensioning)).
- The findings demonstrate that different types of nerve gliding exercises have largely different mechanical effects on the peripheral nervous system. Hence different types of techniques should not be regarded as part of a homogenous group of exercises as they may influence neuropathological processes differently.
- The findings of this study and a discussion of possible beneficial effects of nerve gliding exercises on neuropathological processes may assist the clinician in selecting more appropriate nerve gliding exercises in the conservative and post-operative management of common neuropathies.

Incorporating nerve-gliding techniques in the conservative treatment of cubital tunnel syndrome. Coppieters MW1, Bartholomeeusen KE, Stappaerts KH. J Manipulative Physiol Ther. 2004 Nov-Dec;27(9):560-8.

- Two months after onset, a 17-year-old female nursing student who had a traumatic onset of cubital tunnel syndrome still experienced pain around the elbow and paresthesia in the ulnar nerve distribution. Electrodiagnostic tests were negative. Segmental cervicothoracic motion dysfunctions were present which were regarded as contributing factors hindering natural recovery.
- INTERVENTION AND OUTCOMES:
- After 6 sessions consisting of nerve-gliding techniques and segmental joint manipulation and a home exercise program consisting of nerve gliding and light free-weight exercises, a substantial improvement was recorded on both the impairment and functional level (pain scales, clinical tests, and Northwick Park Questionnaire). Symptoms did not recur within a 10-month follow-up period, and pain and disability had completely resolved.
- CONCLUSIONS:
- Movement-based management may be beneficial in the conservative management of cubital tunnel syndrome. As this intervention is in contrast with the traditional recommendation of immobilization, comparing the effects of both interventions in a systematic way is an essential next step to determine the optimal treatment of patients with cubital tunnel syndrome.

Effects of upper extremity neural mobilization on thermal pain sensitivity: a sham-controlled study in asymptomatic participants. Beneciuk JM1, Bishop MD, George SZ. J Orthop Sports Phys Ther. 2009 Jun;39(6):428-38.

OBJECTIVES:

- To investigate potential mechanisms of neural mobilization (NM), using tensioning techniques in comparison to sham NM on a group of asymptomatic volunteers between the ages of 18 and 50.

RESULTS:

- No group differences were seen for A-delta mediated pain perception at either immediate or carryover times. Group differences were identified for immediate C-fiber mediated pain perception (P = .032), in which hypoalgesia occurred for the NM group but not the sham NM group. This hypoalgesic effect was not maintained at carryover (P = .104). Group differences were also identified for the 3-week and carryover periods for elbow extension ROM (P = .004), and for the participant sensory descriptor ratings (P = .018), in which increased ROM and decreased sensory descriptor ratings were identified in participants in the NM group but not the sham NM group.

CONCLUSION:

- This study provides preliminary evidence that mechanistic effects of tensioning NM differ from sham NM for asymptomatic participants. Specifically, NM resulted in immediate, but not sustained, C-fiber mediated hypoalgesia. Also, NM was associated with increased elbow ROM and a reduction in sensory descriptor ratings at 3-week and carryover assessment times. These differences provide potentially important information on the mechanistic effects of NM, as well as the description of a sham NM for use in future clinical trials.

Short-term changes in median nerve neural tension after a suboccipital muscle inhibition technique in subjects with cervical whiplash: a randomised controlled trial. Antolinos-Campillo PJ1, Oliva-Pascual-Vaca A2, Rodríguez-Blanco C2, Heredia-Rizo AM3, Espí-López GV4, Ricard F1. Physiotherapy. 2014 Sep;100(3):249-55. doi: 10.1016/j.physio.2013.09.005. Epub 2013 Nov 4

PARTICIPANTS:

- Forty subjects {mean age 34 years [standard deviation (SD) 3.6]} with Grade I or II cervical whiplash and a positive response to the ULNT-1 were recruited and distributed into two study groups: intervention group (IG) (n=20) and control group (CG) (n=20).

INTERVENTIONS:

- The IG underwent the SMI technique for 4minutes and the CG received a sham (placebo) intervention. Measures were collected immediately after the intervention.

RESULTS:

- The mean baseline elbow range of motion was 116.0° (SD 10.2) for the CG and 130.1° (SD 7.8) for the IG. The within-group comparison found a significant difference in elbow range of motion for the IG [mean difference -15.4°, 95% confidence interval (CI) -20.1 to -10.6; P=0.01], but not for the CG [mean difference -4.9°, 95% CI -11.8 to 2.0; P=0.15]. In the between-group comparison, the difference in elbow range of motion was significant (mean difference -10.5°, 95% CI -18.6 to -2.3; P=0.013), but the differences in grip strength (P=0.06) and neck pain (P=0.38) were not significant.

