Radiculopathy of the Eight Cervical Nerve

David Greathouse PT, PhD, ECS
Anand Joshi MD

Presented by: David Boyce PT EdD ECS OCS
Purpose

1. To present an unusual presentation of a patient with a C8 radiculopathy.
2. Illustrate the utility of combining physical examination, EMG/NCS, and imaging in diagnosis of C8 radiculopathy.
3. Explore the differential diagnostics related to C8 Radiculopathy.
4. Review elements of an EMG/NCS study
5. Present standards of EMG/NCS testing for cervical radiculopathy.
Case Description

- 49 year old male referred from family physician with suspected ulnar neuropathy of the left upper limb.
- **Chief Complaints:**
  1. 3 month history (> 21 days) of pain, numbness, tingling into medial forearm and digits 4 & 5 (dorsal and ventral). No history of trauma.
  2. Weak grip
  3. Denies neck pain
- **PMH:** cervical ribs resection 10 years ago
- **Meds:** None
- **Examination Findings**
  - ROM: Cervical spine normal and pain free
  - MMT: 3+/5 APB, OP, DI/PI, ADM 4/5 EPL, EI, FPL, FCU, FDP 4/5
  - Reflex: normal B. BR, T, Hoffman negative
  - Sensation: Decreased sensation dorsal and palmar 4\textsuperscript{th} / 5\textsuperscript{th} digit
  - Special Tests: Spurlings, Phalens, Tinels (median/ulnar) negative, TOS testing negative, cranial nerves intact.
CPR for Cervical Radiculopathy

- Spurlings “A”
- Neck Distraction
- ULNT1 * best indicator
- Ipsilateral Cervical ROM of 60 degrees or less
- \(\frac{3}{4}\) - 65\% probability
- 4/4 – 90 \% probability
Differential Diagnosis

• C8 Radiculopathy
• Brachial Plexus Injury (medial cord/inferior trunk)
• Thoracic Outlet Syndrome
• Tumor (pancoast)
• Entrapment Syndrome (ulnar nerve proximal to elbow)
• Cardiac
• Myelopathy

Signs and Symptoms of a Cervical Radiculopathy C5-C8
Etiology of Cervical Radiculopathy

- Spondylosis
- Herniated Nucleus Pulposis
- Lateral Spinal Stenosis
- Spondylolisthesis
- Ligament Hypertrophy
- Inflammatory
- Tumor
- Infection
Epidemiology of Cervical Radiculopathy

- Peak incidence is the 4th and 5th decade of life.
- Prevalence of 2 per 1000 in this group
- Male > Female
- C6 -7 roots most commonly involved
Why EMG/NCS Testing?

- Rule-in or rule-out a clinical impression
- Identification of co-existing conditions
- Quantify region(s) and severity of nerve and muscle injury
- Assist in selecting and focusing other testing and intervention
- Good for serial tracking of a patient condition
- Order 14-21 days after the onset of signs and symptoms
Elements of EMG/NCS Examination

EMG – Electromyogram
- Resting activity - Positive Sharp Waves (PSW’s)
- Motor unit morphology

NCS – Nerve Conduction
- Latencies
- Amplitudes / Velocities

F-wave – evaluates anterior horn and proximal spinal nerve root
H-reflex – evaluates reflex arc

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Adductor Hallucis (L2-3)

Electromyography

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Side</th>
<th>Innervation</th>
<th>Resting Activity</th>
<th>Motor Unit Morphology</th>
<th>Sensory Nerves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vastus Medialis</td>
<td>√</td>
<td>L3-4</td>
<td>Flexed</td>
<td>0-1</td>
<td>3.19 ± 1.15 μV</td>
</tr>
<tr>
<td>Biceps Femoris (short)</td>
<td>√</td>
<td>L3-S1</td>
<td>C. Personal</td>
<td>++</td>
<td>3.7 ± 1.5 μV</td>
</tr>
<tr>
<td>Med. Gastrocnemius</td>
<td>√</td>
<td>L3-2</td>
<td>Flexed</td>
<td>0-1</td>
<td>4.0 ± 1.5 μV</td>
</tr>
<tr>
<td>Ant. Tibialis</td>
<td>√</td>
<td>L4-5</td>
<td>D. Personal</td>
<td>0-1</td>
<td>4.4 ± 1.5 μV</td>
</tr>
<tr>
<td>Peroneus Longus</td>
<td>√</td>
<td>L3-S1</td>
<td>S. Personal</td>
<td>++</td>
<td>4.7 ± 1.5 μV</td>
</tr>
<tr>
<td>Lumbale Paraspinals</td>
<td>√</td>
<td>L1-S1</td>
<td>PPR</td>
<td>0-1</td>
<td>4.7 ± 1.5 μV</td>
</tr>
</tbody>
</table>

