

**PERIPHERAL MONONEUROPATHIES IN THE LOWER EXTREMITIES: AN ANATOMICAL,
CLINICAL AND ELECTROPHYSIOLOGICAL REVIEW**

Combined Section Meeting 2009
Las Vegas, NV ♦ February 9-12, 2009

Speakers:

David G. Greathouse, PT, PhD, ECS, FAPTA
U.S. Army Baylor University DPT Program
Fort Sam Houston, TX

John S. Halle, PT, PhD, ECS
Belmont University, School of Physical Therapy
Nashville, TN

Course Description and Objectives:

Description: This presentation will include a review of the anatomy, clinical examination (subjective and objective), and electrophysiological testing of common mononeuropathies in the lower extremity to include the femoral nerve, lateral cutaneous nerve of the thigh, obturator nerve, saphenous nerve, common fibular (peroneal) nerve, tibial nerve and sural nerve.

Objectives:

1. Describe and discuss the anatomy of the femoral nerve, lateral cutaneous nerve of the thigh, obturator nerve, saphenous nerve, common fibular (peroneal) nerve (deep and superficial branches), tibial nerve (medial and lateral plantar branches) and sural nerve.
2. Discuss the subjective (history) and objective (physical) examination of patients with suspected mononeuropathies in the lower extremity.
3. Discuss the nerve conduction (NCS) and electromyographic (EMG) studies used to confirm mononeuropathies in the lower extremity.
4. Discuss the neuropathology associated with mononeuropathies in the lower extremity.

Slide Presentation:

- **Overview of the Presentation**
 - Major nerves of the lower extremity will be overviewed with:
 - Anatomical overview
 - Clinical exam
 - Incidence
 - Subjective
 - Objective
 - Electrophysiological testing
 - Practical challenges
 - Case report
 - Specific nerves to be examined include:

Peripheral mononeuropathies in the lower extremities, 12 February 2009, property of David Greathouse, PT, PhD and John Halle, PT, PhD, not to be copied without permission

- Femoral
- Lateral cutaneous nerve of the thigh
- Obturator
- Superior and inferior gluteal
- Posterior cutaneous nerve of the thigh
- Fibular nerve with derivatives
- Sciatic nerve with derivatives

- **Assumptions Associated with All ECS Examinations**

- Testing is collaborative with the rest of the diagnostic information available
- Based on a good history
- Based on a good physical exam
 - Same implications as any good orthopedic exam, with adjacent regions also considered

- **Starting Proximally and Working Distally**

- Femoral Neuropathy:
 - Anatomy:
 - Femoral triangle
 - Intermediate cutaneous nerve and/or medial femoral cutaneous nerve
 - Saphenous nerve
 - Clinical presentation
 - Incidence: diabetes, trauma, iliacus hematoma
 - Subjective: pain prior to atrophy
 - Objective:
 - * Quad weakness
 - * Loss of KJ MSR
 - * Sensory impairment

- **Femoral/Saphenous Nerve Anatomy**

- **Femoral Neuropathy (con't)**

- ECS testing:
 - Nerve conduction studies (Many described techniques, some latencies only)
 - Sensory – harder to obtain and recorded typically in uV's – (SNAP)
 - Motor – typically easier to obtain, but the femoral nerve is an exception, due to the dispersion of the nerve: in mV's - (CMAP)
 - NCS Concept:
 - Stimulate and obtain a latency
 - Stimulate at a second site and calculate NCV

- Other:
 - * Amplitude, latency, duration, and conduction velocity

- **Example of NCS**

- Distal sensory latency
- Nerve conduction velocity
- Noteworthy features of sensory NCS:
 - No synapse to contend with
 - Smaller and harder to elicit
 - Antidromic vrs orthodromic

- **Example of NCS**

- Distal motor latency
- Nerve conduction velocity
- Noteworthy features of motor NCS:
 - Assesses segment of nerve, neuromuscular junction, and muscle fibers
 - Larger, typically easier to assess
 - Depth of the nerve being tested

- **Femoral Neuropathy (con't)**

- Assessment of the Saphenous nerve:
 - Sensory impairment (Longest terminal branch of the femoral nerve)
 - Potential Hunter's canal compression site
 - Side to side comparison
 - Technically challenging (Adipose, etc)
- Technique:
 - Antidromic or orthodromic techniques available

- **Femoral Neuropathy (con't)**

- NCS (con't)
 - Challenges:
 - Deep nerve site at inguinal ligament
 - Nerve is dispersed
 - Portion of CMAP is probably not a true NCS
 - If needle stimulating electrode is used lateral to femoral artery, slight arterial risk
 - Oh indicates, "there is no reliable method of assessing the motor NCV" with stimulation above and below the inguinal ligament

- **Femoral Neuropathy (con't)**

- EMG testing: (straightforward, performed 3 to 4 weeks following injury)

