Providing practical solutions for clinical therapists

www.neurodynamicsolutions.com
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About Neurodynamic Solutions (NDS)

Background
Neurodynamic Solutions (NDS) is the teaching entity founded by Michael Shacklock. It was started with the express purpose of offering practical clinical solutions for therapists with an interest in neuromusculoskeletal problems. The emphasis is on clinical neurodynamics for neuromusculoskeletal problems in a way which clarifies and demystifies neurodynamics and makes the subject as clinically applied as possible.

Objectives
Offer practical clinical solutions for therapists who treat patients with musculoskeletal problems with a neural component
Include the most up-to-date research and clinical information
Offer a systematic method of application of neurodynamics
Foster further development in clinical neurodynamics

Resources
Free registration
Web site - neurodynamicsolutions.com
Courses - upper and lower quarters
Newsletters - clinical solutions, new updates in research, conferences announcements, books and other resources, web links - other physiotherapy/physical therapy and educational groups, search engines and physical therapy data bases

Course Manual (8th edition)
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NEURODYNAMIC SOLUTIONS (NDS) COURSES

Courses in clinical neurodynamics as presented in Michael Shacklock’s book are available worldwide. If you are interested in hosting or attending a workshop, seminar or conference event in neurodynamics do contact Neurodynamic Solutions (NDS).

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About Michael Shacklock

Michael Shacklock graduated as a physiotherapist from the Auckland School of Health Sciences in 1980. During his undergraduate training, he quickly developed an interest in manual therapy and has pursued this interest throughout his career. He worked in public hospitals and private practices for several years in New Zealand before traveling to Adelaide, South Australia in 1985, to take part in post-graduate study. In 1989, he completed a Graduate Diploma in Advanced Manipulative Therapy at the University of South Australia and converted this to a Master of Applied Science in 1993. He has taught internationally for over 20 years and has given numerous keynote and invited presentations throughout the western world. His Masters thesis was on the effect of order of movement on the peroneal neurodynamic test, in which he discovered the concept of neurodynamic sequencing. Since then he has studied mechanics and physiology of the nervous system, performing research and writing a number of publications on the subject. Michael edited the extremely successful book Moving in on Pain and has published in Physiotherapy and Manual Therapy and written leading and invited articles for the Australian Journal of Physiotherapy and New Zealand Journal of Physiotherapy. Michael’s most recent publications consist of his new book on clinical neurodynamics, for which he received a Fellow of the Australian College of Physiotherapists by original contribution by monograph. He has been a featured author in Manual Therapy, Australian Journal of Physiotherapy and the New Zealand Journal of Physiotherapy on critical issues in research and clinical application of neurodynamics. His most recent publication is the book, Biomechanics of the Nervous System: Being revisited.

Michael’s recent area of investigation has been the in vivo imaging of mechanical function of the nervous system. He teaches Clinical Neurodynamics internationally. Michael Shacklock’s current positions are founding director of Neurodynamic Solutions (NDS). He is a member of the International Advisory Board for Manual Therapy. He is also a reviewer for the international peer-reviewed journals Manual Therapy.

Some Publications

- Shacklock M 2000b Editorial: Improving application of neurodynamic (neural tension) testing and treatments: a message to researchers and clinicians. manual Therapy 10: 175-179.
Collaboration Between Michael Shacklock and University of Eastern Finland Wins Prestigious Research Awards for NDS Instructor, Marinko Rade, for Investigation of Shacklock’s Proposal on Spinal Cord Movement

Under the support and supervision of Professor Olavi Airaksinen at the University of Eastern Finland, NDS researcher with Michael Shacklock and PhD candidate, Marinko Rade, has won the prestigious Young Investigator of the Year awards with both the International Society for the Study of the Lumbar Spine (2014) and Finnish Spine Society (2013) for research into a new model for non-invasive measurement of spinal cord movement.

So we now have a new model for measurement of neurodynamics with five innovations:

A. measurement of spinal cord longitudinal movement is now possible
B. conscious healthy humans
C. non-invasive
D. emulates clinical testing
E. establishes the effect of unilateral and bilateral testing on cord dynamics.

This opens the door for more research on lumbar spine neurodynamics and may assist in the physical treatment of low back pain and sciatica.

See: www.neurodynamicsolutions.com


Clinical Neurodynamics Book

In this international best-seller, Michael demystifies how the nervous system moves and can cause problems, provides a new systematic approach to prevent provocation of symptoms yet still provide a beneficial effect and how to select advanced techniques ranging from those for the very restricted patient to the athlete.

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NDS Lower Quarter Course Aims

Improve/develop:

- **manual skills**, specifically the ability to feel **abnormalities in movement** related to the nervous system in the lower quarter

- **abilities in diagnosis and interpretation** of lower quarter neurodynamic testing and **musculoskeletal relationships**

- clinician’s **repertoire of diagnosis and treatment** of techniques

- **safety** in relation to clinical neurodynamics

**Please Note**

Participants are responsible for their own well being on this course. It is recommended that participants decline to have any manoeuvres performed on them if the participant may react with undue pain or suffering, have a condition which might influence their ability to tolerate any manoeuvres or predispose to the development of subsequent pain or suffering.

Participants are under no obligation to have a manoeuvre performed on them and may freely decline.
Section 2

General Neurodynamics

Audiovisual Presentation
NDS Lower Quarter Course Aims

- Improve/develop:
  - manual skills, specifically the ability to feel abnormalities in movement related to the nervous system in the lower quarter
  - abilities in diagnosis and interpretation of lower quarter neurodynamic testing and musculoskeletal relationships
  - clinician’s repertoire of diagnosis and treatment of techniques
  - safety in relation to clinical neurodynamics

Problems with ‘Tension’

- Makes us think of tightness in nervous system
- Corollary is ‘stretch’
- Stretch:
  - can cause injury
  - can increase pain
  - often ineffective
  - caused therapists to abandon the approach

Proposal 1995 - ‘Neurodynamics’

- Many other aspects were being omitted:
  - sliding, pressure
  - physiology
  - intraneural blood flow
  - mechanosensitivity
  - inflammation in neural tissues

- Challenge the word “tension”
Must link mechanics and physiology and function of the musculoskeletal system
Shacklock 1995 Physiotherapy

Clinical Neurodynamics Definition - clinical application of mechanics and physiology of the nervous system as they relate to each other and are integrated with musculoskeletal function

Concept of Neurodynamics (cont.)

Benefits of Clinical Neurodynamics

Safer - less stretching of nerves
Links diagnosis and treatment to causal mechanisms
Integrates neural aspects with the musculoskeletal system
Systematic

General Neurodynamics

Definition

Principles of clinical neurodynamics that apply to the whole body no matter what region. They are therefore general or universal principles.
Nervous System Primary Functions

Withstand tension
- 18%-22% elongation before failure
- varies between individuals and between specific nerves

Position a

Position b

Nervous System Primary Functions

Sliding - longitudinal

Longitudinal sliding prevents excessive tension.
Nervous System Primary Functions

Sliding - transverse
Transverse movement of the median nerve at the wrist
1-5 mm
Nakamichi and Takibana 1995
Greening et al 1999

Transverse sliding prevents excessive compression.

Compression
Compression of nerve during daily movement
Similar events occur with joints and fascia

Three Ways to Move Nerves
1. Move the joint
Force direction is away from the joint. DIFFERENT FROM direction of movement.
Three Ways to Move Nerves (cont.)

2. Move the Innervated tissues

Other nerves:
- femoral
- peroneal
- sural
- tibial
- medial calcaneal
- lateral femoral cutan.

Ways to Load the Nervous System

3. Move the interfacing soft tissues

- muscle
- fascia
The Nervous System is a Continuum

Definition
When the therapist moves the neural structures in question (remotely) without moving the musculoskeletal structures.

The nervous system is emphasized.

Structural Differentiation (cont.)
Offers us structural differentiation

Stable

Release neck flexion (RNF) for lumbar symptoms
Full slump  Release neck flexion

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Structural differentiation is used in ALL neurodynamic tests in diagnosis.

Transmission of forces along the system:

Type of neural effects during neurodynamic technique:
- early in movement - taking up slack
- mid range - sliding effects
- end range - tension effects
- universal finding

Charnley (1951), McLellan and Swash (1976), Wright et al (1996)

Gives Us Progressions

Early in movement - just apply small force to nerve without producing significant movement

Mid range - produce sliding

End range - apply tension

Convergence

Shucklock 2005 Elsevier
Nerves slide to the point where tension is applied.

**Sliding of Nerves**

The nerves slide toward the site where force (elongation) is initiated - ‘down the tension gradient’

**Neurodynamic Sequencing**

Summary
- The sequence of movements influences the location of symptoms.
- More symptoms at the region that is moved first and most strongly (distal)
- Eg. foot - peroneal nerve (Shacklock 1989)
- Upper limb (Zorn, Shacklock & Trott 1995)

Tsai 1995 - cadaver study on ulnar nerve
- Proximal to distal sequence
- Distal to proximal sequence
- Elbow first sequence

Greater strain in the ulnar nerve at the elbow with the elbow first sequence (approx. 20%)

Intraneural tension reflected this change.
Neurodynamic Sequencing

Tsai 1995
- almost 20% more strain in nerve with local sequence

Neurodynamic Sequencing

General principles
- Sequence of movements influences local tension and strain in the neural tissues.
- Greater strain in nerves occurs where the force is applied first and most strongly.
- This translates into changes in symptom responses with human subjects.

