DIFFERENTIAL DIAGNOSIS AND CURRENT STRATEGIES FOR TREATMENT OF NERVE ENTRAPMENTS

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ENTRAPMENT PROCESS CAUSES PAIN

Changes in nerve pressure from repetitive micro-trauma; any incident of acute trauma that overwhelms a nerve; as well as high pressure on a nerve for a short period of time or low pressure exerted for long periods of time
PRESSURE GRADIENT INCREASES

• Increased pressure causes fluid leakage or edema with an increase in the endoneurial compartment which decreases blood flow to a nerve.

• The increased pressure causes neural connective tissue changes with continuing nerve fiber damage.

NERVE STRESSES

• IMMobilization
• LENGTHENING
• COMPRESSION
• REPETITIVE
• PRESSURE

CHARACTERISTICS OF NERVE LESIONS

• Neuropraxia – conduction slowed due to myelin sheath damage (transient functional loss)
  – temporary loss of function (not necessary complete); no neural disruption

• Axonotmesis – endoneurium remains intact
  – Axonal & sheath disruption w/ connective tissue sheath preserved; recovery dependent on distance from lesion to insertion

• Neurotmesis - damage to axon and endoneurium
  – Complete anatomical interruption of the nerve; complete loss of function; no spontaneous recovery; usually secondary trauma
PERIPHERAL NERVE INJURIES

- Excessive pressure compromises blood supply of neural tissue (ischemia)
- Mechanical irritation causes an inflammatory response
- Fibrosis or scarring
- All of these lead to changes in axonal transport, conduction change and CNS changes.

WHAT NERVES LOVE

- They are Claustrophobic
- Gotta move by sliding and gliding
- Plenty of blood supply
- Action potential

- Pain, weakness, lack of control, body schema changes, and motor problems

WHY PARESTHESIA

- Vascular impairment occurs in blood nerve barrier with fluid shifts causing endo-neural edema
- Slow lymphatic drainage - few vessels
- Blood supply cut off by compressing arterioles
- Impairment with sodium/potassium exchange pump
- Changes in the metabolic conduction block
CHANGES THAT OCCUR WITH ENTRAPMENT

• Localized swelling of nerve
• Degeneration of nerve
• As nerve attempts to heal it may result in intraneural fibrosis

ENTRAPMENT RELATED TO SOFT TISSUE

• Soft tissue adaptation
• Postural malalignments
• Myofascial shortening and lengthening

• Muscle imbalance
• Nerve entrapment
• Functional impairment

PAIN IS A BRAIN OUTPUT

• Close allies — Brain and Body
• Brain is Protector
• Both depend on brain map of body
• Thinking about movement can hurt

PATHOPHYSIOLOGY OF PAIN MECHANISMS

- Nociception
- Peripheral Neuropathic and Neurogenic
- Central Sensitization
- Inflammatory Neurogenic

NOCICEPTION

The reception of sensations carried by nociceptors (free nerve endings) in response to tissue damage. Nociceptors located in periphery carry signals from noxious stimuli.
MECHANISMS OF PAIN
PERIPHERAL NEUROGENIC

• Occur in periphery before dorsal horn
• Nerve or neural tissue
• Provocative test, such as upper limb nerve tension testing (ULNT), will determine specific areas of entrapment

NEUROGENIC PAIN

• Provocative test, such as upper limb neural dynamic testing (ULNT), will determine specific areas of entrapment
• ULNT and Tinel’s sign can assist in locating the neurogenic irritability proximal and distal
  — Often associated with double-crush syndrome

MOVEMENT OF NERVES

• Nerves do not stretch
• Axonal folding and unfolding
• If nerve is lengthen 6-8% slow blood flow, 15% stop blood flow, and 20% cells die in the dorsal horn
• Increase pressure is toxic to a nerve

Lundborg et al 1983
IDENTIFICATION OF CENTRAL SENSITIZATION

• Symptoms of pain are generalized not localized
• Often away from primary site of injury
• Spreads throughout body in abnormal pattern
• Allodynia, Hyperalgesia, Cold Hyperalgesia
• Increased response to multiple stimuli to Mechanical, thermal or chemical
• Basic intolerance to both physical and emotional stressors

Nijs, J, It hurts when you touch me, March 2012

CENTRAL SENSITIZATION

Pain related to Altered CNS Circuitry and Processing
CNS neurons fire more readily with
– Non-noxious stimuli and lower threshold
– Stimuli outside the receptive field
– Presence of Abnormal Pain States-allodynia and hyperalgesia

Urban and Gebhart, 1999

PERSISTENT PAIN LASTING AFTER HEALING HAS OCCURRED

• Sensitization of brain & spinal cord
• Diagnoses based on tissue processes must be reconsidered
  – Pain persist, spreads or is worsening
  – Small movements hurt
  – Hurts if you think about it
  – Pain is worse with anxiety or depression
  – Pain moves around the body
How to Explain Central Sensitization to Patients with ‘unexplained’ chronic musculoskeletal pain


PAIN HYPERSENSITIVITY

Allodynia
Thresholds lower so stimuli that normally wouldn’t cause pain now do.

Hyperalgesia
Responsiveness is increased so that noxious stimuli produces exaggerated and prolonged pain.

IDENTIFICATION OF OTHER SYMPTOMS

• Wear sun glasses inside
• Hugs hurt them
• TV or Radio noise
• Turning of pages
• Thinking about moving hurts
• Fatigue, concentration difficulties, insomnia
• Symptoms cant be reproduced and don’t make sense
WHY ISN’T MY PATIENT GETTING BETTER

• Symptoms > 3 months
• Still having the same symptoms and now spreading to other sites
• Pressure pain threshold lower—Quantitative Sensory Testing
• Not tolerant of cold or heat
• Hyperalgesia in region of injury
• Abnormal movement

BRAIN CHANGES

• Persistent pain, immobilization and inflammation causes cortical reorganization
• Impaired 2 point discrimination.
• Inability to identify R from L
• Shrinkage of Cortical Representation of affected limb.
• Smudging
• Fear of Moving

HOMUNCULUS
Smudging
Brain areas normally devoted to specific body parts or functions start to overlap. In the motor cortex this may make it more difficult to isolate and move that body part, in the sensory cortex too sensitive to move, perhaps as protective strategies.

