Neural Mobility: Examination & Intervention Strategies
An Overview
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Objectives

- Review current state of evidence
- Review neuropathic pain and neural sensitivity
- Identify patients with neural sensitivity
- Quantify restricted neural mobility
- Understand basic treatment principles to treat patients with restricted neural dynamics

Neural Mobilization: A Systematic Review of Randomized Controlled Trials with an Analysis of Therapeutic Efficacy

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Abstract: Neural mobilization is a treatment modality used in relation to pathologies of the nervous system. It has been suggested that neural mobilization is an effective treatment modality, although support of this suggestion is primarily anecdotal. The purpose of this paper was to provide a systematic review of the literature pertaining to the therapeutic efficacy of neural mobilization. A search to identify randomized controlled trials investigating neural mobilization was conducted using the key words neural mobilization, neural sensitivity, physical therapy, neural mobilization, and neural mobilization of. The titles and abstracts of the papers identified were reviewed, and studies specifically detailing neural mobilization as a treatment modality. The PEDro scale, a 9-point rating scale used to evaluate methodological quality, was used to assess these trials. Methodological assessment allowed an analysis of research investigating the efficacy of neural mobilization. Ten randomized clinical trials discussed in 11 retrieved articles were identified that discussed the therapeutic effect of neural mobilization. This review highlights the lack in quantity and quality of the available research. Qualitative analysis of these studies revealed that there is only limited evidence to support the use of neural mobilization. Future research needs to examine the application of neural mobilization with use of more homogeneous study designs and methodologies in addition, it should standardize the neural mobilization interventions used in the study.

J Man Manipulative Ther. 2008;16(1):8-22
How Effective is Neural Mobilization?

- Ten RCT’s reviewed
- Different methods used for each
- Different neurodynamic dysfunctions for each
- No standardization for assessment or treatment
- All utilized tensioning techniques

Conclusion

- Limited evidence to support neural mobilization
- Justification for treatment based on anatomy, physiology, clinical trials, anecdotal evidence

Recommendations for Future Studies

- Need to classify into homogeneous subcategories
- *Need to standardize treatment and assessment techniques*
- Then proceed with clinical research
Ideal Conditions for Nerve Health

- Space
- Movement
- Limited sustained tension

Brief Review of Nerve Anatomy & Physiology

- Connective Tissue
- Vasa Nervorum
- Axonal Transport
- Nervi Nervorum

Connective Tissue Layers

- Endoneurium
- Perineurium
- Epineurium
- Mesoneurium
Endoneurium

- Separates individual axons
- Highly elastic

Perineurium

- Surrounds fascicles
- Contributes most to nerve’s tensile strength
- Collagen based

Epineurium

- Internal
  - Adipose
  - Loose connective tissue

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Epineurium

- External
  - Collagen based

Mesoneurium

- Loose connective tissue
- Facilitates gliding
Potential for Nerve Injury

- Nerve passes through several tight anatomic compartments along nerve bed
  - Conflict between free space and contents
    - Diminished compartment aperture
    - Increased volume of contents
- Result → restricted gliding between tissues in the compartment, interrupted nerve physiology & impaired blood supply

Pop Quiz
Video Quiz
This individual is stamping his foot and moving in this manner because:
A. Of the toilet tissue stuck on his shoe
B. The edge of the toilet seat cut off the blood supply to the sciatic nerve and his leg has gone to “sleep”
C. The toilet seat interrupted the axonal transport system of the sciatic nerve and his leg has gone to “sleep”
D. All of the above

Vasa Nervorum

Axonal Transport
- Uninterrupted axonal transport is necessary for neuron health
- Activity affects intra-cellular motility
Axonal Transport

- Antegrade flow
  - Fast: 400 mm / day
  - Slow: 1 – 6 mm / day
- Retrograde flow: 200 mm / day

Axonal Transport Vehicle

Kinesin & Dynein Motor Protein
Video Quiz

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Inflammation & Axonal Transport

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Disruption of Fast Axonal Transport in the Rat induces Behavioral Changes Consistent With Neuropathic Pain
Andrew Gilley, * Natalia Iharshak, Kim G. Furman, & Geoffrey M. Boxall

Abstract: Axonal transport is essential for the normal function of neurons. In this study, we examined the role of axonal transport in the development of neuropathic pain. We found that inhibition of axonal transport led to an increase in pain behavior. This is consistent with previous studies that have shown that disruption of axonal transport can lead to pain.

