Localization of CNS Pathology Based on the Physical Exam

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FERNE Brain Illness and Injury Course

FERNE Foundation for Education and Research in Neurological Emergencies

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Session Objectives

• Emphasize the essential elements of the H&P for localizing CNS pathology
• Describe an algorithmic, systematic approach to localizing neurologic pathology
  • The patient presenting with weakness

Key Clinical Questions

• Is the clinical presentation consistent with neurological pathology
• Where does the pathology localize to?
• What diagnoses exist at that localization?
• What acute interventions exist for those diagnoses?
**Key Learning Points**

- Consider the neuroanatomy systematically
- Use key features of the history and neuro exam to narrow down the localization

**An Algorithm for Diagnostic Localization**

- Unilateral versus bilateral
- Start from the cortex and work your way down and out

**Unilateral: Key Questions**

- Cortical signs?
- Face involved?
- Dermatomal / Myotomal?
- Peripheral nerve specific?

**Bilateral: Key Facts**

- Mental status impaired?
- Which limbs?
- Sensory level or involvement?
- Bladder involvement?
- Proximal vs distal?
- Fluctuating or fatiguing pattern?
- Ocular or bulbar signs?

**Weakness Cause of : Grouped by Anatomic Subunit**

**Diagnostic Algorithm for Acute Nontraumatic Unilateral Weakness**

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<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortical signs (Associated visual field deficit, gaze preference, aphasia, neglect)?</td>
<td>Yes</td>
</tr>
<tr>
<td>Limbs and lower face on same side (UMN signs)?</td>
<td>Yes</td>
</tr>
<tr>
<td>Contralateral cerebral hemisphere process</td>
<td>Yes</td>
</tr>
<tr>
<td>Combination of: Right sided hemiparesis?</td>
<td>No</td>
</tr>
<tr>
<td>Right sided sensory deficit?</td>
<td>No</td>
</tr>
<tr>
<td>Right visual field deficit?</td>
<td>No</td>
</tr>
<tr>
<td>Left gaze preference?</td>
<td>No</td>
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<tr>
<td>Aphasia?</td>
<td>No</td>
</tr>
<tr>
<td>Lacunar syndrome?</td>
<td>No</td>
</tr>
<tr>
<td>Left (dominant) cerebral hemisphere process ?</td>
<td>No</td>
</tr>
<tr>
<td>Combination of: Left-sided hemiparesis?</td>
<td>No</td>
</tr>
<tr>
<td>Left-sided sensory loss?</td>
<td>No</td>
</tr>
<tr>
<td>Left visual field deficit?</td>
<td>No</td>
</tr>
<tr>
<td>Right gaze preference?</td>
<td>No</td>
</tr>
<tr>
<td>Left-sided neglect?</td>
<td>No</td>
</tr>
<tr>
<td>Right (non-dominant) cerebral hemisphere process</td>
<td>No</td>
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</tbody>
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Motor Neuron Neuroanatomy

- UMN - Cortex to the lateral column of the spinal cord
- LMN - Anterior column to the motor end-plate

Upper vs Lower Motor Neuron Weakness

<table>
<thead>
<tr>
<th>Clinical</th>
<th>UMN</th>
<th>LMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑</td>
<td></td>
<td></td>
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<tr>
<td>↓</td>
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</tbody>
</table>

Muscle tone

- ↑
- ↓

Fasciculation

- None
- Present

Atrophy

- None
- Severe

Babinski sign

- Present
- Absent

Somatotopic Organization in the Brain

Diagnostic Algorithm for Acute Nontraumatic Unilateral Weakness

<table>
<thead>
<tr>
<th>Cranial nerve signs?</th>
</tr>
</thead>
<tbody>
<tr>
<td>hemiparesis (ipsilateral face/contralateral body, UMN signs)?</td>
</tr>
</tbody>
</table>

Brainstem process

- Yes
- No

Notable Midbrain and Brainstem Syndromes Causing Unilateral Weakness

- Weber 3rd nerve palsy
  - Midbrain
  - Ipsilateral facial weakness
  - Contralateral hemiparesis

Pons Millard-Gubler
- Facial Palsy
- Hemiparesis

Pons Foville’s Facial Paresis, Abducens’ palsy
- Hemiparesis

Anatomy of the Midbrain at the Level of the Third Nerve
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Diagnostic Algorithm for Acute Nontraumatic Unilateral Weakness

- Cranial nerve signs +/- hemiparesis (ipsilateral face/contralateral body, UMN signs)?
  - Yes: Brainstem process
  - No

- Hemiplegia or monoplegia, ipsilateral loss of vibration/proprioception, contralateral loss of pain and temperature?
  - Yes: Brown-Sequard syndrome
  - No

- Myotomal weakness (weakness associated with an isolated spinal nerve), dermatomal sensory involving (usually pain)?
  - Yes: Radiculopathy
  - No

Spinal Cord- 3 Basic Areas

- Posterior column (sensory - proprioception & vibration)
- Lateral Column
  - a. corticospinal (motor)
  - b. spinothalamic (sensory - pain & temperature)
- Anterior Column (motor)