CASE STUDY 1

• 60 year-old active, r hand dominant female
• 5 months out from distal radius fracture
• Hand and wrist swollen, colder to touch, color changes
• Cold temperature increases pain
• Unable to tolerate any material on the dorsum of the hand especially over dorsal sensory radial nerve

CASE STUDY 1 (continued)

• Limited ROM, will not actively do ulnar deviation because of increasing symptoms
• McGill Pain Questionnaire - VAS and self-report of pain
• I don’t want to move because it will hurt. Fear of movement - Tampa Kinesiophobia Scale
TAMPA KINESIOPHOBIA SCALE

Where's the problem

Central Sensitivity
- Peripheral nerve sensitization
- Central sensitization

- Treating the peripheral symptoms didn't work

Treatment
- Neuroscience education
- Calm CNS-mindfulness
- Get nerve gently sliding and gliding
- Overcome fear of movement-educate and mirror therapy
- Non-exhausting exercises
- Desensitizing of hypersensitive areas
IT’S NOT ALL ABOUT THE HAND

DOUBLE CRUSH PHENOMENON

Definition:
General term referring to the coexistence of dual compressive lesions along the course of the nerve

Study 1972 by Upton and McComas:

- Proximal or distal compression CAN SET UP A NERVE for additional changes
- Nerve compression at one point along the nerve renders both distal and proximal sites less tolerant of effects of compression.

PERIPHERAL NERVE ENTRAPMENT

Double crush injury:
- Entrapment in more than one site of the peripheral nerve
- Not commonly diagnosed; often contributes to poor outcomes from distal surgeries
- Proximal entrapment can cause distal symptoms or vice versa
- Each entrapment site can have equal or greater/lesser compression than the next
- Many times a double crush injury is discovered by the OT / PT
**CLINICAL EXAMPLE**

- Patient undergoes nerve release and still has the same symptoms after surgery, or gets relieve for a few days then symptoms come back or symptoms continue to increase with time.

- Schmid and Coppieters (2011) reported on mechanisms that may cause double crush.

- **ALWAYS EVALUATE THE ENTIRE UPPER EXTREMITY, NECK AND SPINE. REGIONAL INTERDEPENDENCE**

**CLINICAL EXAMINATION CERVICAL RADICULAR SYMPTOMS**

- 3 Special tests
- Reflexes—muscle unit supplied by single nerve, involuntary response to a sensory input
- Myotomal—muscle unit supplied by a single nerve root
- Dermatomal—nerve supplied by a single spinal root
- Upper limb Neuro-dynamic test

**CERVICAL SCREEN**

- Rule in or rule out cervical symptoms such as nerve root impingement or disc
- Examination will lead you down the path
- Check cervical ROM
- Check for cervical thoracic mobility and other spinal dysfunctions
- Evaluate soft tissue and muscles imbalances
- Evaluate nerve sliding and gliding
RED FLAGS

• Hoffman’s Test determines if there is an upper motor neuron pressure of spinal cord so have more hyperreflexia
• Test is noxious stimuli to middle finger and nail bed
• Positive-thumb and finger flexion is abnormal and compare sides
• Rotation impaired(20%) and muscle spasm think C2 fracture

EVALUATION
(CERVICAL RADICULOPATHY)

• History and Exam
  – Gradual or acute onset differs from patient to patient-neck pain/radiating arm pain
• Cervical Spine = ROM  – AM stiffness
• Cervical Compression-
  – Spurling’s Test
  – Cervical Distraction Test
  – Range of Motion Test
  – ULNT

PATHOPHYSIOLOGY
NEURAL ENTRAPMENT

• Radiculopathy - impingement and inflammation of a nerve root induced by a space-occupying lesion the decreases the size of the foramen
• Peripheral entrapment- compression of a nerve through-out its course

NEURAL ENTRAPMENT

• Radiculopathy - impingement and inflammation of a nerve root induced by a space-occupying lesion the decreases the size of the foramen
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Cervical Radiculopathy

SYMPTOMS

- Pain
- Numbness
- Weakness
- Paresthesia

- C4/5 and C5/C6-Bicep Weakness and dermatome numbness, positive reflex

Spurling's Test
Foramen Encroachment
SPURLING’S TEST

• The patient is seated and the neck is passively side bent toward the symptomatic side.

• The therapist applies approximately 7 kg (15.4 lbs) of force through the patient’s head with a caudally directed force.

• Positive if reproduction of the patient’s upper extremity symptoms

SPURLING’S TEST

• Put pressure on posterior lateral complex – articular pillars, facets and neural-foramina

• Could be a ligament, tendon, muscle guarding, tumor, or nerve root impingement

• Look for radicular pain down the arm

NECK DISTRACTION TEST

• The patient is positioned supine and the therapist grasps under the patient’s chin and occiput.

• The therapist flexes the neck to patient comfort and then applies a distraction force of approximately 14 kg.

