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Session 204: A New Approach for Treatment of Entrapment Neuropathies
Susan Stralka, PT, DPT, MS

THE NERVE IN NEED: NERVE INJURY, REPAIR, AND REHAB

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EVERY NERVE HAS A BRAIN

NEURODYNAMICS AND BIOLOGY OF PAIN

THE BRAIN AND NERVES

• Nerves are the conduits of information that run from the brain to the rest of the body, and vice versa. The upper extremity contains numerous nerves that transmit stimulus for functions such as muscle contraction, sensation, and reflexes. As therapist we must identify all abnormal impulse generators(AIG) in the upper quadrant often resulting in identification of double crush syndromes.
NERVE PAIN

PERIPHERAL NERVE COMPRESSION 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 or conduction change

ENTRAPMENT NEUROPATHIES

- Repeated compression-ischemia, edema formation in sub-endoneural and synovium leading to fibrosis.
- Nerve tethering due to scar tissue leading to reduced gliding and ischemia.
- Localized mechanical pressure from fascia binding scarring, retinaculum cause nerves to be clausatrobic.
ROLE OF THE FASCICLES

- Multiple neural fascicles protect the nerve and the more fascicles slower the conduction, but nerve is less vulnerable.

PRESSURE GRADIENT INCREASES

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

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

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 sixfold
ENTRAPMENT RELATED TO SOFT TISSUE

- Soft tissue adaptation
- Postural malalignments
- Myofascial shortening and lengthening
- Muscle imbalance
- Nerve entrapment
- Functional impairment

CONSEQUENCES OF INJURY

- Inflammation – pain, swelling, redness, heat
- Fluid congestion
- Scarring
- Tissue anoxia
- Narrowing of tunnels
- Loss of neural mobility
- Loss of soft tissue elasticity
- Fibrosis between fascicles
- Fibrosis in the epineurium
- Collagen cross-linking
- Chronic inflammation
PATHOLOGICAL CONSEQUENCE

• **INTRANEURAL** – elongation and tension potential is compromised
• **EXTRANEURAL** - nervous system mobility limited within the nerve bed resulting in symptoms and limitation of motion.

**CLINICAL RESPONSE** – provocation causes symptoms, limited range of motion with reflex muscle guarding
**TREATMENT** – nerve mobilization by gliding a nerve and freeing tissue around a nerve

INFLAMMATION

• Decreased activation threshold of nerve fibers (primary hyperalgesia)
• Awakening of sleeping nociceptors
• Tissue changes – damages due to unhealthy nervous system
• Unhealthy barrage of impulses into CNS
• Causes cortical changes

PERIPHERAL NERVE ENTRAPMENT

• **Anatomical**
  - Nerves may pass through muscles or close to bone
• **Postural**
  - Repetitive motions combined with certain positions
• **Development**
  - Anomalous structures may overfill a space, place a nerve on stretch (1st cervical rib)
• **Inflammatory** – synovitis
• **Traumatic** – fractures
• **Metabolic** – fluid retention
IT’S NOT ALL ABOUT THE HAND

MEDIAN NERVE ENTRAPMENT SITES
- Cervical spine
- Scalene Triangle
- Costoclavicular
- Subpectoral – pectoralis minor
- Lacertus fibrosis-fascial binding
- Pronator teres
- Carpal tunnel
- Motor branches

DOUBLE CRUSH IS NOT A RIDDLE WRAPPED IN A MYSTERY INSIDE AN ENIGMA
CAUSES OF THORACIC OUTLET

- Compression
- Common sites of Compression:
  - Between middle and anterior scalene
  - Between 1st rib and clavicle
  - Under pectoralis minor
  - Traction under the coracoid during arm elevation
- Repetitive Overhead Activity
- Unknown etiology

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, arm
  - Shoulder
  - Cervical and thoracic spine
- Subjective complaints of hand/arm weakness
  - Especially with arms raised overhead
- Complaints of swelling in the absence of true swelling
- All symptoms are variable

DOUBLE CRUSH PHENOMENON

- Proximal level of compression could predispose distal sites to be more sensitive. Example: cervical radiculopathy and median neuropathy, thoracic outlet syndrome with ulnar neuropathy.

