Neurologic Localization Made Easy
(Ok a little easier)

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Learning Objectives
1. Identify key anatomic structures needed for the localization of neurologic lesions.
2. Analyze clues from the history and physical examination and to correlate with common patterns of neurologic disease.
3. When presented with a case scenario, evaluate clues presented from the history and physical examination to arrive at a correct diagnosis or anatomic localization of the lesion.

Caveats
1. Present this from primary care standpoint to recognize basic patterns (Simon’s Rules) that will point the provider in the right direction toward location of the lesion and perhaps the correct diagnosis.
2. Present a basic review that will be helpful when you take PANRE.
Getting on the same page

- Central Nervous System
  - Cerebrum
  - Cerebellum
  - Brain stem
  - Spinal cord
  - Plus all things thalamus
- Long tracks
  - Corticospinal
  - Spinothalamic
  - Spinocerebellar
  - Posterior columns
- Brain stem
  - Midbrain
  - Pons
  - Medulla
- Peripheral Nervous System
  - Both motor and sensory nerves

General Process to Localize Neurologic Lesions

- Locate to one of the following areas
  - Cortex
  - Midbrain
  - Spinal cord
  - Motor neuron
  - Peripheral nerve
  - Neuromuscular junction
  - Muscle

General Process to Localize Neurologic Lesions

- Where the lesion is
- What the lesion is
- Follow Ockham’s Razor for lesions
  - Put the lesion in one site if possible
- Then
When you hear hoof beats

Case 1 Ms. H

- Ms. H is a 23-year-old nurse aid that was referred for evaluation of severe headaches of 6 months’ duration. She reported that the pain was not constant but had become more pronounced during the past month, and she felt that her eyesight had deteriorated in the past few weeks. She also stated that she now often felt cold, even in warm weather.

Neurologic examination showed following:
- Mental Status A and O x3, appropriate
- Cranial Nerves I and III-XII intact, exam of CN II demonstrated loss of the outer portion of both lateral VF. There was no clear papilledema, but the disks had become flattened and slightly pale.
- Motor Strength 5/5 both UE and LE
- Sensory intact to PP and LT
- Reflexes All DTRs +2/4 symmetric
Case 1 Ms. H

1.1 Where is the lesion?
- Cortex
- Midbrain
- Spinal cord
- Motor neuron
- Peripheral nerve
- Neuromuscular junction
- Muscle

1.2 From a neurologic standpoint what two things are going on that produced the findings on exam?
- 1. bitemporal hemianopsia from pressure on optic Chiasm
- 2. flattened discs from increased intracranial pressure
Case 1 Ms. H

1.3 What is it?

- Most common pituitary adenoma
- Signs/symptoms depend on whether the adenoma is functional or not

Case 1 Mrs. H

• Isolated cranial nerve dysfunction indicates a lesion above the foramen magnum

Simon’s Rules

#1 Isolated cranial nerve dysfunction indicates a lesion above the foramen magnum
Simon’s Rules

#2 Bitemporal hemianopsia strongly suggests an abnormal sellar mass pressing on the optic chiasm

Case 2 Mr.X

• Mr. X is a 40 year old diabetic patient who presents to the ED with 3 hours of vision loss in the right eye.
• On exam it is clear that Mr. X has no vision (no light perception) O.D.

Case 2 Mr.x

• 2.1 Where is the lesion?
  – Right optic nerve or
  – Cortex?
Case 2 Mr.x

• 2.1 Where is the lesion?
  – Right optic nerve or
  – Cortex?

Case 2 Mr. X

• What is the lesion?
• Given history likely a vascular cause

Simon’s Rules

• #3 Bilateral connections from the cortex prevents a cortex lesion from causing:
  – loss of vision in one eye (CN 2)
  – difficulty in moving one eye or inequality of one pupil (CN 3,4,6)
  – unilateral weakness of massaeter (CN5)
  – Hearing loss (CN8)
  – Difficulty in swallowing or hoarseness (CN9,10)
  – Difficulty raising the shoulder or turning the head (CN 11)
Case 2 Mr. X

- A 16-year-old male, is immobile and hospitalized for pneumonia. He has a long history of progressive weakening of his muscles, he complains that his weakness is the same throughout the day. He has difficulty in walking up the stairs. During his earlier teen years he had to use braces on occasion to walk. He is not complaining of pain or other sensory phenomena.