• Positive with reduction or resolution of the patient’s upper extremity symptoms.
CERVICAL RANGE OF MOTION TEST

• Positive if less than 60% of opposite side

BRACHIAL PLEXUS (ULNT)

RESEARCH WAINNER ET AL 2003

• Positive Spurling – aggravates symptoms
• Positive Distraction – reduces symptoms
• Ipsilateral cervical Rotation < 60 degrees
• Upper limb Neurodynamic test-median

• Specificity -2. positive .56
  3. positive .94
  4. positive .99
TREATMENT IDEAS

• Calm CNS- yoga, mindfulness, breathing
• Soft tissue and fascial changes
• Cervical and thoracic mobilization
• Normal movement patterns -sensorimotor
• Ergonomics
• Neck stabilization exercises, mobility and endurance (deep neck flexors-longus colli) do not strengthen SCM

THORACIC OUTLET SYNDROME (TOS)

• Pressure in the thoracic outlet/inlet can cause nerve compression or traction.
• INTERSCALENE TRIANGLE AREA BETWEEN ANTERIOR AND MIDDLE SCALENE
• COSTOCLAVICULAR SPACE BETWEEN RIB AND CLAVICLE
• UNDER THE PECTORALIS MINOR MUSCLE
PATHO ANATOMICAL CAUSES OF TOS

Other Causes:
- Congenital bony structures
- Fibro-muscular anomalies
- Postural deviations elevated rib
- Muscle imbalances — scapula drops
- Trauma can produce muscle spasm, inflammation and fibrosis
- Myofascial trigger points
- Cervical rib
- Forward shoulders
- Poor posture
- Fracture of the first rib

TYPICAL NEUROGENIC COMPLAINTS

- Paresthesia
- Numbness
- Pain
- Hand weakness, cervical rib, atrophy and EMG showing axon compression

Based on interpretation of the history, symptoms and clinical examination
CLINICAL PRESENTATION OF TOS

- Numbness/tingling in ring and small finger
- Paresthesias occurs at night and/or during daily activities
- Vague pain in uninvolved extremity can occur in
  - Hand
  - Elbow
  - Shoulder
  - Cervical spine
- Subjective complaints of hand/arm weakness
  - Especially with arms raised overhead
- Complaints of swelling in the absence of true swelling

PROVOCATIVE TEST

- Adson Test
- Wright's Test
- Roos Test
- Cyriax Release Test
- Elevated arm stress test
- Costoclavicular Test
- Elevated First Rib Test
- Upper Limb Neurodynamics Test

EAST-ROOS TEST
(test is positive if patient shows signs of compression TOS)
LINDGREN TEST

• Positive test: Limited mobility

CERVICAL ROTATION LATERAL FLEXION TEST (LINDGREN)

• Passively Rotate the cervical spine to the contralateral side and then maximally side bend in the sagittal plane.
• A reduction in side bending mobility is suggestive of an elevated first rib on the side opposite from which the side was rotated.

LINDGREN TEST

https://youtu.be/U7ZRo09Vn04?t=6
TOS
THREE PHASES OF TREATMENT

❖ Control of symptoms
❖ Restorative
❖ Functional rehabilitation

TREATMENT DIRECTED TOWARDS ALTERING NOT ELIMINATING SYMPTOMS

FIRST RULE OF TREATMENT

❖ Patient must own it and understand their symptoms

EDUCATE  EDUCATE  EDUCATE

TREATABLE FUNCTIONAL CAUSES

• Poor posture
• Abnormal breathing patterns
• Cervical and thoracic dysfunction
• Muscle imbalances and trigger points
• Shoulder pathologies
• Movement patterns
• Spine and Joint dysfunctions
CONSEQUENCE OF TIGHT MUSCULATURE

PROBLEMS WITH SCAPULAR DEPRESSION

- Turns on or increases sensitivity of CNS
- ROM limited
- Muscle guarding – scalenes and SCM
- Gentle nerve gliding

- SCAPULA UP AND RIB DOWN

GOALS FOR BOTTOM-UP TREATMENT

- Educate and empower patient
- Set small goal and give patient control
- Treat the entrapment sites-soft tissue, postural changes, nerve gliding limitations, and abnormal movement patterns
- Get rib and joint mobility – GHJ, SCJ, ACJ, CT junction, spine and T4 mobility
- Slow progression but it will happen
**TOS TREATMENT BOTTOM UP**

- Nociceptive and neurogenic treatment
- Evaluation and examination – upper quadrant screen
- Treat abnormal impulse generators
- Patient education
- Treatment priority - entrapment

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**ACUTE RADIATING TOS SYMPTOMS**

- Mindfulness, relaxation, deep breathing - CALM
- Educate - pts expectation of pain and movement
- Decrease muscle guarding
- Mobilization of first rib
- Scapular alignment
- Movement

- BIOPSYCHOSOCIAL APPROACH

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**TOS TREATMENT TOP DOWN**

- Central Sensitivity treatment
- Educate on pain processing system
- Relaxation, Mindfulness-calm nervous system
- Proper breathing
- Focus on ways to improve proprioception
- Good movement patterns
- Ways to conserve energy
TOS CENTRAL SENSITIVITY TREATMENT

- Cognitive Behavioral Training and Relaxation
- Do not focus on pain
- Patient must be empowered to take responsibility – They can’t forget this
- Concentrate on the positives
- Team approach is necessary - Communication
- Stress good neuroplasticity in movement
- Program is based on Neuromuscular principles
- Decrease strain and abnormal movements of upper quadrant

ENTRAPMENT POINTS OF MAJOR NERVES OF THE UPPER EXTREMITY

<table>
<thead>
<tr>
<th>MEDIAN</th>
<th>ULNAR</th>
<th>RADIAL</th>
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<tbody>
<tr>
<td>Ligaments of Struthers</td>
<td>Arcade of Struthers</td>
<td>Spiral groove of humerus</td>
</tr>
<tr>
<td>Bicipital Aponeurosis</td>
<td>Post. to medial epicondyle</td>
<td>Lat. intermuscular septum</td>
</tr>
<tr>
<td>Pronator teres</td>
<td>Cubital tunnel</td>
<td>Supinator</td>
</tr>
<tr>
<td>FDS bridge</td>
<td>Guyon’s canal</td>
<td>Arcade of Frosh</td>
</tr>
<tr>
<td>Carpal Tunnel</td>
<td></td>
<td>Distal lat. forearm</td>
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</tbody>
</table>