Upton and McComas stated that summation of compression along the nerve results in changes in structural and biochemical changes in the nerve cell body, then alterations in axonal plasmic transport thus rendering a nerve more vulnerable to compression neuropathies.
NERVE ENTRAPMENT

Double crush injury: and Multi level crush

- 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
- Each entrapment site can have equal or greater/lesser compression than the next

DOUBLE CRUSH SYNDROME

- 1973-First proposed by Upton and McComas
- 1999-Richardson et al Electrophysiological exploration of double crush
- 2010 Schmidt,Coppieters, Clinicians opinion of double crush survey 528 clinicians – agree with double crush 85% physiotherapist, 51 % hand surgeons 24 % of neurologist
- 2012 Lo, Chous, Meng et al, CTS, Cervical Radicular and Double Crush 26% CTS and Cervical Radiculopathy

DOUBLE CRUSH SYNDROME

- 4 Plausible mechanisms determined by panel 17 experts in 2011
- Impaired axonal transport
- Ion channel upregulation or down regulation
- Inflammation in the spinal cord at dorsal root ganglion
- Neuroma

ULNAR NERVE AND THORACIC OUTLET SYNDROME IN 70 CYCLISTS

- All cyclists had positive ulnar nerve symptoms (ULNT)
- Roos Test or Elevated Arm Stress Test (EAST) and Cyriax release test
- East test and Roos 32% and Cyriax 43%
- Double crush common with ulnar neuropathy and TOS in cyclist


CARPAL TUNNEL SYNDROME AND THORACIC OUTLET SYNDROME—diagnosed by clinical examination

- Clinical examination and electro-diagnostically diagnosed with CTS and TOS
- Case controlled 32 subjects
- Clinical test; NTOS - Roos (EAST)/Cyriax Release test and Lingren Cervical Rotation Lateral Flexion, ULNT, neck and shoulder symptoms,
- Outcome revealed higher number (significantly) with CTS and TOS using the clinical test shown above then controls

Vaught, Brismee, et al. Disturbances in the TOS in Subjects with CTS; Jour Hand Ther. 2011;24: 44-52

RESEARCH

- Wood and Biondi reported on double crush in 42% of cases of TOS, (41 of 165) had CTS.
- CTS 20-45% of TOS
- Cubital Tunnel 10%
- CTS 4-Cervical Radiculopathy
- Cubital Tunnel 3-TOS 3-Ulnar neuropathy Cubital and Guyon Tunnel
- Pronator Syndrome- 1 (biceps rupture repair, pronator signs with cervical radiculopathy – spondylosis)
ABNORMAL IMPULSE GENERATORS (AIG’S)

• Isolated peripheral nerve injuries occurring at specific locates where a nerve is mechanically constricted in a fibrous or fibro-osseous tunnel or deformed by fibrous band as well as soft tissues changes.
• At times the nerve can be injured by direct compression and other instances of angulation or stretching forces causing mechanical damage to a nerve.
• Identify all AIG’S

BOTTOM UP PLAN

• Orthoses, Splints, Taping - protection
• Sensory Reducation
• Neural Mobilization
• Myofascial Mobility and Normal movement
• Activity Modification

• GOOD NEUROPLASTICY

CONSERVATIVE MANAGEMENT

• Patient education and lifestyle modification
• Edema reduction
• Splinting, orthoses, or limb positioning
• Soft tissue and nerve mobilization
• Tendon gliding
• Proximal, distal and trunk strengthening and stabilization
• Spine mobilization
CLINICAL SUCCESS FOR NERVE INJURIES

Understanding both peripheral and central nervous system dysfunction

We can better treat our patients

THE BRAIN: THINGS HAVE CHANGED TOPDOWN TREATMENT

NEURAL MECHANISM BEHIND PAIN

- Nociceptive
- Peripheral Neuropathic-neurogenic
- Central Sensitization
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.

NEUROGENIC PAIN

• Occurs at dorsal horn to distal finger tips
• Reproduce by certain positions and tension
• Can be identified by upper limb tension testing
• Must identify if it is double crush
• Must identify all AIG’S- abnormal impulse generators
• Upper Quadrant exam must be performed

NERVE PAIN

• Produced by the brain based on perception of threat -100%
• Decreased blood flow
• Decreased axoplasmic flow
• Abnormal impulse generators-multiple sites

• PA>PC>PF>PV>PT
PAIN IN THE NERVOUS SYSTEM

Neurogenic – C fibers or nociceptive fibers located in the epineurium which contain Substance P and CGRP.

