

The Cerebellum



**WHAT DOES IT DO? HOW DO I EXAMINE IT? WHY
IS MY PATIENT'S CEREBELLUM NOT WORKING?**

DEX ARNOLD

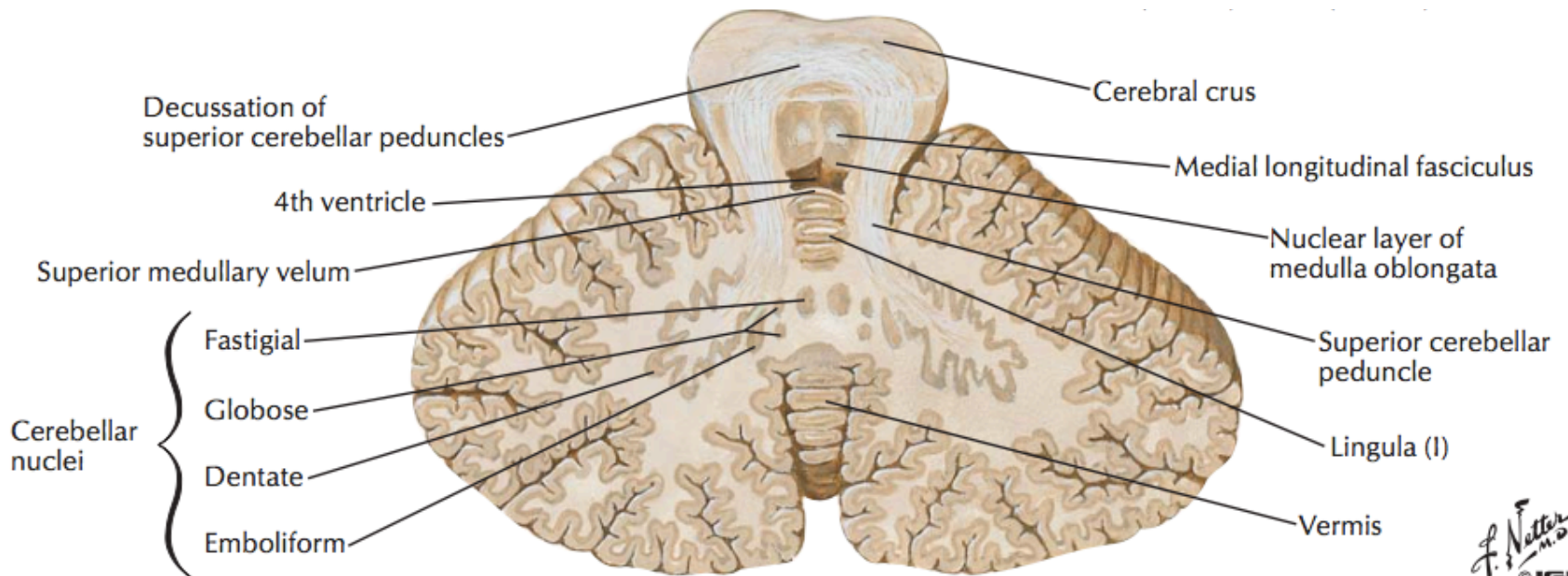
PGY-2 UNIVERSITY OF CALGARY NEUROLOGY

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**REVIEWED BY FACULTY DR. SURESH
SUBRAMANIAM**



Function, Anatomy, Exam, and Localization



Section in plane of superior cerebellar peduncle

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Its Function and Dysfunction



- The cerebellum does not contribute to motor power.
- It organizes and sequences agonist, antagonist, and synergist muscle contraction to regulate the rate, range, and force of movement.
- Cerebellar dysfunction often results in “ataxia” (‘a’ – without, ‘taxis’ – order) – and includes the incoordination, tremor, and dysdiadochokinesia that occurs with cerebellar lesions
 - Also may result in nystagmus, balance difficulty and unsteady gait