ENTRAPMENT POINTS OF MAJOR NERVES OF THE UE

- Median Nerve (C6,7,8,T1)
  - Ligaments of Struthers
  - Bicipital Aponeurosis
  - Pronator Teres
  - FDS bridge
  - Transverse Carpal Ligament
**Common sites of compression**

- Ligament of Struther’s (not everyone has this)
- Lacertus Fibrosus – thickened band of tissue across the median nerve at the elbow
- Pronator teres muscle – between the two heads of this muscle
- Proximal edge of the Flexor Digitorium Superficialis
- Under transverse carpal ligament
MEDIAN NERVE

PRONATOR SYDROME

- Aching pain in volar forearm
- Paresthesia and decreased sensibility (mild)
- Tenderness and Tinel's over muscle belly
- No nocturnal signs

PROVOCATIVE TESTS

- Ligament of Struther's, bicep aponeurosis or Lacertus Fibrosis reproduction of symptoms with flexion of the elbow against resistance between 90° to end range supinated
- Pronator teres - reproduction of pain with resisted pronation of the forearm with the elbow extended
- Flexor digitorum superficialis arch – isolated resisted flexion of the middle finger PIP (superficialis muscle)
- Tinel's sign positive over the mid-forearm region
Median Nerve

PROVOCATIVE TESTS

- Biceps fascial restrains – reproduction of symptoms with flexion of the elbow against resistance between 120-135°
- Pronator teres—reproduction of pain with resisted pronation of the forearm with the elbow extended
- Flexor digitorum superficialis arch – resisted flexion of the middle finger superficialis muscle
- Tinel’s sign positive over the mid forearm region

PRONATOR SYNDROME

- Causes of Pronator Syndrome
  - Frequent repetitive pronation/supination actions
  - Forceful repetitive or sustained grasping patterns (writing)
  - Direct trauma (direct blow, carrying heavy objects on the forearm)
  - Anterior displacement of the proximal radial head (fracture)
**PRONATOR SYNDROME THERAPY (NON-SURGICAL)**

- Rest through splinting – neutral forearm splint not allowing forearm rotation
- Soft tissue stretching of finger, wrist & elbow flexors
- Deep tissue massage of the pronator muscle group to decrease pain and increase soft tissue mobility
- Modalities including: heat to prep for soft tissue massage and exercises, ultrasound, cryotherapy and laser
- Nerve gliding exercises
- Progressive strengthening program to hand, wrist and forearm when symptoms significantly decrease
- Retrain the brain

**PRONATOR SYNDROME VS AIN**

- **Things to investigate:**
  - Unable to perform tip to tip of thumb and index finger due to weakness – demonstrates unusual pinch of hyperextension of the thump IP & index DIP joint (Q sign)

**AIN SYNDROME**

*Anterior Interosseous Nerve*

- FPL
- FDP

  Loss of IP thumb flexion
  Loss of DIP flexion index
CARPAL TUNNEL

- Compression under wrist
- Transverse carpal ligament
- Pain and paresthesias in median
- Nerve distribution
- Symptoms increase with repetitive hand or wrist movements
- Night pain is worse

CARPAL TUNNEL

- Risk Factors
  - Diabetes
  - RA
  - Hormonal dysfunction
  - Past fractured bone
  - Tumor
  - Obesity

CARPAL TUNNEL SENSIBILITY EVALUATION

- Light moving touch
- Vibration thresholds
- Cutaneous pressure thresholds
- Two-point discrimination
- Dexterity

- Manual muscle test
- Resisted external rotation and scratch test

Consider CNS Involvement

Elisabet Hagert, MD PhD
Karolinska Institutet – Sweden
2014
CARPAL TUNNEL COMPLEX ISSUES WITH A SIMPLE CONDITION

- Testing
  - Sensation disturbance
    - Decrease light touch, pain in volar thumb
  - Motor disturbance
    - Weakness and atrophy
    - ABD pollicis brevis
    - Opponens
    - Lumbricals
    - Decrease in grip, pinch and endurance
    - Clumsy
    - Rule out dystonia

- Ergonomic Education
  - Use correct tools and seating
  - Avoid long periods of vibration and cold
  - Adjust work area so posture is correct
  - Computer wrist rest
  - Stretch often at worksite
### CARPAL TUNNEL SYNDROME
**CONSERVATIVE PROGRAM**

<table>
<thead>
<tr>
<th>Splints</th>
<th>Nervous System Mobilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>– wrist in neutral position and MPJ supported&lt;br&gt;– Nightly – until seen by MD&lt;br&gt;– Daily – 2-6wks&lt;br&gt;– Do not splint for too long</td>
<td><strong>Tendon Gliding</strong>&lt;br&gt;– 4 positions</td>
</tr>
<tr>
<td><strong>Splint Goals</strong>&lt;br&gt;– Prevent end range wrist&lt;br&gt;– Minimize pressure in carpal canal&lt;br&gt;– Prevent lumbricals entering the canal so keep MPJ in an extended position</td>
<td><strong>HVPDC</strong>&lt;br&gt;– Decrease edema</td>
</tr>
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<td><strong>Nervous System Mobilization</strong></td>
<td><strong>Instrument Assisted Soft Tissue Mobilization (IASTM)</strong></td>
</tr>
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<td><strong>Tendon Gliding</strong></td>
<td><strong>Postural Correction</strong>&lt;br&gt;– Scapular retraction&lt;br&gt;– Cervical chin tucks&lt;br&gt;– Lumbar support</td>
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<td><strong>Education</strong></td>
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### CENTRAL SENSITIZATION