Strong stretching of the connective tissue around a nerve root activates sensory fibers in the dorsal root ganglion.

The brain determines how to respond to the nociceptive input.

Response to ULNT are reproduction of the patients symptoms and differentiation of the symptoms must be followed a complete clinical exam.

Responses are relevant, irrelevant, subclinical, anomalous, or atypical for that person.

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Responses are relevant, irrelevant, subclinical, anomalous, or atypical for that person.

Shacklock M; Clinical Neurodynamics, 2005

PAIN SYSTEMS

- Sensitive enough to detect harmful stimuli
- Too sensitive causing pain that provides no benefit
- Adaptive response occurs after injury
- Pain pathway increase in sensitivity
- After body has healed no value so manifestation of pathological changes in nervous system

WHY CENTRAL SENSITIZATION HAPPENS

- Starts with changes in dorsal horn of spinal cord following intense peripheral noxious stimuli, tissue damage, nerve damage and inflammation
- These changes causes reduction pain threshold, amplification of pain responses, and spread of pain sensitivity to non injured areas
- These changes occur throughout CENTRAL NERVOUS SYSTEM
Mechanisms of Pain Central Sensitization

- Mediated by peripheral pain inputs such as Nociceptive and neurogenic
- CNS neurons become hypersensitive and fire more readily
- Fire with non-noxious stimuli
- Several top-down and bottom-up mechanisms contributing to the hyper-responsiveness of CNS

BOMBARDMENT OF THE CNS

SOME OF THE MOST DEVASTATING AND LONG-LASTING CHANGES WITH ALLODYNA AND OVERALL PAIN EXPERIENCE (PERSISTENT PAIN) RESULTS FROM BOMBARDMENT OF THE CENTRAL NERVOUS SYSTEM.

C.WOOLF-2007

CENTRAL SENSITIZATION FOLLOWING NERVE INJURY

- Following peripheral inflammation and nerve injury there is a change in some dorsal root neurons causing non-nociceptors to induce central sensitization.
- This results in light touch inducing a progressive tactile pain hypersensitivity which can last for hours.
- Activated microglia in dorsal horn fire thus causing additional neuropathic pain
- All the above changes the somatosensory cortex
Pain Causes Brain Changes

- Impaired 2 point discrimination.
- Inability to identify R from L
- Shrinkage of Cortical Representation of affected limb.
- Smudging
- Fear of Moving

Central Sensitization

Pain related to Altered CNS Circuitry and Processing
- Central Sensitization
- Central Hypersensitivity
Mediated by peripheral pain inputs; nociceptive and neurogenic as well as non painful inputs
CNS neurons fire more readily with
- Non-noxious stimuli
- Stimuli outside the receptive field
- Presence of Abnormal Pain States

PAIN AFTER TISSUES OR NERVES ARE HEALED

- This pain is associated with disruption of a range of body related cortical representation
- Evidence that this disruption maintains pain after the tissue has healed
- This disruption reflects maladaptive neuroplastic change so treatment should be aimed to normalize cortical representation.
Treatment of Central Sensitization

• Treatment targeted to cognitive behavioral, sensory and motor strategies.
• Symptoms; high level pain behaviors with goal of reducing feelings of helplessness and give patient some control.
• EDUCATE, EDUCATE, EDUCATE

SYMPTOMS

Pain out of proportion OR persistent pain (after injury has healed)
Temperature changes
Increased sweating – hyperhidrosis
Discoloration and trophic changes
Abnormal movements
Kinesophobia – afraid of moving
Loss of body schema

CENTRAL SENSITIZATION FOLLOWING NERVE INJURY

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CONDITIONS BOTHERING A NERVE

• Temperature
• Anxiety
• Fear
• Movement restrains
• Immune activity
• Blood flow

• Tissue Inflammation
• Neurogenic inflammation
• The brain
• Central Sensitization

SMART, BLAKE, et al 2012-
CLUSTER OF SIGNS

• Disproportionate pain
• Disproportionate aggravating and easing factors
• Diffuse palpation tenderness
• Psychosocial Issues

ABNORMAL SENSATIONS

• Allodynia
  • Thresholds lower so stimuli that normally wouldn't cause pain now does.

