

# How to Get the Most of Nerve Conduction Studies and EMG

# Objectives

- Understand what NCS/EMG is
- Know what conditions or problems EMG/NCS is most likely to be useful for
- Increase your confidence in when to order studies
- Aid in your ability to integrate studies with clinical presentation

# NCS/EMG in One Slide

- NCS
  - Stimulate nerves and measure motor and sensory response (amplitudes and conduction velocities)
  - Decreased amplitudes, slowing of conduction, conduction block
- EMG
  - Needle electrode placed in muscle and record electrical properties of muscle at rest and with activation
  - Myopathic vs Neuropathic changes

# EDX Studies are an Extension of the Clinical Exam

- Tests do not replace a careful history or physical – in fact may lead to confusion
- As in the clinical exam significant weakness and hard sensory findings are easier to localize
- Cooperation is important – a patient that is difficult to assess clinically will be a challenge to assess electrophysiologically

# EDX Studies are an Extension of the Clinical Exam

- Clinically findings related to prior pathology will affect results so let EMGer know about them
- EDX studies are operator dependent
- EDX studies are helpful in localizing deficits found on the clinical exam
  - Therefore if you can't frame your question in anatomical terms EDX is less likely to be helpful

# EDX Studies are an Extension of the Clinical Exam

- If you can confidently localize based on exam are EDX studies going to help you
  - They may – severity, disease activity, prognosis
- EDX studies usually help with localization, but not etiology

# Testing the Tests

- Sensitivity and Specificity
- Problem for some disorders EDX are part of the diagnostic criteria (CTS, CIDP)
- In others other studies/findings may be the gold standard
- Paradoxically the best sensitivity and specificity data exists for conditions where there is a gold standard (MRI)

# Testing the Tests

- EMG is not a single test but evolutionary one
  - Someone with wasting of the hand muscles sent for an ulnar neuropathy but NCS normal
  - Should prompt EMG search for a T1 radiculopathy or motor neuron disease
- EDX studies are not just normal or abnormal so studies must be interpreted in the light of the clinical situation
  - Think of hemoglobin as a good parallel



# Pragmatist or Completist

- Pragmatists order tests that will provide unique or definitive information
  - Risk misdiagnosing conditions particularly those that are rare or mimic more common conditions
- Completist will order tests to describe and document the condition
  - Risk misdiagnosis due to false positive results particularly where there is a low prevalence of the condition
- Understand you biases and the biases of your electromyographer

# Focal Mononeuropathies

- Localization by evidence of slowing or conduction block
- Localization by inference
  - Median nerve normal NCS studies but denervation FPL, FDP-Median but not pronator teres, APB, or FDP-Ulnar = AIN
- Evaluates diffuse processes (polyneuropathy, myopathy)

# Focal Mononeuropathies-Helpful

- For Diagnosis if localization unclear on clinical grounds
- Management
- Prognosis
  
- EMG changes largely not seen until three weeks after nerve injury

**Table 1** Methods used in localising upper limb focal mononeuropathies

Nerve	Site of lesion	Demonstration of focal slowing	Finding changes in CMAP and SAP	Denervation changes in nerve distribution	Comments
<b>Common</b>					
Median	Carpal tunnel	+++	+++	+	EMG not usually needed
Ulnar	Elbow (cubital tunnel)	+	+++	++	
<b>Uncommon</b>					
Radial	Upper arm	+	++	+++	Depends on other ulnar studies being normal Limited usefulness; small risk of pneumothorax
Axillary	Humeral head	NA	NA	++	
Ulnar	Wrist (Guyon's canal) or hand	+	++	+++	
Long thoracic	Not clear	NA	NA	++	
<b>Rare</b>					
Anterior interosseous branch of median nerve	Just below the elbow	NA	NA	++	Depends on other median studies being normal
Posterior interosseous branch of radial nerve	As nerve enters supinator muscle	NA	NA	++	Depends on other radial nerve studies being normal
Suprascapular	Suprascapular notch	NA	+	+++	
Musculocutaneous		NA	+	++	

+++ high likelihood; ++ probable finding; + possible finding; - unlikely finding.

Findings will be dependant on severity of lesion.

CMAP, compound motor action potential; NA, not applicable; SAP, sensory action potential.

**Table 2** Methods used in localising lower limb focal mononeuropathies

Nerve	Site of lesion	Demonstration of focal slowing	Finding changes in CMAP and SAP	Denervation changes in nerve distribution	Comments
<b>Common</b>					
Lateral cutaneous nerve of the thigh	Inguinal ligament	NA	-	NA	Electrodiagnostic studies limited in this common mononeuropathy
Common peroneal Interdigital	Fibular head	++	+++	++	Difficult nerves to study
	Between heads of metatarsals	NA	-	NA	
<b>Uncommon</b>					
Femoral		NA	NA	+++	Distinguish from plexopathy/radiculopathy
Sciatic	Pelvis, buttock or thigh	NA	++	+++	
Tibial, at ankle	Tarsal tunnel	+	++	++	
Perineal	Alcock's canal	NA	NA	NA	
Saphenous	Thigh or knee	NA	+	NA	
<b>Rare</b>					
Tibial, at knee		NA	++	+++	
Posterior cutaneous nerve of the thigh		NA	NA	NA	Limited use
Obturator	Obturator foramen	NA	NA	++	
Gluteal		NA	NA	++	
Sural		NA	+++	NA	

+++ high likelihood; ++ probable finding; + possible finding; - unlikely finding.

Findings will be dependant on severity of lesion.

CMAP, compound motor action potential; NA, not applicable; SAP, sensory action potential.

# Radiculopathies

- In the **majority** of patients MRI will be the best test
- In those with equivocal, or confusing imaging EMG can be helpful
- EMG will rarely ever provide an etiology

# Plexopathies

- These are complex studies requiring fairly sophisticated knowledge of peripheral nerve anatomy and physiology
- Mild abnormalities may be difficult to detect
- If the electrophysiology is not clear cut imaging may be required to evaluate for multiple radiculopathies, or lesion in plexus

# Peripheral Neuropathies

- EDX can categorize peripheral neuropathy
  - motor, sensory, length dependent, axonal, demyelinating, multifocal
- Utility in many chronic mild neuropathies unclear
- Very useful in acute neuropathies – i.e. GBS, asymmetric neuropathies, mononeuritis multiplex, disabling severe neuropathies
- May be normal in patients with mild sensory neuropathy



# Motor Neuron Disease

- Needed to document abnormalities
- Needed to exclude other processes

# Neuromuscular Junction

- EDX pivotal in establishing diagnosis

# Myopathy

- Don't do if a known genetic myopathy
- Helpful if unsure weakness is neurogenic or myopathic
- EMG may show specific features that aid in diagnosis – myotonia, fibrillations and positive sharp waves
- EMG in some myopathies may be normal
- EMG in myopathies may be very hard to interpret

# Syndrome Hunting

# EDX key points

- The tests are there to help you (and if they won't help don't do them)
- NCS and EMG are an extension of clinical examination.
- Generally NCS and EMG are effective at localising the level of the nervous system involved or the site of the lesion but not the cause
- Sometimes NCS can be misleading—for example, finding abnormalities that occur within the general population or misattributing myopathic and neuropathic weakness
- Tests other than NCS or EMG will usually be needed to determine the cause of a problem