

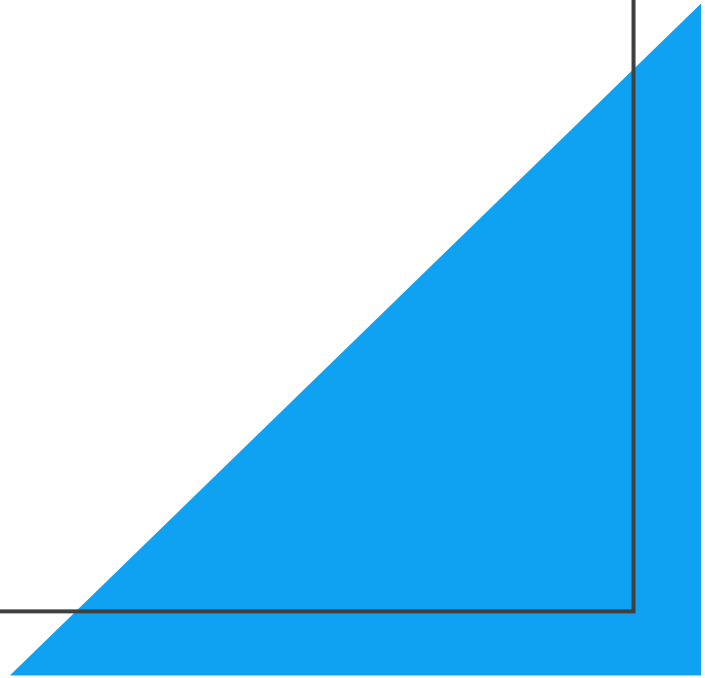


Authentic4D™

A Rampant Diagnosis in Claims: Radiculopathy

John E. Robinton, MD

Authentic4D Chief Clinical Officer





What is a Radiculopathy?

- A disorder of the spinal nerve roots

Radiculopathy - Etiology

Non-
compressive
Pathology

- Toxic/Metabolic
- Autoimmune
- Ischemic
- Infectious

Compressive
Pathology

- Central Spinal Canal Stenosis
- Neuroforaminal Stenosis
- Disc Bulge/Herniation
- Degenerative Pathology

Utility of MRI in Assessing Radiculopathy

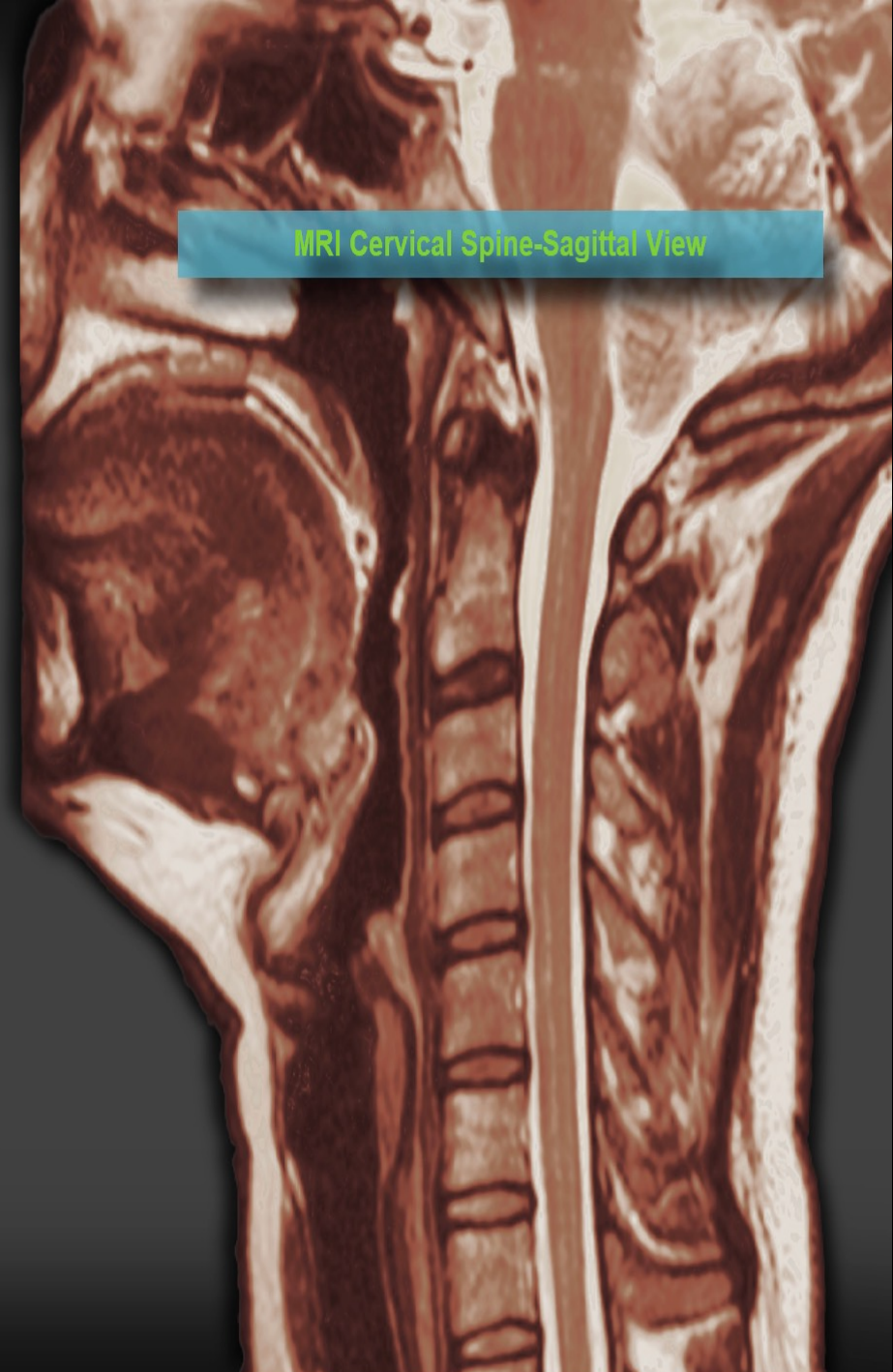
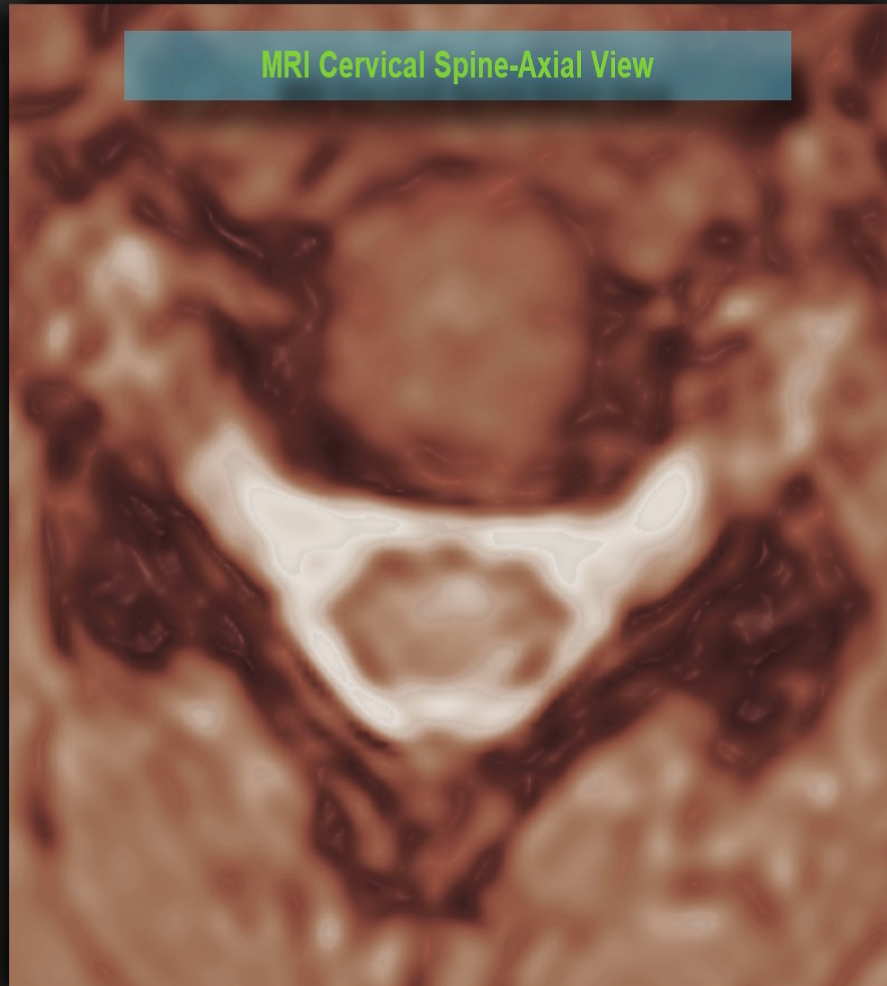
Positives:

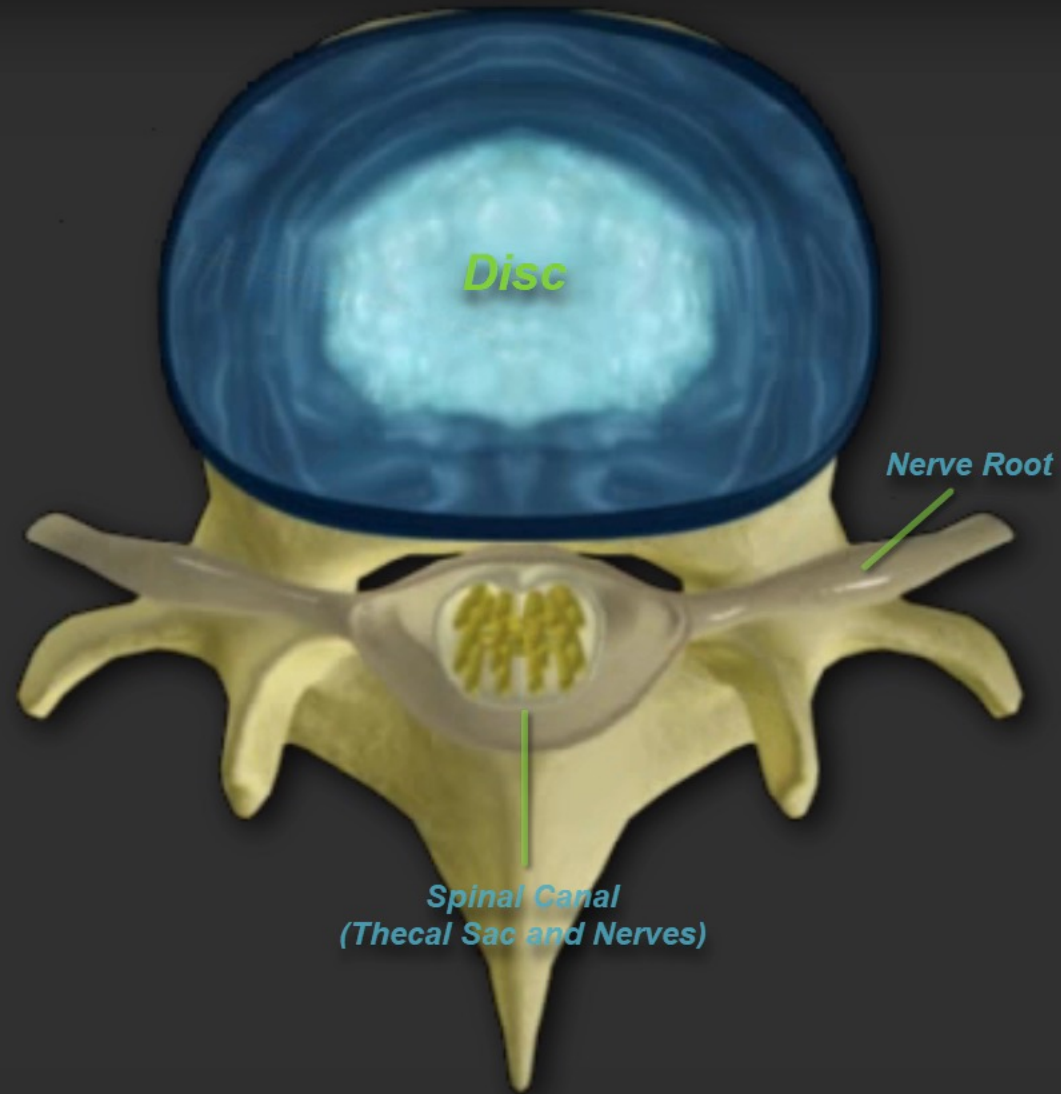
- MRI is the gold standard for evaluating soft tissue injuries
- MRI is far superior to CT in visualizing spinal nerves
- An accurate MRI read can direct the best course of treatment for the patient

Pitfalls:

- The read is subjective (differences in performance of a general radiologist vs a fellowship trained, sub-specialized radiologist)
- Low tesla magnets produce poor quality images
- Artifacts can be present, especially if the patient moves

Anatomy of the Spine on MRI





Disc Bulge

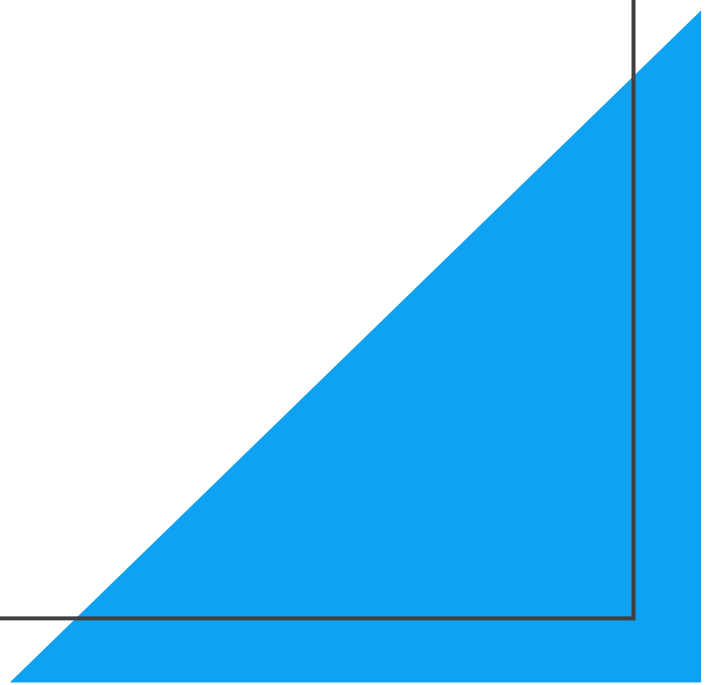
Radiculopathy-Clinical Features of Acute Herniation