Key words: Axonal transport, neuropathic pain, inflammation, inflammation, inflammation, inflammation.
Nerve's Response to Injury

• Mild focal compression
  - Injury to Schwann cell
  - Demyelination results

• More severe trauma
  - Degeneration of the distal axon
  - Reactive changes to the nerve cell body
  - Wallerian degeneration
  - Potential for axonal death

Seddon's Classification

• Published in 1943
• 3 stages of injury
• Useful in predicting outcome and formulating treatment
Neuropraxia

- Segmental reduction or block of conduction
- Axonal continuity preserved – no wallerian degeneration
- Nerve conduction preserved distal and proximal to the lesion
- Full recovery

Axonotmesis

- Axonal damage with preservation of endoneurium
- Distal wallerian degeneration occurs
- Endoneurial tubes guide re-growth of axon

Neurotmesis

- Most severe of nerve injuries
- Connective tissue components of nerve damaged or transected
- Recovery cannot occur through axonal regeneration alone
- Surgical intervention required
Sunderland’s Classification

- Published in 1951
- 5 grades of nerve injury
- Neurpraxia = Grade I
- Axonotmesis = Grade II
- Neurotmesis = Grades III, IV, V

Grade III Injuries

- Damage to the nerve Endoneurial tube
  - Axon
  - Endoneurium
- Perineurium preserved
- Results in intrafascicular scarring

Grade IV Injuries

- Damage to the nerve fasciculi
  - Axon
  - Endoneurium
  - Perineurium
- Epineurium preserved
- Results in intraneural scarring
Grade V Injuries

- Neurotmesis injury
- Nerve trunk divided
- Surgical repair

Injury Without Axonal Degeneration

- The nerve to the nerve
- Consists of C and Aδ fibers
- Protective and pro-inflammatory function

EMG and NCV Testing

- Of value in detecting large diameter motor and Aβ sensory nerve injury
- Of no value in detecting small diameter nerve injury
  - A fibers
  - C fibers
  - Nervi Nervorum

(Greening, 2006; Wilbourn, 2003)
How do we identify these patients

Neural Sensitization
• Very often occurs without axonal damage (Dilley et al, 2005; Schmid et al, 2013)
• Conduction velocities maintained
• Involves sensitization of Aδ and C fibers of the nervi nervorum & nerve (Bove et al, 2003)
• Sensitized nerve fibers respond to pressure and stretch (Dilley et al, 2005)
  – Pressure responding fibers > stretch responders by 50%
  – Stretch responders needed as little as 3% elongation

Mechanism of Occurrence
• Inflammation in and around the nerve (Dilley et al, 2005; Bove, 2009)
• Interruption of axonal transport (Dilley & Bove, 2008, Dilley et al, 2013)
• Mechanical stress of stretch and/or compression ➔ Neuropraxia
Summary

• Vast number of nerve injuries not detected via EMG/NCV

• Neural sensitization involves injury to small diameter Aδ and C fibers of the nerve and nervi nervorum

• Occurs through inflammation and interruption of axonal transport system

• Detected via palpation and stretch on clinical exam

Case Study
Case Study

- 42 y.o. hunter fell while walking in woods
- Axilla impaled by dead tree branch
- Presented to ED with branch spike *in situ*
- Removed by surgeon, wound explored, closed
- Presented to PT 3 weeks later with c/o restricted elbow extension
Motion - Gliding

Tensioning

Gliding = Flossing = Sliding
UE Neural Mobility Testing

• Based on work by R.L. Elvey (1997) and D.S. Butler (2000)

• Kleinrensink et al (2000) demonstrated stressing of the brachial plexus with the ULNT 1 test

• Technique should be standardized

• Use of grading scales recommended by M.W. Butler (2014)

• Test carried out in sequence to onset or change of patient’s symptoms
The Brachial Plexus Biasing Neurodynamic Test