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

Central Sensitization in Carpal Tunnel Syndrome with Extraterritorial Spread of Sensory Symptoms.

Zanette G, Cacciatori C, Tamburin S.

Source: Department of Neurological and Visual Sciences, Section of Rehabilitative Neurology, University of Verona, Verona, Italy


Treatment of Central Sensitization

- Phase One - decrease sensitivity and pain
- Phase Two - move toward function, normal movement and sensation
- Fire non-painful neurotags, don't threaten CNS, trick the brain, use multiple brain areas, restore body schema, use visualization, and view the non-involved limb in a mirror.
- Mirror therapy and graded motor imagery
NEURODYNAMICS

Clinically neurodynamics is essentially the clinical application of mechanics and physiology of the nervous system as they relate to each other and are integrated with musculoskeletal.

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

NERVOUS SYSTEM PRINCIPLES FOR NEURAL MOBILIZATION

- Continuum with central and peripheral tissue connected at the dural sleeve of the spine.
- Nerves are designed to accommodate movement-length of spinal cord is 7cm longer in flexion than extension (cervical and lumbar)
- Protection of peripheral nerves—epineurium, perineural and endoneurial.
- Protection of CNS—meninges
UPPER LIMB NEURODYNAMICS

INDICATIONS
• Any nerve that has ROM limitations and reproduces symptoms.

CONTRAINDICATIONS
• Recently repaired nerve
• Neurogenic inflammation
• Demyelinating Diseases
• Unknown or questionable tumor

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

IRRITABILITY

HIGHLY IRRITABILITY
• Pain at rest
• Significant limitation in ROM
• Easily provoked
• Sleep unrest
• Prolonged Recovery

LOW IRRITABILITY
• None or slight pain at rest
• Slight limitation in ROM
• End range provocation of symptoms
• Sleep ok unless compressing nerve
• Rapid recovery
NEURODYNAMICS

- Nervous system is a continuum (CNS, PNS, ANS)
- Tolerance to tension, stretch, and elongation
- Vascular Flow: 5-10% = 50% decrease in Venule Flow, 11-18% = complete occlusion

NERVE MOVEMENTS

Upper Limb Tension Tests
Consistency in sequencing at each time of testing

- ULTT – median nerve bias - proximal
  1. Shoulder girdle depression
  2. Shoulder joint ABD
  3. Forearm supination
  4. Wrist and finger extension
  5. Shoulder girdle external rotation
  6. Elbow extension

Sensitizing test is cervical lateral flexion away from the symptomatic side and desensitizing test is neutral or lateral flexion towards the symptomatic side.
MEDIAN NERVE - ULNT
- Shoulder Abd and ER
- Forearm Supination
- Wrist and finger extension
- Elbow extension
- Sensitizing movement –shoulder
- ABDUCTION
- Cervical lateral flexion
- Shoulder Girdle Depression
- Shoulder Abd./Ext. rotation
- Forearm Supination
- Wrist and Finger extension
- Elbow Extension

ULNAR NERVE - ULNT
- Shoulder Abd/ER
- Forearm Pronation or Supination
- Wrist and Small finger Extension
- Elbow Flexion
- Sensitizing Motions –shoulder depression and Cervical LF

RADIAL NERVE - ULNT
- Shoulder Abd/IR
- Forearm Pronation
- Wrist/thumb/index Flexion
- Elbow Extension
- Sensitizing Motions-Shoulder Depression and/or Cervical LF
UNDERSTANDING NEUROPLASTICITY AND CORTICAL REORGANIZATION

TOP DOWN - “RETRAIN THE BRAIN”

PAINFUL EXPERIENCES CAN CREATE CHANGE IN THE BRAIN

• Pain memories — through the same mechanisms that enable humans to learn and retain memories

• Pain memories can form through sensitization of the nervous system and is apparent on brain imaging studies.

• The pathways that transport painful stimuli, may change, the structural changes may lead to increased excitation in the brain in the presence of non painful stimulus.
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.
SMUDGING RESEARCH

Reorganization happens quickly - if you place a tourniquet at the elbow, numbing the forearm, the representation of the upper arm will grow into representation of the lower arm in a matter of 20 minutes.
Lundborg, Rosen et al 2005

Four fingers webbed together and smudging in 30 minutes. Lasts 2 hours if webbed for 5 hours
Stavrinou, Della, Penna et al 2006

REBIRTH-IMAGING (fMRI)

What is fMRI?
Functional MRI is based on the increase in blood flow to the local vasculature that accompanies neural activity in the brain (Functional Brain Imagery)

Magnetic resonance imaging can be used to map changes in brain hemodynamics that correspond to mental operations of neural activity as detected by a blood oxygen level dependent signal.

