



Posterior Circulation Stroke

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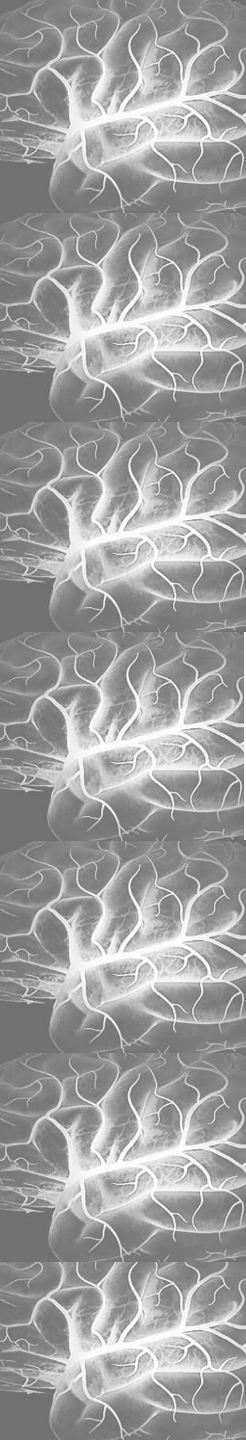
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Webinar #15

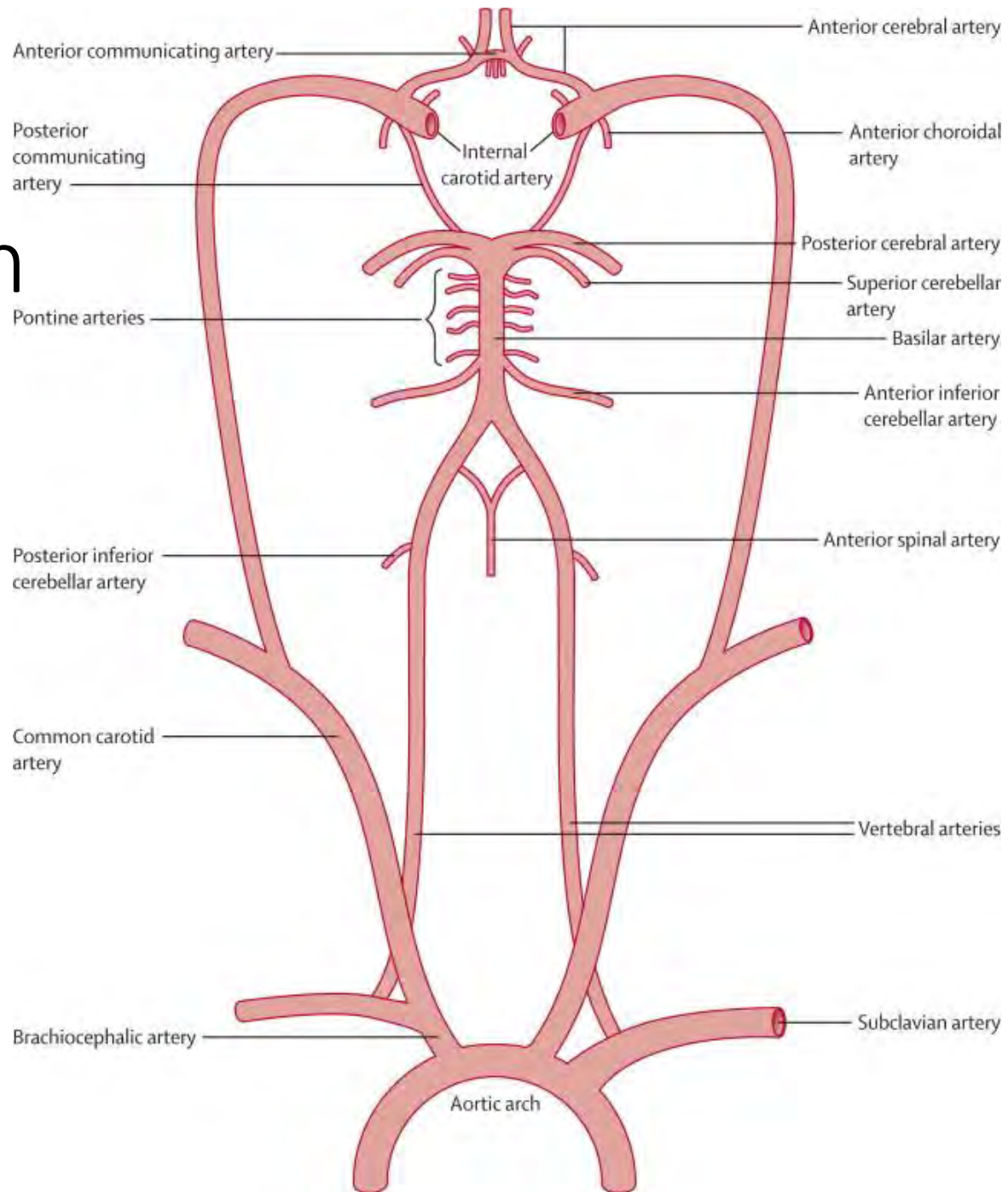


Posterior circulation stroke

- Review anatomy – pipes, plumbing, & parenchyma
- Common stroke syndromes
- NIHSS exam - limitations
- The 5 D's – working through ddx
- Supplemental examination
 - Evaluating the acutely vertiginous patient
 - Evaluating the patient with perceived minor stroke
- Advanced imaging - pitfalls
- Standard-of-care treatment options



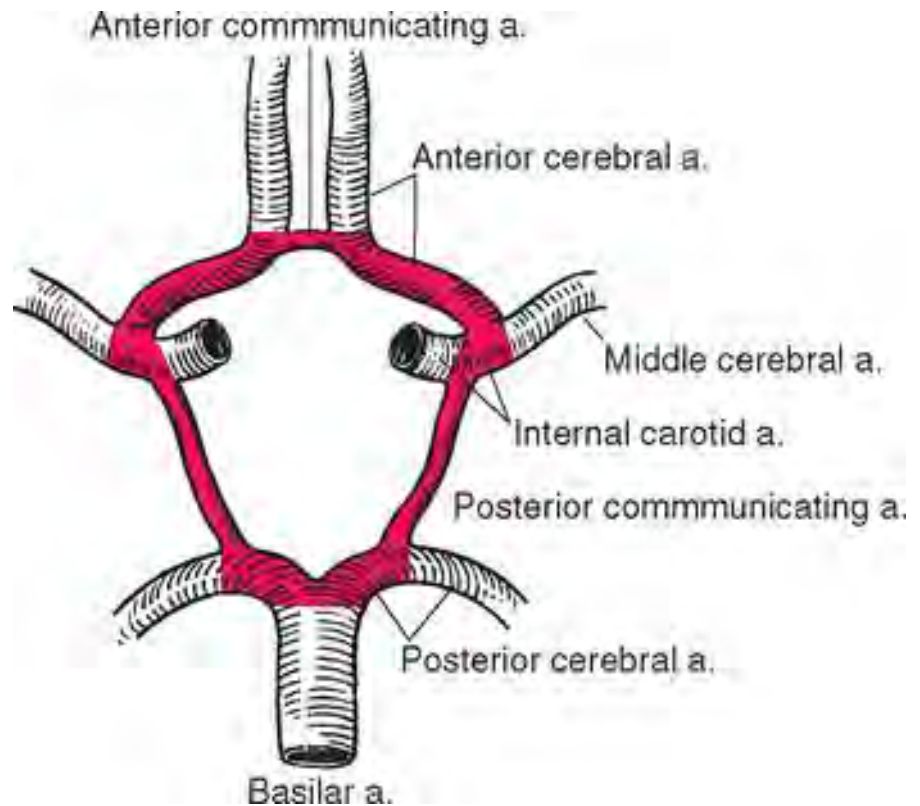
Posterior circulation stroke - Pipes



Posterior circulation stroke

Plumbing variation

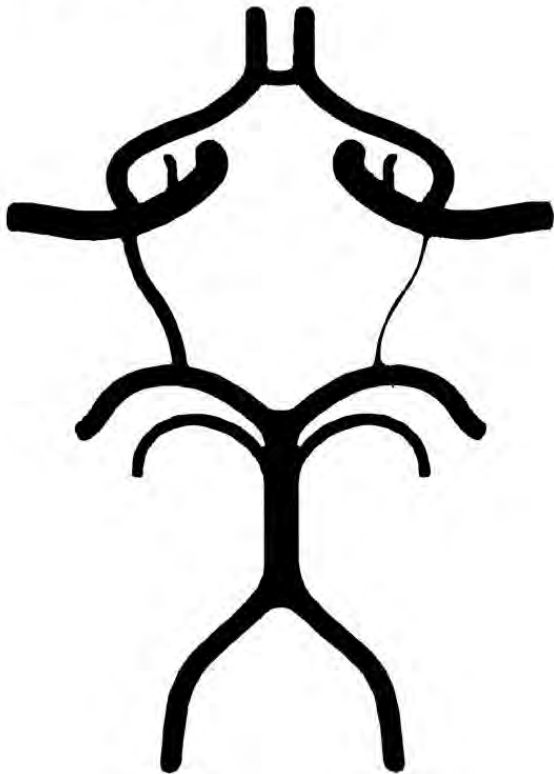
- Normal Circle of Willis
- <50% population