- Insertion
- Rest
- Voluntary contraction
 - Slight contraction
 - Maximal contraction
- Typically will assess a distal and proximal site
- Should also assess paraspinals to assess for potential posterior primary rami involvement, suggesting a plexopathy (avoid being myopic)
- **Basic EMG Exam Elements Demonstrated**
 - Insertion
 - Rest
 - Voluntary activity
- **Femoral Neuropathy – History, Physical Exam, and NCS/EMG**
 - 24 y o painter
 - May 2007 (7 months previously), fell from 12 feet from ladder and sustained severe contusion right anterior thigh
 - Over next several weeks, noted loss of sensation over anterior thigh and medial leg
 - Unable to extend right leg without external assist
 - Reported good general health apart from the symptoms listed above. Normal systems review
 - Gait: ambulates with cane in right hand and with a knee brace
 - Strength: right quadriceps 3/5, other BLE 5/5
 - Sensation: decreased LT and PP to anterior right thigh, right medial knee, and right medial leg
 - MSR's: absent right KJ, left KJ 2+, AJ's equal bilat
 - No pathological reflexes
 - Neural conduction studies (right side):
 - Sural: normal DSL
 - Superficial fibular: normal DSL
 - Saphenous: unable to elicit (left saphenous with normal DSL)
 - Deep fibular: normal DML, NCS and central conduction studies (F-wave)
 - Tibial: normal DML, NCS and central conduction studies (F-wave)
 - Femoral: unable to elicit with standard technique, but able to obtain CMAP with needle in RF
 - EMG:
 - Insertion: Increased in right VMO and VL
 - Rest: Fibrillation potentials (1+) and positive sharp waves (2+) were noted in the right VMO, and VL
 - Voluntary activity: 25% recruitment with some giant motor unit potentials in VMO and VL
 - Other RLE muscles and right paraspinals demonstrated normal EMG (Other muscles tested included in the right lower extremity and right paraspinals included: RF, AL, TA, FL, EHL,

lateral and medial gastrocnemius, BF [long head], semitendinosus, and paraspinals [upper lumbar, mid lumbar, lower lumbar, and sacral])

- **Femoral Neuropathy (Conclusions)**

- Interpretation:
 - 1. Abnormal electrophysiological examination.
 - Electrophysiological evidence of a chronic, moderate to severe right femoral neuropathy (axonopathy), involving the femoral nerve after it innervates the right rectus femoris (see EMG summary). Chronic neuropathy supported by fibrillation potentials < 100 uV's in amplitude, occasional giant motor unit and polyphasic potentials, and length of time since injury.
 - Evidence of a right saphenous neuropathy, as terminal extension of femoral nerve (see NCS summary)
 - 2. Apart from the findings in #1 above, there was no electrophysiological evidence of: (list of all other elements tested)

- **Lateral Cutaneous Nerve of the Thigh**

- Anatomy:
 - Purely sensory nerve
 - Can be compressed as the nerve passes under the inguinal ligament
 - Becomes superficial 10 to 12 cm distal to ASIS
 - Meralgia Paresthetica
- Clinical presentation:
 - Incidence:
 - Peak incidence is middle age
 - Both sides equally affected
 - Most cases are idiopathic

- **Lateral Cutaneous Nerve of the Thigh Anatomy**

- **Lateral Cutaneous Nerve of the Thigh (con't)**

- Clinical presentation (con't):
 - Subjective:
 - Loss of hair over region of paresthesias and pain
 - Altered sensation rarely increased by hip extension
 - Objective:
 - Objective sensory loss in distribution of LCNT
 - Unilateral altered NCS (abnormal latency or < 50% amplitude)
 - Absence of motor deficits

- **Lateral Cutaneous Nerve of the Thigh (con't)**
 - NCS:
 - Antidromic: least artifact
 - Orthodromic: alternate technique
 - Often with at least one needle electrode
 - May be absent in normal individuals – thus, technically challenging
 - Motor – not applicable
 - Practical challenges
 - Obtain on the unaffected side first
 - Course and depth of nerve
 - Adipose
 - SEP is an alternative

- **Lateral Cutaneous Nerve of the Thigh (con't)**
 - Case report:
 - History/subjective:
 - 36 y o plumber
 - Symptoms present x 24 years, associated with MCC and reported hip subluxation
 - Main complaint: N/T and burning in right lateral thigh
 - No weakness
 - Occasional LBP but no radicular symptoms
 - Good general health
 - No HM exposure, thyroid or renal disease, and not ETOH abuse
 - System review: non-contributory for CV, pulmonary, GI, GU, or endocrine
 - No fm hx of neuromuscular disease
 - Physical Exam:
 - Gait: normal, able to heel-walk, toe-walk and squat without difficulty
 - AROM BLE WNL
 - Sensory: decreased PP and LT in right lateral thigh – other WNL BLE
 - MMT: WNL BLE
 - MSR's present and = BLE (2+)
 - Babinski and Chaddock pathological reflexes absent bilaterally
 - Vascular: normal pedal and PTA artery pulses
 - Special test: normal SLR bilaterally