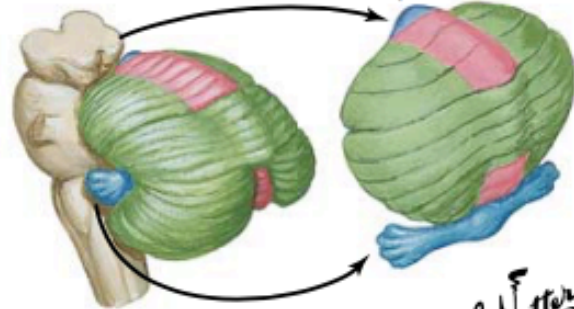
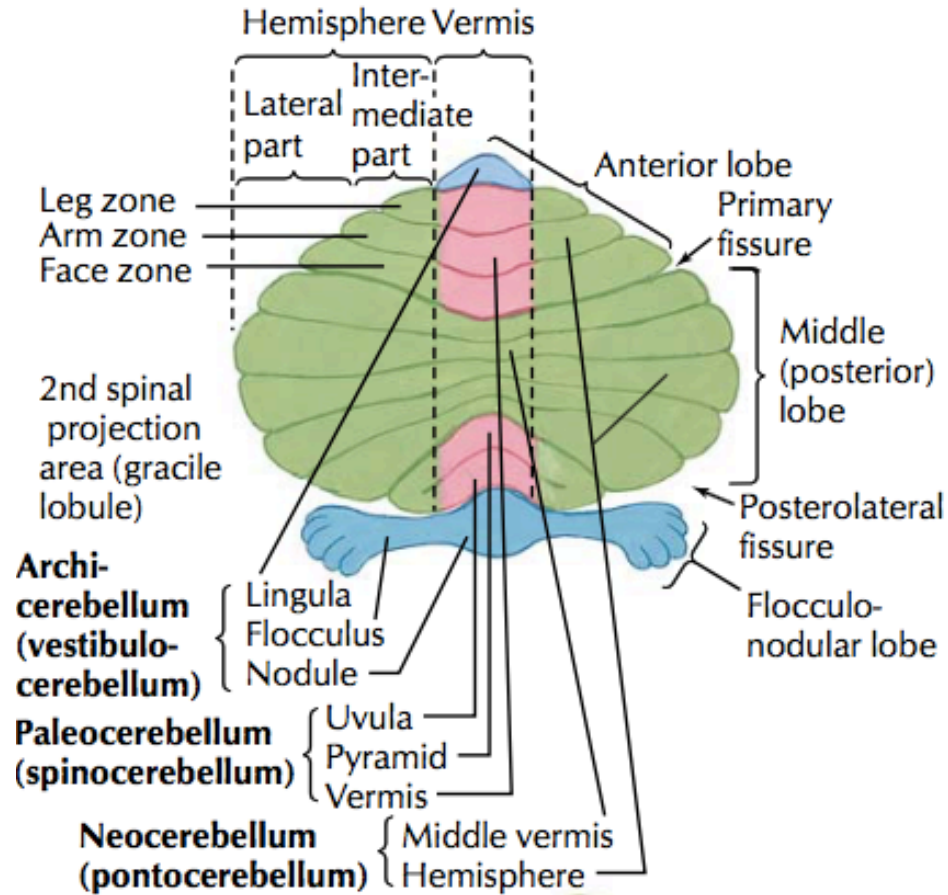
Anatomy



- Located in the posterior fossa
 - Tip: usually, not seen well on CT due to the thick petrous bone, think about MRI
- Separated from the pons by the 4th ventricle
- Multiple anatomical ways to divide up the cerebellum – most clinically useful is into three parts
 1. Cerebellar hemispheres
 2. Midline vermis
 3. Foculonodular lobe



Functional Subdivisions of Cerebellum



Schema of theoretical "unfolding" of cerebellar surface in derivation of above diagram

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Pontine Connections



- Pons, latin for “bridge”
- Connected to the cerebellum by inferior, middle, and superior cerebellar peduncles (different from the cerebral peduncles in the midbrain, part of the motor highway from the homunculus to the musculature)
- Motor information from the cerebral cortex enters via the MCP. SCP is the outflow. ICP connects the cerebellum with medullary nuclei, the vestibular system, and the spinal cord.