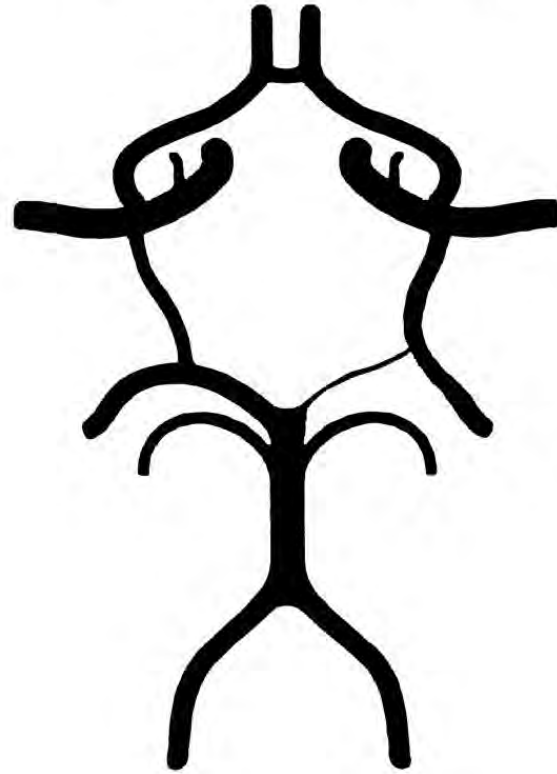
Posterior circulation stroke

Plumbing variation

Hypoplastic posterior communicating artery (16-64%)

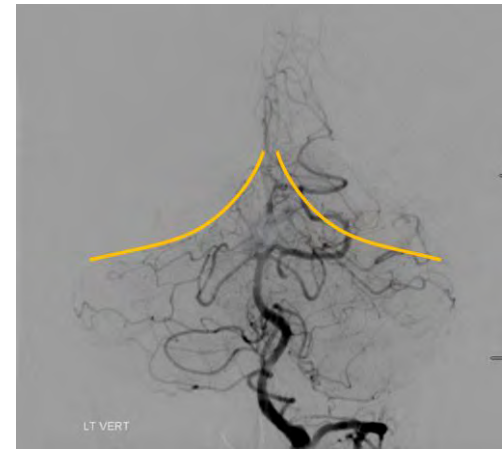
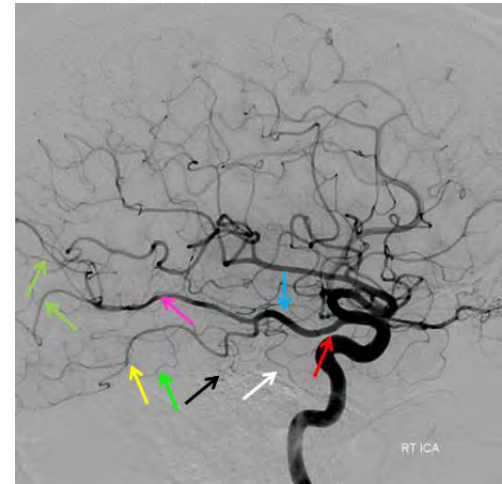
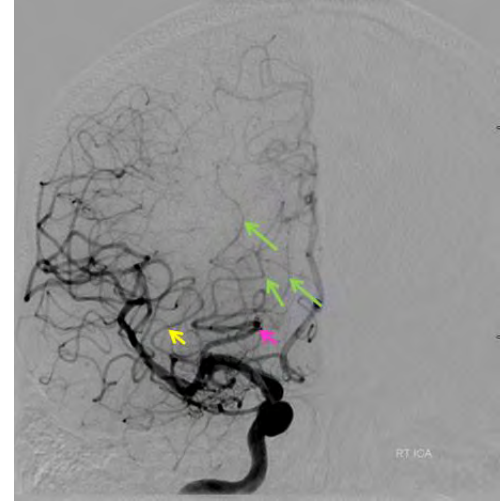


Hypoplastic precommunicating part posterior cerebral artery (9-15%)



Fetal PCA

- fPCA (9.5%) is continuation of Pcomm
- No communication with basilar
- Partial fPCA (15%) has atretic communication with basilar artery
- lack of or smaller thalamoperforators in the absence of a P1 or atretic P1