Why Patients Don’t Get Well

• Signs: abnormality of the normal homuncular organization of the representation in primary somatosensory cortex
  - Chronic pain, intermittent and vague symptoms, control problems or somatosensory dysfunction may be early signs of focal dystonia
  - Treatment must consist of discriminative sensory motor skills
  - Top down treatment is necessary GMIP
BRAIN CHANGES

- Understanding the neuroscience and how the brain processes injury, disease, pain threats and emotion.
- Research based confirmation of success.

BIO-PSYCHO-SOCIAL

- TURN ON SYMPATHETIC NERVOUS SYSTEM
- ADRENALINE OUT PUT INCREASES
- INCREASED MUSCLE TENSION
- BREATHING
- GI SYSTEM
- MEMORY
- PSYCHO-SOCIAL ISSUES
- CORTISOL –LONGER LASTING THREATS

CONSEQUENCES OF STRESS THREAT

- TURN ON SYMPATHETIC NERVOUS SYSTEM
- ADRENALINE OUT PUT INCREASES
- INCREASED MUSCLE TENSION
- BREATHING
- GI SYSTEM
- MEMORY
- PSYCHO-SOCIAL ISSUES
- CORTISOL –LONGER LASTING THREATS
ASSESSING OF PAIN PERCEPTION

- COGNITIVE , AFFECTIVE , GENDER , CULTURAL , ENVIRONMENTAL, LIFESPAN
- MANAGE PAIN PERCEPTIONS- EDUCATE, CONTROL, EMPOWER, HEALTHY HABITS
- EDUCATE, CONTROL EMPOWERMENT

5 R’s of Neuroplasticity

- Remapping
- Rewiring
- Reorganizing
- Restructuring
- Regenerating

NEXT STEPS IN CHANGING YOUR BRAIN

- RELABEL YOUR DECEPTIVE BRAIN MESSAGES SUCH AS UNCOMFORTABLE SENSATIONS
- REFRAME CHANGE YOUR PERCEPTION OTHER IMPORTANCE OF THE DECEPTIVE BRAIN MESSAGES
- REFOCUS USE ACTIVITIES AND MINDFULNESS
- REVALUE CLEARLY SEE THE THOUGHTS, URGES AND IMPULSES – DECEPTIVE BRAIN MESSAGES
Strategies to Normalize Sensory Representation

• Stimulus and functional context are important: example changes are induced in sensory cortical representation if the characteristics of the stimuli are important. Task MUST be important to cause change. Reading braille, playing instrument, or unwrapping food.

• Tactile acuity improves when you have to differentiate stimuli during training

Treatment Includes Graded Exposure to Activity

• The patient is gradually exposed to feared activities without causing pain and thereby lowering the threat level in the brain.

• The feared activities could be imagined movements, novel movements, movement awareness exercises.

• Individualized to the person and to their pain experience

MIRROR THERAPY; A SHORT HISTORY

1996: Ramachandran on phantom pain
1999: Altschuler and Ramachandran on stroke
1999: Ramachandran et al. on hemi neglect
2003: McCabe et al. on CRPS Type I
2004: Moseley et al. on CRPS as part of graded motor imagery
2005: Rosen et al. on hand surgery
2008: Selles et al. on CRPS Type II
2009: Merzenich, Brain Plasticity
2011-2012: 9 research articles on Mirror Therapy
MIRROR THERAPY

Visual Illusions
Tricks the Brain

Mirror Visual Feedback

• 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)

GRADED MOTOR IMAGERY

• GMI is a rehabilitation brain based treatment used to treat pain and movement dysfunction.

• The dysfunction is related to an altered nervous system.