Case 3 Mr. G

- Physical examination reveals atrophy of the muscles in the LE bilat.
- You observe this patient trying to get out of bed and notice he needs to use his hands to push himself to an upright position.
Case 3 Mr. G

- 3.1 Where is the lesion?
  - Cortex
  - Midbrain
  - Spinal cord
  - Motor neuron
  - Peripheral nerve
  - Neuromuscular junction
  - Muscle

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Case 3 Mr. G

- 3.1 Where is the lesion?
  - Cortex
  - Midbrain
  - Spinal cord
  - Motor neuron
  - Peripheral nerve
  - Neuromuscular junction
  - Muscle

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Case 3 Mr. G

- What is it?
  - Muscular dystrophy - an inherited group of progressive myopathic disorders resulting from defects in a number of genes required for normal muscle function.
  - Muscle weakness is the primary symptom. The muscle weakness does not fluctuate as in neuromuscular junction diseases.
  - Many different subtypes, this patient fits with Becker type due to age and retained strength.
Case 3 Mr. G

- Weakness affects proximal before distal limb muscles
- Lower before the upper extremities
- An unusual waddling gait, lumbar lordosis, and calf enlargement are often present
- Watch for dilated cardiomyopathy

Simon's Rules

#4 Think muscle when:
- Proximal > distal weakness
- Weakness is not fatigable
- No sensory complaints other than myalgias
- Hair, Stair Chair

Case 4 Ms. P

- A 28-year-old woman has a four month history of seeing double when watching television. The double vision often disappeared after she had some bed rest. Sometimes her eyelids tended to droop during reading, but after a good night's rest she felt normal again. She had to perform some unusual physical work when her family was to move into a new residence and all the luggage and house hold was to be packed for moving. She felt extremely weak during the activity. Now she even becomes fatigued at the end of a meal from chewing. She has also recently suffered from a URI.
Case 4 Ms. P

• Findings on physical exam
  – Significant findings are as follows
  – Muscle strength: shoulder 2/5 wrist 4/5 hip 1/5
    lower legs 3/5 all bilat Masseter weakness
  – Reflexes +1 at all DTRs
  – Sensory exam intact to PP, LT, Proprioception

Case 4 Ms. P

• 4.1 Where is the lesion?
  – Cortex
  – Midbrain
  – Spinal cord
  – Motor neuron
  – Peripheral nerve
  – Neuromuscular junction
  – Muscle
Case 4 Ms. P

• What is it?
  – Myasthenia gravis
  – Most common disease of neuromuscular transmission
  – Autoimmune antibodies to the acetylcholine receptor (AChR) or receptor tyrosine kinase (MuSK)
  – Bimodal peak 2-3 decade (♀) and 6-8 decade (♂)

Case 4 Ms. P

• Two forms
  – Ocular
  – Generalized (bulbar, limb, respiratory)
• Characterized by fluctuating weakness and muscle fatigue often not described as fatigue per say but weakness.
• Effects proximal muscles > distal
• 15% have concomitant thymoma

Simon’s Rules

• # 5 Think Neuromuscular junction if
  – Proximal > Distal weakness
    • Episodic
    • Fatigable (worse late in day, or after exercise)
• Extraocular & bulbar weakness
• Sensory exam normal
Case 5 Ms. Z

• Ms. Z is a 46 y/o patient with CC of “clumsiness” of her left leg that is getting worse for the last month.
• On exam you find the following
  – Active and passive ROM full both UE and LE
  – Strength 4/5 both UE and LE
• Sensation intact to Light touch, two-point discrimination, proprioception, and vibration in RU, LU and RL extremities but absent in all dermatomes below the umbilicus in the left lower extremity.
  – Sharp dull intact bilat both U and L extremities, bilaterally

Case 5 Ms. Z

• 5.1 Where is the lesion?
  – Cortex
  – Midbrain
  – Spinal cord
  – Motor neuron
  – Peripheral nerve
  – Neuromuscular junction
  – Muscle

Case 5 Ms. Z

• 5.1 Where is the lesion?
  – Cortex
  – Midbrain
  – Spinal cord
  – Motor neuron
  – Peripheral nerve
  – Neuromuscular junction
  – Muscle
5.2 What is the name of this constellation of findings?