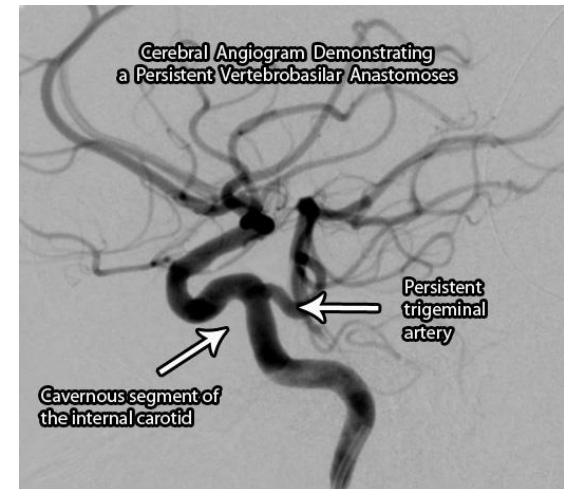
Posterior circulation stroke

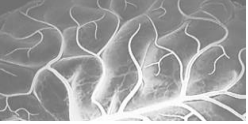
Plumbing variation

- Dominant VA 2/3

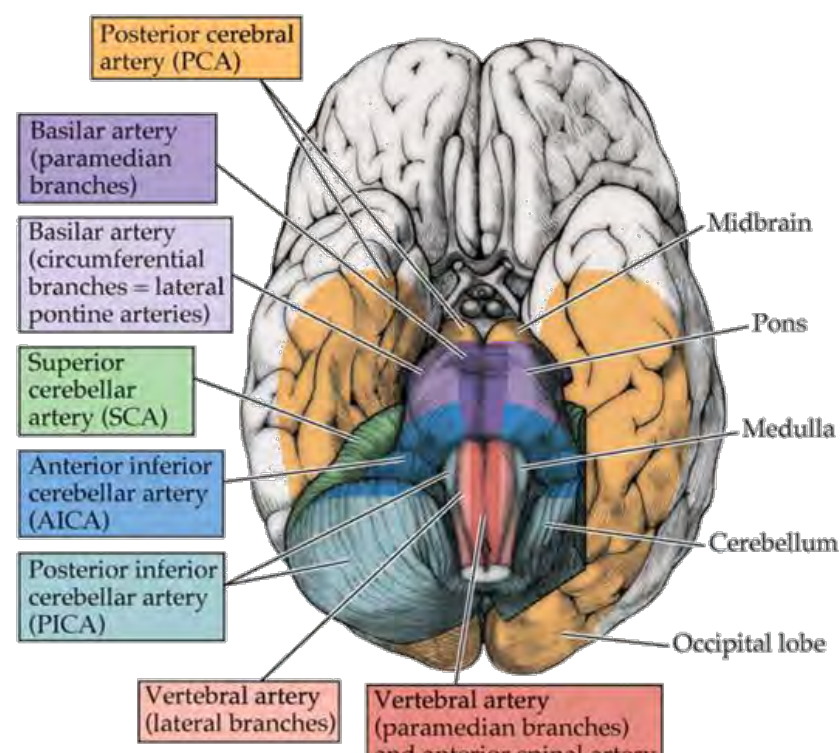


- Persistent trigeminal artery

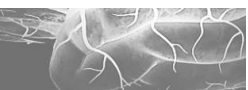
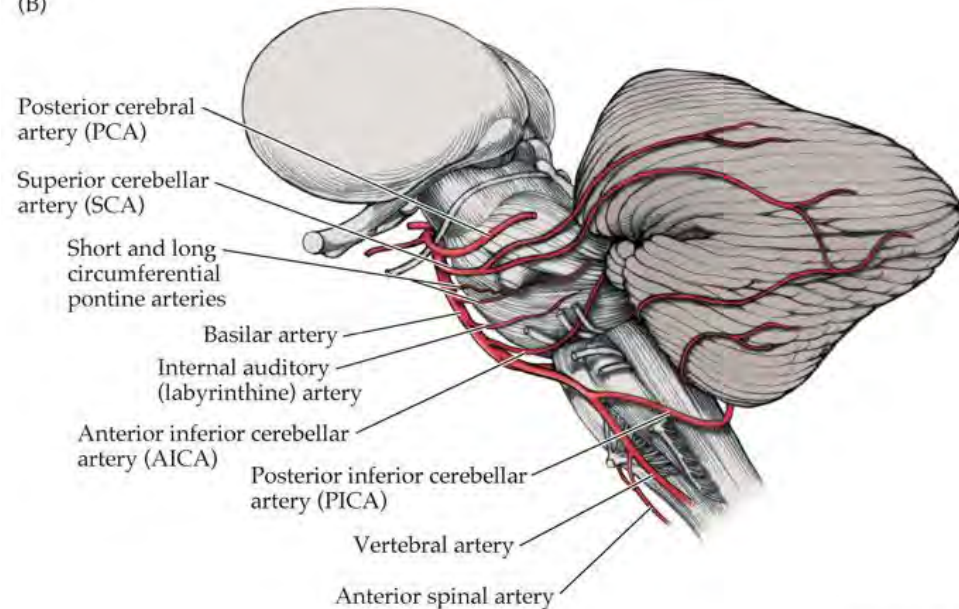


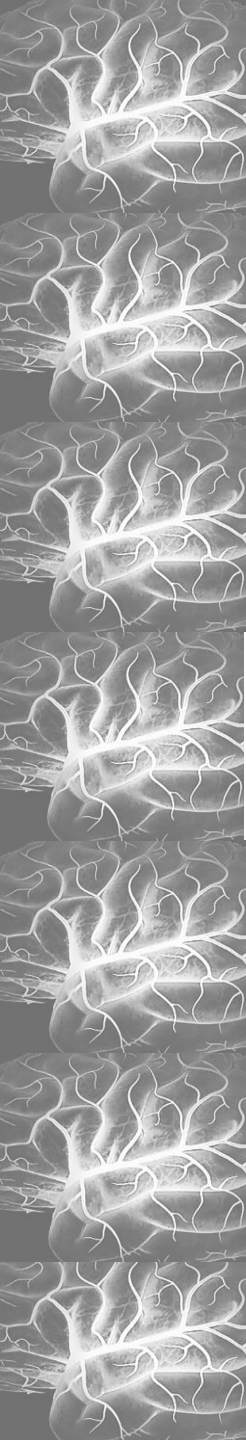


- PCA = midbrain, thalamus, medial surface of occipital lobe, inferior and medial surfaces of temporal lobe
- SCA = superior cerebellum & rostral laterodorsal pons
- AICA = lateral caudal pons & part of cerebellum
- PICA = lateral medulla & inferior cerebellum



(B)



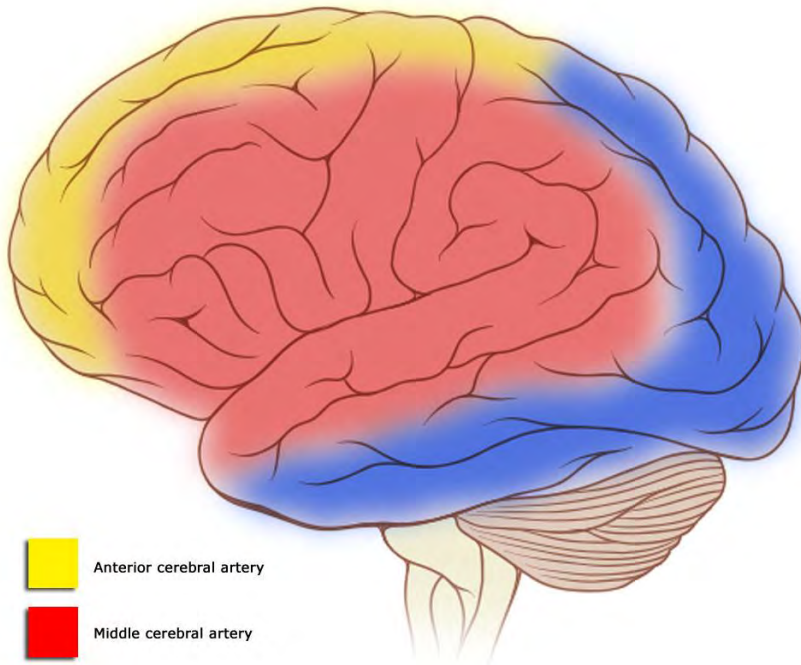





Common stroke syndromes associated with vessel occlusions

- Posterior cerebral artery
- Basilar artery
- Superior cerebellar artery
- Anterior inferior cerebellar artery
- Posterior inferior cerebellar artery
- Anterior spinal artery

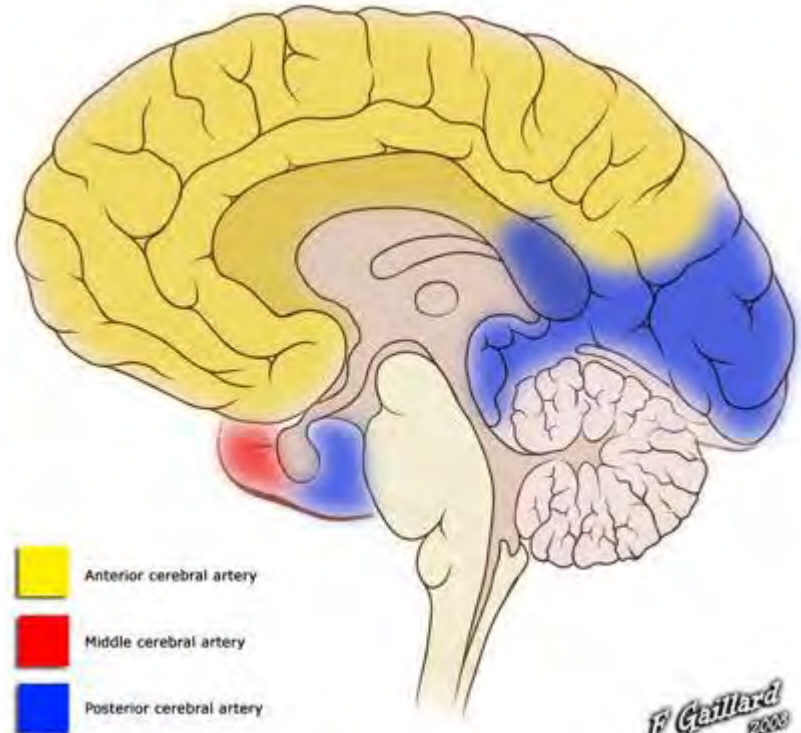
PCA parenchyma




Cortical vascular territories



-  Anterior cerebral artery
-  Middle cerebral artery
-  Posterior cerebral artery

Cortical vascular territories



-  Anterior cerebral artery
-  Middle cerebral artery
-  Posterior cerebral artery

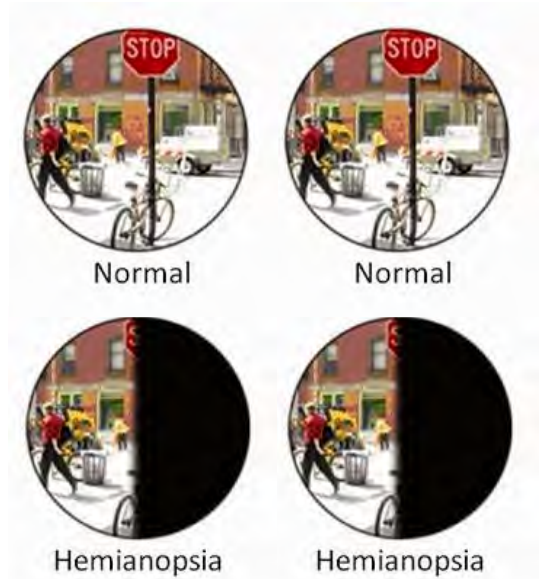
F Gaillard
2003

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Live Braining of brain by Patrick Lynch (patricklynch.net)