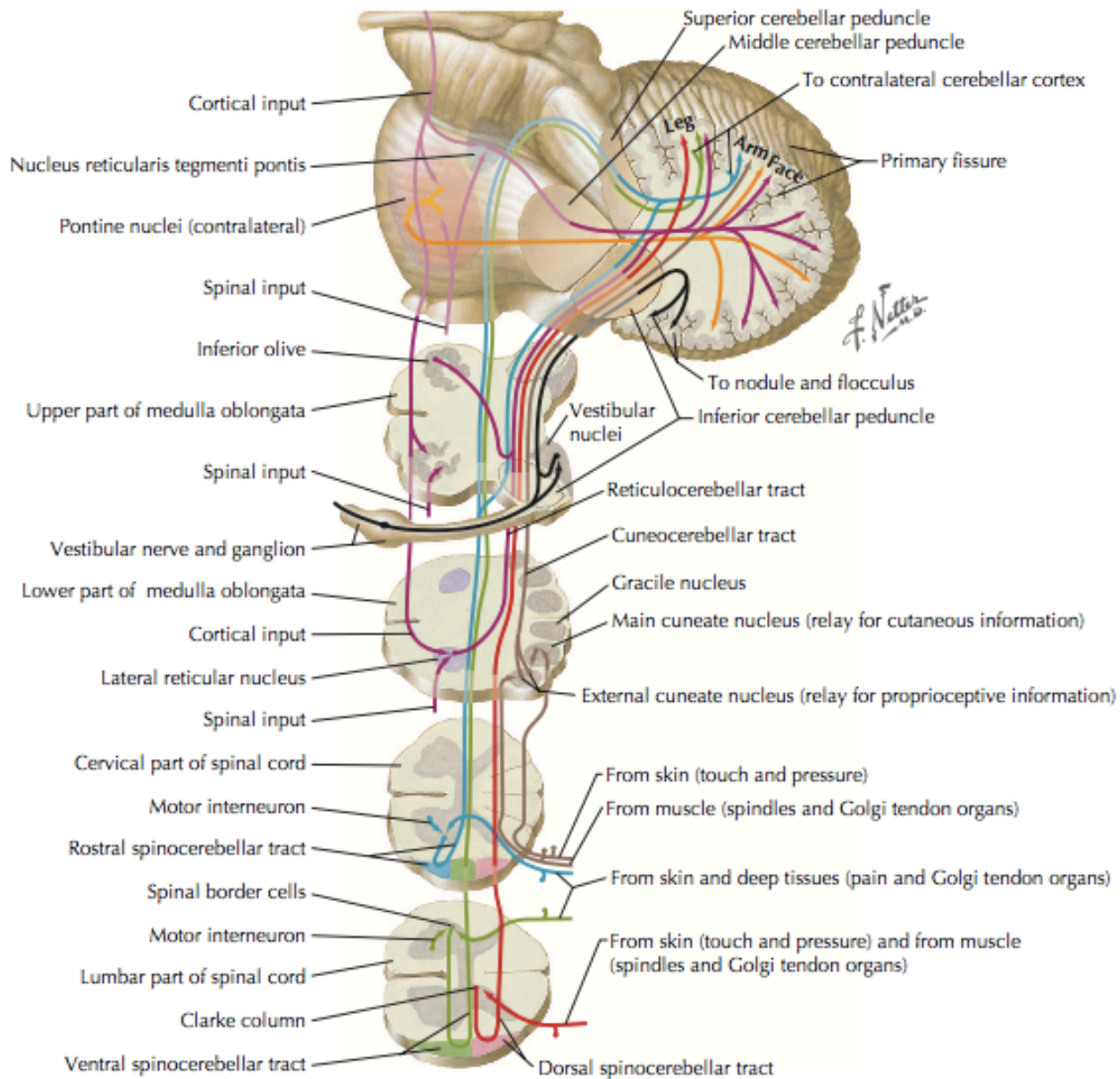