• By exercising the brain in measured and monitored steps as well as progressing to functional activities helps reorganize cortical networks.
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

THERAPIST ROLE: A WINDOW FOR TRAINING

Identify the mechanism as soon as possible.
pre-operative
postoperative
initial evaluation

THERAPIST TREAT THE BRAIN PLASTICITY

• Targeted plasticity or guided plasticity in rehab
• Prevent maladaptive plasticity-EINSTEIN THEORY
• Early intervention
• Use all senses
• Substitute senses
• Observation and tactile stimulation
• Graded motor imagery
Strategies to Normalize Motor Representation

• Pain is a sensory-motor incongruence
• Utilizing sequential graded motor imagery and tactile training might correct cortical body maps which reduces the incongruence between motor commands and sensory feedback

REHAB AFTER NERVE SURGERY

• TREAT THE RAPID REORGANIZATION IN SOMATIC SENSORY
• AFTER INJURY THE BRAIN AND HAND DON’T SPEAK THE SAME LANGUAGE
• PATIENT EDUCATION TO UNDERSTAND TRAINING OF THE BRAIN IS IMPORTANT
• PHASE 1 STARTS IMMEDIATELY AFTER INJURY OR SURGERY BEFORE REGENERATING AXONS HAVE REACHED THE HAND
• PHASE 11 STARTS WHEN THE NEW AXONS HAVE RE-INNERVATED THE SKIN
Cortical effects of nerve injury and repair

Early effect: a "silent" cortical area, deprived of sensory input (phase 1)

Late effect: functional reorganisation of the cortical hand map due to axonal misdirection (phase 2)
Merzenich, Jenkins 1993, J Hand Ther;6:89-104

Our strategy is to start sensory re-education immediately postoperatively to provide the brain with a substitute sensory input in order to maintain the cortical hand representation - a sensory preparation.

REHAB AFTER NERVE SURGERY

- Timing of sensory and motor relearning
- Education
- Postoperative treatment during immobilization
- Desensitisation
- Cold sensitivity
- Phase 1 and 11 and follow-up and assessment

MECHANISMS FOR REMAPPING

- Uncover silent synapses
- Form new axon connection by guided neuroplasty
- Immobilization, inflammation, pain, fear of moving cause brain changes
- Decreased movement need new cortical mapping since with sensory loss motor patterns changing
VISUO-TACTILE INTERACTION

- Sensory cortical areas can be activated by observation of activity.
- Brush a patient's hand then the patient observes another hand being brushed.
- FMRI results indicated firing of same cortical regions
- Tactile experience remodels the CNS representation of body surface


RAPID BRAIN PLASTICITY

- Bjorkman, Lundborg, Rosen, Weilbull – Lund University, Sweden; 2009
- EMA cream for 1 hr. – external manipulation of CNS or cortical competition (local anesthetic of lidocaine/prilocain at 2.5 %)
- Hypothesised that there would be more brain-space to the hand
- Improved two point tactile discrimination and touch pressure threshold by SWM

GUIDED PLASTICITY IN REHABILITATION

- Start immediately after injury or before surgery
- Sensory imagery and touch imagery exercises
- Watching other hands moving normally (activates mirror neurons)
- Laterality or right-left identification
- Imaging from non threatening and progressing
- Mirror therapy
- Dedicated and committed patient
SENSORIMOTOR REEDUCATION

• Goal is to improve cortical mapping
• Progress exercises as sensation improves
• Purposeful movement activities are key with patient specific activities that are important to them
• Progress to Bimanual tasks

SOMATOSENSORY REHAB

• Education
• Quite the nervous system
• Perform similar non target activities and target activities
• Slowly progress and increase repetitions
• Improve biomechanics

• TEACH HOW TO MINIMIZE NEGATIVE LEARNING

SENSORY MOTOR TASKS

• Identify different alphabet letters with eyes opened and closed
• Spell words with alphabet letters – write letters with toes
• Remove small objects from a box and identify and time the task – move objects with toes and feet
• Eyes closed: feel pegs, sense the touch by holding them and put pegs in holes without (no pain or abnormal movement) – attempt with feet
• Increase speed
• With arms resting on thighs, shoulder and hands relaxed – move finger to identify part of the body with light touch or use toe to touch and identify parts of the body.
RESEARCH-EVIDENCE

• Start sensory reeducation immediately after injury and post op to provide brain with substitute sensory input to maintain cortical hand representation


OBJECT IDENTIFICATION

ACTIVE STIMULATION

• Read Braille and play card games in Braille
• Match symbols, letters, figures, shapes
• Play games with eyes closed – dominos
• Put shapes into matched holes – eyes open and closed
• Choose letters and alphabet in sand
• Find matching objects in sand and beans