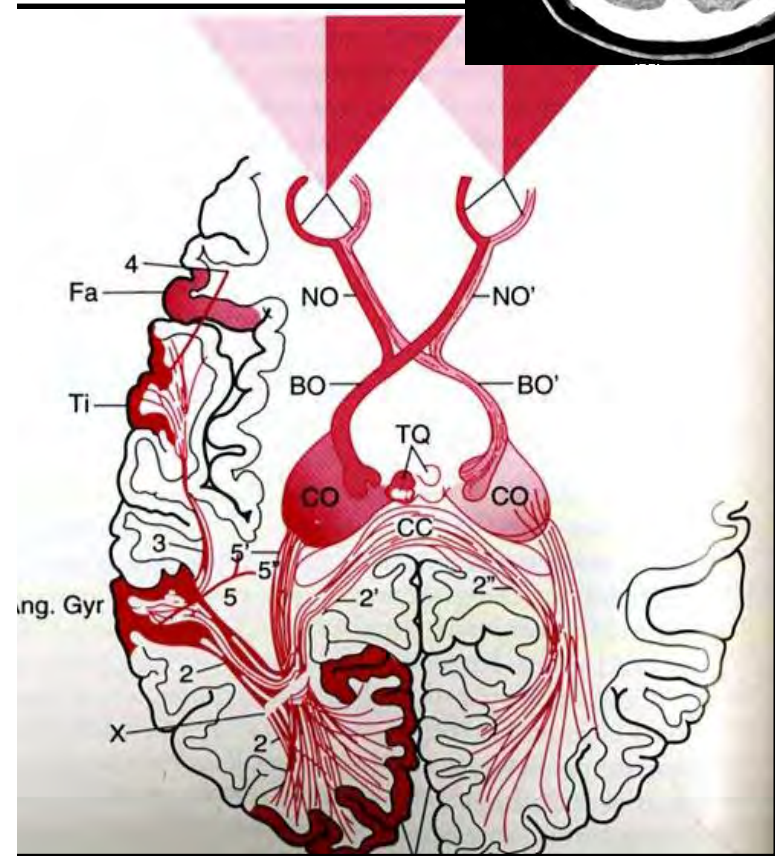
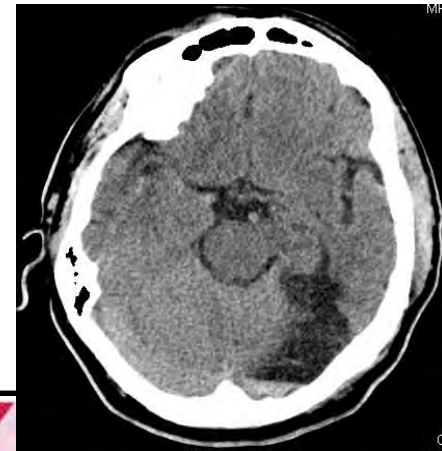
Posterior Cerebral Artery Infarction

- Contralateral homonymous hemianopia
- Larger infarcts affect the thalamus and posterior limb of the internal capsule causing contralateral hemisensory loss and hemiparesis
 - MCA mimicking syndrome
- Left PCA infarcts affecting the splenium of the corpus callosum can cause alexia without agraphia



Posterior Cerebral Artery Disease

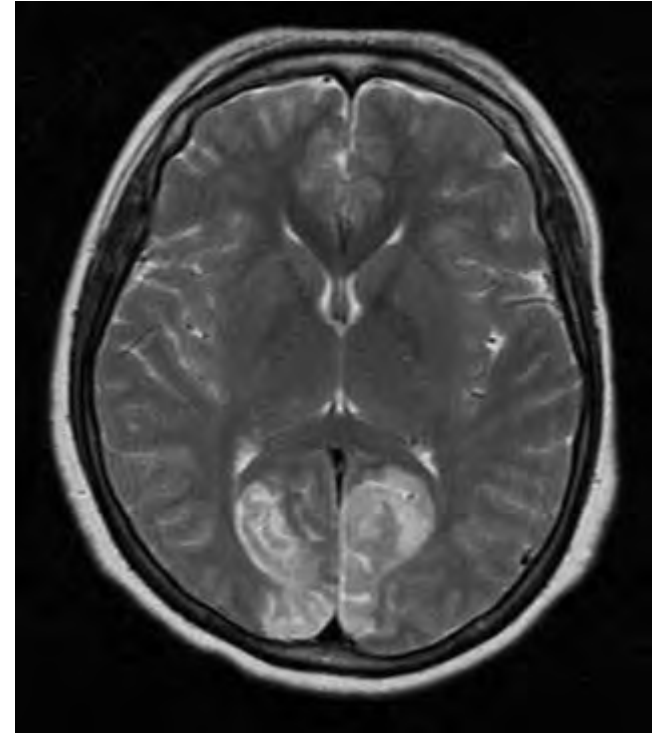
- Alexia \pm agraphia
 - Dominant hemisphere
 - Inability to read with intact writing ability
 - Almost always accompanied by a visual field defect (right Homonymous Hemianopsia)
 - Disconnection of right hemisphere visual perceptual tasks and left language that produces naming a categorization responses



Lesion in X disrupts calcarine cortices from angular gyrus and left language association areas

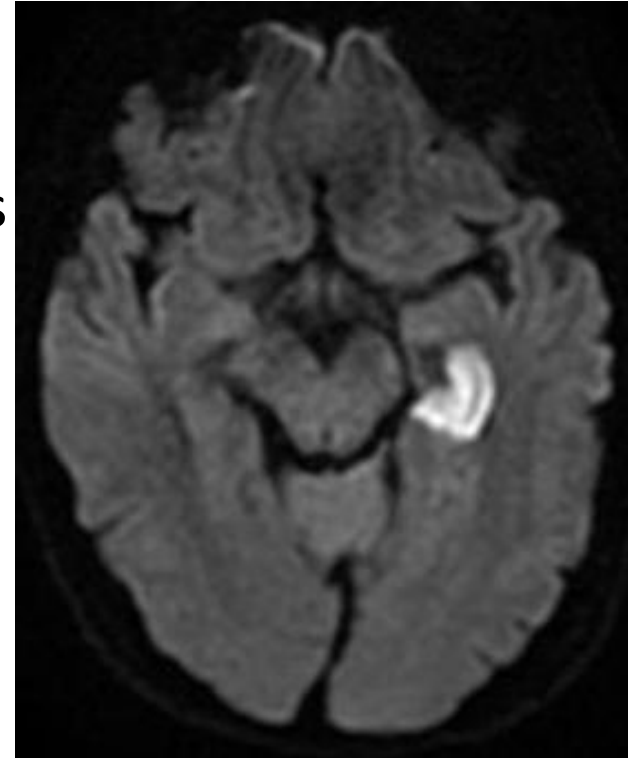
Posterior Cerebral Artery Disease

- Anton's syndrome
 - Bilateral damage to occipital and parietal lobes
 - Denial of blindness
 - Patients confabulate in response to questions about their visual environment



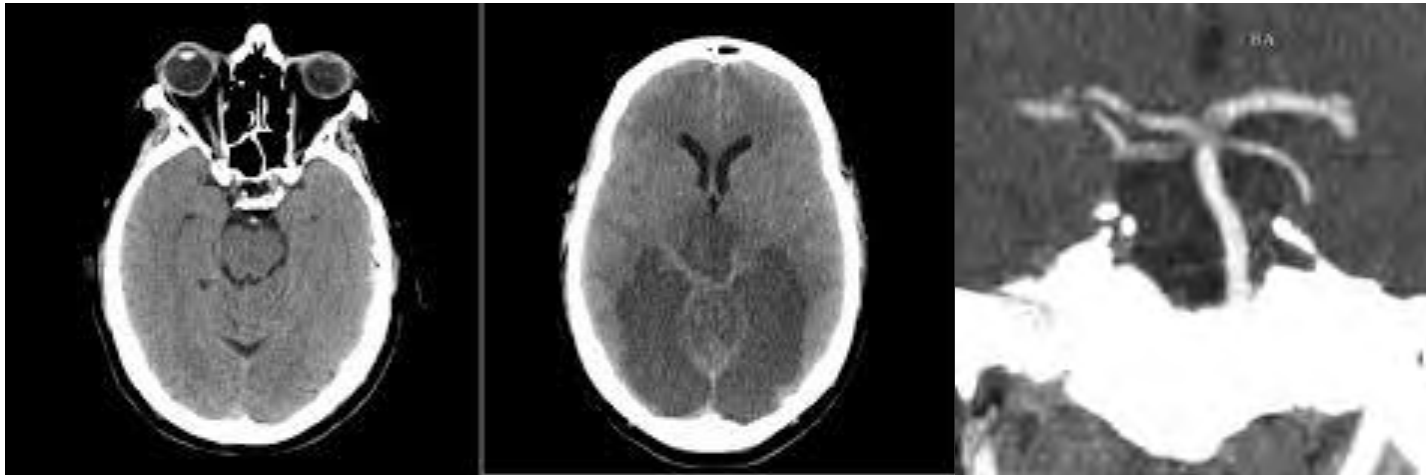
Posterior Cerebral Artery Infarction

- Memory disorder syndromes
 - PCA supplies the inferior temporal lobes and hippocampus
 - Can occur unilaterally
 - Anterograde and/or retrograde impairments