Nerve Conduction Velocities

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>51.5 ± 10.10</td>
</tr>
<tr>
<td>F. Wave</td>
<td>51.5 ± 10.10</td>
</tr>
<tr>
<td>H. Reflex</td>
<td>Absent</td>
</tr>
</tbody>
</table>

Findings:
- NCS:
  1. The right H-reflex is prolonged as compared to the left.
  2. EMG:
      1. The right S1 myotome demonstrate mild acute and ongoing spinal degeneration.

Impression: The findings suggest a right acute and ongoing S1 radiculopathy. The bilateral nerves appear normal at this time.

Thank you for the referral,

David A. Boyce, EdD, PT, ECS, OCS
Board Certified Electromyographer

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Sensitivity of EMG for Radiculopathy?

- Cervical 58% on average (SnOUT)
- Lumbar 68%
- However, the best sensitivity appears to be when EMG/NCS is coupled with MRI
  - Cervical – 67% , Lumbar – 81%

Specificity of EMG for Radiculopathy

- EMG found to be highly specific when a strict diagnostic criteria is utilized (95-100%) (SpIN)
- Can drop as low as 63% when a more liberal criteria is used.

Value of NCS in the Identification of Radiculopathy

- NCS does not help with identification of radiculopathy.
- NCS helps R/O superimposed generalized or specific peripheral neuropathy.
- F-waves – add minimal value

England Muscle Nerve  2005
Wilburn Muscle Nerve 1998
What you should expect..... from your electromyographer

- EMG
  - Radiculopathy is found on EMG
  - 6 limb muscles (2 at suspected level (differing nerve innervations), 2 above and 2 below. Less than six decrease identification rate
  - More than 6 (diminishing return)
  - Paraspinal muscles a must! Significant increase in identification rate.

- NCS
  - Median motor & sensory for cervical radiculopathy

- Identification rate in 94-99% range using this approach
- Clustered with imaging increases sensitivity