Neurodynamic Sequencing

Implications
- Consistency in neurodynamic testing is important
- Change the technique and you change the test
- Small changes in technique can produce BIG changes in the response

TECHNIQUE
IS
IMPORTANT!
Neurodynamic Sequencing - progressions

Focused sequence
Tensioners
Sliders
Protection
LOW
MEDIUM
HIGH

1. Protective - remote sequence (LBP)
Example: low back pain
- Dorsiflexion
- SLR to first onset of pain
- Release dorsiflexion - back pain reduces

Differentiation is the OFF SWITCH

1. Protective - remote sequence (foot)
Example: heel pain
- SLR first
- Dorsiflexion to first onset of pain
- Release SLR - foot pain reduces

Differentiation is the OFF SWITCH

2. Sliders
Proximal/cephalad
Distal/caudal
3. Tensioners

Neutral  Tension

4. Focused Sequence

Start at the relevant location
Ankle:
- dorsiflexion then SLR
- differentiate with SLR

Physiology and Movement (cont.)

Peripheral Nerve Compression
- 30-50 mmHg reduces venous flow from nerve peripheral nerve
- Over one hour and the nerve fails (Gelberman et al 1983)
Clinical pressures can reach 240 mmHg (Werner et al 1985)

Compression (cont)

Nerve Root
- 10 mmHg - acute ischaemia
- 50 mmHg, 2 minutes - oedema
- 120 mmHg - total ischaemia

Patients with radiculopathy - 7 mmHg - 256 (mean 53.2)
Physiology and Movement

Elongation
- Elongation produces changes in blood vessel function
- 8% - Intraneural veins start getting blocked
- 15% - All blood flow through nerve is blocked
  Lundborg and Rydevik (1973)

Physiology and Movement (cont.)

Normal nerve  Pressurized nerve

Force

Time

Mechanosensitivity

How easily nerves are activated when subjected to mechanical force.
Mechanosensitivity (cont.)

Is tested (evaluated) with:
- neurodynamic tests
- palpation
- passive movements
- active movements

Neurodynamic Tests

- Mechanics
- Tension
- Sliding
- Pressure
- Blood flow
- Inflammation
- Sensitivity

Neuropathodynamics

- Abnormal Neurodynamic Tests
- Pathodynamics
- Tension
- Sliding
- Pressure
- Blood flow
- Inflammation
- Sensitivity

Neurodynamic Test

Definition

A series of body movements that produces mechanical and physiological events in the nervous system according to the movements of the test.
Specific Neurodynamics

**Definition**

Local effects of body movement on the nervous system in a way that is specific to each region

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**Mechanical interface - spinal canal**

---

**Intervertebral Foramen - interface**
Lateral Flexion

Neural tissues on the convex side are tightened.
Contralateral lateral flexion can be used to sensitise neurodynamic tests.

Breig 1978 © 2007 Neurodynamic Solutions

Contralateral Neurodynamic Tests

Shacklock 2005 Elsevier

Cervical Cord

© Neurodynamic Solutions
Breig 1990, 1978

A

B
Straight Leg Raise

Reference  Unilateral  Bilateral SLR

Rade M, Shacklock M, Könönen M, Marttila J, Iovin R, Kankaanpää M, Airaksinen O
2015 Spine 40 (12): 935-941

Control 30s  30s + Sham  30s + Knee Ext

Effect of Contralateral Slump Test

NPRS

P<0.001
P ≤ .996
3.80
0.65
0.62

Contralateral Neurodynamic Movements - cadaver study
Slump Test: Effect of Contralateral Knee Extension on Response Sensations in Asymptomatic Subjects and Cadaver Study

Part 1: Slump Test: Effect of Contralateral Knee Extension on Response Sensations in Asymptomatic Subjects

Objectives

- To test if contralateral knee extension consists of a reliable method for diminishing symptoms in asymptomatic subjects.
- To compare the effectiveness of contralateral knee extension with other methods such as lumbar flexion and ankle plantar flexion.

Methods

- A randomized, single-blind study was conducted.
- Sixty-one asymptomatic subjects were tested in this study.
- The slump test (ST) was applied to assess the effectiveness of contralateral knee extension.

Results

- Reduction in symptoms with contralateral knee extension was observed in the study.
- Observations in clinical and normal subjects suggest that the effects are MORE SIGNIFICANT than in cervical spine.
- Possibly because the intradural nerve roots are more parallel and in a better position to assist one another.

Part 2: Contralateral Reduction in Lumbar Neural Tension with Contralateral Knee Extension

Objectives

- To establish the effect of contralateral knee extension on sensations produced by the slump test in asymptomatic subjects.
- To study the effect of contralateral knee extension on sensations produced by the slump test in cadavers.

Methods

- A cadaver study was conducted to simulate the nerve root behavior of asymptomatic subjects.
- Contralateral knee extension was applied to the L5 nerve root of 3 cadavers.

Results

- Contralateral knee extension reduces stretch sensations with the slump test.
- Reduction in symptoms with contralateral knee extension was observed in cadavers, supporting the proposed explanatory hypothesis.

Conclusions

- Contralateral knee extension is an effective method for reducing symptoms in asymptomatic subjects and cadavers.
- This opens the door for more research on lumbar neurodynamics.
ResearchGate

Free research updates

www.researchgate.net/profile/Michael_Shacklock

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Section 3

Nerve Palpation
Practical/lab session

Sciatic
Tibial - tarsal tunnel, medial calcaneal
Fibular (peroneal) - common, superficial, deep
Sural
Nerve Palpation

General Points

Reasons for Use

Detect site of pathology or abnormal response

Establish whether anatomical changes are present in or around the nerve. This means:

What Does Palpation Tell Us?

Where the problem is and how sensitive it is.

Whether the nerve or neighbouring tissues are inflamed or swollen or whether a pathology might exist.

Normal Response

Nerves are normally mechanosensitive, given an adequate stimulus such as strong force. So palpation will elicit symptoms in some people and not others, depending on how sensitive that person’s nerves are.

Possibilities:
- no symptoms
- local discomfort
- sometimes referred symptoms but not usually for normal people
- this could be a subclinical abnormal response

Abnormal Response

Reproduction of symptoms, local or referred.

Different from other (asymptomatic) side or in a fashion that reflects the patient’s problem
- asymmetrical response - more tender on the symptomatic side
- thickening or swelling in or around the nerve

Technique

Large deep nerves - use either the pad of the thumb or index finger

Small superficial nerves - the back of the thumb nail or finger nail

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Perform a ‘catch-it-then-roll-of-it’ action, like a guitar string.

Or: just apply pressure to the nerve and feel the tissues around also.

Deeper nerves - burrow to displace the overlying structures - GENTLY don’t scrape around.

Test along the length of the nerve.

**What To Do**

Palpate the following nerves and write down the following variables:

- **Size, shape and texture of the nerve (thickening?)**
- **Swelling in or around the nerve**
- **Flat nerve, round nerve?**
- **Where the tunnel structures are**
- **Can you feel the fascicles?**
- **Depth of the sulcus or surrounding tissues**
- **Sensitivity of the nerve – how hard to you have to push before symptoms develop**
- **Location of the symptoms – local or remote**
- **Extent of the physical signs ie. how far do they spread**
- **Kind of symptoms – ie. what do they feel like, pins and needles, numbness, aching or tenderness.**
- **Do a bilateral comparison**

You may have to palpate a great distance along the nerve

**Sciatic nerve in the buttock**

Posterior aspect of greater trochanter

Lateral aspect of ischial tuberosity.

In between these two structures, find the groove.

Follow the nerve into the thigh.

**Sciatic nerve with the hamstrings**

Following the nerve into the thigh, you can add knee extension, dorsiflexion or spinal flexion.

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Tibial nerve behind the knee

De-rotate the limb to the neutral position to place the access point for the nerve in the centre of the limb.

Nerve is in the middle between the two dimples behind the knee.

Peroneal nerve at the knee

Place knee in 90 flexion.

Find head of fibula.

Nerve runs horizontally along the neck of the fibula.

Follow it around the neck of the fibula and move your finger up and down.

Tunnel for the superficial peroneal nerve

If necessary, position ankle in a small amount of plantarflexion/inversion to take the slack out of the nerve.

Follow the nerve up to its tunnel, where there is a soft spot which indicates the tunnel.

The nerve often has medial and lateral branches and can anastomose with the sural nerve.

Superficial peroneal nerve over the ankle

You can “twang” the nerve like a guitar string and palpate along its course.
Sensory nerve that supplies most of the dorsum of the foot, but NOT the skin between the first and second toes.

**Deep peroneal nerve at the ankle to its terminal in between the first and second toes**

Between extensor hallucis and digitorum tendons over the dorsum of the ankle.

Follow it along the dorsum of the foot to the lateral aspect of the first metatarsal.