- Onset of symptoms usually abrupt, but may be insidious
- Unilateral radicular arm/leg pain usually accompanied by neck/low back pain
- Some patients report neck/back pain disappears when the arm/leg pain begins, signaling the herniation
- Most commonly occurs at C5-C6, C6-C7, L4-5, and L5-S1 levels
- Isolated acute disc herniation more common in the younger patient (<40)
- Bony root entrapment due to degenerative disease more common in those >50

Radiculopathy-Clinical Features of Acute Herniation

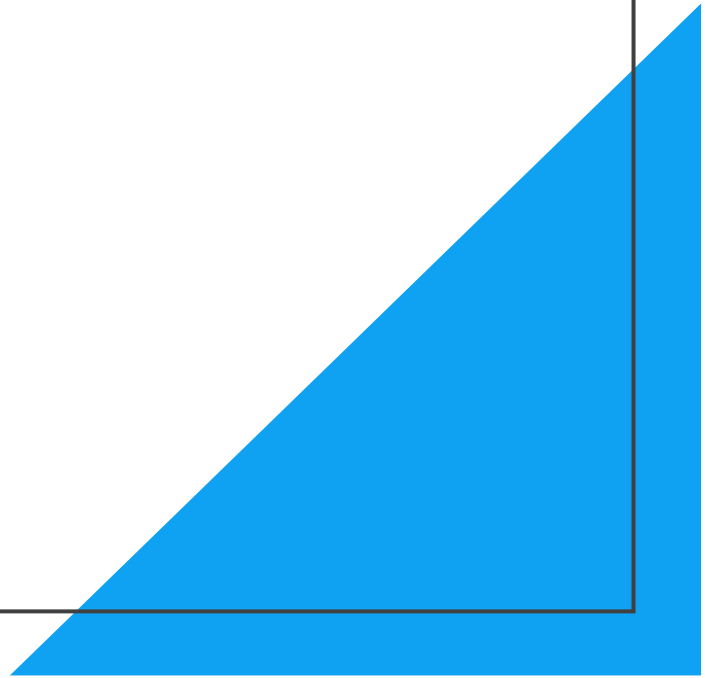
- Full syndrome includes radicular pain, dermatomal sensory loss, weakness in the myotome, and reduction or loss of the DTR for the affected root
- Pain described as knifelike or aching
- Aggravated by coughing, sneezing, any actions producing Valsalva—raising intraspinal pressure
- Paresthesias referred to specific dermatome

Poll 1



Can a chronic disc bulge or herniation cause a radiculopathy?

- A. No
- B. Yes

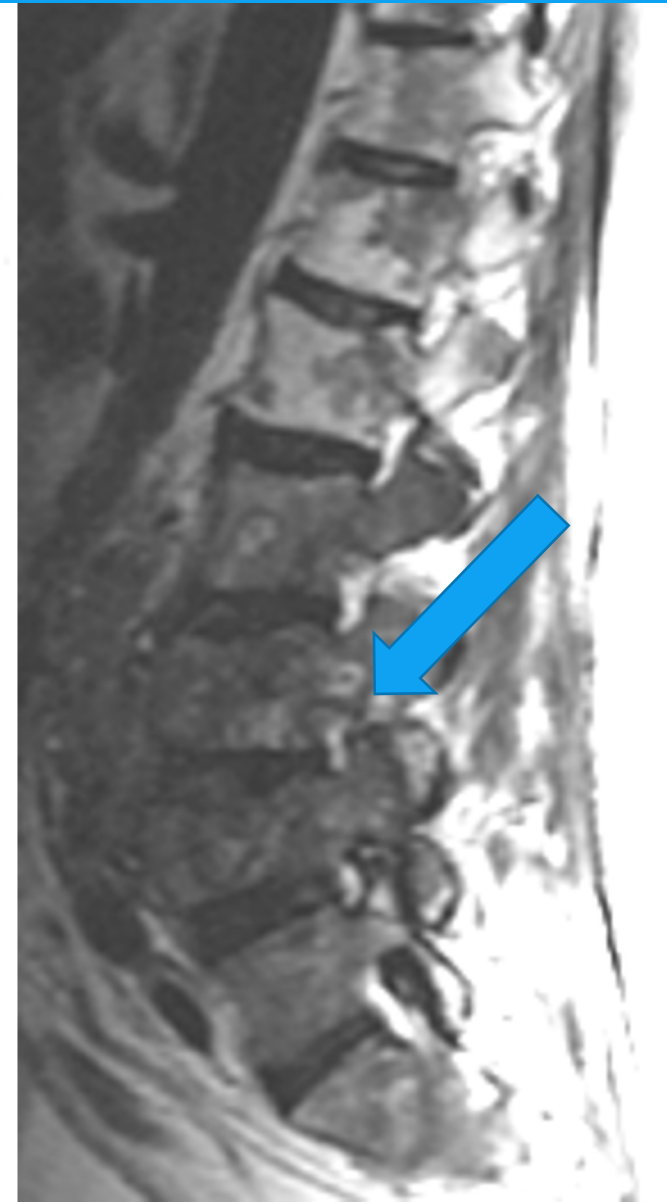
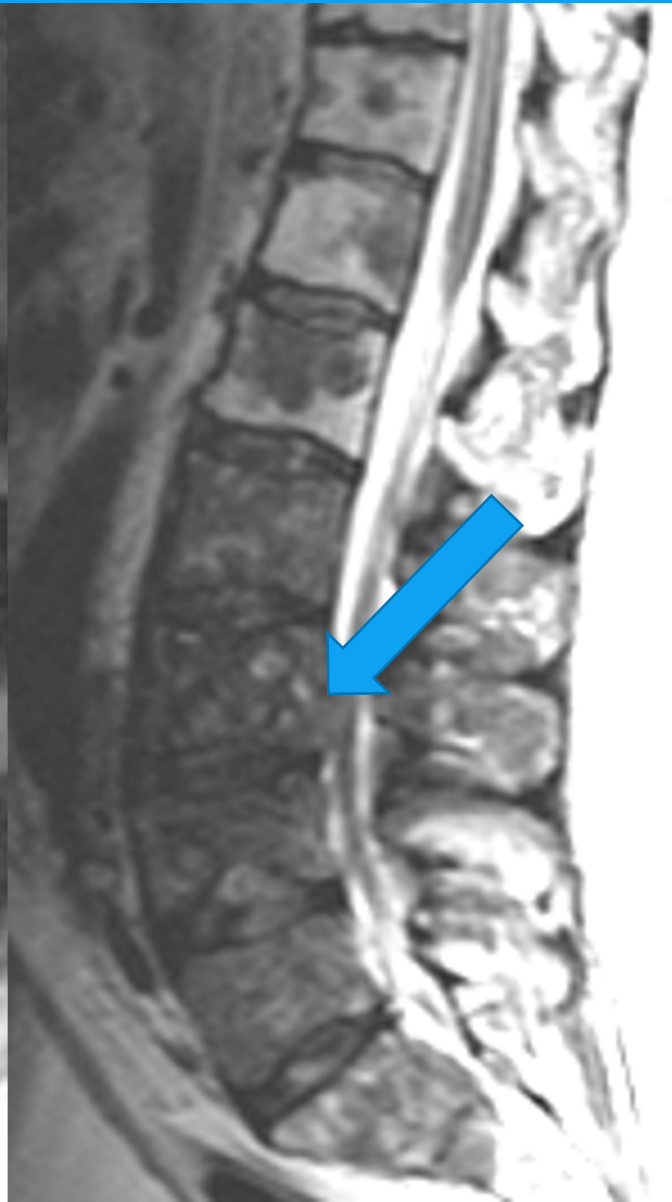
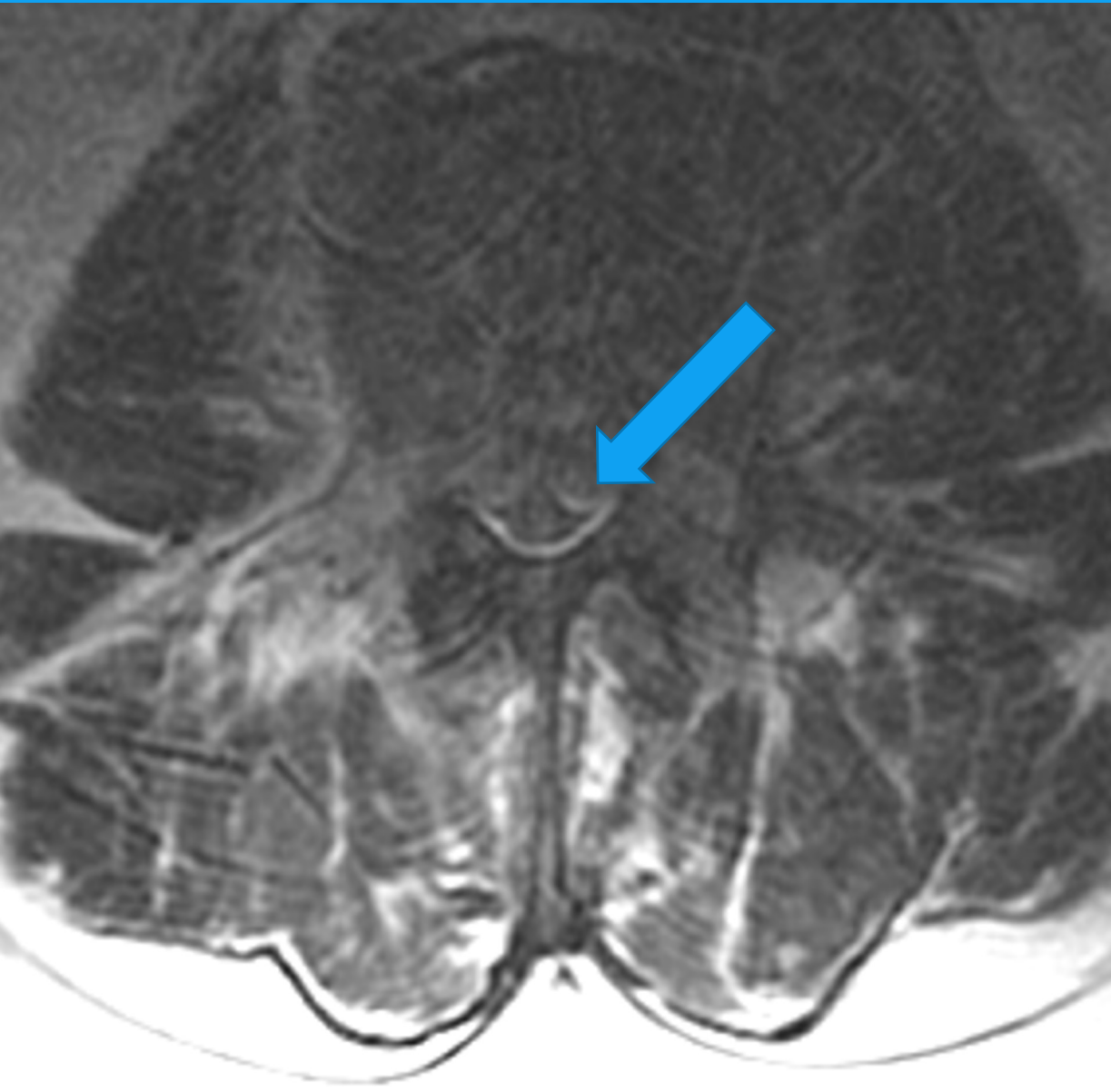