**SIGNS FOR MEDIAN NERVE CENTRALIZATION**

- Allodynia, hyperalgesia, cold intolerance, persistent pain, abnormal movement,
- Symptoms spread
- PPT

### DIFFERENTIAL DIAGNOSIS FOR MEDIAN NERVE

- Cervical radiculopathy<br>  – Spurling’s Test
- Rotator cuff
- Medial epicondylitis
- Carpal Tunnel<br>  – Phalens – increase carpal tunnel pressure<br>  – Tinel’s<br>  – Reverse Phalen – end range wrist extension (distal portion on stretch)
TREATMENT FOR MEDIAN NERVE

- Activity modification-
  - Avoid vibration
  - End range sustained posture
  - Temperature – extreme
  - Repetitive motion of hand and wrist
- Tendon gliding – all 4 positions nerve mobs
- Graded Motor Imagery Program or Mirror Therapy

ASSESSMENT

NERVE MOBILIZATION

- Sliders and Tensioners
  - Slider is a GENTLE movement where tension is placed at one end of the system and slack is at the other end.
    - Sliders provided a large amount of neural movement and are a neural nonaggressive movement for anxious or more acute patients
  - Tensioner can be a vigorous technique that pulls from both ends of the nervous system
NERVE GLIDING

SLIDING (FLOSSING) AND TENSIONING TECHNIQUES

- Large amplitude movements, passive or active, and can be integrated into postures or dance – distract
  - Reduces sensitivity and restores function
  - Eases the threat value of the injury
- Minimizes potential for ion channel upregulation in dorsal root ganglion and CNS
- Novel ways to uncouple learned expectations of pain – decrease fear of movement

NEURO ORTHOPAEDIC INSTITUTE (NOI) (AUSTRALIA)

- Sliders
  - Nonaggressive movement helps decrease anxiety in anxious patients
  - Allows for gentle neural movement
- Tensioners
  - Somewhat aggressive movement
  - Pulling from both ends
WHEN IS A NEURODYNAMIC TEST POSITIVE

- Structural differentiation when the symptoms differ from involved to uninvolved
- Finding – relevant pathobiological process
- Are symptoms primary or secondary hyperalgesia
- Remember- Neurodynamics is another avenue to travel to get the most optimal outcomes

UPPER EXTREMITY NEURODYNAMIC

- Neck lateral flexion – away from painful side
  - Neural effect – takes all slack up from nerve roots to hand – tension in scalenes
  - Normal response – moderate pain and limitation
  - Positive response – decrease ROM with immediate symptoms increasing

MEDIAN NERVE ULNT

- Active and passive test depending on symptoms
- Passive- side bend head away
  - Gentle depression shoulder
  - Supination
  - Abdution
  - Elbow extension and ext rotation
  - Wrist and finger extension
ENTRAPMENT POINTS OF THE MAJOR NERVES OF THE UPPER EXTREMITY

- Ulnar (C8, T1)
  - Arcade of Struthers
  - Posterior to medial epicondyle
  - Cubital tunnel
  - Guyon’s Canal

ULNAR NERVE

• Potential sites of compression

  Arcade of Struther’s: ulnar nerve passes into the post. compartment proximal to the elbow
  Anconeus Epitrochlearis: this muscle directly transverses the ulnar nerve
  Medial head of the triceps (forces ulnar nerve anteriorly around the medial epicondyle with triceps contraction)
  Flexor Carpi Ulnaris: ulnar nerve passes between the two heads of this muscle and at the wrist between hook of hamate and pisiform.

POTENTIAL SITES OF COMPRESSION OF THE ULNAR NERVE
ULNAR NERVE
CUBITAL TUNNEL SYNDROME

- Ulnar nerve compression at the elbow is the 2nd most common entrapment neuropathy of the upper extremity after carpal tunnel (median)
  - The cubital tunnel is a passageway through which the ulnar nerve passes in the medial elbow region
  - The tunnel begins just posterior to the medial epicondyle and is between the epicondyle and the olecranon

CUBITAL TUNNEL SYNDROME

- Causes of cubital tunnel syndrome
  - Acute trauma causing inflammation within the cubital tunnel irritating the ulnar nerve (severe blow to the medial elbow)
  - Fracture of the medial epicondyle or olecranion region - changes the alignment or carrying angle of the joint; can narrow the cubital tunnel and compress the ulnar nerve
  - Chronic compression of the nerve from pressure on the elbow or over stretching the nerve from repetitive or sustained elbow flexion

CUBITAL TUNNEL

Cubital Tunnel Syndrome Pain
CUBITAL TUNNEL SYNDROME

– The cubital tunnel is round in extension but narrows with flexion
– Elbow flexion at 90° and beyond causes threefold increase in pressure within the cubital tunnel
– When the wrist extension and shoulder abduction are added to elbow flexion, the pressure increases six fold

CUBITAL TUNNEL SYNDROME

### Symptoms of Cubital Tunnel Syndrome:
- Most frequent complaints: burning, tingling and numbness of the ring and small fingers
- Vague pain, cramping and achiness in the C8-T1 distribution or in the medial aspect of the elbow radiating up the elbow posteriorly and down the ulnar aspect of the forearm
- Ulnar nerve hand intrinsic muscle wasting including:
  - Hypothenar muscles
  - 3rd & 4th lumbricals
  - Palmar and dorsal interossei (especially 1st dorsal interossei)
  - Deep head of the flexor pollicis brevis
  - Adductor pollicis
CUBITAL TUNNEL SYNDROME

- Symptoms of Cubital Tunnel Syndrome (con’t)
  - Symptoms are generally aggravated by repetitive and/or prolonged elbow flexion of 90° or more
  - Increased symptoms when resting the elbow on a table or hard surface
  - There may be decrease lateral pinch, decreased grip strength and clumsiness of the hand
  - Decreased or absent sensation of the ulnar nerve distribution in the hand may be present