**Sural nerve at the ankle**

With your fingers, provide counter pressure on the medial aspect of the Achilles tendon.

Gently roll your thumb over the nerve.

If you can’t feel it you can add some dorsiflexion/inversion and/or straight leg raise.

**Tibial nerve at the ankle**

Located medially between the medial malleolus and the calcaneum.

Look for swelling in medial aspect of both ankles over the tarsal tunnel.
Section 4

Standard Neurodynamic Tests
Practical/lab session

Straight leg raise
Slump test (unilateral and bilateral)
Tibial nerve
Peroneal nerve
Sural nerve
Standard Neurodynamic Tests

Standard Explanation Before All Neurodynamic Tests

To be done prior to the first neurodynamic test and repeated in short form with subsequent tests.

Aims

› Reassure and relax the patient, reduce expectations
› Inform the patient about the manoeuvre
› Get the patient’s permission
› Make the patient communicate effectively about their response
› Prevent them from compromising the technique

Example

1. “If it’s alright with you, I’d like to perform some movements on your leg.
2. This helps me evaluate the problem and may or may not produce some symptoms.
3. If you do feel anything, make sure that it does not go above mild to moderate (3-4/10).
4. It doesn’t matter if you experience symptoms or not, but I need to know precisely what happens, as it happens.
5. So, without moving your body, please tell me verbally what happens.
6. Do you understand?
7. Now, are you comfortable and relaxed?”

Short Explanation for Subsequent Tests

“I’m going to do another test like the other one on your leg/arm/back, OK?”. Just remember to ..... (discuss any previous problems only). OK?”
Section 4  Standard Neurodynamic Tests

Neurodynamic Testing Procedure

Mental Movement Diagram:
1. Symptoms at rest
2. Change in symptoms during test
3. Change in resistance to movement during test
4. Adaptive movements - these can show abnormalities
5. End range of motion and reason for ceasing the movement
6. Location of symptoms
7. Effect of structural differentiation
8. After completion of the manoeuvre, the characteristics of the symptoms are discussed
9. Full details of the symptoms is obtained so as to determine the response category.

Aims
- Streamline diagnosis
- Prevent provocation of symptoms by reducing the duration of the test

Procedure
1. Is it permissible to perform the NDT on the SYMPTOMATIC SIDE FIRST. This can help reduce the patient’s expectations and concerns that might be evoked by moving the less affected side first. Perform neurodynamic test to point of onset of symptoms (P1) or resistance (somewhere between R1 and R2) or both. It is permissible to go further but this should be judged carefully and must be of value.

2. Ask “Where are your symptoms”

3. Based on the location of symptoms, decide which end of the test to move for structural differentiation (proximal or distal).

4. Perform structural differentiation to ascertain if the test is positive. Note that this does not describe whether it is abnormal at this stage.

5. Return to the neutral position.

6. Analyse the response (symptoms and physical behaviour)
Adaptive Movements

- If not enough information gained in the test used and an adaptive movement is observed, correction of the movement can be performed and the NDT is repeated.
- The effect of structural differentiation on the adaptive movement is assessed. If a change in the adaptive movement occurs, there is a positive link and this may later be considered relevant, depending on the relationship of these events to the patient’s current clinical problem.
- A positive effect of structural differentiation on the adaptive movement may indicate that the adaptive movement holds a neurodynamic component.
- Bilateral comparison is performed in a similar fashion to the ipsilateral side.
- The adaptive movement can be used for reassessment.
- It can also be used in treatment in certain circumstances.

Straight Leg Raise

Introduction

The straight leg raise is used to test the movement and mechanical sensitivity of the lumbosacral neural structures and their distal extensions which consist of the lumbosacral trunk and plexus in the pelvis, sciatic and tibial nerves and their distal extensions in the leg and foot.

Indications

- Lower quarter problems - pathology, dysfunction, pain
- Thoracic spine problems
- Occasionally cervical disorders and headache

Preparation

- **Patient position** - supine, aligned symmetrically, in purest form - no pillow under the patient’s head for reasons of consistency.
- **Therapist position** - stride standing so that the therapist can alter their position and maintain good technique at the same time.
Movements

Hip flexion with a straight knee.

Prevent any variation of movements in the frontal and transverse planes, namely adduction/abduction and internal and external rotation of the hip. This is because all these movements sensitize the test.

Technique

The therapist’s distal hand gently clasps the posterior aspect of the leg, immediately proximal to the ankle. The reason for choosing this position is that patients often experience ankle discomfort if the calcaneum is used at the contact point. This is because, as the limb is raised, its weight pushes the tibia posteriorly on the talus which turns the test into an anterior draw for talocrucal instability and can be uncomfortable in even normal subjects, especially if the ankle is relaxed and hypermobile.

The therapist’s proximal hand is then placed over the anterior aspect of the knee, either immediately distal to the patella over the tibial plateau, or immediately proximal to the patella over the distal insertion of the quadriceps tendon. These hand positions are chosen to avoid patellofemoral compression and subsequent discomfort.

The limb is gently raised and the symptoms and physical responses are monitored closely. During the actual movement, it is crucial that the therapist prevent any knee flexion because small changes in knee position will produce significant changes in the response and range of motion. Movements of the hip in the transverse and frontal planes are also controlled precisely.

Starting position  
Leg raise - hip flexion in sagittal plane

Differentiation with dorsiflexion

Note the changes in position with each phase.

Apply counter pressure distally with proximal hand so as to avoid compression up the limb.

Use your thumb to assist with the DF.
Sensitising Movements (level 3A)

Internal rotation and adduction of the hip

Contralateral lateral flexion of the spine can be added.

Structural Differentiation

**Proximal symptoms** – use dorsiflexion, a change in grip and body position are necessary.

**Distal symptoms** – they are probably already differentiated hip flexion producing distal symptoms.

**ACTIVE CERVICAL FLEXION**

Structural differentiation of the straight leg raise is often attempted by the therapist asking the patient to perform active neck flexion. Unfortunately, this is entirely flawed and can produce a wide variety of false results. The inadequacy of this method is by virtue of the abdominal muscles contracting during the head raise, causing the pelvis to rotate posteriorly. This reduces the hip flexion angle and often reduces the symptoms because of a lowering of the straight leg raise by the mechanism of reversed origin. Conversely, some patients activate their hip flexors which produces an increase in straight leg raise angle by rotating the pelvis anteriorly. On account of the above, active neck flexion in the differentiation of the straight leg raise test is not recommended.

Common Problems with Technique

Not holding the knee in full extension – note that the technique of holding the knee does not force the knee into extension.
Not controlling movements of the hip in the transverse and frontal planes – this produces alterations in sensitization of the test.

Not being able to make the transition from the beginning of the straight leg raise to the end in which the therapist’s standing position changes at the middle part of the test. This will necessitate the therapist paying particular attention to altering the weight on their feet and direction of their own body smoothly. Practising this aspect of the technique on people of different sizes and shapes solves this problem.

Stopping hip flexion at the first movement of the pelvis – this has been a popular technique in structural differentiation. The idea is that if the pelvis has not moved, neither has the lumbar spine. Therefore, if low back pain is reproduced, the problem must have a neural aspect to it. Even though the logic for the use of this approach is reasonable, it houses problems. Since the hip flexion angle never reaches full range, the neural structures are also not moved through their full range. This procedure will therefore be prone to producing false negatives.

Normal response

Pulling and stretching in the posterior thigh that spreads into the posterior knee and sometimes into the upper third of the calf. The range of motion varies between approximately 50°-100°.

Tibial Neurodynamic Test (TNT)

Indications

When symptoms are located in the distribution of the tibial nerve and its extensions ie. posterior tibial nerve, medial calcaneal nerve, and the plantar and digital nerves.

Calf pain, heel pain (including plantar fasciitis) and pain in the plantar aspect of the foot,

Preparation

Step 1 - starting position

Step 2 - dorsiflexion/eversion (both hands)
Section 4  Standard Neurodynamic Tests

Step 3 - stabilise tibia (triceps)  Step 4 - raise leg with straight knee

Common Problems With Technique

Not starting in the right position of kneeling relative to the patient.

Not holding the patient’s foot correctly – must be full comfortable dorsiflexion/inversion. Remember that, because not much of these movements occurs, the test is not particularly sensitive, except in cases that are easily provoked.

Not holding the knee in extension properly with your triceps. Use your triceps because it is uncomfortable for the patient if you use your elbow.

Normal Response

Stretching in the calf region (sometimes medial calf) and this often extends into the medial aspect of the ankle and plantar surface of the foot.

ROM - straight leg raise is usually between 30° and 70°. When performed effectively, the leg can not be raised as far as the standard straight leg raise test in the same individual.
Fibular (Peroneal) Neurodynamic Test (FNT)

Indications

Conditions that affect the anterolateral leg and ankle and dorsal foot areas.

The therapist should also be willing to test use this test in the presence of L4-5 radicular pain because, occasionally, it can be more sensitive for this problem than the standard straight leg raise with dorsiflexion.