Compressive Radiculopathies-Other Causes

- Subdural Bleed
- Infection
 - Epidural Abscess
- Tumors
 - Epidural
 - Intradural
 - Leptomeningeal Disease
 - Intramedullary
- Degenerative
 - Disc Herniation
 - Facet Joint Hypertrophy
 - Ligamentum Flavum Hypertrophy
 - Post-surgical Fibrosis

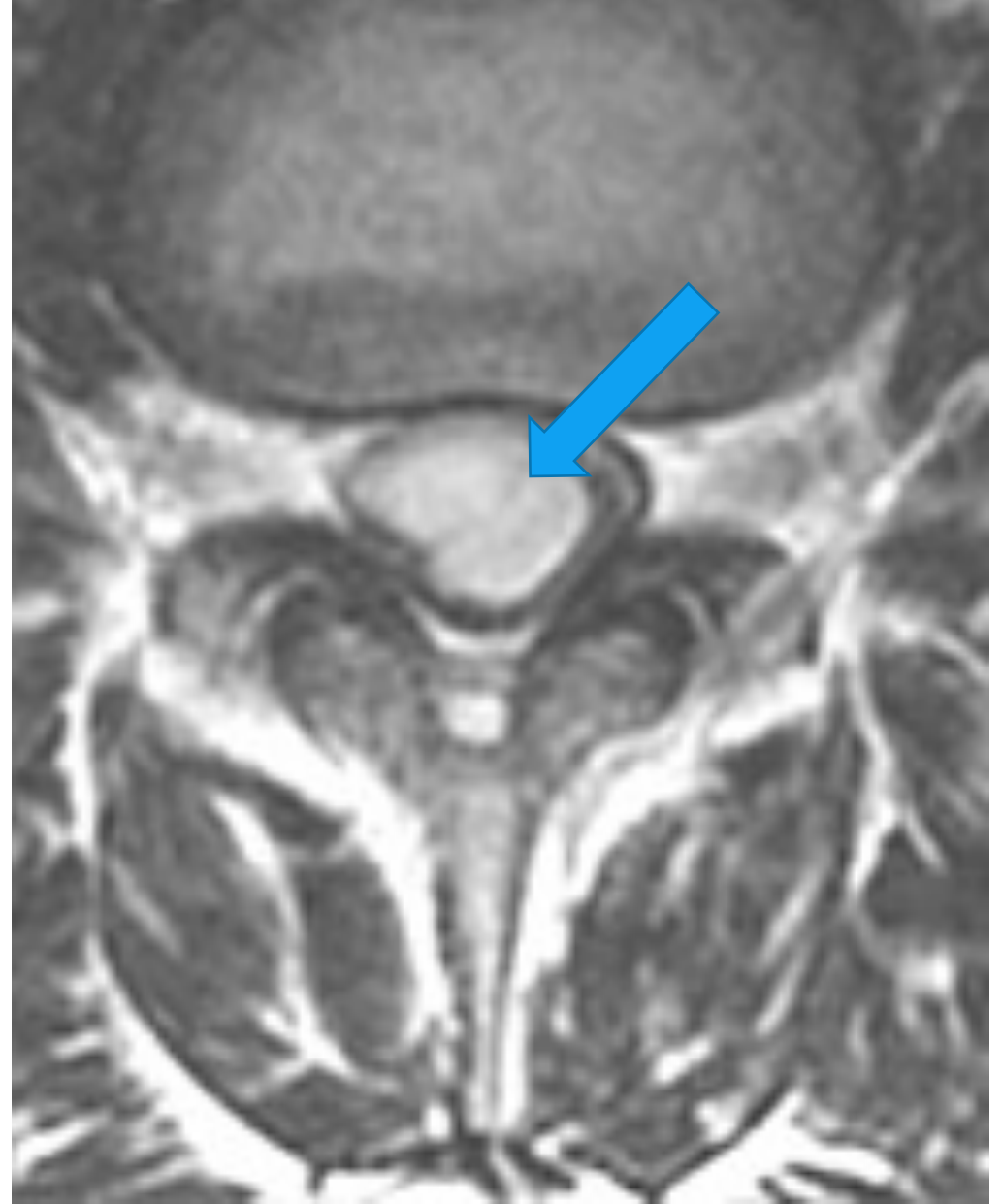
Compressive Radiculopathies: Other Causes