- **Lateral Cutaneous Nerve of the Thigh (con't)**
 - NCS:

- Right sural nerve: normal SCS
- Right superficial fibular nerve: normal sensory conduction study (SCS)
- Right deep fibular nerve: normal motor and F-wave studies
- Right tibial nerve: normal motor and F-wave studies
- Right LCNT: prolonged DSL of 3.4 msec (nl < 3.0 msec) at 12 cm (Butler's method)
- Left LCNT: normal DSL of 2.9 msec (nl < 3.0 msec)
- EMG:
 - Normal insertion, rest, and voluntary activity in right TA, FL, EHL, VM, RF, AL, both heads of gastrocnemius, BF, ST, GM and lumbar/sacral pvm's
- Conclusion: LCNT focal demyelination without evidence of axonal loss (plus comment regarding what was normal)

- **Obturator Nerve**
 - Anatomy
 - Clinical presentation:
 - Incidence: Isolated injury of the obturator nerve is rare, short of pelvic fractures, tumor or injury
 - Subjective: Patient's complain that the lower extremity feels unstable and may describe decreased medial thigh sensation
 - Objective: Ambulates with limb ER'd, and may have weakness of hip adductors

- **Obturator Nerve Anatomy**

- **Obturator Nerve (con't)**
 - NCS: none used routinely (Oh describes one potential study with needle electrode in gracilis)
 - EMG: needle investigation is the key method of evaluating obturator nerve function
 - Key consideration: isolated obturator nerve injury or lumbar plexopathy (assess paraspinals and muscles innervated by adjacent nerves)
 - Practical challenges:
 - No good NCS tests, thus limited in collaborative electrophysiologic data

- **Posterior Cutaneous Nerve of the Thigh**
 - Anatomy
 - Clinical presentation:
 - Incidence: In isolation, or with the sciatic nerve
 - Injections
 - Prolonged bike riding
 - Subjective:
 - Numbness over the posterior thigh
 - Can have altered perineal sensation
 - Objective: loss of sensation over region supplied by this nerve

- **Posterior Cutaneous Nerve of the Thigh Anatomy**

 - **Posterior Cutaneous Nerve of the Thigh (con't)**
 - NCS: SNAP technique available
 - EMG: Not applicable
 - Practical challenges:
 - Technically challenging
 - Usually injured at the same time sciatic nerve is injured, thus often dealing with multiple set of objective and subjective findings
 - SEP is an option with this nerve

 - **Superior and Inferior Gluteal Nerve**
 - Anatomy
 - Clinical presentation:
 - Incidence:
 - Extremely rare
 - Misplaced injections
 - Subjective: Altered gait, challenge to arise from a seated position
 - Objective:
 - Gluteus medius gait with SGN
 - Hip extensor weakness with IGN
 - Any sensory loss is due to other nerves being involved (PCNT, etc)

 - **Superior and Inferior Gluteal Nerve Anatomy**

 - **Superior and Inferior Gluteal Nerve (con't)**
 - NCS: Not possible
 - EMG: Hallmark of this evaluation
 - Practical challenges:
 - Limited electrophysiological data
 - Need to rule out other pathology, such as a lumbosacral plexopathy
-
- **Common Fibular Nerve**
 - CFN most often injured in the LE
 - Etiology

- Trauma (direct, knee injury, fracture fibula)
- Compartment syndrome
 - Anterior – DFN
 - Lateral – SFN
- Chronic ankle sprains
- Excessive kneeling and crossing of legs
- Ganglion cyst
- Inappropriate cast or brace

- **Common Fibular Nerve**

- Subjective
 - Weakness of ankle DF and toe ext
 - N/T in the dorsum of the foot
- Motor
 - SH biceps femoris (L5-S2), CFN
 - Tibialis anterior (L4-5), DFN
 - EDL (L5-S1), DFN
 - EHL (L5-S1), DFN
 - Fibularis tertius (L5-S1), DFN
 - EDB and EHB (L5-S1-2), DFN
 - Fibularis longus and brevis (L5-S1), SFN
- Function
 - “Foot drop” during gait

- **Common Fibular Nerve**

- Sensory
 - DFN – web space between D1-2
 - SFN – lateral leg, dorsum of foot
- Vascular
 - Check dorsal pedis pulse
- Other considerations “rule/out”
 - L5 radiculopathy
 - L4-5 (lumbosacral trunk) contribution to sacral plexopathy
 - Sciatic nerve mononeuropathy
 - Piriformis syndrome
 - CFN mononeuropathy in the thigh
 - Missile or knife wounds
 - Fractured femur

- **Mononeuropathy Case 15 - Hx**

Peripheral mononeuropathies in the lower extremities, 12 February 2009, property of David Greathouse, PT, PhD and John Halle, PT, PhD, not to be copied without permission