Preparation

**Therapist position** - stride standing, facing and leaning caudad.

The therapist’s far hand passes under the plantar aspect of the foot so that, by the time plantarflexion/inversion has occurred, the fingers can come over the top of the toes, after passing distally and wrapping back over their dorsal surface. This is important because movement of the toes (target tissue) is an important part of the test and is often omitted. Executing this part of the technique properly will give the therapist the opportunity to take the nerve to its end range of motion and will necessitate that the therapist cradles the patient’s achilles tendon and ankle regions on the therapist’s forearm.

Place the near (proximal) hand over the anterior aspect of the proximal end of the tibial plateau and grasp it firmly but comfortably. The job of this hand is to maintain the knee in extension.

Prevent internal rotation of the tibia during the plantarflexion/inversion movement so that the patient’s hip does not rotate extraneously.

Starting position for the peroneal neurodynamic test (PNT).

**Movements**

Plantarflexion/inversion of the ankle foot, and toes, followed by the straight leg raise.

**Technique**

The leg raise component movement is performed by the therapist’s distal arm, such that the main weight-bearing surface is the therapist’s distal forearm. This means that the therapist will have to transfer their weight from their front (distal) foot toward their back (proximal) foot so that the movement hinges around the patient’s hip joint during the straight leg raise movement.
Common Problems With Technique

Not holding the foot correctly – in this case, the movements of the foot will be insufficient in amplitude or they may deviate into either too much plantarflexion relative to the inversion.

Not using the distal forearm to produce the straight leg raise (hip flexion) component – this will make it difficult to raise the leg without losing control of the foot movements.

Not fixating the tibia on the femur – this results in internal rotation of the entire lower limb, which, although may be used to sensitise the test, is an extraneous movement in relation to the standard one.

Normal Response

Stretching/pulling in the anterolateral leg, ankle and foot. When it does not extend the whole length of this area, it can occupy patches that are within the distribution of the peroneal nerve.

Sensitising Movements

- contralateral lateral flexion
- slump test
- internal rotation and adduction of the hip joint

Sural Neurodynamic Test (SNT)

Indications

When symptoms appear in the posterolateral leg, ankle and foot eg. sprained ankle, S1 radiculopathy, cuboid syndrome and peroneal tendonitis.

Preparation

The hand hold is the opposite to the peroneal neurodynamic test

Distal hand passes medially around the foot.

Proximal hand passes medially around tibia and knee.
Dorsiflexion/inversion + straight leg raise

Common Problems With Technique
Not holding the knee properly – this enables the knee to straighten slightly, which compromises the sequence of movements and reduces the effectiveness of the test.

Not moving around the patient’s hip joint – this means that the limb will tend to abduct and, again, the effectiveness of the test is reduced. To correct this, it is essential to start from the point of standing with the legs wide apart, leaning around the patient and being prepared to transfer weight from foot to foot.

Normal Response
Pulling/stretch in the lateral ankle region and sometimes this spreads into the posterolateral aspect of the calf.

SLR ROM - 30°-60°
Sensitising Movements

- contralateral lateral flexion of the lumbar spine
- slump test
- internal rotation and adduction of the hip joint

Slump Test

Introduction

The Slump test is used to evaluate the dynamics of the neural structures of the central and peripheral nervous systems from the head, along the spinal cord and sciatic nerve tract and its extensions, in the foot. It is a complex test and is often misunderstood and misinterpreted. In the past, the general technique has been to lower the head and straighten the leg whilst the patient is in the sitting position. If the patient’s pain is reproduce, the test is abnormal. The problem with this is that it does not take into account subtleties that should be applied in order to gain the most from the test and offer the patient an accurate diagnosis. By this, it is meant that sensitive with attention to detail in both technique and interpretation is crucial in effective application of the test.

Indications

Technically, any symptom from the head to the foot that lies in the distribution of the brain and spinal cord could warrant evaluation with the slump test.

Common conditions - headache, pain anywhere in the spine or shoulder girdle, pelvic problems

Lower limb problems in which the pain is located in the distribution of the sciatic nerve and its extensions.

Preparation

Patient position

- sitting with the posterior aspect of their knees against the edge of the treatment couch with their thighs parallel.
- patient’s knees against the edge of the couch

Therapist position

Both feet on the ground, leaning toward the patient’s shoulders, proximal arm over the patient’s shoulders ready to guide the patient’s upper body and neck movements.
Movements

1. Thoracic and lumbar flexion (slump component)

This is the bow string effect between C7 and hip joints. It is not compression, even though some occurs.

Check that the sacrum is vertical at the end of this manoeuvre for consistency reasons.

Apply over pressure - if appropriate

2. Cervical Flexion

The patient slowly lowers their head toward their chest. So that provocation of symptoms is avoided, the therapist places their far hand on the patient’s forehead and controls the speed and amplitude of neck flexion.

The range of motion (determined by prior clinical reasoning) is maintained by the therapist changing their hand position so that the palm of the near hand rests gently on the patient’s occiput.

The hand that controlled the cervical flexion (far hand) is freed to deal with the lower limbs.

The action of the hand that lies over the patient's occiput is one of preventing release of cervical flexion rather than applying overpressure into flexion.

Usually, sufficient information can be obtained without performing overpressure. For this reason, overpressure to cervical flexion should not be part of the standard slump test.

However, gentle overpressure into cervical flexion can be a very useful addition to standard testing, as in more extensive examination. Its benefit is in the detection of subtle abnormalities and is a key part in diagnosis of the covert abnormal response. In patient’s who have such an abnormality, the neck shows greater tightness than usual or the therapist can feel the head trying to elevate in an attempt to release cervical flexion.

3. Knee extension

Active or passive - at the therapist's discretion and will vary between patients.

I suggest a combination of both. In the end, the imperative is for the therapist to have a good understanding of the relationships between each dimension.

In the performance of knee extension, the therapist holds the patient's ankle, which is the easy part. The difficult part of this manoeuvre is to hold the rest of the patient’s body still so that extraneous movements do not occur. This necessitates the therapist holding their near hand and medial forearm on the patient’s occiput and C7 spinous process precisely in the same position throughout the latter stages of the test.
4. Dorsiflexion

Uses - finalize the slump test, differentiate lumbar symptoms

Method - hold the foot with the whole of the therapist’s distal hand and make the movement.

Thoracic and lumbar flexion  Neck flexion

Knee extension  Dorsiflexion

5. Release Neck Flexion

The patient can also have their hands behind their back, resting on the bed.
NORMAL RESPONSE

Cervical flexion - stretching in thoracic region
Knee extension - stretching in posterior thigh
Symptoms differentiate with dorsiflexion and release of cervical flexion
Release of cervical flexion also produces increase ROM of knee extension and dorsiflexion

Level 3a - Neurodynamically Sensitized Slump Test

The complete level 3 (sensitized) slump test consists of the standard slump test and the additional sensitising movements which are as follows.
Section 5

Diagnosis with Neurodynamic Tests

Lecture and practical/lab session

Classification of responses
Interpretation of neurodynamic tests
Practise testing
Diagnosis with Neurodynamic Tests

Interpretation of Neurodynamic Tests

Potential Sources of symptoms

- axons in the nerve
- connective tissues in the nerve (nervi nervorum)
- blood vessels in or around the nerve
- muscles
- joints
- fascia

Therefore structural differentiation manoeuvres are essential.

Structural Differentiation

The first distinction to make is whether the nervous system is involved because it affects the next chain of events with the way we reason through the examination and treatment.

Structural differentiation is used to make a distinction between neural and non-neural structures and is an essential part of neurodynamic testing. As a reminder, it is when the nerves in the problem area are moved without moving the musculoskeletal tissues. Therefore, if the symptoms change with the differentiating manoeuvre, the symptoms are inferred to be neurogenic. In the non-neural response, the symptoms do not change with the differentiating movement. The validity of structural differentiation has not been definitively proven but there is good evidence that, in some cases, it is a valid way of testing nerves.

Here is an example of structural differentiation:

eg. Forearm symptoms with the MNT1. Neural or musculoskeletal?

Change the tension in the nerves with side bending of the neck and, if the symptoms also change, the symptoms are likely to be neural. If they do not, then they are likely to be non-neural (ie. from muscles, joint or fascia). To differentiate symptoms in the neck or shoulder, you would use wrist movements.

The next section on classification of responses challenges some of our old concepts of positivity.
Classification of Responses

Problems exist with the classification of symptoms responses with neurodynamic tests because of the many possible types of responses that can occur and what each means. Here is a suggested classification of responses and a distinction between them must be made for clinical interventions to be well-founded.

Diagnostic/Clinical Pathway

Step 1

PERFORM NEURODYNAMIC TEST

PRECEISE
- hand positions
- joint ranges
- movement resistance
- neurodynamic sequence
- slow
- careful

ADEQUATE
- each movement to first comfortable symptoms
- resistance

PRODUCE RESPONSE/EFFECT

SYMPTOMS
Area/distribution
Choose differentiation movement

PHYSICAL
ROM
Resistance
Muscles responses
Protective movements

Step 2

STRUCTURAL DIFFERENTIATION!
Musculoskeletal
no change in symptoms

Neurodynamic
symptoms change

Symptoms
Physical behaviour

KIND OF RESPONSE!
Normal
Normal

ABNORMAL

KIND OF ABNORMAL RESPONSE!