- Evaluation for cubital tunnel
  - Sensory assessment – watch for decreased sensation in the ulnar half of the 4th and all of the 5th finger volar and dorsal
  - Assess A/PROM of the UE
  - Grip and lateral pinch strength – Jamar dynamometer comparing hand- watch for Froment’s sign with lateral pinch
  - Manual muscle test to the ulnar supplied muscles-noting weak muscles
CUBITAL TUNNEL SYNDROME

- Provocative tests for cubital tunnel syndrome
  - Elbow flexion test: hold the elbow in maximal flexion for 5 minutes, wrist needs to be neutral
  - Positive test – reproduces symptoms or causes sensory changes in the ulnar nerve distribution
  - Tinel's sign over the cubital tunnel region (test bilaterally)

CUBITAL TUNNEL SYNDROME

- Provocative tests for cubital tunnel syndrome
  - Froment's sign- unable to achieve true lateral pinch
  - Palpation of the ulnar nerve mobility at the medial epicondyle – should not be able to sublux the nerve out of the groove (test bilaterally)
  - Wartenberg's sign-abduction of the small finger

FROMENT’S SIGN

ULNAR NERVE

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Therapy for cubital tunnel syndrome (con’t)

- Day use splinting may be necessary for significant pain and tingling/numbness or soft elbow pads during work/home tasks
- Stretching program for shortened muscles (pronators, finger and wrist flexors)
- Modalities: heat, cryotherapy, US, E-stim, iontophoresis, laser or HVDC
- Strengthening program to the UE when symptoms decrease
- Ulnar nerve gliding exercises
- Graded Motor Imagery Program
SURGICAL APPROACHES FOR CUBITAL TUNNEL

- There are basically 3 common surgeries performed to relieve compression of the ulnar nerve
  - Decompression- eliminate the “roof” of the tunnel
  - Medial epicondylectomy – eliminate the “side” of the tunnel
  - Transposition- remove the nerve from the tunnel

GOALS OF THERAPY:

- Early controlled ROM
- Nerve gliding exercises
- Edema control – elevate and move hand and wrist gently
- Pain management – GMIP
  - anti-inflammatory medication and ice
- Tendon mobility/ soft tissue mobility
- Scar mobility

GOALS OF THERAPY:

- Desensitization of dermis and scars
- Splinting-long arm splint and/or soft elbow pads
- Modalities
  - to decrease pain & edema
  - increase soft tissue mobility
- Strengthening exercises
- Enhance ADL's and work tasks
- Patient education
ULNAR NERVE TRANSPOSITION

ULNAR TUNNEL

- **Symptoms** - Numbness, tingling and paresthesia of the ulnar nerve and artery

**GUYON’S CANAL SYNDROME**

- **Ulnar nerve compression at the wrist**
  - The Guyon’s tunnel lies at the level of the proximal carpal bones along the ulnar border
  - The ulnar and radial borders consist of the pisiform and hamate bones
  - The transverse carpal ligament forms the floor of the tunnel with the tendinous insertion of the flexor carpi ulnaris muscle forming the roof
Ulnar Nerve Compression at the Wrist

- The superficial and deep palmar branches of the ulnar nerve run in the ulnar tunnel.
- The superficial branch of the palmar branch innervates the palmaris brevis muscle, the palmar skin of the 5th finger and the ulnar skin of the 4th finger.
- The deep branch innervates the hypothenar muscles, the two lateral lumbrical, all the interossei muscles, the adductor pollicis muscle and the deep head of the flexor pollicis brevis muscle.

Guyon’s Canal Syndrome

Treatment

- Conservative treatment remains the 1st line in treating ulnar nerve compression in the Guyon’s Canal.
- Trials of conservative therapies should not be continued indefinitely (prolonged compression may lead to permanent nerve damage).
- Conservative treatment may take up to 6 months, absence of relief by 6 months, should be surgically treated without delay.
- Avoidance of repetitive trauma, rest immobilization (splinting), local corticosteroid injection and anti-inflammatory medication may be tried individually and in combination to achieve relief.
ULNAR NERVE – ULNT (SHOULDER FIRST)

- Starting position - supine
- With hand under patient’s scapula, depress shoulder girdle –load BP and lower cervical nerve roots
- Shoulder abduction to tissue tightness
- Lateral rotation of shoulder
- Elbow flexion
- Wrist and finger extension
- Forearm pronation – hypothenar and little finger pain

ULNAR NERVE GLIDING

Scratch Collapse Test

- Another test to see if more then 1 area of a nerve is compressed.
ENTRAPMENT POINTS OF MAJOR NERVES OF THE UE

- Radial Nerve (C5,6,7,8, and T1)
  - Spiral groove of humerus
  - Lateral intermuscular septum
  - Supinator
  - Arcade of Frohse
  - Distal lateral forearm
**RADIAL TUNNEL SYNDROME**

- Symptoms of Radial Tunnel Syndrome
  - Aching pain in the wrist extensor/ supinator muscle mass
  - Complaints of weakness and pain with grip tasks and wrist/finger extension
  - Symptoms occur with exertion and may become worse at night but absent upon awakening
  - Pain can mimic lateral epicondylitis — often missed diagnosed
  - Symptoms generally radiate down from the elbow to the wrist — due to sensory entrapment of the nerve

- Causes of Radial Tunnel Syndrome
  - Exacerbated by repetitive forearm rotation – twisting
  - Compression enhanced by passive wrist flexion with forearm pronation or with active wrist extension and forearm supination against resistance
  - Repetitive elbow extension
**RADIAL TUNNEL SYNDROME**

- **Common sites of compression**
  
  - Arcade of Frohse - forms a ligamentous band over deep radial nerve as it enters the supinator muscle (most common site of compression)
  