Epidural Disease with Cauda Equina & Nerve Root Compression from Prostate Cancer



Compressive Radiculopathies: Other Causes

Subdural Hemorrhage from a Lumbar Puncture



Case Study 1- *Part 1*

A 48-year-old diabetic dockworker notes acute onset of proximal right leg pain while at work. They see the company doctor and are treated with anti-inflammatory agents and then therapy. An MRI reveals mid-size herniated right L5-S1 disc. The patient is treated conservatively though requires narcotics for pain relief.

The patient is sent for EMG and nerve conduction studies to Dr. X, who the orthopedist believes does a good job. Dr. X, in fact, had limited training in his residency, has had no continuing education, and is not board-certified in EMG. Dr. X reports peripheral neuropathy and S1 radiculopathy.

The patient goes to surgery and is unchanged after. The patient remains disabled.

Case Study 1- *Part 2 (EMG)*

The patient is sent to see Dr. Y by the insurance company. He has is board certified in EMG. He finds evidence of proximal limb weakness. A repeat EMG is performed which reveals the presence of what appears to be a lumbar polyradiculopathy.

A diagnosis of diabetic radiculoneuropathy and neuropathy is made. This is not related to the patient's work situation.

Case Study 1- *A Note on Costs*

Costs vary greatly for insurance claims with a diagnosis of radiculopathy depending on clinical aspects like testing and treatment as well as policy limits. Factors that affect the bottom line for a claims settlement in radiculopathy include:

- Treatment and Testing
 - Imaging, medications, PT, ESI, chiropractic visits, EMGs
- Quality
 - Imaging Technology
 - Provider Credentials
- Etiology of the Diagnosis

Because the patient was sent to a quality physician who was board certified in EMG, the cause of the radiculopathy was found to be unrelated to occupation and the insurance company was no longer liable for the condition or treatment of the patient.

Utility of EMG in Assessing Radiculopathy

Positives:

- Can pinpoint a source of pain or symptoms if done correctly
- May help to age an injury
- Can diagnose conditions that cause overlapping symptoms of radiculopathy (ie: diabetic neuropathy)

Pitfalls:

- An incorrect diagnosis based on an inaccurate EMG often leads to extended disability
- Complications resulting from unnecessary surgery result in unnecessary extended disability
- Difficult to learn; loose requirements for those doing the testing

What is an EMG?

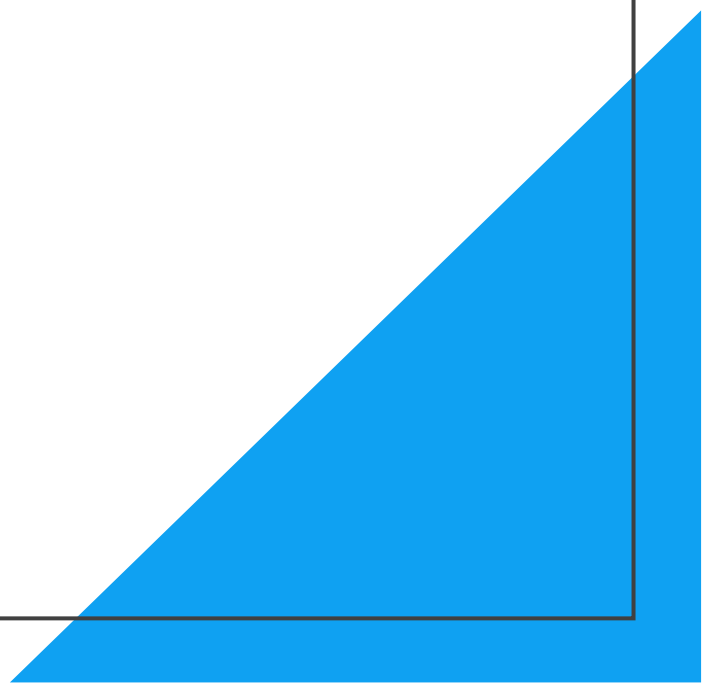
Nerve conduction (NCS): Quantitative measurement of health of a nerve using several parameters, including speed of conduction of impulses along nerve and size of a nerve. The obtained measurements are then compared to normal numbers.

EMG: The study of muscles using needle electrodes which assesses their health by measuring and observing certain parameters including size of individual potentials, speed of response of certain potentials, and total number of potentials observed. Sophisticated analysis of EMG allows statements regarding the health of nerve supply to muscle and muscle fibers.

Basics of EMG

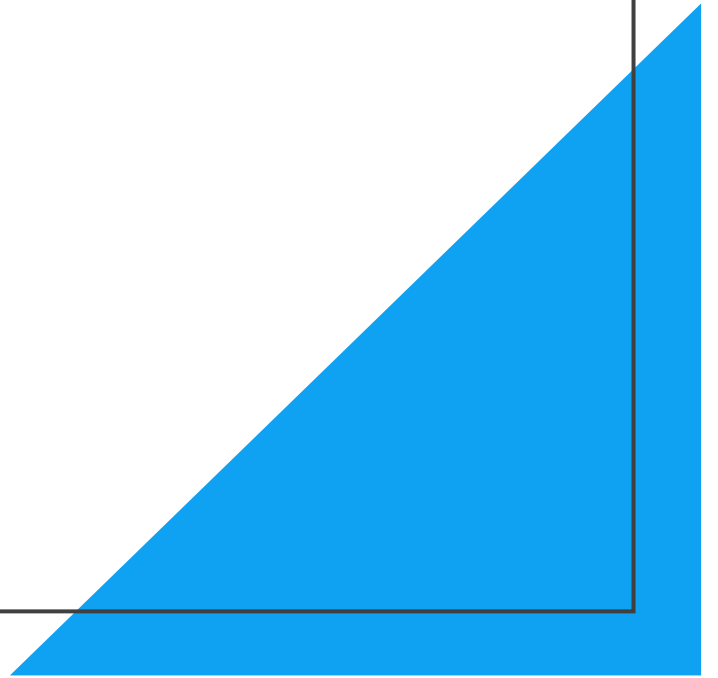
- A needle electrode is placed into the muscle
 - Needle is sterile and disposable
- Muscles examined depends on the clinical problem
- Detailed knowledge of anatomy is necessary to identify specific locations
- Muscle is studied at rest and at different levels of sustained, voluntary contraction
- At rest, the muscle should be silent - Any activity may signal a nerve or muscle abnormality
- During activity, the electrical shape and pattern of the response can distinguish between nerve and muscle disease

Poll 2



Have you ever sent us an EMG
claim for review?