REPRODUCING

NON-REPRODUCING

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Musculoskeletal Response
A musculoskeletal response does not change when a differentiating movement is performed. Neurodynamic tests can produce this kind of response. In which case the neural tissues are not likely to be the source of symptoms.

Normal Neural Responses
The ULNTs are very sensitive tests because they are neurogenic in normal subjects (Kenneally et al 1988). So here are some crucial questions.
Q: What does a positive test mean if they are positive in normals?
A: It is normal for test to produce a neurogenic response. Therefore, we must now distinguish between normal neurogenic and abnormal neurogenic responses in our patients.
Are differentiated to be neural
Are similar in location and range of movement and quality of symptoms to those in normal subjects
Reasonably symmetrical in site and quality of symptoms
Reasonably symmetrical in range of motion and behaviour of resistance
Does not reproduce the clinical symptoms

Abnormal Neurogenic Responses (neuropathic)
Are differentiated to be neural with structural differentiation
Are different from those in normal subjects
Show reduced range of movement compared with the unaffected side
Show increased resistance compared with the unaffected side
The location or quality of symptoms can be different from normal or unaffected side.

A. Overt Abnormal Response
Structural differentiation gives a neural result
The test reproduces the patient’s symptoms
The range of motion may be reduced.

B. Covert Abnormal Response
Is differentiated to be neural
Evokes abnormal symptoms but it:
Does not reproduce the patient’s clinical pain
May be asymmetrical in range, resistance pattern or distribution of symptoms
May be a “comparable sign” worth treating.
The most important thing is to determine the relevance of the response. In the symptomatic patient, it could be a subtle problem that needs treatment.
Or, in the asymptomatic person, the response could be a hidden subclinical abnormality, or even a variation on normal for that individual. Matching this response with the patient problem is a key aspect of interpreting responses to neurodynamic tests.

eg. a patient complains of forearm pain when working with computers. A cramping ache is evoked by the MNT1 in the region of the problem but it is not the sharp pain like it is with using a computer. The clinical pain is not reproduced but something abnormal is evoked. It is differentiated to be neural with neck contralateral lateral flexion and the range of elbow extension is reduced by several degrees compared with the normal side. The supination component of the test is tight compared with the other side, and this loosens with releasing neck contralateral lateral flexion. These physical signs could be relevant and to miss them would leave the patient without the option of potentially effective treatment.

What Is a Positive Test and What Does It Mean?

Get away from using the term positive because tests are neurogenic (positive) in normal subjects. The NDTs are sometimes so sensitive that an ordinary neurogenic response does not necessarily indicate an abnormality. So it is suggested that you do NOT use the term “positive”.

Use the terms - “normal neurogenic” or “abnormal neurogenic” (neuropathic) and then categorise what type of abnormal neurogenic response it is.

An abnormal neurodynamic response does not indicate the cause. For more discussion see (Shacklock 1996).

Step 3
Relevant
- reproduces the patient’s current clinical pain - overt abnormal
- is tighter than normal
- the symptoms spread further than normal
- this is different from the asymptomatic side
- the difference is in the right location for the patient problem.

Irrelevant
- relates to an old problem that is no longer symptomatic
- anomalous response that is symmetrical eg. bilateral tightness
- normally tight for that person and is symmetrical
- may have an anatomical anomaly that is not relevant.

It is possible that not all nerve problems are painful (Neary et al 1975).

Relationship of NDTs to the Cause

An abnormal neurodynamic test does not establish the cause. This is ascertained in the entirety of the evaluation process and involves subjective and physical examinations, medical and radiological tests etc.

Therefore, the main thing that an abnormal neurodynamic test offers is that fact that something in the nervous system is wrong and the cause must be established. Possible causes of an abnormal neurodynamic test:
- Pancoast tumour and malignancies
- osteophytes
- disc bulges
- swollen joints and tendon sheaths
- ganglia
- myotendinous and nervous system anomalies
- neuritis
- nerve compression
- joint movement dysfunctions.

Therefore it is imperative that NDTs are only used as an indicator that something is wrong.

An abnormal neurodynamic test means that the neural tissues may be mechanosensitive or contain movement impairment for which the cause must be established.
Section 5  Diagnosis with Neurodynamic Tests

Step 4 - what is the cause and how should it be treated or managed?

What is the best treatment?

Treatment is very much dependent on what the problem is (diagnostic category) and what level (progression) it occupies.

Practical Application - exercises in diagnosis. Practise the three steps on your colleague(s)

Steps summarized again

Step 1
Step 2

If you find something wrong, you may be able to relate it to your colleague's clinical situation

Step 3

If you find something wrong, you may be able to relate it to your colleague's clinical situation
Section 6

Planning Examination and Treatment

Lecture
Planning Examination and Treatment

*How extensive should it be?*

**General Points**

Confusion exists about how to select examination and treatment techniques

- how strongly should a neurodynamic test be performed?
- how far into a provoking movement should a test be taken?

There is a spectrum of patient problems ranging from the very sensitive to the athletic which systematic treatment can take into account

- which neurodynamic sequence should be used?
- sliding versus tension treatments
- interface versus neural treatments
- standard tests in evaluation/treatment or limited or extensive/sensitised techniques

Decisions on the extent and type of examination are influenced by many clinical factors that need clarification.

Below is a three tier system of deciding on the extent of the examination in the planning of neurodynamic testing. Naturally, not all criteria will occur simultaneously in the same patient and it is the role of the practitioner to choose the most appropriate elements in deciding on the extent of the examination.
Level Zero – Neurodynamic Testing Contraindicated

- Severe pain
- Psychological influences
- Legal problems
- Highly unstable condition, worsening rapidly and other priorities take precedence
- Obvious severe pathology with neurological impairment eg. syrinx, CVA etc, acute foot drop etc.

Level 1 - Limited

Description

This level of examination is designed to open new and safer avenues for assessment and treatment in the patient with irritable symptoms or a pathology through refined testing.

Previously this has not been the case because, in the presence of risk factors, therapists have generally neglected the neural component.

Safety is the primary concern.

Indications

- When pain that is easily provoked and takes a long time to settle after movement. This relates to Maitland’s concept of irritability in which irritable problems are treated more gently and with greater caution than non-irritable problems (Maitland 1986).
- Severe pain is present, a complete neurodynamic assessment may not be appropriate for ethical and safety reasons.
- Latent pain – when the patient’s pain develops a long time after physical testing. Latency carries risk because adequate warning of an imminent increase in symptoms does not occur at the time of testing.
- Pathology is present either in the nervous system or the mechanical interface eg. a severe disc bulge or stenosed lateral recess in which pressure on the nerve root might be elevated and the excursion of the nerve root may be limited.
- Neurological deficit may necessitate a level 1 examination so as not to provoke neural irritation or damage.
- When a lasting increase in neurological symptoms is possible with neurodynamic testing.
- Progressive worsening prior to physical examination.
- Uncertain that the nervous system will tolerate standard testing (level 2 examination). If performance of a level 1 examination is found to be safe and does not reveal sufficient information, then the therapist may progress carefully toward a level 2 examination by gradually including more features of a level 2 technique.
Method (General Points)

Some of the components of a neurodynamic test may be omitted so that only minimal forces are applied to the nervous system.

It will also be necessary to modify the sequence of movements (eg. remote).

The therapist performs the usual neurodynamic tests and other mechanical tests for the musculoskeletal structures separately ie. simultaneous testing of the nervous system, interface and innervated tissues is avoided.

Restricted to evoking first onset of symptoms once only, if possible

Full range of motion is often not be achieved

The level 1 examination can provide sufficient information about the problem, particularly whether a neural component exists.

Structural differentiation is still performed, however, it takes a modified form.

Modified Structural Differentiation

Differentiating tension movement is performed prior to the application of any other test movements. The rest of the level 1 test is performed so that, at the first onset of symptoms, the differentiating movement can be released to produce a reduction in symptoms. This is instead of performing a differentiating movement that increases tension at the end of the neurodynamic test and so prevents further provocation of symptoms.

Structural differentiation becomes the ‘off switch’.

Clinical Example: irritable lumbar nerve root

- ankle dorsiflexion first
- slow and gentle SLR to first onset of mild symptoms
- release dorsiflexion to differentiate
- structural differentiation (dorsiflexion becomes the off-switch)
Level 2 - Standard

Description

Standard tests are used
Interface, neural and innervated tissues are tested/treated separately
Neurodynamic tests are performed to a comfortable production of symptoms only.
May be, but not necessarily, taken to end range.

Indications

The problem is not particularly irritable
Neurological symptoms are absent, or are only a minor part of the condition, and these neurological symptoms are not easily provoked
The problem is reasonably stable and is certainly not deteriorating rapidly
The pain is not severe at the time of examination, neither is there severe latency in terms of symptom provocation.