Basilar artery stroke top of the basilar syndrome

- Embolus typically lodges at the terminal bifurcation of the basilar artery and obstructs the posterior cerebral and superior cerebellar arteries, including the central branches from the proximal part of the posterior cerebrals



Basilar artery stroke top of the basilar syndrome

- Coma (from infarction of reticular formation of midbrain and rostral pons)
- Diverging eyes with fixed, dilated pupils (bilateral infarction of fibers of III)



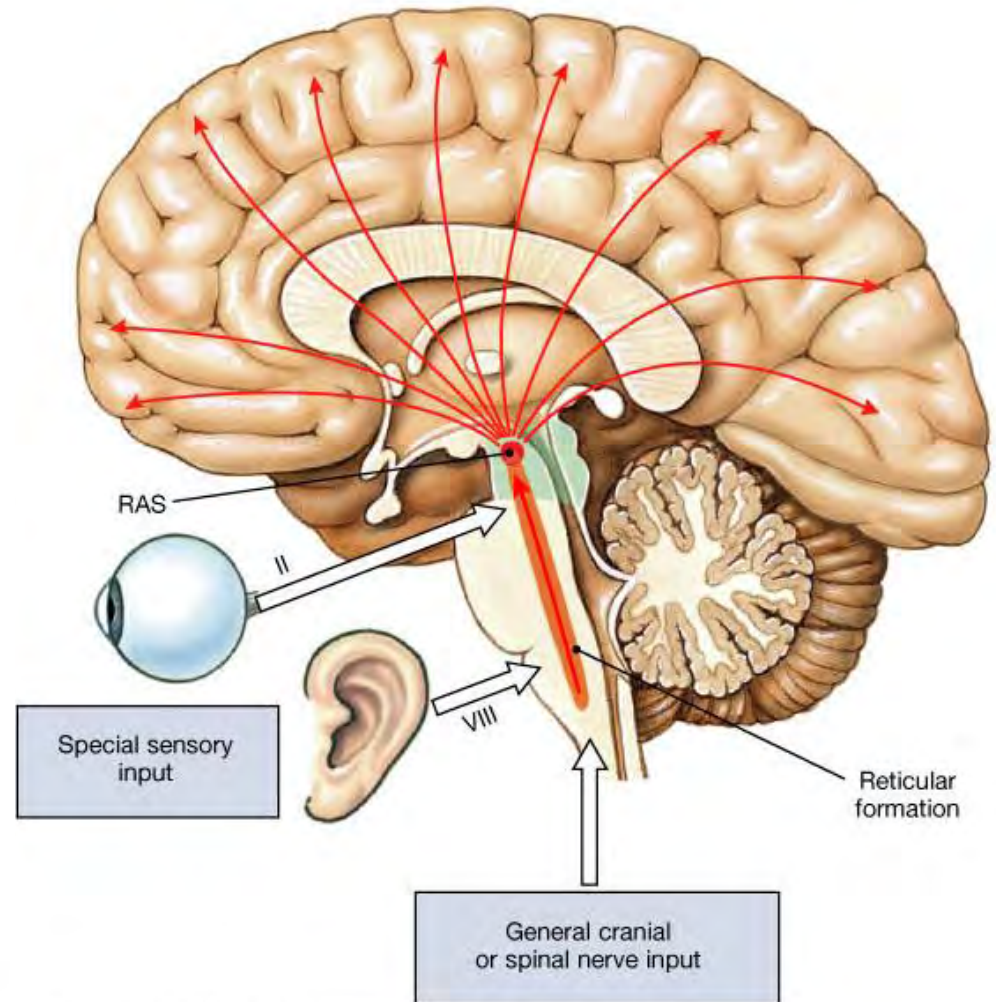
Unilateral complete CNIII palsy



Bilateral complete CNIII palsy

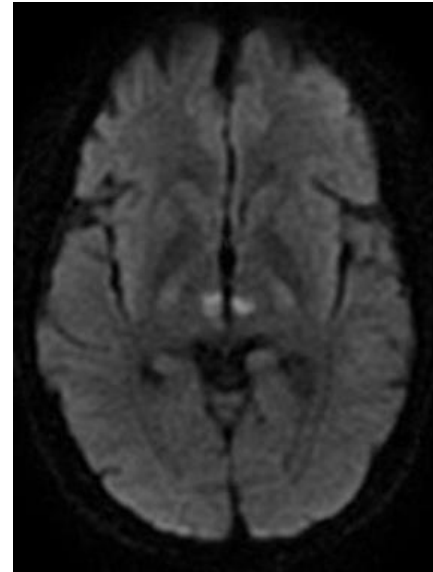
Reticular activating system

- Group of nuclei scattered throughout the brainstem that are involved with consciousness, wakefulness, sleep
- Headquarters for the reticular activating system are located in the mesencephalon

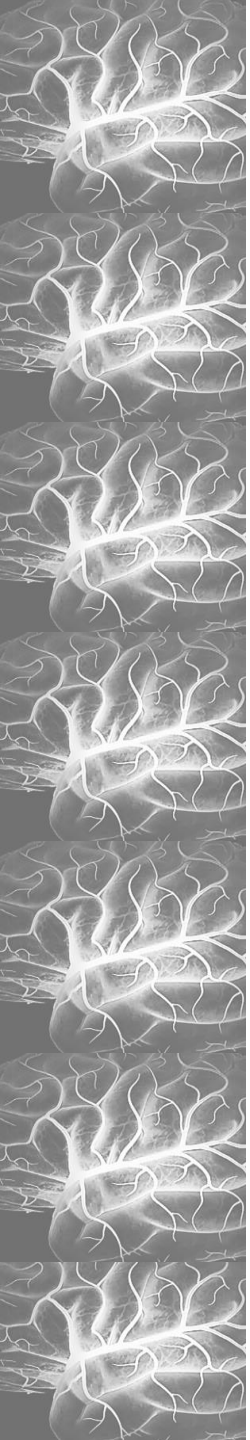


Artery of Percheron infarction

- bilateral paramedian thalamic infarcts
- mental state disturbances
- hypersomnolence
- aphasia/dysarthria
- amnesia
- ocular movement disorders, especially vertical gaze palsy



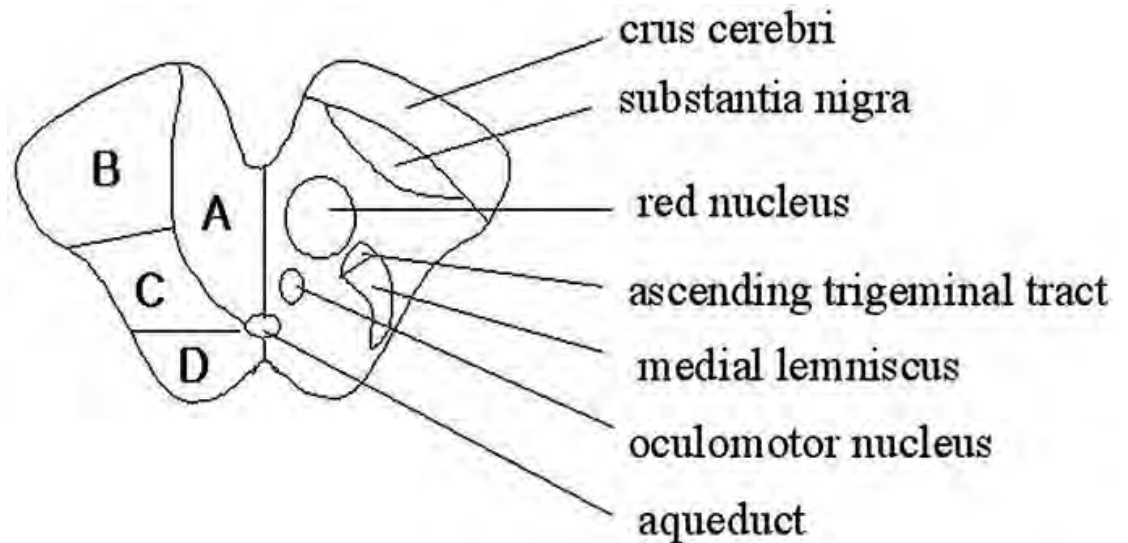
Posterior circulation
strokes involving the
brainstem and/or
cerebellum