Adapted from Nancy Byl
TARGET SENSORY TASKS
HAND IS RELAXED

• Feel the work tool or instrument
• Identify points – eyes open and closed
• Use individual fingers on the computer keyboard
• Use one finger at a time and explore all parts of the tool or instrument

Adapted from Byl – Chapter 4

Sensory cortical areas can be activated by observation of activity


• fMRI patients hand is brushed then the patient observes hand being brushed
• RESULTS- A visuo-tactile interaction during just by observation

SELECTIVE SENSORIMOTOR TRAINING
FINE MOTOR CONTROL

• Imagine the object and imagine placing the hand on the tool or instrument
• Have non-involved hand in front of mirror and involved inside the box – imagine and then move
• Try moving both hands if no pain or abnormal movement progresses
• Diaphragmatic breathing and relaxation
• Perform movement on tool or instrument with non-involved hand

Adapted from Byl – Chapter 4

*203. Evidence Based Treatment for Complex Regional Pain Syndrome. This information is the property of Susan Stralka and should not be copied or otherwise used without express written permission of the author.
MIRRON NEURONS- CONCERNED NOT ONLY WITH THE MOTION BUT THE MOTIVATION BEHIND THE MOTION

- Iacoboni -2005 ; B. Rosen 2011

• Functional activities are higher activation then just doing an activity
IMMOBILIZATION

- As short as possible but as long as necessary
- Cerebral effects
- Clinical problems – pain, edema, decreased tactile function and decreased motor skills
- Fine motor skills significantly impaired

NERVE LACERATION AND TRANSECTION

BRAIN PLASTICITY

- Problem: misdirection of regeneration of axons
- Cortical mapping of re-innervated territories of sensory and motor
- Solution: reeducation training immediately to restore sensory functions
SENSORY RE-EDUCATION

1. Laterality – identify right and left pictures
   • Start simple
   • Progress to different positions
2. Visual Imagery – Visualize the hand and visualize moving the hand
3. Mirror Therapy – Look in to the mirror and see reflection of the hand
4. Localization – draw or trace hand for demo
   • Close eyes and place mark on hand
   • Ask client to place mark in different color – measure difference
   • Adult – 0-1.5 cm from point of contact

SENSORY RE-EDUCATION

5. Kinesthesia – draw 10 lines – 5 lines per hand
   • Close eyes
   • Take middle finger – start point to touch point
   • Measure (less than 1.5 cm)
6. Graphesthesia – therapist draws designs on finger pads then client draws same side on paper
7. Stereognosis – 12 keys, same base, different cuts on key
   • Photocopy of one key
   • Client puts keys under table – take 1 key and identify it to picture (timed activity – 10-20 min.)

SENSORY-MOTOR RE-EDUCATION

8. Sensorimotor Accuracy
   • Draw oval
   • Red pen – right hand; blue pen – left hand
   • Follow line – start with unaffected side
   • Measure time
9. Desensitization or deprogramming of bad habits
   • Use limb with balanced posture
   • Breathing exercise
   • Strengthening the appropriate muscles
   • Use the balanced extremity
   • Remaining of instrument
   • Splints may help
   • Metronome for tempo
10. Sensorimotor discriminative training
   • Never perform if abnormal movement or pain occurs
   • Reduce stress
   • Goal directed and highly attentive activity for short sessions
TOPDOWN TREATMENT

- Contribution of CNS
- Cognitive reeducation
- Neuroplasticity
- Cortical Reorganization
EXERCISE STIMULATES THE BRAIN AND WARMS THE HEART

TOP DOWN TREATMENT

- Education – including Cognitive Behavioral
- Calm PNS, CNS, and SNS
- Take the Fear Away
- Sensory Reeducation – tactile stimuli
- Mirror Therapy or Graded Motor Imagery

TREATMENT SUCCESS

- Bio-Psycho-Social Approach- educate on neuroscience
- Central and Peripheral Nervous system
- Nerve mobilizations
- Normalize movement
- Early Top-down treatment
- Calm CNS
- Good neuroplasticity
NEUROPLASTICITY: AS THE FOUNDATION FOR TREATMENT

• Identify all peripheral and central pathophysiology and treat

• Normalize hyperexcitable central neural activity