Cervical Myotomes

- C4 Elbow flexors (biceps, brachialis, & brachioradialis)
- C5 Wrist extensors (extensor carpi radialis longus & brevis)
- C6 Elbow extensors (triceps)
- C7 Finger flexors (distal phalanx – flexor digitorum profundus)
- C8 Small finger abductor (abductor digiti minimi)
- T1 Small finger abductor (abductor digiti minimi)

Lumbosacral Myotomes

- L2 Hip flexors (iliopsoas)
- L3 Knee extensors (quadriceps)
- L4 Ankle dorsiflexors (tibialis anterior)
- L5 Long toe extensors (extensor hallucis longus)
- S1 Ankle plantar flexors (gastrocnemius, soleus)

Sensory Dermatomes

- C4 Top of ACJ
- C5 Lateral ACF
- C6 Thumb
- C7 Middle finger
- C8 Little Finger
- T1 Medial ACF
- T4 Nipple line
- T19 Umbilicus
- L4 Medial malleolus
- L5 Dorsal 2-3 MTP
- S1 Lateral heal
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Diagnostic Algorithm for Acute Nontraumatic Unilateral Weakness

- Nerve plexus syndrome?
  - Yes
    - Brachial plexopathy
      - (Shoulder, back or arm pain, followed by weakness of the arm, shoulder girdle, diminish reflexes)
    - Lumbar plexopathy
      - (Lateral back pain, insidiously progressing leg weakness, sensory findings are absent, deep tendon reflexes may be diminished; bowel and bladder function are not affected)
  - No
    - No

- Peripheral nerve entrapment neuropathy syndrome?
  - Yes
    - Median nerve compression
      - (Carpal tunnel syndrome)
      - Weakness of abduction/opposition of the thumb; sensory findings in palmar and dorsal surfaces of thumb, index, and middle fingers
    - Ulnar nerve entrapment
      - (Weakness of small finger flexion, adduction/abduction of fingers; sensory findings in small & ring fingers)
    - Radial nerve palsy
      - (Saturday night palsy)
      - Wrist drop and weakness of finger and thumb extension; sensory findings usually minimal
    - Sciatic nerve compression
      - (Weakness of the anterior tibial and gastrocnemius muscles)
      - Entrapment of the common or deep peroneal nerve
      - (Footdrop; sensory findings in web space between great and second toes)
  - No
    - No

Lumbosacral Plexus

- More difficult to recognize and localize than lesions of the spinal roots or peripheral nerves
- Trauma, radiation or malignancies
- Best clue is a motor and sensory deficit involving more than one spinal or peripheral nerve
- LMN signs more prominent than the sensory changes

Plexopathies

Diagnostic Algorithm for Acute Nontraumatic Bilateral Weakness

- Lassitude associated with an acute illness?
  - Yes
    - Treat acute illness
  - No
    - Bilateral weakness and diminished mental status?
      - Yes
        - Massive cerebral process
      - No
      - Tetraparesis
        - (UMN signs) + CN signs?
          - Yes
            - Brainstem process
          - No

Brainstem Process

Consider infectious or Massromenial Disease
Locked-in Syndrome

- Quadriplegia, mutism, and preserved consciousness
- Pontine lesion paralyses
  - Horizontal eye movements
  - Jaw, face, bulbar muscles
- Can be misdiagnosed as coma

Diagnostic Algorithm for Acute Nontraumatic Bilateral Weakness

All 4 limbs (UMN signs), sensory level, bladder dysfunction?

Yes → Mid or upper cervical myelopathy

No → Legs and hands (UMN signs)?

Yes → Low cervical myelopathy

No → Legs, UMN signs?

Yes → Thoracic myelopathy (Also may be caused by a parasagittal lesion in the interhemispheric fissure)

No

Myelopathies

- Intact cranial nerves and speech
- UMN signs to some degree
  - Except in spinal shock
- Distinct level to sensory findings
- Bladder dysfunction

<table>
<thead>
<tr>
<th>LMN and Beyond</th>
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<tbody>
<tr>
<td>Distribution</td>
</tr>
<tr>
<td>Distribution</td>
</tr>
<tr>
<td>Sensory</td>
</tr>
<tr>
<td>Fatigue</td>
</tr>
<tr>
<td>Serum CPK</td>
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</table>
Polyneuropathy

- Affect both motor and sensory symptoms
  - Unlike myopathies and NMJ disorders
- Often heralded by paresthesias
- Invariably, vibratory sense is lost distally
- Weakness due to the involvement of a large number of nerves
- Distal power reduced most dramatically
  - Longer nerves since most severely affected
- DTR's characteristically diminished

Myopathies

- Primary process in the myocyte
- Systemic disorder
  - Metabolic, inflammatory, drug related, etc.
- Reflexes maintained until weakness is severe
- Inflammatory myopathies "classically" involve proximal muscles

Conclusions

- Approach CNS Pathology Localization
  - Systematically
  - In the context of important distinguishing features
  - Based on the relevant neuroanatomy

Questions?

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