Method

The nervous system is effectively put through all its normal paces, but without combining neural tests with musculoskeletal ones. The test movements should not evoke excessive pain, neurological symptoms or go into a great deal of resistance.
Standard neurodynamic tests are used
Neural and musculoskeletal structures are examined separately
Movement into some symptoms is acceptable, as long as they are not severe and settle down immediately after the test
A degree of resistance may be encountered, however, it should not be strong
Full range of movement may be reached but this is not essential.
Level 3 – Advanced

General Description
Testing of the nervous system is more extensive than the previous levels.
Specificity and sensitivity are the focus and this is based heavily on the neuropathodynamic mechanisms.
Neural structures can be tested in relation to the musculoskeletal tissues - more sensitive.

Indications
Level 2 (standard) examination tests are normal, or do not reveal sufficient useful information, and the clinician wishes to investigate the problem more extensively
The problem is stable
When the patient’s clinical pain is difficult to evoke
When there is no evidence of pathology that might adversely affect the nervous system
No neurological abnormalities eg. loss of conduction are present
High expectations in physical function.

In any patient from whom sufficient information has been gained by the execution of a level 1 or 2 examination, the level 3 examination is unnecessary and contraindicated.

Level/type 3a. Neurodynamically Sensitised
Definition
More neural tension is added to the standard neurodynamic test through the addition of sensitising movements.
Standard test but “more-of-the-same’ technique”
- lumbar contralateral lateral flexion
- hip internal rotation/adduction

Method
The level 2 examination is performed prior to executing one at level 3. This is to be sure that the nervous system can cope with such testing.
Only the sensitizing movements of the standard neurodynamic test are added to the standard test.

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Level/type 3b. Neurodynamic Sequencing (Localised)

Description

Local sequence - movements start locally and become progressively more remote.

A particular part of the nervous system is emphasized.

Level/type 3c. Multistructural

Description

Neural structures are tested in combination with tests for musculoskeletal structures.

Generally used in the person with high expectations in terms of human function in which minor mechanical problems will provoke symptoms more easily than in patients whose needs are less extensive.

Often athletes, sports people and persons who work in occupational settings where high demands are a feature of their activities.

Method

Many movements and structures can be used.

Interface, neural and innervated tissues can be moved at the same time eg. opener and neural, with some innervated tissues testing also.

Neurodynamic sequencing is modified to suit the patient’s specific pathodynamics.
Section 7

**Neuropathodynamics**

**DIAGNOSTIC CATEGORIES**

*Audiovisual presentation*

Opening and closing dysfunctions
Neural tension dysfunction
Combined dysfunctions - level/type 3c
**Aims**

Present some new diagnostic categories for mechanical diagnosis and treatment

Link neural system to the musculoskeletal system

Base the classifications on causal mechanisms

Mechanisms will interact and coexist

---

**Types of Dysfunction**

1. Mechanical interface
2. Neural
3. Innervated tissue

---

**Mechanical Interface**

Reduced Closing Dysfunction Definition

When the mechanical interface lacks appropriate movement in the closing direction

Often due to increased pressure on the nervous system and often houses a space-occupying element eg. disc bulge, swollen joint, tendons etc.

Always suspect pathology.
Clinical Features

- Severe cases - contralateral shift
- Reduced closing eg. extension or ipsilateral lateral flexion
- Symptom production or reproduction on closing
- Opening movements ease eg. flexion or contralateral lateral flexion

Reduced Opening Dysfunction

- Hypomobile/stiff in opening eg. contralateral lateral flexion
- Severe cases - ipsilateral shift
- Production or reproduction of symptoms with opening movement eg. contralateral lateral flexion
- Neural tension signs common (ie. often coexists with neural tension dysfunction).

Neural Tension Dysfunction

Clinical Features

- ABNORMAL TEST RESPONSE
  - Overt
  - Covert

  TENSION MOVEMENTS
  - Increase symptoms

  TENSION RELEASE
  - Decreases symptoms

Neural Tension Dysfunction (cont.)
Neural Sliding Dysfunction
Clinical Features

**Key Features**

- Tension movement sometimes relieve the pain
- Neck flexion in slump produces back pain
- Knee extension decreases the pain

**Cephalad (upward) Sliding Dysfunction**

- Neck flexion increases symptoms
- Knee flexion increases symptoms

**Caudal (downward) Sliding Dysfunction**

- Neck extension
- Knee extension
Context for Sliding Dysfunctions

Sliding dysfunctions are rare but they do happen
1. Consistent responses to physical testing
2. Localising signs
3. History of pathological process in the region
   - trauma, inflammation, degeneration
4. Radiological evidence of pathology in the interface
   Not as likely in patients with erratic physical signs and central and psychosocial mechanisms.

Pathoanatomical Dysfunction

Definition
When disturbance of nervous system function is caused by pathology in the nervous system

Examples:
- Neurapraxia, axonotmesis, neurotmesis (Seddon, Sunderland)
- Arachnoiditis, tumours (Schwannoma), neuromas, amyotrophy

Pathophysiological Dysfunction

Definition
When an aspect of the physiology of the nervous system is abnormal

Intraneural blood flow - elevated pressure and the tourniquet effect
Pressure - tourniquet effect

Impaired Pressure Gradients

Links Between Pathomechanics and Pathophysiology

Mechanical Irritation
Mechanosensitivity

Overview
Mechanosensitivity is how nerves hurt with movement.

Definition
How easily impulses are activated from a site in the nervous system where mechanical force is applied.

Mechanosensitive Axons
Sympathetic
Motor
Proprioceptive
Nociceptive
Nerves are mechanosensitive when given enough force.

Normal nerves hurt if you pull or push hard enough on them.

Full neurodynamic tests pull hard enough to produce a symptom response.

**Mechanism?**
- ischaemia
- stretch/nociceptive receptors

<table>
<thead>
<tr>
<th>STRUCTURAL DIFFERENTIATION</th>
<th>KIND OF RESPONSE</th>
<th>KIND OF ABNORMAL RESPONSE</th>
<th>RELEVANT?</th>
<th>CAUSE!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musculoskeletal no change in symptoms</td>
<td>Normal</td>
<td>Normal</td>
<td>OVERT</td>
<td>No</td>
</tr>
<tr>
<td>Neurodynamic symptoms change</td>
<td>Normal</td>
<td>ABNORMAL</td>
<td>COVERT</td>
<td>No</td>
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Section 8

Treatment Method
Lecture

Working through a system of techniques
Treatment - working through a system of techniques

Note that the system of levels and types of examination applies to treatment in the same way that it does to examination.

Disc Function
- behaviour of the nucleus, annulus and foramen are different. This has implications for the nerve root.

As the segment extends, the nucleus moves forward but the annulus moves backward. This is because compression at the back of the disc displaces annulus out of the area. Also, the approximation of the posterior vertebral surface loosens the annulus which bulges backward.

The opposite occurs in flexion.

This is in the case of normal, degenerated and protruding discs.
Lumbar disc protrusion in standing, flexion/extension - annulus bulges more in extension and less in flexion.

Annulus compresses nerve root during extension.

Foramen dynamics with opening and closing.

Schmid et al 1999
General Principles

Observe symptoms at all times - before, during and after treatment

Reassess symptoms and physical signs - particularly neurodynamic status immediately after treatment, unless there is reason not to, such as to avoid provocation or undue focus on the problem. This includes neurological examination when appropriate.

Classify the dysfunction

Base treatment on the dysfunction category and level/type of examination

Avoid the words ‘stretch’ and ‘tension’ - I say “this technique is designed to improve the function of the nerve”

Respect resistance - low, medium or high

Be extremely sensitive - because this forms the basis for close analysis between you and the patient so that treatment can be responsive and derived from the patient’s response.

Speed - slow and gentle

Amplitude - generally the movement should come back to the inner range each time so the mobilisations are usually medium to large in amplitude

Dosage/Repetitions - perform several movements then reassess symptoms at rest or some physical sign that is not irritated with reassessment. This may be performed up to several times in one treatment session, as long as there is some value in the technique.
Sometimes, at higher levels (2 and 3) treatment can evoke (or elicit) symptoms - but it should not provoke them. There is a difference. I use provoke to designate a more severe and long lasting response. Evoke suggests that symptoms have been triggered but more on an instantaneous basis rather than the response being long lasting.

Slider Techniques

Produce:

- a lot of neural movement without producing much tension
- hypoalgesic effects (more than tensioners)

Can be used:

- level 1 tension dysfunction
- to reduce possibility of treatment soreness and settle symptoms down with advanced treatments
Section 9

Clinical Application
Practical/lab session

Low back and radicular pain - specific dysfunctions
Piriformis syndrome
Hamstrings
Heel pain and tibial nerve
Low Back and Radicular Pain

Treatment progressions

Mechanical interface - reduced closing dysfunction

The techniques below are particularly suited to patients with significant distal symptoms that involve pain, pins and needles or loss of sensation.

Indications

Predominantly distal symptoms - particularly pins and needles, numbness and weakness, neurological signs

Persistent/continuous distal symptoms

Not as common to use these techniques with acute/severe low back pain without referral of symptoms into the lower limb

Distal symptoms provoked by closing movements - extension, ipsilateral lateral flexion

Reduced ROM of closing movements

Key aspect - MUST do a neurological examination before and after each treatment.