- A. No
- B. Yes



Radiculopathy-Standard Findings in NCS

- Sensory NCS:
 - Normal
 - Dorsal root ganglion spared

Motor NCS:

- May demonstrate decreased CMAP amplitude
- Milder radiculopathies have normal CMAP amplitude

Radiculopathy-Standard Findings in EMG

- Extremity Muscles:
 - Spontaneous activity and/or MUP changes in muscles innervated by a common root but different nerve

Paraspinal Muscles:

- Spontaneous activity
- Motor unit changes not generally assessed

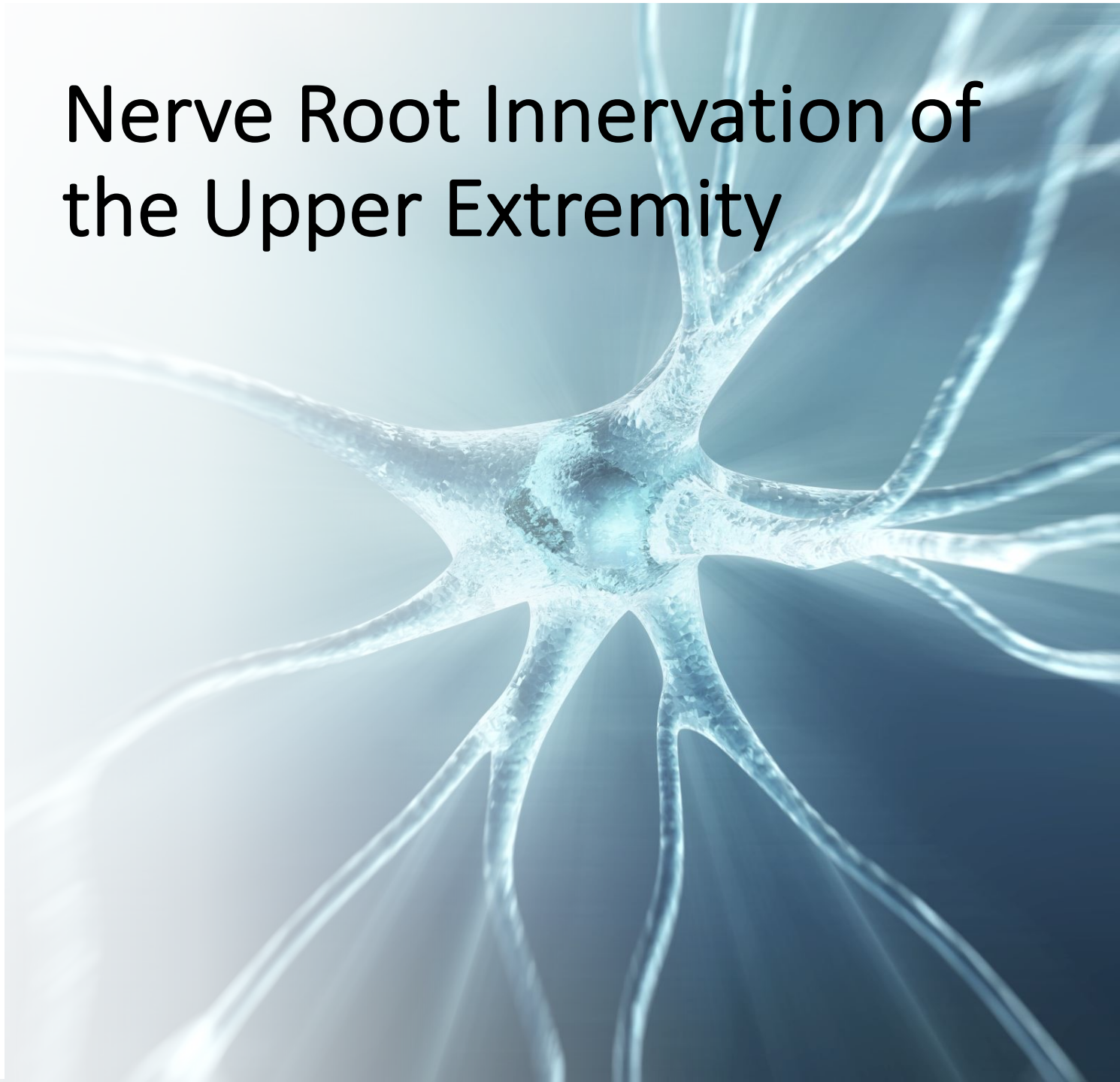
Proximal Nerves		C5	C6	C7	C8	T1
Serratus Anterior	(Long Thoracic Nerve)					
Rhomboids	(Dorsal Scapular Nerve)					
Supraspinatus	(Suprascapular Nerve)					
Infraspinatus	(Suprascapular Nerve)					
Latissimus Dorsi	(Thoracodorsal Nerve)					
Deltoid	(Axillary Nerve)					
Biceps	(Musculocutaneous Nerve)					

Radial Nerve		C5	C6	C7	C8	T1
Triceps						
Anconeus						
Brachioradialis						
Extensor Carpi Radialis						
Supinator	(Posterior Interosseous Nerve)					
Extensor Digitorum Communis	(Posterior Interosseous Nerve)					
Extensor Digiti Minimi	(Posterior Interosseous Nerve)					
Extensor Carpi Ulnaris	(Posterior Interosseous Nerve)					
Abductor Pollicis Longus	(Posterior Interosseous Nerve)					
Extensor Pollicis Longus	(Posterior Interosseous Nerve)					
Extensor Pollicis Brevis	(Posterior Interosseous Nerve)					
Extensor Indicis Proprius	(Posterior Interosseous Nerve)					

Median Nerve		C5	C6	C7	C8	T1
Pronator Teres						
Flexor Carpi Radialis						
Flexor Digitorum Superficialis						
Flexor Digitorum Profundus I, II	(Anterior Interosseous Nerve)					
Flexor Pollicis Longus	(Anterior Interosseous Nerve)					
Pronator Quadratus	(Anterior Interosseous Nerve)					
Abductor Pollicis Brevis						
Opponens Pollicis						
Flexor Pollicis Brevis (superficial head)						
Lumbricals I & II						

Ulnar Nerve		C5	C6	C7	C8	T1
Flexor Carpi Ulnaris						
Flexor Digitorum Profundus III, IV						
Abductor Digiti Minimi						
Palmar/Dorsal Interossei						
Lumbricals III & IV						
Adductor Pollicis						
Flexor Pollicis Brevis (deep head)						

Nerve Root Innervation of the Upper Extremity



Femoral Nerve	L2	L3	L4	L5	S1	S2
Iliacus	■	■	■			
Rectus Femoris		■	■	■		
Vastus Lateralis		■	■	■		
Vastus Medialis		■	■	■		

