EDX Evaluation of the Brachial Plexus and Upper Limb Nerves

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Financial Disclosure

Nothing to Disclose.
Principles and Practice

1) Hx & Px before EDx
2) Watch twitch, then measure
3) Distal vs Proximal Shocks
4) Linear or Nonlinear Changes
5) Short and Long of NCS
Neuropathy

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Mononeuropathy

- Median Nerve
- Carpal Tunnel Syndrome
- Ulnar Nerve
- Cubital Tunnel Syndrome
- Radial Nerve
- Saturday Night Palsy
- Peroneal Nerve
- Fibular Head Compression
- Tibial Nerve
  - Baxter Neuropathy

Polyneuropathy

- Systemic Disease
  - Diabetic
  - Uremic
  - Paraneoplastic
  - Paraproteinemic
  - Critical Illness

  - Autoimmune
    - CIDP
  - GBS
  - AMAN
  - Diphtheritic

  - Metabolic & Toxic
    - Alcoholic
    - Drug Induced

  - Hereditary
    - CMT
    - Dejerine-Sota
    - Refsum
    - Porphyria

Mononeuropathy Multiplex

- Demyelination
  - MMN
  - HNPP

- Axonal Degeneration
  - Vasculitis
  - Leprosy
  - HIV Neuropathy
  - Lyme Disease

From Kimura, 2013.
Principles and Practice

1) Hx & Px before EDx
2) Watch twitch, then measure
3) Distal vs Proximal Shocks
4) Linear or Nonlinear Changes
5) Short and Long of NCS
From Kimura, 2013.
71 year old Chinese woman with multiple myeloma

Palm

Wrist

Elbow

5/27/09

0.5 mV

5 ms
Principles and Practice

1) Hx & Px before EDx
2) Watch twitch, then measure
3) Distal vs Proximal Shocks
4) Linear or Nonlinear Changes
5) Short and Long of NCS
Response

NORMAL initially

ABSENT in a few days

Nerve excitability distal to the lesions in neurotmesis
Patient History

• 63 y.o. right handed male with a history of left biceps tendon rupture

• Currently experiencing left forearm and thumb pain and feeling of “tightness” in radial forearm
From Kimura, 2013.
Diagnostic Nerve Ultrasound Video
Final Diagnosis: Ultrasound

- Study is somewhat limited due to excess scar tissue and post-operative status.
- There has been complete transection of the lateral antebrachial cutaneous nerve with subsequent neuroma formation at the proximal biceps repair site.
- There also is most likely repair failure approximately 1 cm proximal to radial insertion based primarily on dynamic evaluation.
- Excessive scar tissue is present.
Nerve Conduction and Electromyography

### Motor Nerve Conduction Data

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Side</th>
<th>Site</th>
<th>Latency</th>
<th>Amplitude</th>
<th>Segment</th>
<th>Distance</th>
<th>NCV</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulnar</td>
<td>Right</td>
<td>Wrist</td>
<td>3.2ms</td>
<td>&lt;3.4</td>
<td>9.6mV</td>
<td>&gt;2.8</td>
<td>Wrist</td>
<td>230mm 55m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Below Elbow</td>
<td>7.4ms</td>
<td>&lt;7.5</td>
<td>9.2mV</td>
<td>&gt;2.8</td>
<td>Wrist-Below Elbow</td>
<td>230mm 55m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above Elbow</td>
<td>9.1ms</td>
<td>&lt;9.8</td>
<td>9.2mV</td>
<td>&gt;2.8</td>
<td>Above Elbow-Axilla</td>
<td>100mm 59m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Axilla</td>
<td>10.6ms</td>
<td>&lt;11.7</td>
<td>8.8mV</td>
<td>&gt;2.8</td>
<td>Above Elbow-Axilla</td>
<td>90mm 60m/s</td>
</tr>
<tr>
<td>Median</td>
<td>Left</td>
<td>Palm</td>
<td>2.8ms</td>
<td>&lt;2.4</td>
<td>5.2mV</td>
<td>&gt;3.5</td>
<td>Palm</td>
<td>80mm 50m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrist</td>
<td>4.0ms</td>
<td>&lt;4.2</td>
<td>4.5mV</td>
<td>&gt;3.5</td>
<td>Wrist-Palm</td>
<td>235mm 53m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elbow</td>
<td>8.4ms</td>
<td>&lt;8.8</td>
<td>3.6mV</td>
<td>&gt;3.5</td>
<td>Elbow-Palm</td>
<td>115mm 58m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Axilla</td>
<td>10.4ms</td>
<td>&lt;11.6</td>
<td>3.5mV</td>
<td>&gt;3.5</td>
<td>Axilla-Palm</td>
<td>115mm 58m/s</td>
</tr>
<tr>
<td>Radial</td>
<td>Left</td>
<td>Forearm</td>
<td>1.9ms</td>
<td>&lt;3.4</td>
<td>4.2mV</td>
<td>&gt;3.5</td>
<td>Forearm</td>
<td>220mm 69m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above Elbow</td>
<td>5.1ms</td>
<td>&lt;3.6</td>
<td>3.8mV</td>
<td>&gt;3.5</td>
<td>Above Elbow-FOREARM</td>
<td>220mm 69m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Erb's Point</td>
<td>10.1ms</td>
<td>&lt;3.8</td>
<td>3.8mV</td>
<td>&gt;3.5</td>
<td>Erb's Point</td>
<td>355mm 71m/s</td>
</tr>
</tbody>
</table>