Treatment is directed at reducing the pathophysiology in the nerve root rather than the mechanical dysfunction. This is because to treat the mechanical dysfunction (ie. closing) would be to risk provoking the nerve root.
Level 1 - Limited

1. Static Opener

Position - painful side uppermost with a bolster under the lower side.

Progression 1a. Towel between ilium and trochanter

Progression 1b - One leg over the side

Place in open position - painful side up, legs flexed to 90°, one foot placed over the side of the couch.

If this increases symptoms return foot to couch and place a bolster under waist instead.

Do not mobilise.

Degree of opening - depends on response to positioning

Duration - 30-60 seconds at first. If better, repeat several times. If the same, still repeat once more and reassess at the next session.

Monitor symptoms at rest and, if they improve, offer this position as a pain relief strategy.

Either leg can be lowered, depending which is more effective in achieving lateral flexion and what is more comfortable for the patient.

Progression 1c - both legs over the side

Position - as above, two feet placed over the side of the couch. Dosage same as in progression 1.

Dosage - up to several minutes at a time, hourly. Good gains can be achieved by doing this manoeuvre several times per day.
Progression 1d - manual opening to maximize.

2. Dynamic Opener/mobilisation (Level 1 continued)

Passive opener - contralateral lateral flexion

Can be done as small or large amplitude, in the inner or outer range.

Can be performed as a home also

Level 2 - Standard

Indications and Clinical Features

At this point, there is little to be found on neurological examination.

The distal symptoms are not easily provoked and are now intermittent or absent.

Neurodynamic testing shows minor signs (overt abnormal response (OAR) and covert abnormal response (CAR) late in range).

The interface dysfunctions are still present (reduced closing).

Now the treatment changes from treating pathophysiology in the nerve root to treating the mechanical dysfunction in the interface.

Dynamic Closer

Closer mobilisation – inner, middle and outer range

Position - start mobilisation in open position and gently move toward closed position

Mobilisation - in the direction of closing but only to the point of first symptoms and the mobilisation is less than this range.

Perform slowly and carefully and with respect to the patient’s symptoms and physical responses, especially resistance and protective responses.
Dosage - 5-6 gentle movements then reassess. If there is an improvement, repeat several more movements. If the same after mobilisations, repeat sets of mobilisations, stop and reassess at next session.

This can be progressed by positioning the patient into ipsilateral rotation, less hip/lumbopelvic flexion and even into some extension but care must be exercised.

Neural Tension Dysfunction

Clinical Features

- SLR painful +/- PNF painful in severe cases
- Slump - NF painful - knee extension +/- dorsiflexion painful
The MORE and LESS are with respect to TENSION in the treated nerve root.

Contralateral and ipsilateral - THE LIMB that is used to produce the tension changes.

The following are pictures of the movement progressions but they are performed manually by the therapist.

Moving Through the Progressions
It may not always be necessary to pass through each progression because they provide small increments. It is therefore possible in many patients to jump a progression or two. However, this should always be done carefully with respect to the patient’s signs and symptoms and sufficient time should be allowed between treatments so that accurate observation of patient responses can be achieved.

LEVEL 1 - Progression 1 - Position LESS - Position LESS (tension)
ipsilateral limb - contralateral limb

Generic off-loader for the median nerve (applies to whole upper quarter)

Contralateral limb - hip flexed approximately 90˚ if possible
- contralateral knee extension
- hold for approx. 15 secs, longer if comfortable and safe (no problems in the contralateral limb - pins and needles or other symptoms)

Ipsilateral limb  Contralateral limb

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Progression 2 - Position LESS - Move LESS (tension)

ipsilateral limb *  - contralateral limb

As above (1) except the knee is extended and flexed
Perform approx. 5-10 times. This set can be repeated up to 3-5 more times.

Progression 3 - Position MORE - move LESS (tension) - knee flexion/ext.

ipsilateral limb *  - contralateral limb

Ipsilateral lower limb in neutral  
Ipsilateral dorsiflexion

Add ipsilateral SLR  
Move LESS - contralateral knee

More SLR  
Move LESS - contralateral knee

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Progression 4 - Position LESS - move MORE (tension)
contralateral limb - ipsilateral limb *

Sitting

Position LESS
- contralateral knee extension
- protects nerve root
- dorsiflexion optional

Move MORE
- ipsilateral knee extension
- dorsiflexion optional

OPTIONS:
- ipsilateral dorsiflexion
- neck flexion

Progression 5 - Position MORE - Move MORE (tension)
contralateral limb - ipsilateral limb *

From this:

This was the progression 4 starting position.

Now the protection from the contralateral knee is removed (remove the contralateral knee extension).
To this:
Position MORE
Move MORE - ipsilateral knee extension

Add cervical flexion
Move MORE - ipsilateral knee extension

WHAT IS THIS?
Option - add dorsiflexion

This is now level 2, the standard slump test.

You now have a wide variety of techniques below level two that are not likely to provoke symptoms.

Level/type 3a - Position MORE - move MORE (to tension)
Contralateral lateral flexion  Ipsilateral knee extension
HERE IS THE PROCEDURE FOR SAFER MORE ADVANCED TECHNIQUE

1. Test neurological function. If abnormal, this technique at level 3a is not recommended.

2. Position the patient comfortably.

3. Ask if the patient has any symptoms at rest. If “Yes”, do NOT proceed. The problem may not be at level 3.

4. Explain that symptoms may occur and, if they do, they must only be mild at most. Generally reproduction of the patient’s clinical symptoms is to be avoided. Stretching sensations are common.

5. Perform a test movement to the first onset of symptoms.
   5.1. make sure the patient moves slowly and carefully and that they learn to stop at the right place.
   5.2. return to the starting position and check that any symptoms disappear instantly. If not, wait until they do. If they take more than a few seconds, it may be better to do something more gentle.

6. If this goes according to plan:
   6.1. perform 3-5 movements the same way, making sure that the symptoms stop between movements.
   6.2. return to the start position for at least a second or two each time a movement is performed.

7. Do NOT stay in the end range position for more than about one second.

8. Test the neurological status to be sure that it has not deteriorated. If a deterioration occurs, the technique is contraindicated.

Position - as for slump test

Movement - cervical, thoracic, lumbar flexion, contralateral lateral flexion, knee extension, dorsiflexion.

Make sure the amplitude is large so you retreat from the symptomatic position each time.
Level/type 3c. Advanced - reduced closing with neural tension dysfunction

**Patient position** - painful side up

**Mobilisation** - closing (ipsilateral lateral flexion) + neck flexion and knee extension (ie. two-ended tensioner)

This one often needs practice so the patients gets the movements right.
Mechanical Interface - reduced opening dysfunction
Level 1 to Level 2

**Position** - leaning over the patient with both hands around the pelvis.

**Mobilisation** - as an opener from the slightly closed position to the slightly opened position.

Should not provoke pain.

This is effectively the opening mobilisation shown earlier except that a sustained opener is not performed for reasons of provocation.

The same as the dynamic opener for the closing dysfunction, but for different reasons.
Level 3c. Multistructural - reduced opening with neural tension dysfunction - dynamic opener

Dynamic opener + one-ended or two ended tensioner

Optional - neck flexion or not, depending on the desired progression.
It is normally positioned. Active neck flexion makes the patients stabilize their pelvis which reduces the opening, not desirable.

This is used when there is:
- less risk of provocation
- a tension dysfunction with reduced opening - quite common
Distal/Caudal (downward) Sliding Dysfunction

Clinical Features

- SLR painful - neck flexion OK or eases
- Slump - release neck flexion painful

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Progression 1 position LESS (up/cephalic) - position LESS (up/cephalic)

Same as in progression 2 except the neck is positioned in the flexion for a rest position to ease pain.

Progression 2 - position LESS (up/cephalic) - move LESS (up/cephalic)

Aim - to move the neural tissues away from the provoking direction and to do so with little neural tension.

Position - reduced tension (off-loaded) position

- painful side up, neutral spinal position in the sagittal and frontal planes
- approximately 45° of bilateral hip flexion, 45° of bilateral knee flexion

Movement - gentle passive neck flexion

Symptoms are not evoked

Observe symptoms as you would in all other progressions.
Progression 3 - position MORE (down/caudal) - move LESS (up/cephalic)

**Position** - same as above, add a small amount of ipsilateral knee extension prior to the mobilisation. This position should not evoke or reproduce any symptoms.

**Movement** - passive neck flexion again (position

This does not take the system to its end point of sliding, nor does it produce symptoms.

Progression 4 - position LESS (up/cephalic) - move MORE (down/caudal)

**Position** - painful side up, neck in flexion (to bring the neural tissues into a cephalad position in the canal - position away).

**Movement** - straight leg raise (move IN to dysfunction - down/caudad).

Some symptoms may be evoked but they should be mild and should cease immediately after the technique. However, if this mobilisation is provocative, it may be modified, as in the following:

You can then go further into SLR as a progression or add dorsiflexion if you wish.

Progression 5

This progression permits more caudal (downward) positioning (position IN - move IN = position down/caudal - move down/caudal).