- Date of exam – September 22, 2008
 - 73 y o w female who is a retired executive secretary and presently a homemaker.
 - In July 2008 the patient fell down 4 stairs landing on the lateral LLE. The patient had increased pain in the left ankle with some swelling of the left ankle. The patient also noted weakness of the left ankle DF and toe ext after this fall.
 - The weakness in the left foot/ankle continued and the patient has fallen 5x since the initial fall. The patient has pain in the anterior/lateral left leg and dorsum of the left foot. She has hypersensitivity in the left lateral/anterior leg and dorsum of the left foot. The patient has history of multiple falls in the past and numerous ankle injuries.
 - She denies any previous left foot/ankle weakness. The patient has occasional LBP on standing but denies radicular pain in BLE.
 - The patient has no pain, N/T or weakness in the RLE.
 - No bowel or bladder incontinence
 - General Medical Health (GMH) – fair; diagnosed in 2004 with myasthenia gravis by a neurological MD for double vision – on meds with improved sight; left THA in August 2005; OA multiple joints BUE and BLE; HTN – on meds; hypercholesterol – on meds; Type II DM in 2008 presently on daily insulin injections; right rotator cuff problems.
 - No heavy metal exposure, thyroid disease, renal disease or ETOH abuse
 - Review of Systems – other than above, non contributory for cardiovascular, pulmonary, gastrointestinal, genitourinary, or endocrine
 - No family history of neuromuscular disease
- **Mononeuropathy Case 15 - PE**
 - Gait – ambulated into the clinic with left short leg walking brace; uses walker at home but did not use the walker today; without the left leg brace she had a noticeable limp LLE secondary to weakness of the left ankle DF and toe ext.
 - Toe/Heel Walk – **unable to heel walk left**; able to toe walk left with hand support for balance; normal heel and toe walk RLE
 - Squat – normal 60 knee flexion squat bilaterally
 - Active LE Mobility – normal hip flex/ext/abd/add/ER/IR; knee flex/ext; ankle DF/PF; forefoot IN/EV; toe flex/ext in BLE
 - Motor – **left tibialis anterior 1/5; EDL 2-/5; EHL 1/5; EDB 2-/5 and fibularis longus 0/5**; otherwise normal (5/5) strength hip flex/ext/abd/add/ER/IR; knee flex/ext; ankle DF/PF; forefoot IN/EV; toe flex/ext in BLE; no atrophy; no clonus present BLE
 - MSR – present and equal BLE for quadriceps reflex and Achilles (gastroc/soleus) reflex; ¼ MSRs in BLE with reinforcement
 - Pathological Reflex – Babinski and Chaddock reflexes absent bilaterally
 - Sensory – **hypersensitivity to LT and PP in the lateral/anterior left leg and dorsum left foot (SFN)**; otherwise normal light touch (LT) and pinprick (PP) for all dermatomes (L1-S3) and peripheral nerves in BLE
 - SLR – normal bilaterally both in sitting and supine position

- Vascular – normal pedal and PTA pulses
- **Mononeuropathy – Case 15 NCS**
 - Neural Conduction Studies – Summary (normal values adjusted for age, 73 years)
 - Left Sural Nerve – normal sensory conduction studies
 - Left Superficial Fibular (Peroneal) Nerve – no response
 - Left Deep Fibular (Peroneal) Nerve
 - Normal DML, 4.1 msec; decreased amplitude CMAP, 0.8 mV (nl > 2)
 - Slowed MNCV fibular head to ankle, 31 m/sec (nl > 39)
 - Normal MNCV popliteal space to fibular head, 47 m/sec
 - F wave – no response
 - Left Tibial Nerve – normal motor and central (F wave) conduction studies
 - Right Sural Nerve – normal sensory conduction studies
 - Right Superficial Fibular (Peroneal) Nerve – normal sensory conduction studies
 - Right Deep Fibular (Peroneal) Nerve – normal motor and central (F wave) conduction studies
 - Right Tibial Nerve – normal motor and central (F wave) conduction studies
- **Mononeuropathy Case 15 - EMG**
 - Muscles tested in LLE: Tibialis anterior, Fibularis (Peroneus) longus, EDL, EDB, EHL, Tibialis posterior, Vastus medialis, Rectus femoris, Med gastroc, Lat gastroc, LH biceps femoris, SH biceps femoris, Semitendinosus, mid lumbar pvm, low lumbar pvm and sacral pvm.
 - Insertion – There was increased insertional activity in the left tibialis anterior, fibularis longus, EHL, EDL, and EDB. Otherwise, there was normal insertional activity in the muscles tested.
 - Rest – There were fibrillation potentials and positive waves in the left tibialis anterior (4+, 4+), fibularis longus (3+, 3+), EDL (4+, 4+), EHL (3+, 3+), and EDB (2+, 2+). The amplitude of the fibs was > 100 uV which is compatible with acute denervation. Otherwise, there were no fibrillation potentials, positive waves, fasciculations or other abnormal spontaneous electrical activity in the muscles at rest.
 - Voluntary Activity – The shape, duration and amplitude of the MUPs was normal. There were decreased MUP activity in the left tibialis anterior (2 MUPs), EDL (1 MUP), EHL (2 MUPs), EDB (1 MUP) and fibularis longus (no MUPs). Otherwise, the number, recruitment and interference pattern of the MUPs was normal during minimal and maximal contraction.
 - The patient tolerated the NCS study well and the EMG study fairly well.
- **Mononeuropathy Case 15 - Conclusion**
 - This is an abnormal EMG and NCS study of the LLE.
 - There is electrophysiologic evidence on this exam of a **left common fibular nerve mononeuropathy at the fibular head; affecting both the left deep fibular and superficial fibular nerve branches**; axonal loss and demyelinating neuropathic process; acute denervation in the left tibialis anterior, EDL, EHL, EDB and fibularis longus. EMG of the left short head of