Obturator Nerve	L2	L3	L4	L5	S1	S2
Adductor Longus	■	■	■	■		
Adductor Magnus (Also has Sciatic Nerve Innervation)	■	■	■	■		

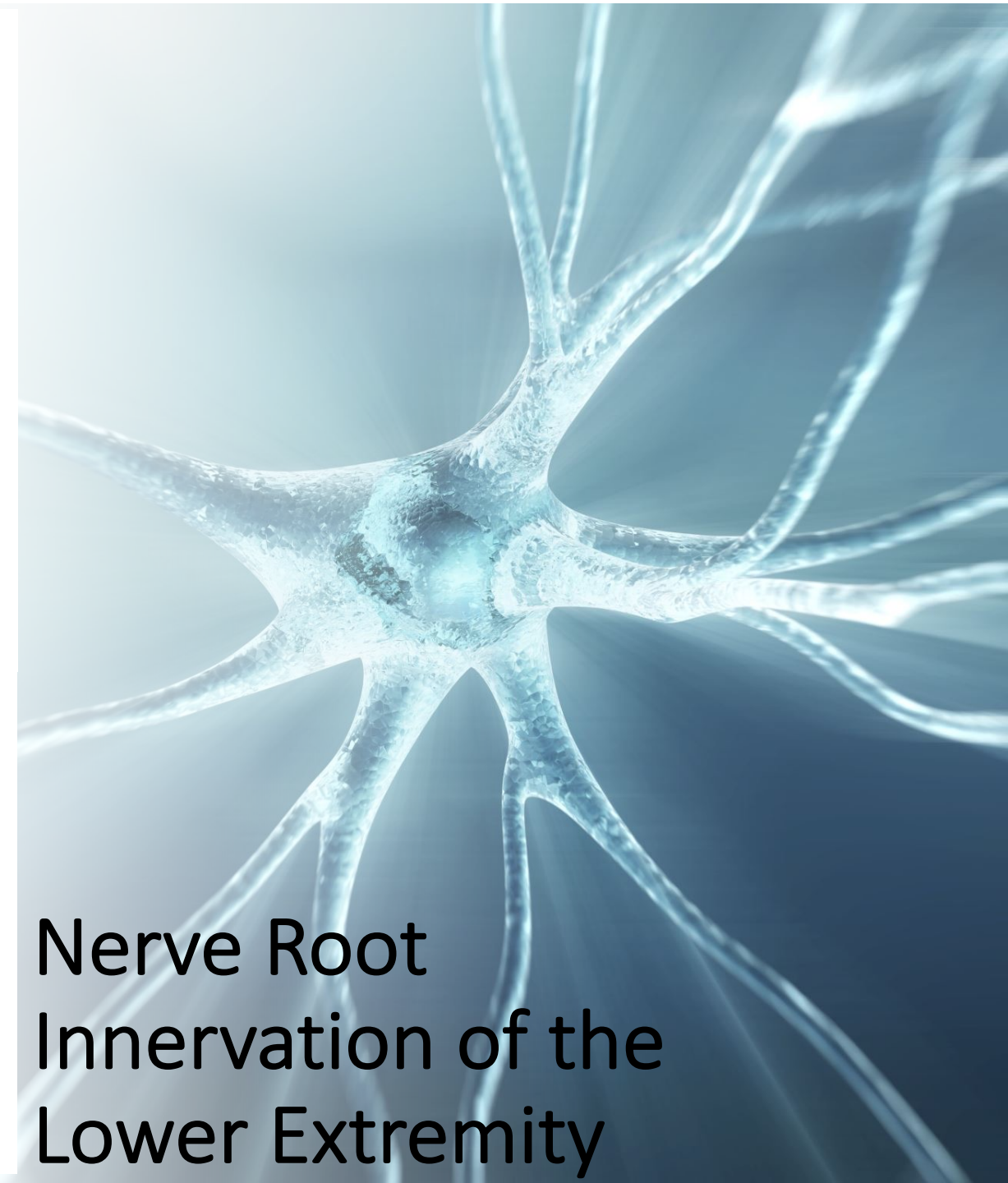
Superior Gluteal Nerve	L2	L3	L4	L5	S1	S2
Gluteus Medius				■	■	
Tensor Fascia Lata				■	■	

Inferior Gluteal Nerve	L2	L3	L4	L5	S1	S2
Gluteus Maximus				■	■	

Sciatic Nerve	L2	L3	L4	L5	S1	S2
Semitendinosus (Tibial Nerve Division)				■		
Semimembranosus (Tibial Nerve Division)				■		
Biceps Femoris, Long Head (Tibial Nerve Division)				■	■	■
Biceps Femoris, Short Head (Peroneal Nerve Division)				■	■	■

Peroneal Nerve	L2	L3	L4	L5	S1	S2
Tibialis Anterior (Deep Peroneal Nerve)			■	■		
Extensor Digitorum Longus (Deep Peroneal Nerve)			■	■		
Extensor Hallucis Longus (Deep Peroneal Nerve)			■	■		
Peroneus Longus (Superficial Peroneal Nerve)				■		
Peroneus Brevis (Superficial Peroneal Nerve)				■	■	
Extensor Digitorum Brevis (Deep Peroneal Nerve)				■	■	

Tibial Nerve	L2	L3	L4	L5	S1	S2
Tibialis Posterior				■	■	
Flexor Digitorum Longus				■	■	
Gastrocnemius (lateral head)				■	■	
Gastrocnemius (medial head)				■	■	■
Soleus				■	■	■
Abductor Hallucis				■	■	■
Abductor Digiti Quinti Pedis				■	■	■