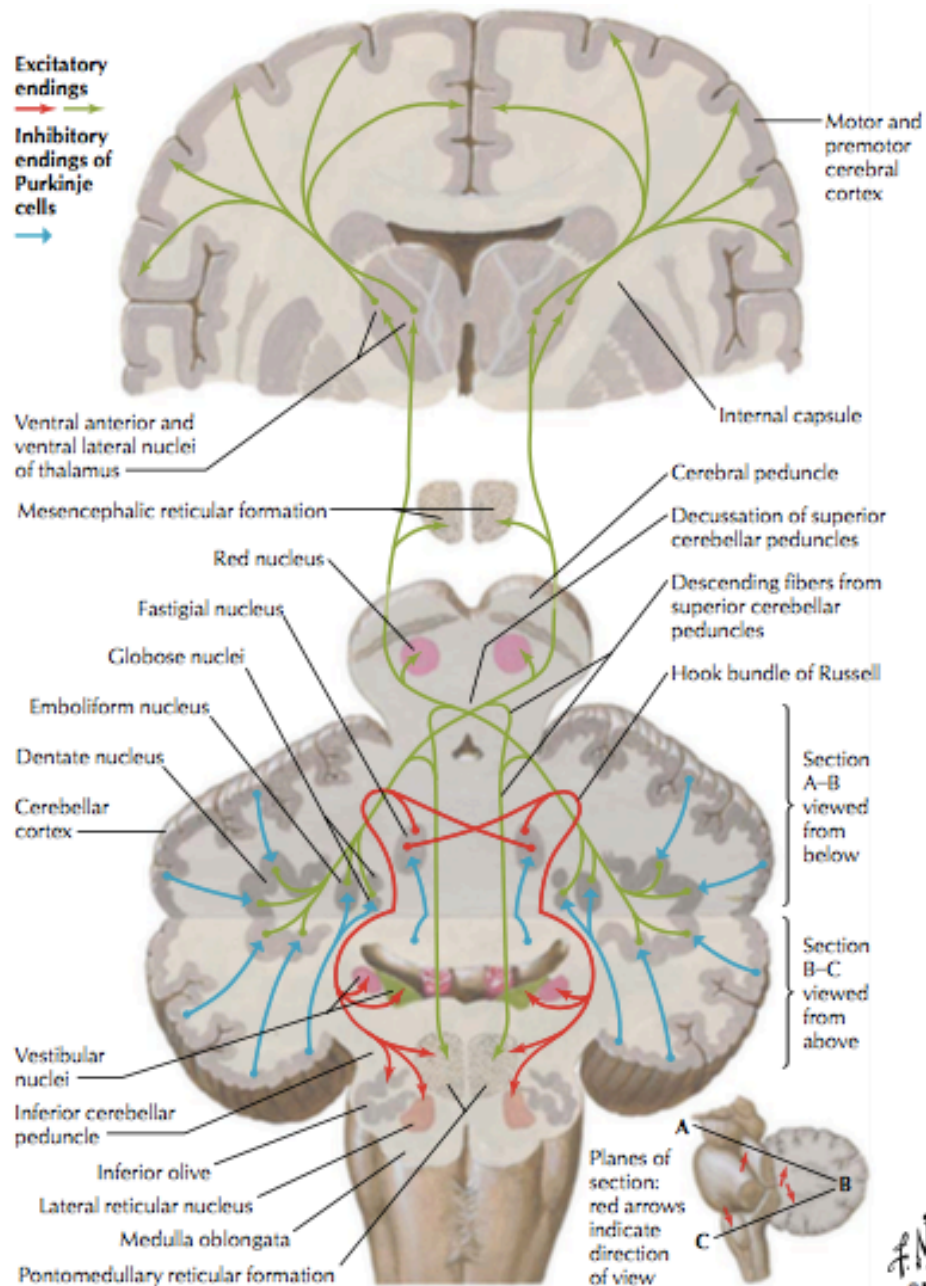