CONCLUSION:

- The SMI technique has an immediate positive effect on elbow extension in the ULNT-1. No immediate effects on self-perceived cervical pain or grip strength were observed.

Acute effects of neural mobilization and infrared on the mechanics of the median nerve. Monara Kedma Nunes,1,* Gabrielly Fontenele dos Santos,1 Diandra Caroline Martins e Silva,1 Ana Cláudia Mota de Freitas,1 Isadora Ferreira Henriques,2 Peterson Marco Andrade,3 Dionis de Castro Machado,1,4 Silmar Teixeira,5 Marco Orsini Neves,6 Gildário Dias,7 Fernando Silva-Júnior,1,5,7 and Victor Hugo Bastos1,4. J Phys Ther Sci. 2016 Jun; 28(6): 1720–1723.

- This study analyzed the acute effects of infrared and neural mobilization on the median nerve on the range of elbow extension of the dominant limb.
- Forty participants from university, neurologically asymptomatic, 12 males and 28 females (22.8 ± 1.9 years), were randomly divided into four groups: Group 1 (control) rested for 25 minutes in the supine position; Group 2 received the specific neural mobilization for the median nerve; Group 3 received an application of infrared for 15 minutes on the forearm; Group 4 received the same application of infrared followed by neural mobilization.
- Significant differences of extension value were observed between Group 1 and Group 3 (15.75 degrees), and between Group 1 and Group 4 (14.60 degrees), and the average higher in Group 3 (26.35 degrees).
- This research provides new experimental evidence that NM in relation to superficial heat produces an immediate effect on elbow range of motion versus NM isolated.

Central sensitization does not identify patients with carpal tunnel syndrome who are likely to achieve short-term success with physical therapy. Fernández-de-Las-Peñas C1, Cleland JA, Ortega-Santiago R, de-la-Llave-Rincon AI, Martínez-Perez A, Pareja JA.

The aim of the current study was to identify whether hyperexcitability of the central nervous system is a prognostic factor for individuals with carpal tunnel syndrome (CTS) likely to experience rapid and clinical self-reported improvement following a physical therapy program including soft tissue mobilization and nerve slider neurodynamic interventions.

Participants underwent a standardized examination and then a physical therapy session. The physical therapy sessions included both soft tissue mobilization directed at the anatomical sites of potential median nerve entrapment and a passive nerve slider neurodynamic technique targeted to the median nerve.

Pressure pain thresholds (PPT) over the median, radial and ulnar nerves, C5-C6 zygapophyseal joint, carpal tunnel and tibialis anterior muscle were assessed bilaterally. Additionally, thermal detection and pain thresholds were measured over the carpal tunnel and thenar eminence bilaterally to evaluate central nervous system excitability.

Subjects were classified as responders (having achieved a successful outcome) or non-responders based on self-perceived recovery.

Three variables including PPT over the C5-C6 joint affected side <137 kPa, HPT carpal tunnel affected side <39.6º and general health >66 points were identified. If 2 out of 3 variables were present (LR + 14.8), the likelihood of success increased from 48.6 to 93.3%. We identified 3 factors that may be associated with a rapid clinical response to both soft tissue mobilization and nerve slider neurodynamic techniques targeted to the median nerve in women presenting with CTS. Our results support that widespread central sensitization may not be present in women with CTS who are likely to achieve a successful outcome with physical therapy. Future studies are now necessary to validate these findings.

Effects of neuromobilization maneuver on clinical and electrophysiological measures of patients with carpal tunnel syndrome. Oskouei AE1, Talebi GA2, Shakouri SK1, Ghabili K3.

- The aim of this study was to investigate the efficacy of neuromobilization combined with routine physiotherapy in patients with carpal tunnel syndrome through subjective, physical, and electrophysiological studies.
- Twenty patients with carpal tunnel syndrome (totally 32 hands) were assigned two groups: treatment and control groups. In both groups, patients received the routine physiotherapy. In addition to the routine physiotherapy, patients in the treatment group received neuromobilization. The symptoms severity scale, visual analogue scale, functional status scale, Phalen's sign, median nerve tension test, and median nerve distal sensory and motor latency were assessed.
- There were significant improvements in the symptoms severity scale, visual analogue scale, median nerve tension test, and Phalen's sign in both groups. However, the functional status scale and median nerve distal motor latency were significantly improved only in the treatment group.
- Neuromobilization in combination with routine physiotherapy improves some clinical findings more effectively than routine physiotherapy. Therefore, this combination can be used as an alternative effective non-invasive treatment for patients with carpal tunnel syndrome.