### Sensory Nerve Conduction Data

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Side</th>
<th>Site</th>
<th>Latency</th>
<th>Amplitude</th>
<th>Segment</th>
<th>Distance</th>
<th>NCV</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulnar</td>
<td>Right</td>
<td>Wrist</td>
<td>3.0ms</td>
<td>&lt;3.1</td>
<td>23.5mV</td>
<td>&gt;18</td>
<td>Wrist</td>
<td>135mm 45m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Below Elbow</td>
<td>6.9ms</td>
<td>&lt;6.9</td>
<td>17.0mV</td>
<td>&gt;18</td>
<td>Below Elbow-Below Elbow</td>
<td>230mm 59m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above Elbow</td>
<td>8.6ms</td>
<td>&lt;8.7</td>
<td>18.0mV</td>
<td>&gt;18</td>
<td>Above Elbow-Axilla</td>
<td>100mm 59m/s</td>
</tr>
<tr>
<td>Median</td>
<td>Left</td>
<td>Palm</td>
<td>1.7ms</td>
<td>&lt;1.9</td>
<td>23.1mV</td>
<td>&gt;20</td>
<td>Palm</td>
<td>80mm 57m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrist</td>
<td>3.0ms</td>
<td>&lt;3.5</td>
<td>19.6mV</td>
<td>&gt;20</td>
<td>Wrist-Palm</td>
<td>235mm 58m/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elbow</td>
<td>7.0ms</td>
<td>&lt;7.9</td>
<td>11.0mV</td>
<td>&gt;20</td>
<td>Elbow-Erb</td>
<td>235mm 58m/s</td>
</tr>
<tr>
<td>Radial</td>
<td>Left</td>
<td>Forearm</td>
<td>1.6ms</td>
<td>&lt;1.9</td>
<td>19.6mV</td>
<td>&gt;20</td>
<td>Forearm</td>
<td>220mm 69m/s</td>
</tr>
<tr>
<td>Antebrachial</td>
<td>Left</td>
<td>Lateral</td>
<td>1.0ms</td>
<td>&lt;3.0</td>
<td>4.7mV</td>
<td>&gt;20</td>
<td>Lateral</td>
<td>220mm 69m/s</td>
</tr>
</tbody>
</table>

### F-Wave Data

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Side</th>
<th>StimSite</th>
<th>RecSite</th>
<th>Min. Latency</th>
<th>Height</th>
<th>4 % / degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulnar</td>
<td>Right</td>
<td>Wrist</td>
<td>25.8ms</td>
<td>&lt;31.0</td>
<td>182.5cm</td>
<td>58 - 59</td>
</tr>
<tr>
<td>Median</td>
<td>Left</td>
<td>Wrist</td>
<td>APB</td>
<td>27.1ms</td>
<td>182.5cm</td>
<td>58 - 59</td>
</tr>
</tbody>
</table>

### EMG Needle Findings

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Side</th>
<th>Insertion</th>
<th>Fibs.</th>
<th>PSW</th>
<th>Amplitude</th>
<th>Duratio</th>
<th>Polya</th>
<th>Recruit</th>
<th>Interfer</th>
<th>Fascic.</th>
<th>ORD</th>
<th>Myoton</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extn.Carsi Radialis</td>
<td>Left</td>
<td>Normal</td>
<td>0</td>
<td>0</td>
<td>Normal</td>
<td>Normal</td>
<td>Full</td>
<td>Full</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extn.Carsi Ulnaris</td>
<td>Left</td>
<td>Normal</td>
<td>0</td>
<td>0</td>
<td>Normal</td>
<td>Normal</td>
<td>Full</td>
<td>Full</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Principles and Practice