Figure 1-20 Cerebellar Afferent Pathways.





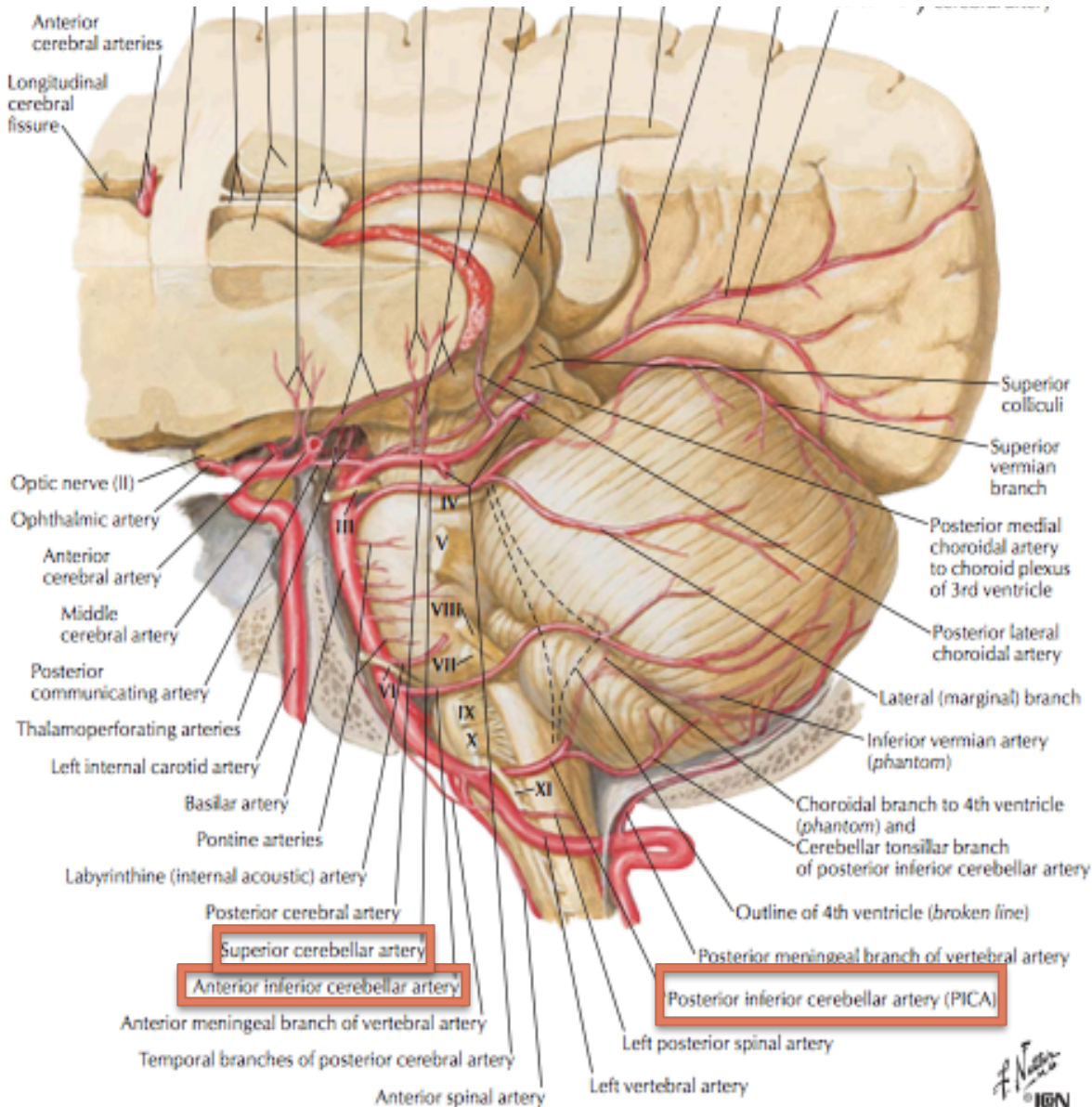
Signs



- Dysmetria
- Dysdiadochokinesia
- Tremor
- Hypotonia
- Dysarthria
- Ocular findings



Vascular Anatomy



- Supplied by three major paired vessels off of the basilar

- PICA
- AICA
- SCA



The Cerebellar Exam



- Ocular movements
- Finger-to-nose testing – watch for the intention tremor
- Rapid alternating movements
- Heel-to-shin
- Past-pointing
- Gait and balance: wide-based, abnormal tandem

- **TIPS**
 1. Handedness will result in a normal degree of asymmetry between sides
 2. Use yourself as a control
 3. Give time for pathology to manifest
 4. Testing both sides at once may accentuate pathology



Localization



TABLE 43.1 Clinical Manifestations of Disorders of the Cerebellum (Related to the Different Zones of the Cerebellum)

Zone of Cerebellum	Clinical Manifestation	Possible Disorder
Flocculonodular lobe (archicerebellum)	Nystagmus; extraocular movement abnormalities	Medulloblastoma
Vermis (paleocerebellum)	Gait ataxia	Alcoholic degeneration
Hemisphere (neocerebellum)	Appendicular ataxia	Tumor; stroke
Pancerebellar	All of the above	Paraneoplastic



Vermian Pathology



- Common etiologies preferentially affecting the vermis include chronic alcohol toxicity and medulloblastomas
- Gait ataxia (wide-based, staggering), truncal ataxia, and even a constant head nod (termed titubation), with relative sparing of limb coordination



Hemispheric Pathology



- Different from the cerebral cortex, the cerebellar hemispheres map **ipsilateral** to the limbs.
- Common pathologies affecting the cerebellar hemispheres include astrocytomas, lateral medullary strokes (Wallenberg's), and multiple sclerosis



Sensory Ataxia and Other Mimics in the CNS



- Sensory ataxia is caused by loss of proprioception from the extremities.
- Hallmark exam differentiation is that the sensory ataxia worsens with eyes closed. Cerebellar ataxias tend to be less affected by visual input.
- Note that “cerebellar signs” may be present if the patient has significant weakness, rigidity, sensory loss, or spasticity.
 - Eg. frontal lobe ataxia



The Differential



An Approach



- The Ddx is broad. Neurology is all about localization with the exam, and then the etiology will arise from the history and laboratory tests.
- One approach is genetic versus acquired.
- For genetic, it can be further subdivided by inheritance pattern.
- Examples include the AD Spinocerebellar ataxias (31 types!) and episodic ataxias, Fragile X syndrome, and the mitochondrial disorder MELAS



In the ED



- A common question in the ED is to differentiate peripheral versus central causes of vertigo (cerebellar stroke or hemorrhage)
 - Ask your staff or senior resident about the HINTS exam
 - Other neighborhood brainstem symptoms can help make the cerebellar localization