Midbrain stroke syndromes

- Weber's syndrome
- Claude's syndrome
- Benedikt's syndrome

- (A) anteromedial
- (B) anterolateral
- (C) lateral
- (D) posterior



Midbrain stroke syndromes

Weber's syndrome

Midbrain basis

Branches of PCA and
top of basilar artery

Anatomical structure

Oculomotor nerve fascicles

Cerebral peduncle



clinical features

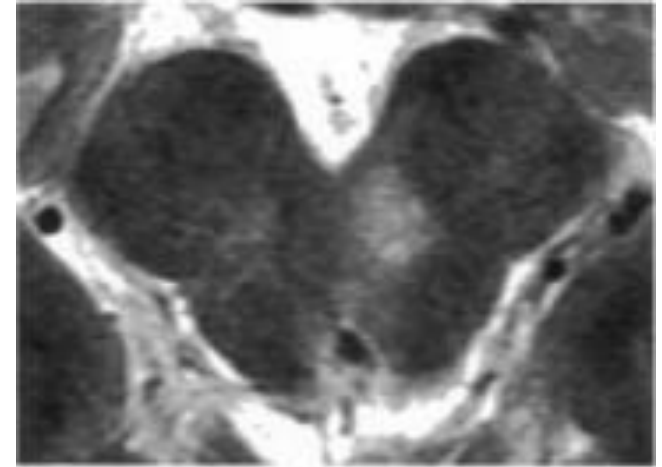
ipsilateral CN III palsy

contralateral
hemiparesis

Midbrain stroke syndromes

Claude's syndrome

- Midbrain tegmentum
- Branches of PCA and top of basilar artery



Anatomical structures

Oculomotor nerve fascicles

Red nucleus, substantia nigra, superior cerebellar peduncle fibers

clinical features

ipsilateral third-nerve palsy

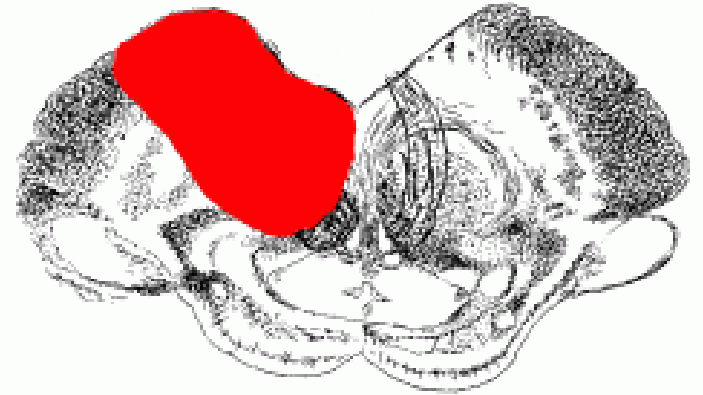
contralateral ataxia, tremor, and involuntary movements

Midbrain stroke syndromes

Benedikt's syndrome

Midbrain basis and tegmentum

Branches of PCA and
top of basilar artery



Anatomical structures

Oculomotor nerve fascicles

Cerebral peduncle

Red nucleus, substantia
nigra, superior cerebellar
peduncle fibers

clinical features

ipsilateral third-nerve palsy

contralateral hemiparesis

contralateral ataxia, tremor,
and involuntary movements,
hyperkinesia (athetosis, chorea)

Internuclear ophthalmoplegia

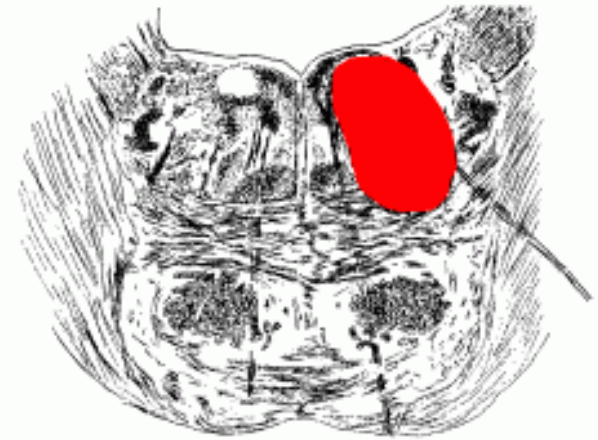
- INO is a horizontal gaze palsy, resulting from a lesion affecting the MLF between the nuclei of CN VI and III, most commonly in the pons.
- When a patient with a lesion in the left MLF attempts to look to his/her right (ie, away from the involved side), he/she shows no adduction of the left eye and full abduction of the right eye with the end-point abduction nystagmus.
- Convergence is preserved since both nuclei of CN III and peripheral innervation of the medial recti muscles are intact.



Pontine stroke syndromes

Foville's syndrome

- Paramedian branches of basilar artery, ventral and dorsal territories



Anatomical structures

Corticospinal and corticobulbar tracts

Facial colliculus

Abducens nucleus

clinical features

contralateral face, arm, and leg weakness; dysarthria

ipsilateral face weakness;

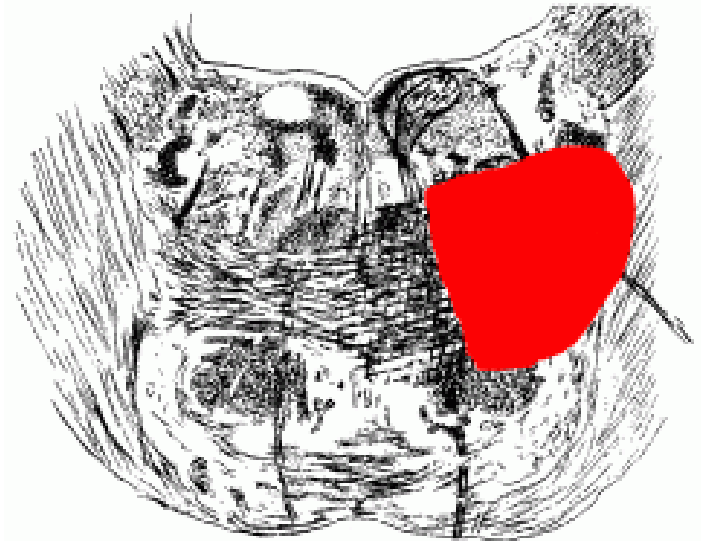
ipsilateral horizontal gaze palsy

Pontine stroke syndromes

Millard-Gubler's syndrome

hemiparesis alternans facialis

- Foville's syndrome without the ipsilateral horizontal gaze palsy
- Ipsilateral facial paresis
- Contralateral hemiparesis

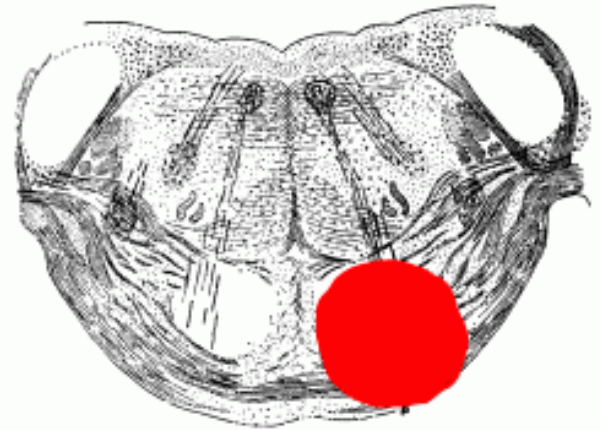



Pontine stroke syndromes

Raymond's syndrome

hemiparesis alternans abducens

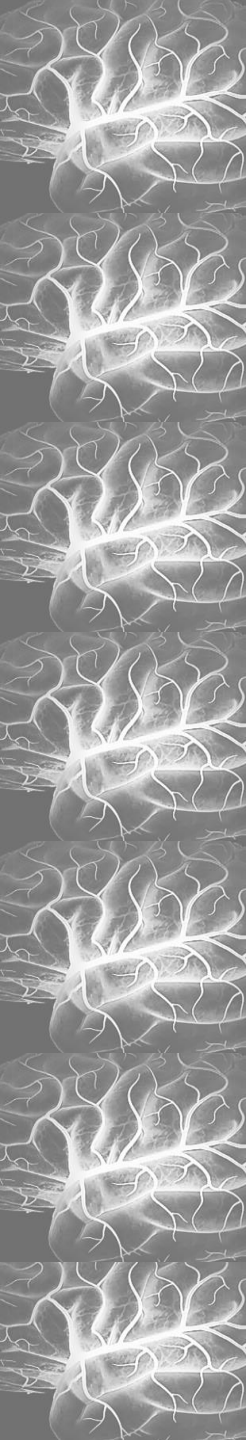
- Descending motor fibres.
Fibers of abducens nerve.
- Contralateral hemiplegia.
Ipsilateral VI nerve palsy (but no abnormality of movements of contralateral eye).