Sensory Dissociation

Dissociation of Sensory Loss

- The loss of one or two sensory modalities (such as pain and temperature sense) with preservation of others (such as touch, vibration and joint position sense) is termed a "dissociated sensory loss" and is in contrast to the loss of all sensory modalities associated
#6 Simon’s Rules

Anatomically speaking the spinal cord is the only place sensory dissociation can occur

**Case 5 Ms. Z**

- Let’s review a bit deeper in this case. Specifically which element from the following is involved in this case?
  - A. Spinothalamic tract
  - B. Spinocerebellar tract
  - C. Corticospinal tract
  - D. Posterior columns
  - E. Corticobulbar tract

**Case 5 Ms. Z**

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  - A. Spinothalamic tract
  - B. Spinocerebellar tract
  - C. Corticospinal tract
  - D. Posterior columns
  - E. Corticobulbar tract
Case 5 Ms. Z

• What is it?
  – Tumor is always a consideration
  – Multiple Sclerosis

Remember when checking sensation

• Can they perceive the stimulus?
• Prevent fatigue
• Vary pattern
• Close their eyes
Sensory Testing

Case 6 Mr. W

- Mr. W is a 58 y/o man who is seen in the clinic for a drivers license physical examination. During the course of the exam you ask him to stand with feet together and arms extended with palms supinated. When you ask him to close his eyes he begins to fall.

Case 6 Mr. W

- 6.1 Where is the lesion?
  - A. Spinothalamic tract
  - B. Cerebellum
  - C. Corticospinal tract
  - D. Posterior columns
  - E. Corticobulbar tract
Case 6 Mr. W

- 6.1 Where is the lesion?
  - A. Spinothalamic tract
  - B. Cerebellum
  - C. Corticospinal tract
  - D. Posterior columns
  - E. Spinocerebellar tract

Case 7 Mr. BB

- Mr. BB thinks he is having some sort of neurologic problem and is unhappy. On your exam you find the following
- Where is the lesion?
Case 7 Mr. BB

• Review reflex levels

Remember...1/2, 3/4, 5/6, 7/8

Case 7 Mr. BB

• Where is the lesion?
  • C7-8

Simon’s Rules

#7 When dealing with reflex changes look for the change level
Case 8 Mr. CC

- Mr. CC is also unhappy, here are his exam findings
- Where is his lesion?

Case 8 Mr. CC

- Mr. CC is also unhappy, here are his exam findings
- Where is his lesion?
  - Higher than the highest reflex level we checked on exam

Case 9 Mr. Q

- Mr. Q is a 32y/o who is brought to the emergency department by EMS after suffering a sudden onset of difficulty in speaking and weakness of the limbs.
Case 9 Mr. Q

- On the neurologic exam you find the following:
  - He is unable to produce spontaneous language, repeat phrases or follow commands except to utter a single syllable “tan”
  - There is drooping of the right lower face
  - The right upper extremity 1/5 strength
  - The M-S reflexes in the right upper extremity are 4/4 at biceps and triceps
  - With the right hand pronated you support the terminal phalanx of the long finger and flick the fingernail. You note that the thumb adducts and flexes

9.1 Where is the lesion?
- Cortex
- Midbrain
- Spinal cord
- Motor neuron
- Peripheral nerve
- Neuromuscular junction
- Muscle
Case 9 Mr. Q

- Can we be more specific?
- Left Cortex

Simon’s Rules

#8 Same side face, same side body points toward cortex

Case 9 Mr. Q

- What accounts for the reflex, strength and hand changes that we see in this patient?
### Case 9 Mr. Q