The Acquired Causes

Table 72.1 Acquired Causes of Ataxia

Entity	Diagnostic Process
Vascular disease	History of strokes, imaging
Hypoxic encephalopathy	History of hypoxic episode
Demyelinating disease	Remitting and relapsing episodes, imaging
Tumors in the posterior fossa	Imaging
Cranio-vertebral junction anomalies	Imaging
Hypothyroidism	Thyroid function
Toxic disorders: Alcohol Chemotherapy (5-fluoracil, ara-C) Metals (Hg, Bi) Solvents (toluene) Anticonvulsants (diphenylhydantoin)	History
Infections:	Imaging, serology, cerebrospinal fluid (CSF) studies
Acute cerebellar ataxia of childhood	History
Postinfectious	History, imaging, CSF
Bickerstaff encephalitis	Imaging
Human immunodeficiency virus (HIV)	Serology
Creutzfeldt-Jakob disease (CJD)	Biopsy
Autoimmune	Serology
Paraneoplastic	Anti-Hu, anti-Yo, anti-Ri, others
Gluten sensitivity	Gliadin, anti-endomysial antibody
GAD antibody-mediated	Glutamate carboxylase (GAD) antibody
Glutamate receptor antibody mediated	Glutamate receptor antibody
Superficial siderosis	Magnetic resonance imaging (brain)

- Big things to think about include stroke, tumour, hypothyroidism, HIV, alcohol, dilantin, chemotherapy, and paraneoplastic disorders.



Cases



TIME TO PRACTICE



Case 1



- 70 yo RHD male, hx of HTN, **sudden** onset of nausea, vomiting, and unsteadiness.
- On exam, dysarthria, slowed tongue movements, impaired finger-to-nose and heel-to-shin on the left, and left-sided dysdiadochokinesia. Fell to left upon standing.

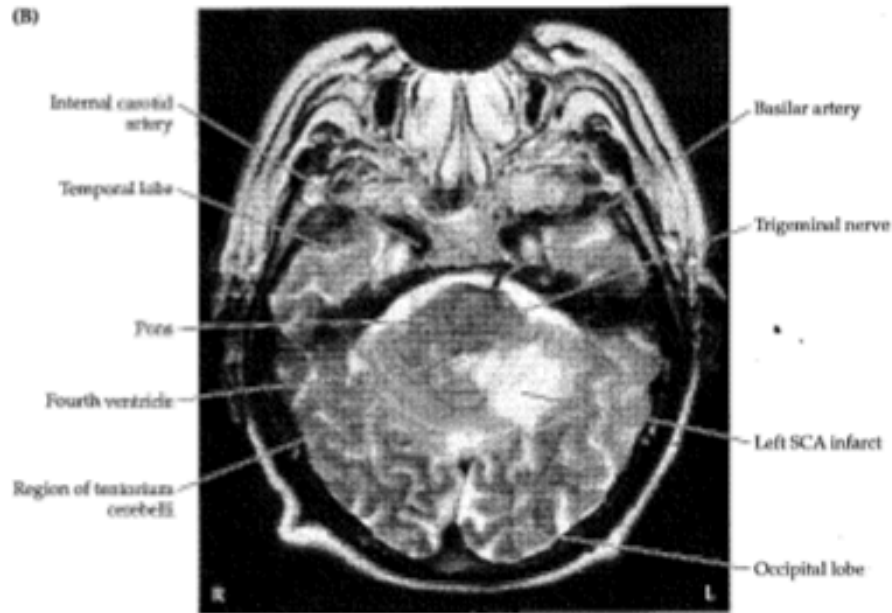
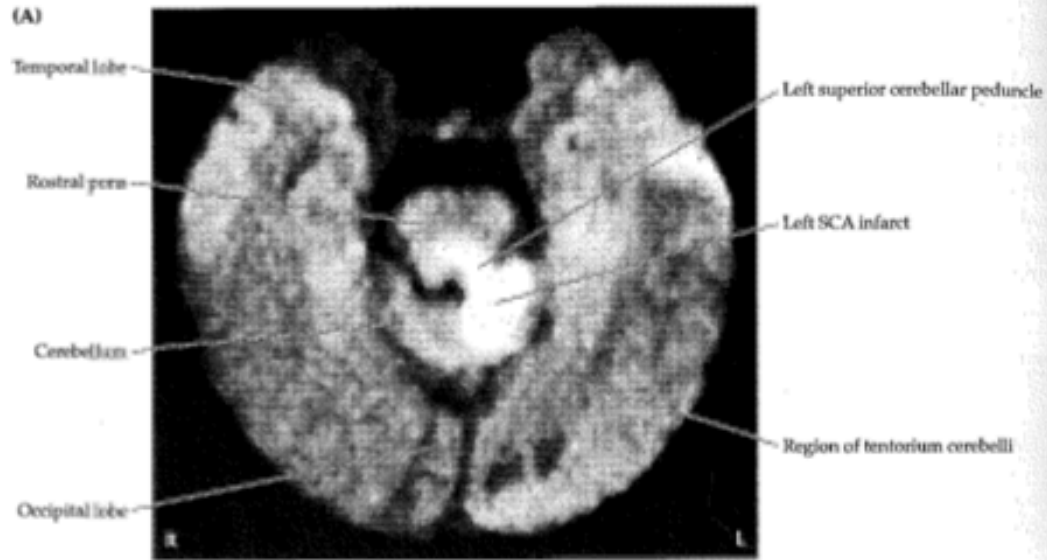