Sensory & Motor NCS

Median Sensory D3

Median Motor Nerve
# NCS Data Collection

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Latency</th>
<th>Amp/Vel</th>
<th>Normals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Sensory</td>
<td>3.2 ms</td>
<td>39 µV</td>
<td>&lt;3.6/&gt;15</td>
</tr>
<tr>
<td>Ulnar Sensory</td>
<td>3.1 ms</td>
<td>24 µV</td>
<td>&lt;3.5/&gt;10</td>
</tr>
<tr>
<td>Dorsal Ulnar Cut.</td>
<td>1.6 ms</td>
<td>28 µV</td>
<td>&lt;2.2/&gt;10</td>
</tr>
<tr>
<td>Radial Sensory</td>
<td>2.2 ms</td>
<td>25 µV</td>
<td>&lt;2.7/&gt;10</td>
</tr>
<tr>
<td>Lat. Ant. Brach. Sen.</td>
<td>2.4 ms</td>
<td>8 µV</td>
<td>&lt;3.2/&gt;8</td>
</tr>
<tr>
<td>Med. Ant, Brach. Sen.</td>
<td>2.4 ms</td>
<td>9 µV</td>
<td>&lt;3.2/&gt;8</td>
</tr>
<tr>
<td>Median Motor</td>
<td>3.9 ms 6 MV</td>
<td>56 m/s</td>
<td>&lt;4.0/&gt;5/&gt;50</td>
</tr>
<tr>
<td>Ulnar Motor</td>
<td>2.9 ms 7 MV</td>
<td>63 &amp; 68 m/s</td>
<td>&lt;3.6/&gt;5/&gt;50</td>
</tr>
<tr>
<td>F-Waves (median/ Ulnar)</td>
<td>27-29.0 ms</td>
<td></td>
<td>&lt; 32 ms</td>
</tr>
</tbody>
</table>
Normal Insertional & Motor Unit Activity
<table>
<thead>
<tr>
<th>EMG</th>
<th>Nerve</th>
<th>Root</th>
<th>Fibs/PSW</th>
<th>MUAP</th>
<th>Int. Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid Paraspinals</td>
<td>PPR</td>
<td>C4-6</td>
<td>Norm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Paraspinals</td>
<td>PPR</td>
<td>C7-8</td>
<td>+1/+2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trapezius</td>
<td>Sp. Acc.</td>
<td>C3-4</td>
<td>Norm</td>
<td>Norm</td>
<td>Norm</td>
</tr>
<tr>
<td>Pec. Major Sternal</td>
<td>M. Pect</td>
<td>C8-T1</td>
<td>+1/+2</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>Pec. Major Clavic</td>
<td>L. Pect</td>
<td>C5-7</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>SScap</td>
<td>C5</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>Deltoid</td>
<td>Axillary</td>
<td>C5</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>Triceps</td>
<td>Radial</td>
<td>C6-8</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>Biceps</td>
<td>Muscul</td>
<td>C5-6</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>FDP (4/5)/FCU</td>
<td>Ulnar</td>
<td>C8-T1</td>
<td>+1/+1</td>
<td>Norm</td>
<td>75%</td>
</tr>
<tr>
<td>ECRL</td>
<td>Radial</td>
<td>C6-7</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>EPL</td>
<td>Radial</td>
<td>C7-8</td>
<td>+1/+2</td>
<td>Norm</td>
<td>75%</td>
</tr>
<tr>
<td>Pronator Teres</td>
<td>Median</td>
<td>C6-7</td>
<td>Norm</td>
<td>Norm</td>
<td>100%</td>
</tr>
<tr>
<td>FDI/ADM</td>
<td>Ulnar</td>
<td>C8-T1</td>
<td>+2/+2</td>
<td>Norm</td>
<td>50%</td>
</tr>
<tr>
<td>APB</td>
<td>Median</td>
<td>C8-T1</td>
<td>+2/+2</td>
<td>Polyphasic</td>
<td>50%</td>
</tr>
</tbody>
</table>
Fibrillation Potentials
Electrophysiologic Impression

1. There is electrophysiological evidence of a C8 radiculopathy of the left upper limb. In addition, acute axonal degeneration was noted in the lower left paracervical muscles.

2. There is no electrophysiological evidence of brachial plexopathy or ulnar neuropathy.
Imaging Studies

- Performed after EMG/NCS study
- Radiographs – C5/6/7 Spondylosis, anteriolisthesis C7-T1
- Chest X-ray negative
- CT Myelogram/MRI – disc herniation at C7/T1
Intervention & Follow-up

- Patient declined neurosurgery
- Patient declined other conservative interventions.
- One year later patient opted for surgery after worsening.
- C7-T1 laminectomy, excision of disc herniation, foraminotomy (posterior approach).
- One month follow up demonstrated decreased arm pain, 4/5 strength, decreased sensation 4th and 5th digit.
Cervical Radiculopathy

Prognosis

- 90% of patients improve with active conservative treatment.
- Patients with hard neuro signs took 19 weeks longer to return to sport and 60% still had residual symptoms.

If at 6 months post the radiculopathy is present and the 5 factors are present then prognosis is poor and surgical intervention considered.

- History 5 years reoccurring cervical radiculopathy
- More than 3 episodes
- Bilateral paresthesia
- Female over 50
- Symptoms are worsening

Wainner  JOSPT 2000
Conclusions

- Patients with upper limb weakness with the absence of cervical pain raise a red flag and require in-depth differential diagnostics.
- CPR for cervical radiculopathy does not always apply.
- Understand when to refer a patient for EMG/NCS.
- Understand EMG/NCS guidelines and typical findings for radiculopathy.
- Appreciate prognostic factors related to radiculopathy.
Questions
Ulnar Nerve Anatomy

- Medial compartment of the arm – gives off branch to FCU above the elbow.
- Ulnar groove at the elbow
- Pierces the FCU, then innervates FDP to D4/5
- DUCN 12 cm above wrist, sensation to dorsum of hand medial half of 4th and entire 5th digit.
- Passes into hand innervating hypothenar muscles, medial lumbricals and intrinsics (DI/VI).
- Terminal sensory branch – medial aspect of the 4th and entire 5th digit.
Abnormal Motor Unit Morphology

Polyphasic Motor Unit
Rapid Recruitment