  - Fibrous bands lying anterior to radial head at entrance to the radial tunnel
  
  - Extensor carpi radialis brevis origin

- **Provocative tests for radial tunnel syndrome (no motor weakness)**
  
  - Resisted forearm supination with elbow extended
  
  - "Middle finger test" in which resistance is applied to proximal phalanx of middle finger with elbow extension and neutral wrist-transmits force to the ECRB which forms the lateral edge of the tunnel
  
  - Full elbow flexion, forearm supination and neutral wrist position – hold for 1-2 minutes; can reproduce symptoms if compression by fibrous band
  
  - Passive pronation of forearm with elbow 45-90° of flexion with full wrist flexion (ECRB compression)
  
  - Passive elbow extension, wrist flexion and finger flexion

- **Therapy for radial tunnel (non-surgical)**
  
  - Soft tissue mobilization to extensors to increase mobility and decrease pain with activity
  
  - Desensitization – fluidotherapy, textures, vibration
  
  - Radial nerve mobilization to increase neural gliding – gentle with elbow flexed
  
  - Edema control – retro grade massage
  
  - Modalities: heat prior to soft tissue/nerve mobilizations, iontophoresis, ultrasound, ice massage
  
  - Splinting: wrist extension immobilization splint at 25-30° of wrist extension. To be worn continuously for 6 weeks – to help prevent forceful wrist extension or thumb spica
  
  - Begin hand strengthening exercises when symptoms decrease: hand helper, gripper putty, etc. Gradually incorporate wrist and forearm strengthening
DORSAL SENSORY RADIAL NERVE

SUPERFICIAL BRANCH OF RADIAL NERVE

- Symptoms
  - Pain in forearm
  - Numbness & painful paresthesia of back of hand
- Clinical signs
  - Local tenderness in area of "snuff box"
  - Condition often misdiagnosed as deQuervain's
- Special tests – Finkelstein
- Subjective history
  - Direct blow to forearm
  - Tight cast or watchband
  - Handcuffs

TREATMENT

- Splinting – rarely used (sometime thumb spica)
- Soft tissue massage – superior and exterior stretch
- Edema control and desensitization
- Shoulder and scapula stability
- Radial nerve gliding
  - Do not aggravate. Start in most protected position
  - Elbow flexed – extension – pronation – shoulder abduction with ulnar deviation
  - GMIP for central sensitization
**TREATMENT**

- Activity modification
  - Remove watchband
  - Avoid repetitive wrist extension and forearm rotation
  - Use palm up lift with 2 hands
  - Adjust tools and work site
  - Job rotation and exercise breaks

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**Differentiation Between**

- **Sensory** – Radial Nerve Forearm (no paresthesia)
  - Radial Tunnel Syndrome

- **Motor** – Posterior Interosseous Nerve Syndrome

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**Radial Tunnel Syndrome**

- Pain only symptom
- No motor weakness
- Lateral arm proximal pain at rest and night pain is distal to extensor origin overlying the supinator

**Posterior Interosseous Nerve Syndrome**

- Weakness in EDC, EDM, EIP, EPB, EPL, APL
- Wrist deviates radially with weakness ECU
- Slight supinator muscle

**Lateral Epicondylitis**

- Tenderness and pain overlying
- Increased pain with resisted wrist extension
- Increased pain with middle finger extension
EDUCATION

- “Knowledge is de-threatening gives meaning to symptoms, provides explanation, helps with compliance, allows problem solving, goal setting and progression of treatment.”


UPPER EXTREMITY NERVE ENTRAPMENT TREATMENT

- History and physical exam
- Treat BOTH peripheral and central symptoms
- Calm down sympathetic nervous system, breathing, yoga, mindfulness, imagery
CONSERVATIVE MANAGEMENT FOR NERVE ENTRAPMENTS

- Decrease pressure around the nerve by improving muscle length and fascial mobility
- Motion is lotion get the nerve moving
- Activity Modification
- Use orthoses or splints as needed for short periods of protection
- Taping

CENTRAL SENSITIZATION

- Educate, Educate, Educate: pt must understand pain is a brain output. All components of Bio-psycho-social approach using the new pain matrix must be presented. Make sure they understand central sensitization.
- Calm down sympathetic tone: breathing, relaxation
- Start with mirror therapy or graded motor imagery to not fire pain neurotags
- Exercises must be paced and manageable
- Movement is not harmful to the body or brain
- Don’t use the P word, no dwelling on symptoms
- Treatment is managing their symptoms not curing their symptoms. Progress may be slow
- Goal: Reinforce the emphasis on Quality of life and improving function

EVIDENCE TO TREAT CENTRAL SENSITIZATION

- Unexplained chronic musculoskeletal pain
- Change maladaptive illness perception
- Education on physiology of pain: Pain is in the Brain and is an Output
- Bio-psycho-social approach
- Continuous process in educating and answering questions

Nijs J, Manual Therapy, 2011
PLAN OF CARE

Nociceptive or Neurogenic
• Pharmacologic agents
• Treat symptoms and tissue-physical agents
• Manual techniques
• Splints or orthotics
• Exercise
• Neuromuscular retraining

Promote Tissue Healing

Central Sensitivity
• Education first
• Neuromuscular retraining
• Graded Motor Imagery
• Cognitive and Behavioral
• Psychological Assistance
• Pharmacologic Agents

Treat Peripheral Pain Inputs

PAIN NEUROMATRIX

TOPDOWN TREATMENT

• Contribution of CNS
• Cognitive reeducation
• Neuroplasticity
• Cortical Reorganization
REWIRING THE BRAIN

Susan W. Stralka PT,DPT,MS

THE BRAIN HAS CHANGED
CORTICAL REORGANIZATION

BRAIN PLASTIC
REVOLUTION
NEUROIMMUNE ERA

GRADED MOTOR
IMAGERY

• One method that has been used to activate Cortical Network Representations

• Theory:
  – Reconciles motor output and sensory feedback (Ramachandran 1995)
  – Activates pre-motor cortices which is associated with activation of the visual processing areas. (Seitz 1998)
THE CLINICAL APPROACH GMI FOCUSES ON:

• Decreasing all inputs that imply that body tissue is in danger
• Then activating components of the pain neuromatrix without activating its pain output
• Rehabilitation progresses to increase exposure to threatening input across sensory and non-sensory domains.