the biceps femoris is normal which is proximal to the site of the CFN mononeuropathy. (see PE for motor weakness in the LLE musculature)

- There is no electrophysiologic evidence on this exam of
 - Left L2-S2 radiculopathy in the LLE or left L/S pvm
 - Right common fibular mononeuropathy – including deep and superficial fibular nerve branches
 - Bilateral tibial or sural mononeuropathy

- **Tibial Nerve**

- Most common site of injury or involvement of the tibial nerve is at the posterior tarsal tunnel
 - Medial plantar nerve
 - Lateral plantar nerve
 - Medial calcaneal nerve
- Etiology
 - Trauma
 - Distal tibia fracture
 - Tarsal fractures (talus, calcaneous)
 - Posterior tarsal tunnel syndrome
 - Ankle sprains
 - Posterior (superficial or deep) compartment syndrome

- **Tibial Nerve**

- Subjective
 - Pain and N/T in the sole (plantar surface) of the foot
 - Weakness in the foot intrinsic muscles
 - Pain at the posterior tarsal tunnel
- Motor – distal tibial nerve
 - MPN – FDB, ABD hallucis (S2-3)
 - LPN – ADM, interossei (S2-3)
- Motor – tibial nerve
 - Hamstrings
 - LH biceps femoris, semitendinosus, semimembranosus (L5-S2)
 - Superficial compartment – med/lat gastroc, soleus (S1-2)
 - Deep compartment – popliteus, plantaris, FDL (S1-3), FHL (S1-3), tibialis posterior (L4-5)
- Function – loss of ankle PF and toe flexion during gait
- Sensory – plantar surface of the foot
 - LPN or MPN

- **Tibial Nerve**

- Vascular – posterior tibial artery

- MPA
- LPA
- MSR
 - Ankle jerk (achilles) S1
- Other considerations “rule out”
 - S1 radiculopathy
 - S2-4 radiculopathy
 - Sacral plexopathy
 - Proximal tibial nerve mononeuropathy
- **Mononeuropathy – Case 6 Hx**
 - 26 y o w male with injury to RLE when he jumped from helo and fx right fibula in March 2000 in Kosovo.
 - Surgery plating with bone graft – March 2000
 - Pnt noted “shocking pain” and N/T in the sole of the right foot
 - NCS/EMG in March 2001 with dx of right tibial neuropathy at or distal to the PTT.
 - Right ankle surgery in 2002 with release of scar tissue in tendons of FDL, FHL and TP.
 - Toes in right foot “curling” and difficult to run
 - Pnt continues with N/T sole of right foot – no N/T proximal to right ankle or dorsum of foot
 - No sx LLE. No B/B problems
 - GMH good
 - ROS noncontributory for CV, CP, GI and GU
 - No DM or HM. No thyroid problems
 - EMG/NCS for medical board
 - Date of exam Aug 5, 2005
 - PE per MEB
- **Mononeuropathy Case 6 - NCS**
 - Right Sural Nerve – normal sensory conduction studies
 - Right Superficial Fibular Nerve – normal sensory conduction studies
 - Right Deep Fibular Nerve – normal motor and central (F wave) conduction studies
 - Right Tibial Nerve
 - Normal DML (Abd Hall), 4.8 msec; amplitude CMAP 4 Mv
 - Normal MNCV popliteal space to ankle, 47 m/sec
 - Normal F wave, 49.4 msec
 - Right Plantar Nerves
 - Normal MPN DML, 4.8 msec; 4 mV
 - Normal LPN DML, 4.8 msec; 3 mV
 - Normal comparison studies right MPN/LPN: $4.8 - 4.8 = 0$ (nl < 1 msec)

- Prolonged MPN DSL, 5.6 msec; 27 uV
- Prolonged LPN DSL, 5.6 msec; 24 uV

- **Mononeuropathy Case 6 - EMG**

- Muscles tested in the RLE: tibialis anterior, fibularis longus, rectus femoris, medial gastroc, lateral gastroc, EDB, Abd hallucis, and ADM.
- Insertion – There was increased insertional activity in the right Abd Hallucis. Otherwise, there was normal insertional activity in the muscles tested.
- Rest – There were 1+ fibrillation potentials and positive waves in the right Abd hallucis. The amplitude of the fibs was < 100 uV, compatible with old or chronic denervation. Otherwise there were no fibs, PWs, fasciculations or other abnormal spontaneous electrical activity in the muscles tested at rest.
- Voluntary Activity – The shape, duration and amplitude of the MUPs was normal. The number, recruitment, and interference pattern was normal during minimal and maximal contraction.