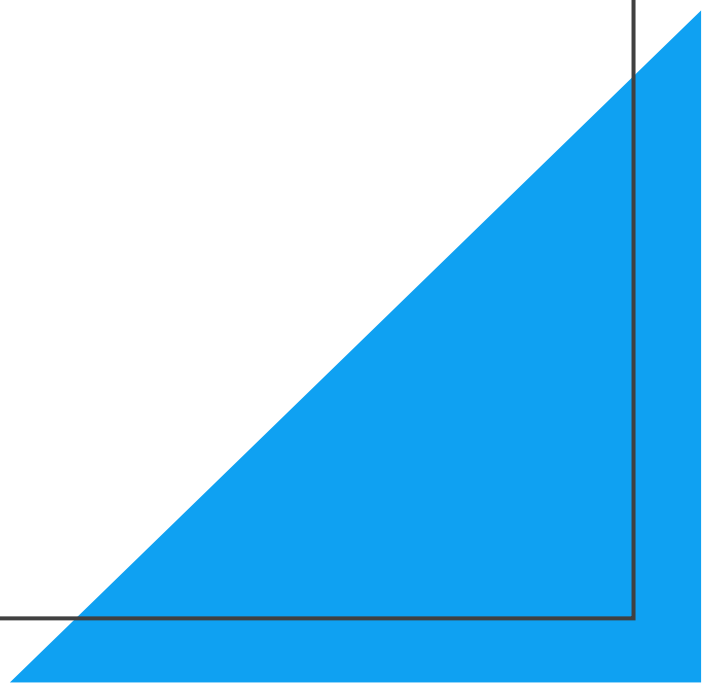


Nerve Root
Innervation of the
Lower Extremity

Radiculopathy-Timeline of EMG Abnormalities

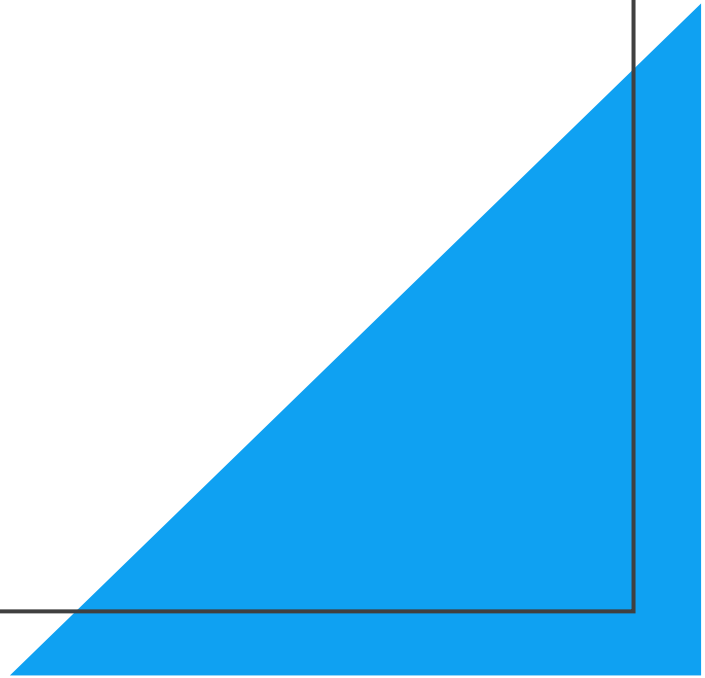
- Fibrillation potential develop 3 weeks after axon loss.
 - Progress is proximal (paraspinal muscles) to distal (limb muscles).
- Decreased recruitment with rapid firing rate
 - a.k.a. a “neurogenic” MUP firing pattern
- Large, polyphasic MUP due to sprouting and reinnervation develop after 2-3 months.

Poll 3



How soon after an accident should an EMG be performed?

- A. 21 days
- B. Immediately
- C. 5 days
- D. 2 months



Radiculopathy-Three Goals for Electrodiagnosis

1. Exclude a more distal lesion (plexopathy, mononeuropathy)
2. Confirm evidence of root compression
3. Localize compression to either a single or multiple roots

Case Study 2- *Part 1*

A 60-year-old construction worker presents with a 5-year history of progressively severe episodic low back pain with radiation into the posterolateral thigh. His most recent episode resulted in a loss of work for 4 weeks. Numerous repeated lumbosacral MRIs have demonstrated persistent DJD throughout, but no specific areas of foraminal compromise or frank disc herniation.

An EMG is ordered.

Case Study 2- *Part 2 (EMG Results)*

- Peroneal & Tibial Motor: Normal
- Sural Sensory NCS: Normal
- EMG Right Leg
 - Vastus Lateralis: Normal
 - Anterior Tibialis: Increased insertional activity, mild spontaneous activity, neurogenic motor units, recruitment limited by pain.
 - Flexor Digitorum Communis: Increased insertional activity, mild spontaneous activity, neurogenic motor units, recruitment limited by pain.
 - LS Paraspinals: Increased insertional activity, moderate SA at L5-S1

Case Study 2- *Part 3 (MRI Results & Treatment)*

A repeat Lumbosacral MRI with careful review demonstrated significant foraminal narrowing at the right L5 level, but without clear nerve root compression in the supine position. The patient reported his symptoms have consistently appeared on those days during which he was involved in heavy bending, lifting, and torsion.

A foraminotomy was performed at L5 with relief of symptoms and a return to work.

Case Study 3- *Part 1*

A 57-year-old waiter underwent right knee replacement for severe DJD and returned home for further recovery.

Two weeks after discharge, he called his orthopedist complaining of a persistent right foot drop and was told to return to the office for evaluation.

He missed his appointment and called again, stating he was very upset by this new problem and that he had found another orthopedist.

Case Study 3- *Part 2*

Four weeks later, a letter from his attorney arrived requesting medical records for pending legal action. During Discovery, the defense attorneys reviewed the outside medical records. EMG & NCS from an outlying neurologist reportedly demonstrated “Severe denervation in the right anterior tibialis muscle, with an absent peroneal motor nerve response consistent with a severe peroneal nerve injury.”

At the request of the Defense, the Court ordered a repeat EMG & NCS.

Case Study 3- *Part 3: (Needle EMG Results)*

Anterior Tibialis:

Increased insertional activity, moderate spontaneous activity, neurogenic motor units, moderately reduced recruitment

Gastrocnemius:

Increased insertional activity, moderate spontaneous activity, neurogenic motor units, moderately reduced recruitment

Vastus Lateralis:

Normal

Biceps Femoris (Short Head):

Increased insertional activity, moderate spontaneous activity, neurogenic motor units, moderately reduced recruitment

Gluteus Maximus:

Increased insertional activity, moderate spontaneous activity, neurogenic motor units, moderately reduced recruitment

Lumbosacral Paraspinals:

Severe spontaneous activity at L4-L5 and L5-S1

Case Study 3- *Part 4: (MRI & Course)*

Lumbosacral MRI demonstrated severe DJD in the lower lumbar spine with acute disc herniations at L5-S1 and impingement of both the L5 and S1 roots.

Under questioning during his deposition, the patient admitted to slipping on the ice when transferring from his car to his front door on the day of discharge, landing flat on his buttocks and noting significant low back pain and posterolateral numbness of the leg thereafter.

After review of the medical evidence, a judge ordered the case dismissed before trial.

Case Study 4- *Part 1 (EMG + MRI)*

A 55-year-old male from Pennsylvania was involved in an auto accident. There was an alleged lumbar disc herniation at L4-L5 with an annular tear on MRI. The EMG report indicated bilateral radiculopathy at the L4 and L5 nerve roots. Upon review by a fellowship trained, sub-specialized radiologist, the true MRI findings were found to be chronic in nature with no evidence of an annular tear.

Case Study 4- *Part 2 (Expert Review)*

The EMG was reviewed by an electrodiagnostic expert (ABEM certified) who found the following:

- The treating physician failed to meet the minimum testing standards to accurately diagnose a radiculopathy.
- The original report contained negative values for amplitudes, a medical impossibility.
- The treating physician failed to properly record waveforms per AANEM guidelines.
- The expert report concluded that "The study performed has no medical usefulness."

Case Study 4- *A Note on Costs*

Secondary review of the images and testing is an important step in cost savings.

This case was valued at \$175k but due to the secondary review by highly credentialed physicians, the case settled for \$40k.

Summary- Utility of EMG in Radiculopathy

- Highly sensitive indicator of early nerve injury
- Detects dynamic and functional injury missed by MRI
- Provides information regarding chronicity of nerve injury
- Highly localizing
- Clarifies clinical scenarios when one disorder mimics another
- Identifies more global neuromuscular injury with focal onset
- Provides longitudinal data for charting course, response to therapy

All dependent on a reliable laboratory with full repertoire of techniques

30800 Telegraph Rd, Suite 4775,
Bingham Farms, Michigan 48025

(844)-334-6243

www.authentic4d.com

orders@authentic4d.com

Nate Hessel
Head of Sales
Email: nhessel@authentic4d.com

Dr. John Robinton
Chief Clinical Officer
Email: jrobinton@authentic4d.com

Kimberly Ticknor
EMG Management
Email: kticknor@authentic4d.com



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