Case 1



- **Localization:**
 - Left Cerebellar Hemisphere +/- Vermis. Other possibilities: Left-cerebellar peduncles
- **Most likely etiology:**
 - Vascular
 - ✦ At this point, could be hemorrhagic or ischemic





Case 2



- 72 yo RHD woman with a 40+ pack year smoking history. Several **months** of **worsening** nausea and vomiting. Little improvement with antiemetics. Also, 2 months of deteriorating handwriting, as well as difficulties opening bottles and putting on earrings with her right hand. Mild gait unsteadiness with slipping more frequently than usual on the ice. Subjective cool sensation on right face. 3 pound weight loss in 2 months, and a couple episodes of hemoptysis.



Case 2



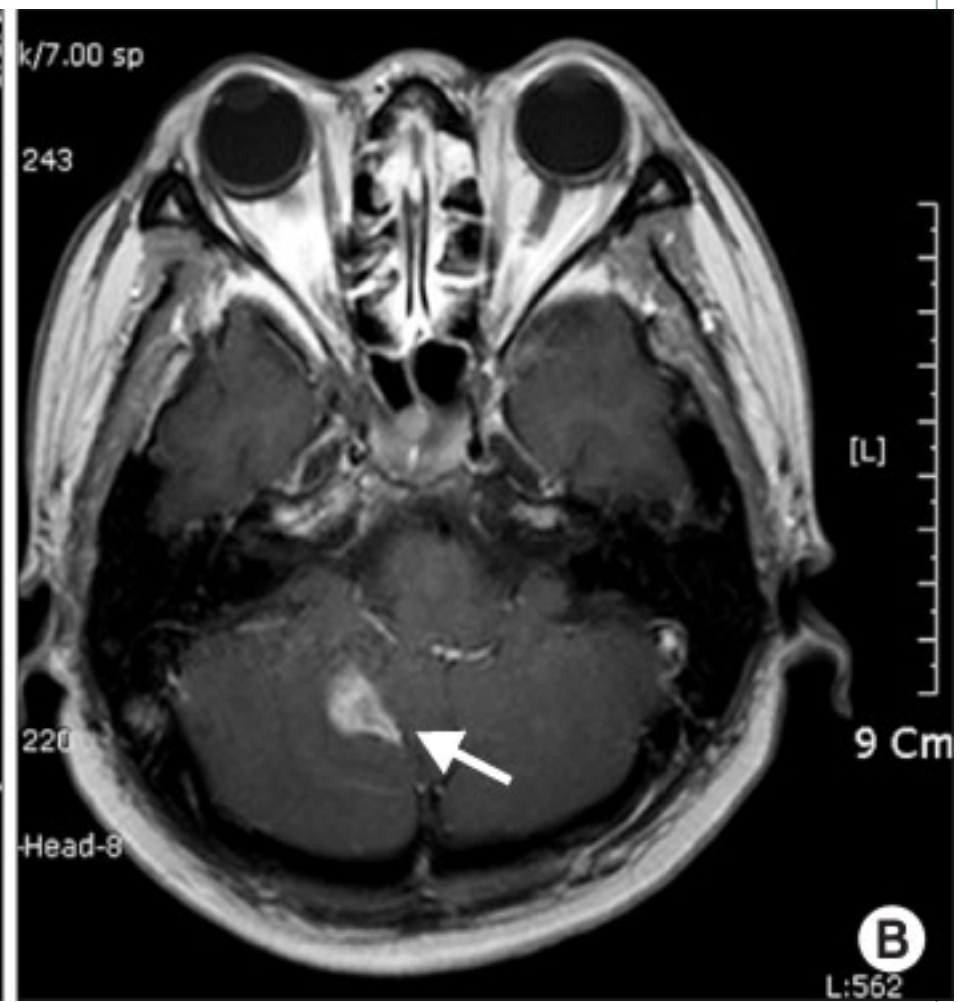
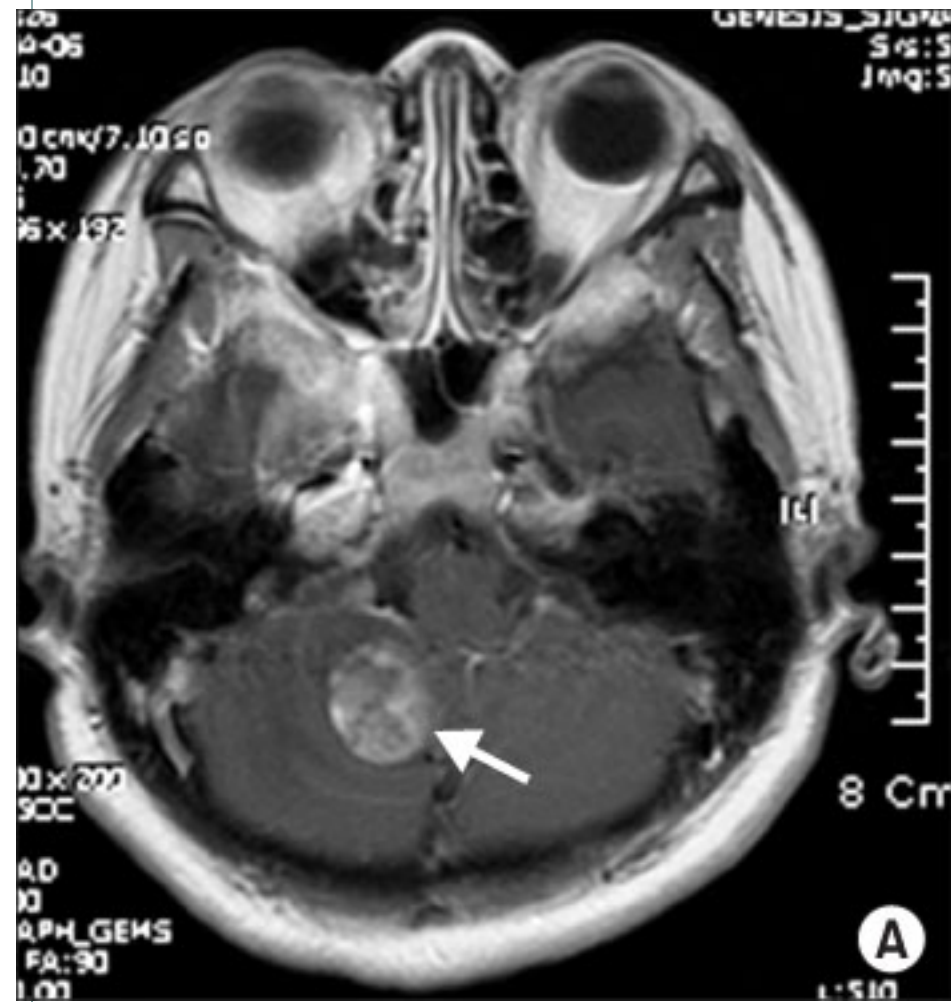
- On exam, nystagmus with horizontal and vertical end gaze, decreased temperature sensation on the right face, and mild to moderate ataxia with right finger-to-nose and heel-to-shin testing. Falling to the right with tandem gaze.





- **Localization:**
 - Right cerebellum or inferior cerebellar peduncle. Also lesion involving the right spinal trigeminal nucleus or tract. Nausea is less specific, but could relate to cerebellar-vestibular connections, or possibly raised ICP.
- **Most likely etiology:**
 - Metastatic disease from primary lung cancer to right cerebellum. On Ddx would be primary neoplasm, vascular malformation, and abscess.





Summary



- The cerebellum can functionally be divided into three parts: the vermis, the hemispheres, and the flocculonodular lobe
- The cerebellar hemispheres localize *ipsilaterally*
- Due to its many connections with the brainstem, brainstem pathology may present with cerebellar signs (false localization)
- Due to its many connections with the vestibular circuits, cerebellar pathology often present with nausea, vomiting, vertigo, and nystagmus
- Cerebellar ataxia chiefly arises from imbalance and imprecision of agonist and antagonist muscle activity. Look for this on exam.



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