Evaluation and Treatment of Upper Extremity NerveEntrapment Syndromes
Eric E. Floranda, MDa,*, Bret C. Jacobs, DO, MAb,c

- INTRODUCTION
- These syndromes present with various symptoms and signs corresponding to the site of compression and anatomic distribution supplied by the involved nerve.
- To make a diagnosis, the clinician must recognize the muscles innervated, sensory distribution, muscle stretch reflex, and compressive sites associated to a particular nerve.
- Nerves can be purely motor, purely sensory, or mixed.
- KEY POINTS
  - A firm knowledge of muscles and the cutaneous distribution of nerve innervates is essential in localizing nerve injury.
  - Patients usually present with weakness, pain, and paresthesias in a distribution particular to the nerve and the level of the lesion.
  - Tools are available to aid the clinician in the diagnosis and prognostication of nerve injury.
  - Conservative management is generally the first-line treatment before surgery is contemplated.

Bilateral widespread mechanical pain sensitivity in carpal tunnel syndrome: evidence of central processing in unilateral neuropathy. Fernández-de-las-Peñas C1, de la Llave-Rincón AI, Fernández-Carnero J, Cuadrado ML, Arendt-Nielsen L, Pareja JA. Brain. 2009 Jun;132(Pt 6):1472-9.

- The aim of this study was to investigate whether bilateral widespread pressure hypersensitivity exists in patients with unilateral carpal tunnel syndrome. A total of 20 females with carpal tunnel syndrome (aged 22-60 years), and 20 healthy matched females (aged 21-60 years old) were recruited. Pressure pain thresholds were assessed bilaterally over median, ulnar, and radial nerve trunks, the C5-C6 zygapophyseal joint, the carpal tunnel and the tibialis anterior muscle in a blinded design.
- **The results showed that pressure pain threshold levels were significantly decreased bilaterally over the median, ulnar, and radial nerve trunks, the carpal tunnel, the C5-C6 zygapophyseal joint, and the tibialis anterior muscle in patients with unilateral carpal tunnel syndrome as compared to healthy controls** (all, $P < 0.001$).
- Pressure pain threshold was negatively correlated to both hand pain intensity and duration of symptoms (all, $P < 0.001$). Our findings revealed bilateral widespread pressure hypersensitivity in subjects with carpal tunnel syndrome, which suggest that widespread central sensitization is involved in patients with unilateral carpal tunnel syndrome.

Impact of shoulder internal rotation on ulnar nerve excursion and strain in embalmed cadavers. A pilot study. Gugliotti M1, Futterman B1, Ahrens T1, Block D1, Brown L1, Dagro M1, Falesto J1, Lyon A1. J Man Manip Ther. 2016 May;24(2):111-6

OBJECTIVE:

- To determine if the substitution of shoulder internal rotation for external rotation during the upper limb neurodynamic test (ULNT3) evokes a comparable ulnar nerve excursion and strain in embalmed cadavers. Shoulder external rotation is a primary movement component of the ULNT3. It has been suggested that shoulder internal rotation may provide a similar load to the nervous system. There are no data to either support or negate this claim.

METHODS:

- Excursion and strain were measured in the ulnar nerve of six embalmed cadavers during the traditional ULNT3 and an experimental maneuver using shoulder internal rotation.

RESULTS:

- The total means±SD of excursion for the traditional and experimental maneuvers were 2·11±0·89 and 2·09±0·92 mm, respectively. The total means±SD of strain for the traditional and experimental maneuvers were 5·274±2·223 and 5·241±2·308%, respectively. A very strong correlation ($r = 0.98$) was shown to exist between maneuvers and this relationship was determined to be significant ($P = 0.001$).

DISCUSSION:

- The results of this study provide evidence that there is no appreciable difference in excursion or strain when substituting shoulder internal rotation for external rotation during the ULNT3. Patients who exhibit limitation of shoulder external rotation mobility may benefit from this substitution when presenting with signs of ulnar nerve pathodynamics. Further research involving patients will be needed to assess the validity of the experimental maneuver for clinical application.