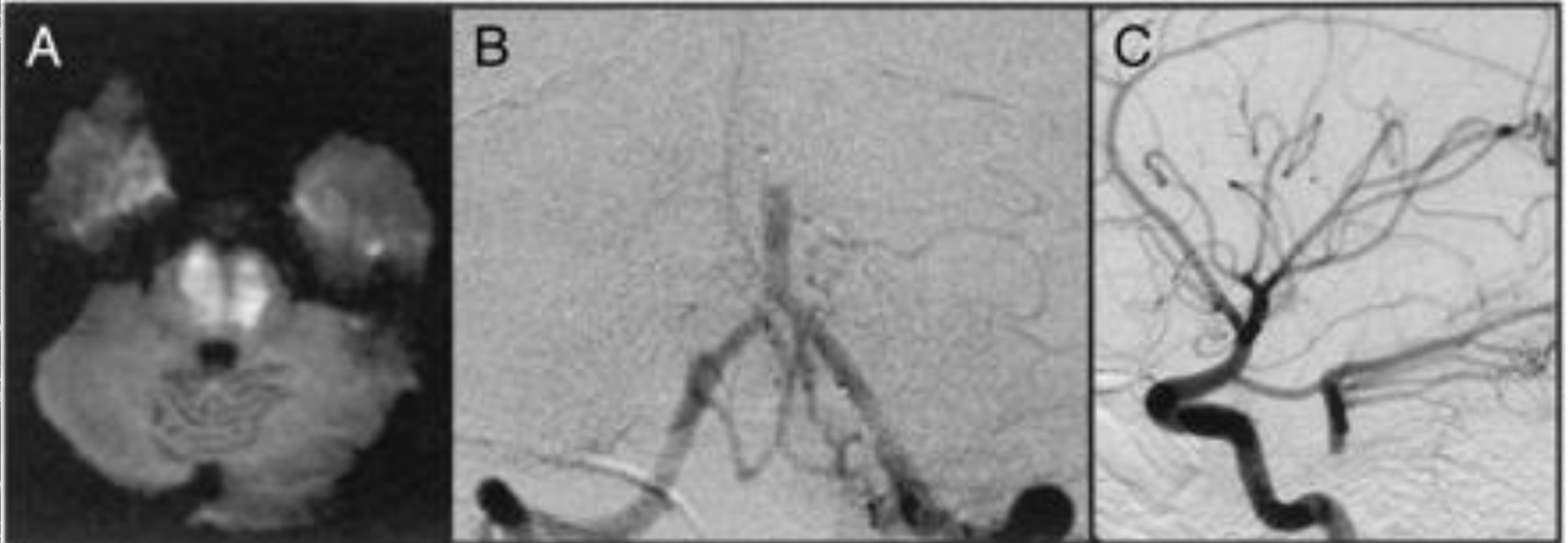
Summary of symptoms suggestive of pontine infarctions

- Combination of ipsilateral facial weakness
 - Severe dysarthria
 - Dysphagia
- Contralateral hemiparesis
- Double vision with ipsilateral CN VI palsy
 - Sustained horizontal nystagmus
- Sensation of ear fullness



The dreaded basilar artery thrombosis

- Causes “locked in” syndrome
- Patient is awake and alert but tetraplegic and only able to blink





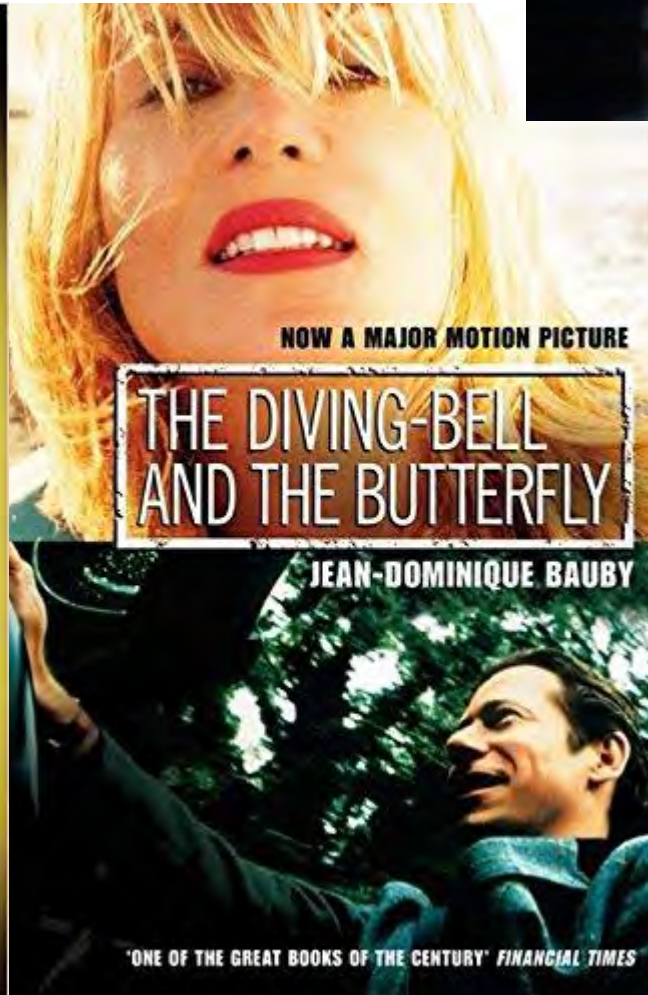
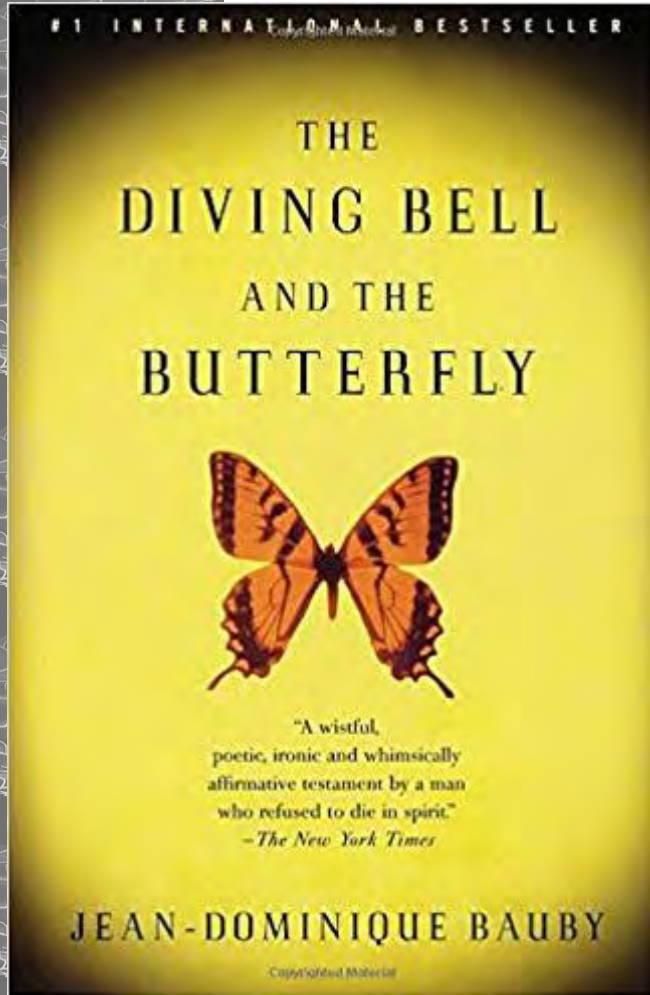
Prodromal symptoms

60% of patients with basilar artery thrombosis

- Stuttering or progressive onset of symptoms
- 2 weeks prior to ED presentation

- Vertigo and Nausea (30%)
- Headache and/or neckache (20%)
- Hemiparesis (10%) “herald hemiparesis”
- Dysarthria and/or diplopia (10%)
- Hemianopia (6%)