<table>
<thead>
<tr>
<th>UMNL</th>
<th>LMNL</th>
</tr>
</thead>
<tbody>
<tr>
<td>S = Strength</td>
<td>Lowers</td>
</tr>
<tr>
<td>T = Tone</td>
<td>Increases</td>
</tr>
<tr>
<td>O = Others</td>
<td>Superficial reflexes absent</td>
</tr>
<tr>
<td>R = Reflexes = DTR or Deep tendon reflexes</td>
<td>Increased</td>
</tr>
<tr>
<td>M = Muscle Mass</td>
<td>Slight loss only</td>
</tr>
<tr>
<td>Baby = Babinski Sign</td>
<td>Present (toes up)</td>
</tr>
</tbody>
</table>

From Medchrome.com

### Pathologic reflexes in UMN disease
- Babinski
- Hoffman
- Oppenheim (anterior tibial surface)
- Gordon (squeeze calves vigorously)
- Chaddock (strok ing along dorsum of foot from back of lateral malleolus to lateral dorsum of foot)
Case 9 Mr. Q

- More specific localization
  - Middle cerebral artery
- Aphasia
  - Left hemisphere
  - Dominant in 99% of R handers, 60-70% L handers
  - Perisylvian region of the left cortex (Broca's and Wernicke's)

Case 9 Mr. Q

- Luis Victor Leborgne, nicknamed "Tan"
- aphmie

Case 10 Ms. F

- Ms. F is a 60 y/o female who presents with the sudden onset of slurring her words slightly and some difficulty in placing her right leg when walking.
- You find the following on exam
  - Pts left- Weakness and atrophy of the tongue
  - Pts right- Spastic paralysis, ↓ proprioception and hyperreflexia
Case 10 Ms. F

• 10.1 Where is the lesion?
  – Cortex
  – Midbrain
  – Spinal cord
  – Motor neuron
  – Peripheral nerve
  – Neuromuscular junction
  – Muscle

Simon’s Rules

#9 a cranial nerve deficit on one side paired with a contralateral extremity deficit equals brainstem lesion
Case 11 Mr. M

- You are working as a hospitalist PA and are tasked to see Mr. M. for admission work up. He is a 49 y/o who is admitted after a fall where he hit his head and was confused for a period of time. He had been having difficulty walking over the last day, he felt uncoordinated. He has had “balance problems” over the last month.

Neurologic Exam Findings

- Patient’s right side
  - VA OD is 20/80
  - Babinski present
  - Ataxia

- Patient’s left side
  - With EOMs OS does not adduct
  - OD adducts but has nystagmus
  - Facial weakness

- 11.1 Where is the lesion?
  - Cortex
  - Midbrain
  - Spinal cord
  - Motor neuron
  - Peripheral nerve
  - Neuromuscular junction
  - Muscle
Case 11 Mr. M

• This is a trick question, no single lesion can explain these findings. Could be multiple simultaneous lesions but...

Simon’s Rules

#10 when faced with a scenario that cannot be explained by a single lesion think multiple sclerosis

Case 12 Mr. L

• A 60 y/o chemist c/o progressive weakness of both legs x 9 months. Two months previously, his arms had become weak but not as much as his legs. He recently begun to have difficulty swallowing solid food.
• On Neurologic examination
  – poor elevation of the uvula, a hoarse voice, and loss of tongue mobility.
  – Muscular atrophy was noted about the shoulders, in the intrinsic hand muscles, and in the proximal leg muscles,
  – All four extremities showed fasciculations at rest.
  – Strength in all extremities was 2/5.
  – Cerebellar tests were normal.
  – All reflexes were 4/4
  – Sensory exam was intact.
Case 12 Mr. L

• 12.1 Where is the lesion?
  – Cortex
  – Midbrain
  – Spinal cord
  – Motor neuron
  – Peripheral nerve
  – Neuromuscular junction
  – Muscle

Simon’s Rules

#11 The combination of upper and lower motor findings equals degenerative motor neuron disease Amyotrophic Lateral Sclerosis is the most common
# References