Increased pain sensitivity is not associated with electrodiagnostic findings in women with carpal tunnel syndrome. de la Llave-Rincón AI1, Fernández-de-las-Peñas C, Laguarta-Val S, Alonso-Blanco C, Martínez-Perez A, Arendt-Nielsen L, Pareja JA. Clin J Pain. 2011 Nov-Dec;27(9):747-54.

A total of 72 women with CTS (19 with minimal, 18 with moderate, and 35 with severe) and 19 healthy age-matched women participated. Pressure pain thresholds were bilaterally assessed over the median, ulnar, and radial nerves, the C5 to C6 zygapophyseal joint, the carpal tunnel, and the tibialis anterior muscle. In addition, warm and cold detection thresholds and heat and cold pain thresholds were bilaterally assessed over the carpal tunnel and the thenar eminence. All outcome parameters were assessed by an assessor blinded to the participant's condition.

- RESULTS:
- No significant differences in pain parameters among patients with minimal, moderate, and severe CTS were found. The results showed that PPT were significantly decreased bilaterally over the median, ulnar, and radial nerve trunks, the carpal tunnel, C5 to C6 zygapophyseal joint, and the tibialis anterior muscle in patients with minimal, moderate, or severe CTS as compared with healthy controls (all, P<0.001).
- In addition, patients with CTS also showed lower heat pain threshold and reduced cold pain threshold compared with controls (P<0.001). No significant sensory differences between minimal, moderate, or severe CTS were found.

CONCLUSIONS:

- The similar widespread pressure and thermal hypersensitivity in patients with minimal, moderate, or severe CTS and pain intensity suggests that increased pain sensitivity is not related to electrodiagnostic findings.

**Do 'sliders' slide and 'tensioners' tension? An analysis of neurodynamic techniques and considerations regarding their application.** Coppieters MW[1], Butler DS. Man Ther. 2008 Jun;13(3):213-21. Epub 2007 Mar 30.

- The results confirmed the clinical assumption that 'sliding techniques' result in a substantially larger excursion of the nerve than 'tensioning techniques' (e.g., median nerve at the wrist: 12.6 versus 6.1mm, ulnar nerve at the elbow: 8.3 versus 3.8mm), and that this larger excursion is associated with a much smaller change in strain (e.g., median nerve at the wrist: 0.8% (sliding) versus 6.8% (tensioning)). The findings demonstrate that different types of nerve gliding exercises have largely different mechanical effects on the peripheral nervous system

Nerve entrapments of the lower leg, ankle and foot in sport. McCrory P1, Bell S, Bradshaw C. Sports Med. 2002;32(6):371-91.

- “The same fascial restriction that predisposes to muscle compartment syndromes may also envelop the neurovascular structures within the leg resulting in either ischemic or neurogenic symptoms.”
- “many different pathologies may coexist in the lower limb and may be a source of confusion for the clinician or alternatively may be the reason for poor treatment outcomes.”

**Entrapment of the suprascapular nerve** Th. Fabre, C. Piton, G. Leclouerec, F. Gervais-Delion, A. Durandeau. *J Bone Joint Surg [Br]* 1999;81-B:414-9.

- "Entrapment of the suprascapular nerve may cause pain in the shoulder which may be attributed wrongly to tendinitis, a tear of the rotator cuff or cervical disc disease"

## Casestudy

- 63 y/o TKA with multiple LOA's for adhesions, hx of CIPD

## Casestudy

- 17 y/o D1 prospect golfer with R shoulder pain
  - c/o shoulder "locking up" during tournaments
  - Pain would increase as tournaments went on
  - MRI negative
  - Palpable guarding with attempts to flex beyond 110
  - Normal capsular mobility
  - No symptoms with practice

## Casestudy

- 56 y/o female s/p Biceps Tenodesis and cyst removal
  - Excruciating pain 1st visit post op
  - Pendulums increased pain
  - Sharp point of pain laterally on arm and numbess medial aspect of the humerus
  - Steroid dose pack reduced symptoms

## Casestudy

- 68 y/o female s/p RTC repair
  - Full PROM flexion and ER
  - PROM ABD limited to 100
  - When began Phase III (strengthening) c/o excruciating pain at the shoulder, flexion dropped to 90 deg and ER 30
  - c/o numbness and swelling along inside of the arm digits 4-5

## Case Study

- 67 y/o male with L sided Radicular pain dx Lumbar stenosis
  - c/o increased symptoms sitting esp on toilet with pain at the groin that is new
  - Had hx of reoccurrent Post hip/LBP 1-2x/year
  - Walking alleviates except some tightness in calf

## Questions?

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