- **Mononeuropathy Case 6 - Impression**

- There is electrophysiological evidence on this exam of a right medial and lateral plantar neuropathy; affecting sensory > motor fibers; focal demyelinating > axonal loss; evidence of “old” or “chronic” denervation in the right Abd hallucis.
- There is no electrophysiological evidence on this exam of
 - Right tibial neuropathy proximal to the medial malleolus
 - Right sural, SFN, or DFN mononeuropathy
 - Right lumbar or sacral plexopathy
 - Right L2-S2 radiculopathy in the RLE (L/S pvm not tested)

- **Mononeuropathy Case 13 - Hx**

- Date of exam – September 9, 2008
- 30 y o w male who is a construction worker.
- On July 12, 2008 the patient fell asleep (possible ETOH use) and awoke unable to move the RLE. The patient had a right leg fasciotomy on July 12/13, 2008. The patient was hospitalized until August 7, 2008 and has a drain in the right lateral leg.
- No PMH of RLE problems.
- Occasional LBP in past but no radicular pain in BLE.
- The patient also has N/T and decreased sensation in the left thigh – ant, med, lat, and post but normal sensation and no N/T or pain in the LLE distal to the knee.
- The patient has decreased sensation and N/T in the RLE distal to the knee and decreased movement in the right leg and foot. The patient also states some N/T in the lower abdominal region.
- No bowel or bladder incontinence
- General Medical Health (GMH) – good
- No diabetes, heavy metal exposure, thyroid disease, or renal disease

- Review of Systems – other than above, non contributory for cardiovascular, pulmonary, gastrointestinal, genitourinary, or endocrine
- No family history of neuromuscular disease
- **Mononeuropathy Case 13 - PE**
 - Gait – The patient ambulated into the clinic using a cane and an obvious right foot drop with steppage gait RLE. There is only partial WB of the RLE in stance.
 - Toe/Heel Walk – unable to heel or toe walk RLE; normal heel and toe walk LLE
 - Squat – normal 60 knee flexion squat bilaterally
 - Active LE Mobility – normal hip and knee motions RLE; no right ankle or foot motions normal hip flex/ext/abd/add/ER/IR; knee flex/ext; ankle DF/PF; forefoot IN/EV; toe flex/ext in LLE
 - Motor – **0/5 right ankle DF and PF; forefoot IN/EV; toe flex; EHL; foot intrinsic 3/5 right knee flex; 1/5 right EDL and tibialis anterior;** normal (5/5) strength hip flex/ext/abd/add/ER/IR; knee flex/ext; ankle DF/PF; forefoot IN/EV; toe flex/ext in BLE; no atrophy; no clonus present BLE
 - MSR – **0/4 right AJ MSR;** 2/4 left MSR; present and equal BLE for quadriceps reflex
 - Pathological Reflex – Babinski and Chaddock reflexes absent bilaterally
 - Sensory – **decreased LT and PP (only pressure) right leg (ant/post/med) and dorsum/sole right foot; decreased LT and PP left med/ant/lat/post left thigh;** normal LT and PP right thigh and left leg/foot
 - SLR – normal bilaterally both in sitting and supine position
 - Vascular – normal pedal and PTA pulses LLE; decreased PTA and dorsal pedis RLE
- **Mononeuropathy Case 13 - NCS**
 - Left Sural Nerve – normal sensory conduction studies
 - Left Superficial Fibular (Peroneal) Nerve – normal sensory conduction studies
 - Left Deep Fibular (Peroneal) Nerve – normal motor and central (F wave) conduction studies
 - Left Tibial Nerve – normal motor and central (F wave) conduction studies
 - Right Sural Nerve – no response
 - Right Superficial Fibular (Peroneal) Nerve – no response
 - Right Deep Fibular (Peroneal) Nerve – no response in the right EDB when stimulated at the ankle, fibular head or popliteal space
 - Right Tibial Nerve – no response in the right abductor hallucis when stimulated at the ankle or popliteal space
- **Mononeuropathy Case 13 - EMG**
 - Muscles tested in RLE: Tibialis anterior, EDL, EHL, Tibialis posterior, Vastus medialis, Rectus femoris, Adductor longus, Med gastroc, Lat gastroc, LH biceps femoris, SH biceps femoris, Gluteus medius, Gluteus maximus, Semitendinosus, mid lumbar pvm, low lumbar pvm and sacral pvm.