ULTT 1, ULNT 1

or

BPNT

BPNT 0/5

• Shoulder in IR
• Elbow at 90°
• Arm across stomach
• Wrist and fingers in neutral

BPNT 1/5

• Shoulder ER to neutral
• Elbow at 90°
• Wrist and fingers in neutral
BPNT 2/5
- Shoulder in ~ 100° of abduction
- Elbow at 90°
- Neutral rotation
- Wrist and fingers in neutral
- Thumb in radial abduction – align with humerus

BPNT 3/5
- Shoulder in ~ 100° of abduction, 90° ER
- Elbow at 90°
- Forearm in supination
- Fingers in neutral
- Thumb in radial abduction

BPNT 4/5
- Shoulder in ~100° of abduction, 90° ER
- Elbow at 0°
- Forearm in supination
- Fingers in neutral
- Thumb in radial abduction
BPNT 5/5

- Shoulder in ~ 100° of abduction, 90° ER
- Elbow at 0°
- Forearm supination
- Wrist extension
- Fingers in neutral
- Thumb in radial abduction

BPNT

Important points

- DO NOT DEPRESS THE SHOULDER – only block elevation
- Do not drop the shoulder into extension or bring it into flexion during testing
- Change to ‘gangsta’ grip at 45° shoulder position between 1/5 and 2/5
- Pause at each of the above steps to check your patient’s status before moving to the next step
Test data points:

- S1 = onset or change of patient’s symptoms
- S2 = definite stop point in the test based on patient’s discomfort level
- Motion available between S1 & S2 = the treatment zone

Add (+) if beyond a grade level, but less than halfway to the next level i.e. 3+/5

Use the next level with a (-) if over halfway to that level i.e. 4-/5

Recognition Reliability BPNT

- Data collected between March to October 2014
- Collected in Austin, Chicago, Philadelphia, Atlanta, and Kansas City
- Video of 7 different test positions graded
- PT’s, PTA’s, OT’s, COTA’s, ATC’s, CHT’s, PA’s; N = 223
- Intertester Reliability = 0.9007 or 90%

The Median Nerve Biasing Neurodynamic Test

ULTT 2A, ULNT2A
or
MNT
MNT 0/5

- Stand at your patient’s head with them laying diagonally, their shoulder just off the table
- Shoulder in IR
- Elbow at 90°
- Wrist & fingers neutral

MNT 1/5

- Depress the shoulder 1” with your hip
- Shoulder ER to neutral
- Shoulder abduction to 45°
- Wrist and fingers relaxed-neutral

MNT 2/5

- Externally rotate the patient’s shoulder to 90°
- Elbow maintained at 90°
- Wrist and fingers in relaxed-neutral
MNT 3/5

- Elbow Extension
- Forearm neutral
- Wrist and fingers relaxed-neutral

MNT 4/5

- Shoulder in ER
- Forearm supination
- Elbow extended
- Wrist & fingers in relaxed-neutral

MNT 5/5

- Extend the patient’s wrist with focus on the thumb through ring fingers.
- The thumb in radial abduction
The Radial Nerve Biasing Neurodynamic Test
ULTT 2B, ULNT 2B
or
RNT

RNT 0/5
- Stand at your patient’s head with them laying diagonally, their shoulder just off the table
- Shoulder in IR
- Elbow at 90°
- Wrist & fingers neutral
RNT 1/5

- Depress the shoulder 1” with your hip
- Shoulder ER to neutral
- Shoulder abduction to 45°
- Wrist and fingers relaxed-neutral

RNT 2/5

- Internally rotate the patient’s shoulder
- Elbow maintained at 90°
- Wrist and fingers in relaxed-neutral

RNT 3/5

- Elbow Extension
- Forearm neutral
- Wrist and fingers relaxed-neutral
- Shoulder maintained in IR
RNT 4/5

- Shoulder in IR
- Forearm pronated
- Elbow extended
- Wrist & fingers in relaxed-neutral