5.1 As progression 4 position cervical spine in neutral then extension (down/caudad). Move the SLR for (downward/caudad) movement of the nerve roots.
5.2 Position - sitting across the plinth as if for the slump test, neck and thoracic spine straight.

Movements - cervical and thoracic extension with knee extension.

To progress - add dorsiflexion.

Ipsilateral lateral flexion can be added for more effect.

Understanding Sliders

Uses
- easing pain in the low level tension dysfunction
- easing pain or soreness from treatment
- promote movement
- muscle relaxation.

Mechanical Effects
- maximal sliding with minimal tensile forces inside the nerves
- may maintain or improve sliding mechanism, eg. prevention of adhesion or loss of movement in the case of surgery, trauma with bruising or bleeding from adjacent structures.

Physiological Effects
- may improve blood flow of nerve
- sliders produce greater hypoalgesic effects than tensioners.

Care with Sliders
- general slider for the tension dysfunction is a high progression for the siding dysfunction so:
  
  - if there is a sliding dysfunction, use the slider progressions provided above.
  
  - If sliders increase pain, you may be treating an actual sliding dysfunction at a high progression for what you though was a tension dysfunction.
Piriformis Syndrome

Mechanical Interface

You can use plantarflexion/inversion or dorsiflexion with these techniques because of the relationship the peroneal nerve has with the sciatic nerve in the pelvis and with piriformis. Sometimes the peroneal component can feature in the patient’s symptomatology.

Level 1

Progression 1 - Static opener

Hip position - slight flexion, abduction, external rotation
Knee position - slight flexion
Ankle position - neutral

Can do this in side lying or supine lying

Progression 2 - Dynamic opener

Passive external rotation - slow speed and large amplitude

This is for pain relief and can be performed as a home exercise

Level 2

Progression 1 - interface (muscle) release technique

Passive stretch of piriformis to be performed by therapist then as a home exercise by the patient. Even though this will produce closing during the technique, it will subsequently produce an opening effect as the muscle releases. This can be combined with contract/relax techniques.

Piriformis stretch - external rotation is IMPORTANT!
Neural

Level 1

1. Off-loader for Sciatic Nerve and Piriformis

- hip flexion below 70°, abduction/external rotation
- knee flexion
- foot comfortable
- can do this in supine also

General Point About Peroneal and Tibial Components

With all these following techniques, you can emphasize one part of the nerve in some people by using:

- plantarflexion/inversion - peroneal (fibular) nerve

- dorsiflexion - tibial nerve
2. Taking up the slack in the nerve - expected. ROM

3. Slider for the nerve (one-ended) - expected ROM

Option - place neck in extension to facilitate distal movement

Level 2

4. Tensioner for the nerve (one-ended) - expected ROM
Option - add neck flexion to increase tension

Then you could progress to the standard slump test as the treatment with knee extension as the mobilisation.

Level/type 3c

Piriformis Slump Test

In the slump position, perform the following movements in the following order:

- hip adduction
- passive external rotation (stretches piriformis onto the sciatic nerve)
- knee extension
- check response - reproduction of symptoms etc
- differentiate if need to with foot (PFI or DF) and neck movements
- sometimes the neural and interface components can be distinguished
- release external rotation
  - increase pain -> neural, decrease pain -> muscle

Piriformis slump test.

You can use dorsiflexion or plantarflexion/inversion to differentiate the two components of the sciatic nerve - tibial and fibular (peroneal).
Hamstrings and the Sciatic Nerve

Turl and George (1998) found that 57% of repetitive hamstring patients had an abnormal slump test between episodes (Rugby players).

Kornberg and Lew (1989) found that, during an episode, 76% had abnormal slump test. Both used the overt abnormal response category.

Level 1

**Two-ended Sliders**

Patients often can’t stretch their hamstrings

**Distal Slider**

- Pillow under knee
- So the hamstrings and ischial tuberosity stay stable, be careful NOT to move the hips
- Movements - ipsilateral lateral flexion/dorsiflexion

**Proximal Slider**

- Contralateral lateral flexion/plantarflexion.
- This produces very little movement of the hamstrings.
Next: In long sitting with the knee remaining stable, you can do the following:

Hip flexion - plantarflexion
Hip extension - dorsiflexion

This will start to produce movement in the hamstrings.

Level 2
Progress to the standard slump test using knee extension and neck flexion.

Level 3

**Muscle and Nerve**

In: slump test position

Do: contract relax technique to the hamstrings and as they relax you can release the muscle.

Dorsiflexion is an option.

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**Manual Treatment of the Hamstrings and Sciatic Nerve**

Combined Techniques

Manual techniques eg. connective tissue massage, deep frictions

Neural mobilisation - active dorsiflexion
Heel Pain

Alias - plantar fasci-itis/opathy, posterior tarsal tunnel syndrome

Mechanical Interface

Level 1

Progression 1 - static opener

Ankle position - plantar flexion/inversion, adduction and pronation of the forefoot on the hindfoot.

Nerve component - use generic off-loading positions as for releasing tension along the whole tract.

Progression 2 - dynamic opener

- Passive plantarflexion/inversion of ankle
- Adduction/pronation of forefoot on hindfoot
- Technique is important here.
- Do it in a plane that both opens the interface and reduces tension in the tibial nerve

Palpatory techniques for the interface and nerve - you can use your hands to massage the tunnel and nerve proximally to reduce local congestion.

Level 2

Progression 1 - closers

Dorsiflexion/eversion/abduction/supination - gentle because it is a closer - monitor symptoms afterwards, as usual.

Neural - tibial nerve at the ankle

Level 1

Progression 1 - off-loader as a position

Sciatic nerve generic off-loader - rest foot in neutral or open position

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Progression 2 - two-ended slider

Toe flexion + SLR, hold the ankle still, you can do this in sitting with the patient leaning forward or backwards or passively as an SLR.

Starting position

PROXIMAL SLIDER – knee extension/toe flexion

DISTAL SLIDER
Hip and knee flexion/toe dorsiflexion

Level 2 - tensioner

Progression 1 - tensioner/slider relative to the tendons
Ankle/toe dorsiflexion with SLR/knee extension

Level/type 3c. Multistructural (interface + neural)

Closer moving the heel into abduction/eversion during a slider or tensioner.
Section 10 References

References


Breig A 1978 Adverse mechanical tension differences in the central nervous system. Almqvist and Wiksell, Stockholm

Butler D, Gifford L 1989 The concept of adverse mechanical tension in the nervous system. Physiotherapy 75 (11): 622-636


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Section 10  References


Daniels T, Lau J, Hearn T 1998 The effects of foot position and load on tibial nerve tension. Foot and Ankle International 19 (2): 73-78


Elie E, Benoliel R, Tal M 2001 Inflammation with no axonal damage of the rat saphenous nerve trunk induces ectopic discharge and mechanosensitivity in myelinated axons. Neuroscience Letters 311: 49-52


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Hough A, Moore A, Jones M Restricted excursion of the median nerve in carpal tunnel syndrome. Poster presentation, Manipulation Association of Chartered Physiotherapists conference, Edinburgh; 2005


Laban M, MacKenzie J, Zemenick G 1989 Anatomic observations in carpal tunnel syndrome as they relate to the tethered median nerve stress test. Archives of Physical Medicine and Rehabilitation 70: 41-46


Miller A 1986 The straight leg raise. Unpublished Graduate Diploma in Advanced Manipulative Therapy thesis, University of South Australia


© 2017-18 NDS Neurodynamic Solutions
Nakamichi K, Tachibana S 1995 Restricted motion of the median nerve in carpal tunnel syndrome. Journal of Hand Surgery 20B: 460-464
Pechan J, Julis I 1975 The pressure measurement in the ulnar nerve. A contribution to the pathophysiology of cubital tunnel syndrome. Journal of Biomechanics 8: 75-79

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Selvaratnam P, Cook S, Matyas T 1997 Transmission of mechanical stimulation to the median nerve at the wrist during the upper limb tension test. In: Proceedings of the Manipulative Physiotherapists’ Association of Australia, Melbourne: 182-188


Shacklock M 1995a Neurodynamics. Physiotherapy 81: 9-16


Shacklock M 1996 Positive upper limb tension test is a case of surgically proven neuropathy: analysis and validity. Manual Therapy 1: 154-161


Shacklock M. Manual Therapy 2007 letter to the Editor, reply to Greening J, Leary R 2007

Shacklock M, Wilkinson M 2000 Dynamics of the median nerve in the wrist and forearm with specific active and passive movements of the upper limb and neck in the conscious human. Unpublished recordings, School of Medical Radiation, University of South Australia


Shacklock, M, Wilkinson M, Scutter S 2002 Dynamics of the median nerve at the elbow and posterior interosseous nerve during pronation and supination movements of the forearm. Unpublished recordings, School of Medical Radiation, University of South Australia


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Tsai Y-Y 1995 Tension change in the ulnar nerve by different order of upper limb tension test. Master of Science Thesis, Northwestern University, Chicago


Werner C, Haeffner F, Rosén 1980 Direct recording of local pressure in the radial tunnel during passive stretch and active contraction of the supinator muscle. Archives of Orthopaedic and Traumatic Surgery 96: 299-301