- Muscles tested in LLE: Tibialis anterior, EHL, Tibialis posterior, Vastus medialis, Rectus femoris, Adductor longus, Lat gastroc, LH biceps femoris, mid lumbar pvm, and low lumbar pvm.
- Insertion – There was increased insertional activity in the right tibialis anterior, EDL, EHL, EDB, abductor hallucis, lateral gastroc, medial gastroc, tibialis posterior, LH biceps femoris, SH biceps femoris and semitendinosus. Otherwise, there was normal insertional activity in the muscles tested.
- Rest – There were fibrillation potentials and positive waves in the right tibialis anterior (3+, 3+), EDL (3+, 3+), EHL (3+, 3+), EDB (4+, 4+), abductor hallucis (4+, 4+), lateral and medial gastroc (3+, 3+), tibialis posterior (3+, 3+), LH biceps femoris (3+, 3+), SH biceps femoris (2+, 2+), and semitendinosus (3+, 3+). The amplitude of the fibs was > 100 uV which is compatible with acute denervation. Otherwise, there were no fibrillation potentials, positive waves, fasciculations or other abnormal spontaneous electrical activity in the muscles at rest.
- Voluntary Activity – There were polyphasic MUPs in the right tibialis anterior and EDL. Otherwise, the shape, duration and amplitude of the MUPs were normal. There were NO MUPs in the right EHL, EDB, abductor hallucis, tibialis posterior, medial gastroc and lateral gastroc. There was 1 polyphasic MUP in the right tibialis anterior and 2 polyphasic MUPs in the right EDL. There was a decreased interference pattern in the right LH biceps (50%), SH biceps (50%), and semitendinosus (50%). Otherwise, the number, recruitment and interference pattern of the MUPs was normal during minimal and maximal contraction.
- The patient tolerated the NCS study well and the EMG study fairly well with some discomfort on needle examination of the left rectus femoris.

• **Mononeuropathy Case 13 - Conclusion**

- This is an abnormal EMG and NCS study of the RLE.
- There is electrophysiologic evidence on this exam of a **right sciatic nerve mononeuropathy involving both the common fibular and tibial nerves**; axonal loss and demyelinating neuropathic process; acute denervation with NO MUPs in the right EHL, EDB, abductor hallucis, tibialis posterior, medial gastroc and lateral gastroc; acute denervation with 1-2 polyphasic MUPs in the right tibialis anterior and EDL; acute denervation with 50% screen fill in the right semitendinosus, LH biceps femoris, and SH biceps femoris; **EMG of the right gluteus medius and gluteus maximus is normal which is compatible with the sciatic nerve mononeuropathy being distal to the superior and inferior gluteal nerves**. Polyphasic MUPs in the right tibialis anterior and EDL may be compatible with reinnervation of the DFN.
- There is no electrophysiologic evidence on this exam of
 - Right L2-S2 radiculopathy in the RLE or right L/S pvm
 - Right lumbar or sacral plexopathy
 - Bilateral femoral and obturator mononeuropathy
 - Left L2-S2 radiculopathy in the LLE or left L/S pvm
 - Left lumbar or sacral plexopathy
 - Left tibial, deep fibular, sural or superficial fibular mononeuropathy

• **Sural Nerve**

- Lies in superficial fascia of the leg (crura)
- Medial and Lateral Sural Nerves

- Lateral malleolus
- Not a common site of entrapment
- Etiology
 - Ganglion cyst
 - Tight combat or ski boots
 - Stretch injury
 - Generalized polyneuropathy – sensory nerve
- Motor – none
- Sensory – lateral border of the foot

- **Sural Nerve - History**
 - 19 y o w female who has completed BCT and 91W (medical specialist) training.
 - Referred to r/o right S1 radiculopathy
 - During BCT (4 months ago), the patient noted onset of N/T and pain in the lateral border of the right foot and D5. The symptoms have become more severe during AIT training especially on prolonged standing and marching. N/T decreases when in running shoes and during running activities.
 - No PMH of RLE problems
 - No history of trauma or injury to the RLE or back
 - No history of back pain, radicular pain BLE or thigh/leg pain bilaterally
 - No weakness in the RLE
 - No N/T in the dorsum of the right foot
 - No pain, N/T or weakness in the LLE
 - No B/B sx

- **Sural Nerve - History**
 - ROS noncontributory for CV, pulmonary, GI, GU or endocrine
 - No history of
 - DM
 - Thyroid disease
 - Renal disease
 - Exposure to heavy metals
 - ETOH
 - NMD (family)

- **Sural Nerve - PE**
 - Gait – normal cycle without limp BLE; no adaptive equipment
 - Toe/Heel Walk – normal toe/heel walk bilaterally
 - Squat – normal 90 knee flexion squat bilaterally