CNS CHANGE DURING REHAB

• Drive changes with learned based training
• Neural adaptation varies
• Ability to change
• Balance excitatory and inhibitory
• Good information in and good information out
• Anatomy physiology, neural transmitter, hormones, personality, motivation – 
  MUST work together

GRADED MOTOR IMAGERY PROGRAM (GMIP)

Convince patients in a non-threatening way that they can move

Laterality  ➔ Imagery  ➔ Mirror Therapy
LATERALITY TRAINING OR RECONSTRUCTION

Recognise® Limb laterality recognition program. Developed and published by Noigroup Publications. www.noigroup.com

GRADED MOTOR IMAGERY

• Brain reeducation
• Exercise for Synapses
• Target the activation of different brain regions

• GOAL: Uses Brains ability to adapt without setting off pain. Don’t fire non wanted areas such as pain neurotags
GRADED MOTOR IMAGERY

Top Down Training

- Laterality stimulates premotor areas
- Visual imagery used for relearning cognitive and planning aspect of movement
- Mirror and motor imagery used to re-educate or retrain the brain for basic motor skills by concentrating on the non-painful movement
- Smooth and controlled movements must act as example for brain to reset circuitry that mediates voluntary movement

GMIP-REWIRING THE BRAIN

- Laterality Training or Reconstruction
  - Restoration of brain's concept of left and right
  - When you look at someone's hand, try to imagine your hand in that position.
- Imagery
  - Conscious access to brain which are involved in intention, preparation and then carrying out the movement
- Mirror Therapy
  - The brain is tricked into thinking that the limb is better than the brain thinks it is

LATERALITY RECOGNITION

Laterality is motor imagery, but not actual movement. It takes longer to identify awkward pictures. It is up to the mind to make automatic judgment and then the mind confirms the painful hand which usually increases the time to identify.

Moseley, 2004
Parson, 1987
Parson and Fox, 1998
Sekiyama, 1982
LATERALITY TRAINING

• Patient must understand we are retraining the brain
  – Flash Cards
    • Identify right or left limb
  – Timed identification to monitor improvement
  – Decrease time to look at right or left
  – Room identification for right or left in human subjects
  – Circle pictures in magazine
    • Timed and number of correct answers
  – Two weeks minimum for laterality

LATERALITY TRAINING PROTOCOL USING GMI

•Laterality Training – 20/30 cards, establish the baseline of number of correct and length of time it takes to identify. Continue training at home daily 10 sessions up to 10/15 minutes each session. Have them match cards, use I Pad or I phone picture, or magazines. Continue for 2 week period at home and in clinic.
  • Start with “Plain Vanilla” pictures and move to more difficult pictures with activities in them
  • Keep a diary of patients progress

IMAGERY

• Conscious access to brain
• Think - preparation and carrying out movement
• Imagining or watching an activity
• Start static posture then imagine it moving
**Mental Imagery**
Capacity to imagine objects or events that are not there

**Motor Imagery**
Covert Cognitive
Process of imagining a movement of your own body without actually moving your body

**Movement Observation**
Perception of action of others

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**IMAGERY IDEAS**

- Consider what it feel like to have limb in a certain position then watch others
- Consider what it is like to move or manipulate an object
- Watch others using their extremities, watch DVD’s and TV

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**IMAGERY PROTOCOL USING GMI**

- Imagery – mental representation of static postures first. Then moving postures doing activities.
- Conscious access to the mind using intervention, preparation to carry out movement. Think how this feels.
- Start with imagery of self or use other body parts or another person, if this is too painful or increases symptoms look in magazines.
- Change environment and activates as progress improves
- Six–ten times daily for 10-15 minutes progress with length of imagery as tolerated
MIRROR THERAPY

- Tricks the brain into correcting its distorted image of the body
- Pain results from a mismatch in the way the brain perceives the body and the actual condition of the body
- Brain is tricked into thinking that the limb is actually better than the brain thinks it is
- Affected limb inside box
- Unaffected limb outside box

MIRROR VISUAL FEEDBACK

- Mirror to view healthy limb and reflection of same healthy limb mimics the involved limb
- Told to concentrate hard on the image as if both limbs were normal
- Environment should be non-threatening
MIRROR PROTOCOL USING GMI

- Any mirror will work. Always put the un-involved side in front of the mirror. Remove all jewelry and cover tattoos. Object: Look at the image of the non-involved in the mirror and it looks like the involved.
- View the image in the mirror and look at your hand, wrist, arm and in vision it is your involved one. Start just viewing the extremity and then try movement of non-involved in mirror. Do not attempt movement of involved too soon.
- 6-10 time sessions no longer then 10-15 minute sessions daily for two weeks

TIPS OF THE TRADE

- Graded motor imagery must be graded
- Laterality must show improvement in recognition and speed
- Motor imagery - Imagery first then must start thinking about movement
- Movement of uninvolved limb must not cause pain in involved limb
- Mirror work always starts with involved limb in box or hidden from view

EVALUATION

- Determine the entrapment site or sites
- Specific tests-3 to confirm
- Identify pain mechanisms-nerve is neurogenic and mechanisms are peripheral or central or both
- Neuroscience science education
- Treat Biopsychosocial Approach
THANK YOU

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REFERENCES

Nerve Entrapment