1) Hx & Px before EDx
2) Watch twitch, then measure
3) Distal vs Proximal Shocks
4) Linear or Nonlinear Changes
5) Short and Long of NCS
Median nerve stimulation

MNAP

SNAP (Index)

SNAP (Middle)

From Kimura, 2013.
Median nerve stimulation

From Kimura, 2013.
症例  49歳  男性  設計技師

主訴：右上肢脱力

2年前より次第に右上肢の挙上困難が出現、次第に設計のためPenを持つのも困難になって来た。同時に、右上肢の筋萎縮も出現、某大学病院でALSの診断を受ける。
Case DM  49-year-old male, an architect

C.C. Weakness in Rt. Upper Extremity

Difficulty in holding a pen for 3 yrs in raising the right arm for 2 yrs.

Atrophy of the right shoulder girdle and small hand muscles became gradually prominent.

Slowly Progressive Course and No Sensory Complaints.

Clinical Diagnosis: Motor Neuron Disease

Anti-GM1 Titer: > X800
## Physiological Findings

### Nerve Conduction Study

<table>
<thead>
<tr>
<th></th>
<th>CV (m/sec)</th>
<th>Amp (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist (d.l.)</td>
<td>3.4</td>
<td>6</td>
</tr>
<tr>
<td>Wrist-elbow</td>
<td>51</td>
<td>6.2</td>
</tr>
<tr>
<td>Elbow-axilla</td>
<td>51</td>
<td>5.5</td>
</tr>
<tr>
<td>Axilla-Erb</td>
<td>40</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Ulnar</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist (d.l.)</td>
<td>2.9</td>
<td>14</td>
</tr>
<tr>
<td>Wrist-b.elb</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td>B.elb-axilla</td>
<td>54</td>
<td>13</td>
</tr>
<tr>
<td>Axilla-Erb</td>
<td><strong>not evoked</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Radial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.elb (d.l.)</td>
<td>3.6</td>
<td>11</td>
</tr>
<tr>
<td>B.elb-a.elb</td>
<td>50</td>
<td>11</td>
</tr>
<tr>
<td>A.elb-sp.groove</td>
<td>72</td>
<td>9.8</td>
</tr>
<tr>
<td>Sp.groove-Erb</td>
<td>48</td>
<td>1.6</td>
</tr>
</tbody>
</table>

### EMG

- 1+ fibs and positives in rt supraspinatus, deltoid and APB
- Chronic partial denervation in rt serratus ant, deltoid, supra-/infra-spinati, triceps, biceps, EDC, APB, 1st DIO
- Normal in paraspinal muscles
図3：翼状肩甲（症例2）

ヘモプレイン療法後、翼状肩甲が消失した（右）。
Principles and Practice

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2) Watch twitch, then measure
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4) Linear or Nonlinear Changes
5) Short and Long of NCS
Medical History

• 8 y.o. African boy with left elbow injury in 2015 while in Uganda.

• Closed reduction and casting at a local hospital.

• Dislocation but no apparent fracture by X-ray study.
Musculoskeletal Exam

- Clinically 30° varus deformity of the left elbow with arm extended
- Range from 15° hyperextension to 130° flexion on affected side.
- Range from 20° hyperextension to 150° flexion on unaffected side.
- No intrinsic muscle wasting noted
From Kimura, 2013.
Left Ulnar Inching

1.1 ms shift above ulnar groove
Ulnar Inching Superimposed
Case AW  39-year-old male, a businessman

C.C. Weakness in Hands and Legs

Weakness and Atrophy
   in Lt Small Hand Muscles for 3 years
   Rt Peroneal Muscles for 2 years
   Lt Tibial Muscles for 1 year
   Rt Small Hand Muscles for 6 months

Slowly Progressive Course
   and No Sensory Complaints

DTRs : Normal in Upper Extremities
       Hypoactive in Lower Extremities

Anti-GM1 Titer : X400
NCS: Long and Short of It

1) Short distances magnify focal abnormality despite increased measurement error.

2) Long distances, though insensitive to focal lesions, yield better for diffuse process
From Kimura, 2013.