RNT 5/5

- Wrist and finger flexion with ulnar deviation
Important Points for MNT & RNT

- Prevent patient from laterally flexing their neck away from the side being tested
- Depress your patient’s shoulder ~ 1 inch, watching their face for signs of discomfort before continuing on with the test
- Keep the patient’s arm in line with the axillary midline
- Pause at each step to check your patient’s status before continuing on with the test
- Once symptoms occur or intensify, there is no reason to continue with the test

The Ulnar Nerve Biasing Neurodynamic Test
ULTT 3, ULNT 3
or
UNT

UNT 0/5

- Start standing below the patient’s shoulder
- Shoulder in IR
- Elbow at 90°
- Arm across stomach
- Wrist and fingers in neutral
UNT 1/5

- Shoulder ER to neutral
- Shoulder abduction to 45°
- Free hand blocks shoulder elevation

UNT 2/5

- Externally rotate the shoulder to 90°
- Maintain stabilizing hand on shoulder to block elevation

UNT 3/5

- Prevent shoulder hiking with firm counter pressure using your shoulder stabilizing hand
- Abduct the patient’s shoulder to 110°
UNT 4/5

• Pronate the patient’s forearm
• Extend the wrist, ring and small finger
• Maintain firm counter pressure with your shoulder stabilizing hand

UNT 5/5

• Flex the patient’s elbow, bringing their hand to the side of their face
• Maintain stabilizing force on the shoulder, wrist, and fingers

UNT
LE Neural Mobility Testing

The SLR

- Described in 1880 by a Serbian physician Laza Lazarevic to detect back pain via tension on the sciatic nerve
- Used to detect herniated lumbar discs
  - Cochrane Review estimated a sensitivity of 92% and a specificity of 28% (van der Windt et al, 2010)
- Modifications allow for nerve biasing and tissue differentiation
Hamstrings Schematic

- Increases origin-insertion distance
- Decreases origin-insertion distance

Sciatic Nerve Schematic

- Imparts windlass effect on the nerve around the ischial tuberosity

Hamstring Pattern
Neural Pattern

Piriformis Syndrome

- External rotator at neutral
- By 60° SLR has become an internal rotator
- Piriformis/sciatic nerve anomalies exist in ~10% of the population (Kosukegawa et al, 2006)

Normal vs. Piriformis Pattern

Normal Piriformis
Initial Treatment Objectives

- Patient education of problem
- Instruct in diaphragmatic breathing
- Establish Home Exercise Program
- Link posture to recovery
- Teach stable sleeping position
Diaphragmatic Breathing

• Seated and supine
• Hand position for feedback

Home Exercise Program

• Posture Correction
• Proximal Glides
• Tray Nerve Glides
• Functional Box

Posture

• Most important aspect of treatment
• Patient’s inability to achieve proper posture with comfort predicts treatment failure
• Goal is to help patient achieve habitual proper resting posture
Posture Correction with Proximal Gliding

Posture Correction with Proximal Gliding - The “D”

The Tray
The Box

Sleeping Position

Ongoing Treatment Objectives

• Maximize space along the nerve bed
• Maximize tolerance to nerve bed length changes (restore neural mobility)
• Minimize sustained adverse tension on neural tissue
Scapular Clock Shrugs

HEP Progression
the
‘Vanna White’ or ‘Spiderman’

The Vanna White / Spiderman
Therapist Intervention

- Plexus mobilization - glides and stretches
- Scalene mobilization
- Pectoralis minor lift / mobilization

Flossing

Sciatic Ankle Pumps
Mobilizing the Plexus
‘Tensioning’

Proximal Plexus:
Lateral Cervical Glides

IVF Opening with Nerve Glide
IVF Opening with Nerve Glide

Proximal Plexus: Scalene Mobilization

Distal Plexus: Pectoralis Minor Lift + Stretch
Distal Plexus: Pectoralis Minor Lift + Glide

Strengthening: Lower / Middle / Upper Traps

Strengthening: Serratus Anterior
Important Treatment Points

- Postural symmetry and awareness – reduce sustained tension on neural tissue
- Neural mobility
- Breathing patterns
- Symptom "quiet point" for rest and sleep
- Tolerance to exercise
- Manual Interventions to enhance mobility and create space - decompress
Questions?

Thank You

References