- Active LE Mobility – normal hip flex/ext/abd/add/ER/IR; knee flex/ext; ankle DF/PF; forefoot IN/EV; toe flex/ext in BLE
 - Motor – normal (5/5) strength hip flex/ext/abd/add/ER/IR; knee flex/ext; ankle DF/PF; forefoot IN/EV; toe flex/ext in BLE; no atrophy; no clonus present BLE
 - MSR – present and equal BLE for quadriceps reflex and Achilles (gastroc/soleus) reflex
 - Pathological Reflex – Babinski and Chaddock reflexes absent bilaterally
 - Sensory – **decreased LT and PP lateral border right foot**; otherwise normal light touch (LT) and pinprick (PP) for all dermatomes (L1-S3) and peripheral nerves in BLE
 - SLR – normal bilaterally both in sitting and supine position
 - Vascular – normal pedal and PTA pulses bilaterally
- **Sural Nerve - NCS**
 - Left Sural Nerve – normal DSL, 4.0 msec (nl < 4.3); normal amplitude SNAP, 10 uV
 - Left Superficial Fibular Nerve – normal DSL, 3.7 msec (nl < 4.0); normal amplitude SNAP, 8 uV
 - Left Deep Fibular Nerve
 - Normal DML, 4.6 msec (nl < 6.2); normal amplitude CMAP, 4 mV
 - Normal MNCV fibular head to ankle, 51 m/sec
 - Normal F wave, 52.3 msec
 - Left Tibial Nerve
 - Normal DML, 5.6 msec (nl < 6.2); normal amplitude CMAP, 6 mV
 - Normal MNCV popliteal space to ankle, 48 m/sec
 - Normal F wave, 51.9 msec
 - Normal comparison study between the left gastroc/soleus (tibial) H reflex, 30.4 msec – right H reflex, 30.0 msec = 0.4 msec (nl < 1.5)
 - **Sural Nerve - NCS**
 - Right Sural Nerve – prolonged DSL, 5.2 msec (nl < 4.3); normal amplitude SNAP, 6 uV (nl > 5)
 - Right Superficial Fibular Nerve – normal DSL, 3.6 msec (nl < 4.0); normal amplitude SNAP, 10 Uv
 - Right Deep Fibular Nerve
 - Normal DML, 4.4 msec (nl < 6.2); normal amplitude CMAP, 3 mV
 - Normal MNCV fibular head to ankle, 49 m/sec
 - Normal F wave, 52.6 msec
 - Right Tibial Nerve
 - Normal DML, 5.8 msec (nl < 6.2); normal amplitude CMAP, 5 mV
 - Normal MNCV popliteal space to ankle, 47 m/sec
 - Normal F wave, 51.5 msec
 - **Sural Nerve - EMG**

- **Electromyography – Summary**

- Muscles tested in RLE: Tibialis anterior, Fibularis (Peroneus) longus, EHL, Vastus medialis, Rectus femoris, Adductor longus, Med gastroc, Lat gastroc, LH biceps femoris, Semitendinosus, mid lumbar pvm, low lumbar pvm and sacral pvm.
- Insertion – There was normal insertional activity in the muscles tested.
- Rest – There were no fibrillation potentials, positive waves, fasciculations or other abnormal spontaneous electrical activity in the muscles at rest.
- Voluntary Activity – The shape, duration and amplitude of the MUPs was normal. The number, recruitment and interference pattern of the MUPs was normal during minimal and maximal contraction.

- **Sural Nerve - Conclusion**

- This is an abnormal NCS study of the RLE.
- There is electrophysiologic evidence on this exam of a **right sural mononeuropathy after the joining of the lateral and medial sural nerves in the distal right posterior leg;** demyelinating neuropathic process.
- There is no electrophysiologic evidence on this exam of
 - Right L2-S2 radiculopathy in the RLE or right L/S pvm
 - Right lumbar or sacral plexopathy
 - Left sural mononeuropathy
 - Bilateral DFN, SFN or tibial mononeuropathy

- **Concluding Remarks:**

References:

1. Moore KL, Dalley AF. Clinically Oriented Anatomy (5th edition). Lippincott Williams & Wilkins: Baltimore, MD; 2006.
2. Netter FH. Atlas of Human Anatomy (4th edition), Hansen JT consulting editor. Saunders Elsevier:Philadelphia, PA; 2006.
3. Magee DJ. Orthopedic Physical Assessment. Saunder Elsevier:Philadelphia, PA. 2008.
4. Dumitru D, Amato AA, Zwarts M. Electrodiagnostic Medicine (2nd edition). Hanley & Belfus, Inc.: Philadelphia, PA; 2002.
5. Kimura J. Electrodiagnosis in Diseases of Nerve and Muscle: Principles and Practice (3rd edition). Oxford University Press: New York, NY; 2001.
6. Halle JS, Greathouse DG. Nerve Entrapments of the Lower Extremity in Orthopaedic Physical Therapy Secrets (Placzek and Boyce eds): Hanley & Belfus:Philadelphia; 2001.