Living locked-in



Superior cerebellar artery infarction

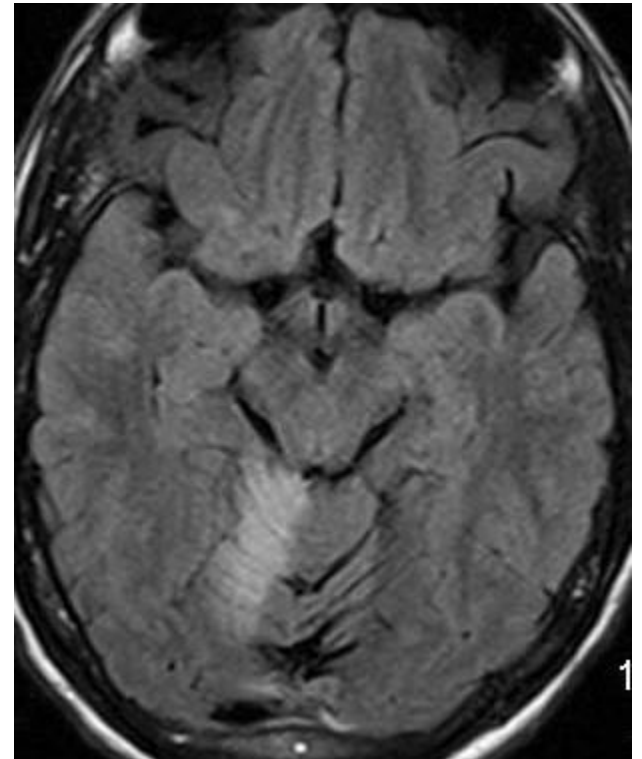
Classic SCA syndrome

Dizziness/vertigo

Ipsilateral limb dysmetria/ataxia

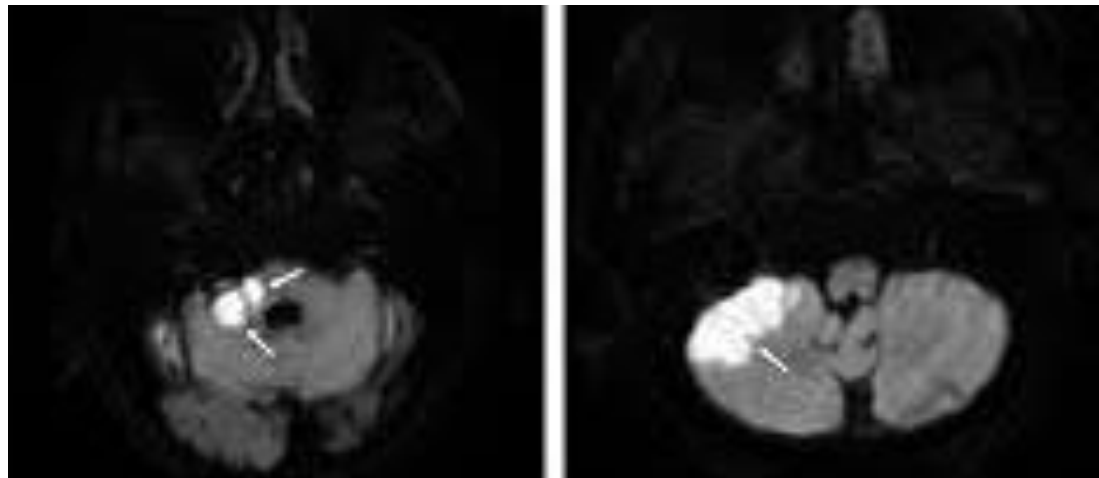
+/-

- ipsilateral Horner's syndrome
- contralateral pain and temperature loss
- contralateral 4th cranial nerve palsy
- ipsilateral loss of expression in the face
- unilateral or bilateral hearing loss
- +/- choreiform or athetoid movement disorders
- +/- coarse tremors



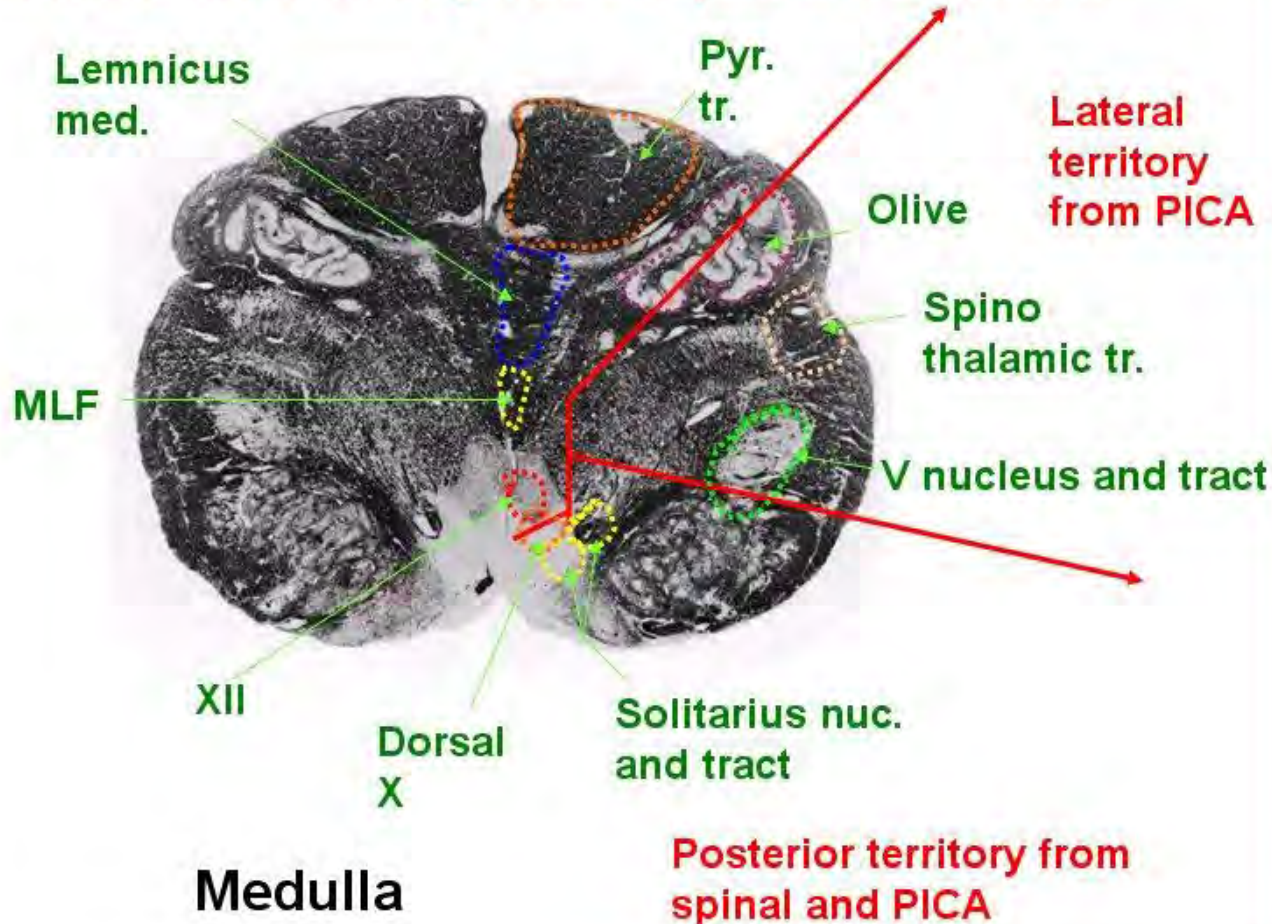
Anterior inferior cerebellar artery (AICA) stroke

- Ipsilateral ataxia (cerebellum, middle cerebellar peduncle)
- Vertigo
- Ipsilateral deafness (from inner ear infarction, the labyrinthine artery being in most people a branch of AICA).



Vascular territories at the level of medulla, pons and midbrain.

Antero medial territory from ant.spinal and vertebral a.



Three territories are located at the level of medulla: Antero-medial, lateral and posterior. The cerebellum is vascularized by the three cerebellar arteries, PICA, AICA and the superior cerebellar artery.

According to H.Duvernoy .Human Brainstem vessels.Springer 1978

PICA occlusion

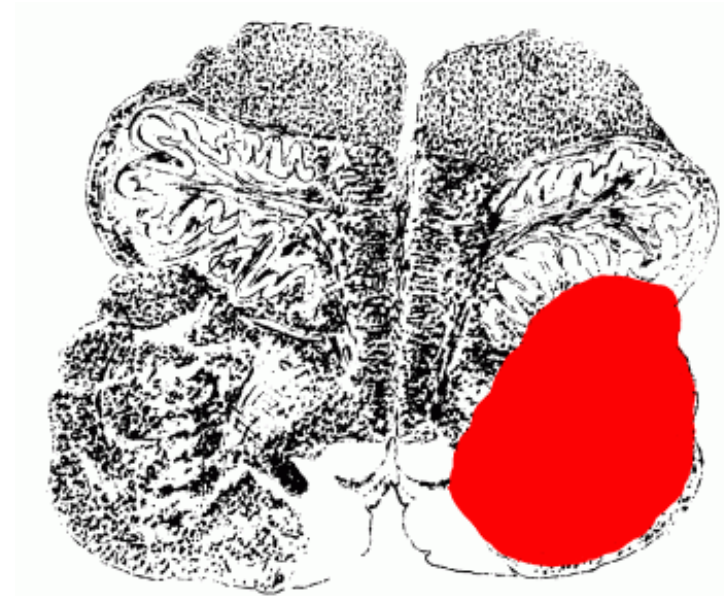
3 distinct clinical patterns

- **Dorsal lateral medullary syndrome**
- **PICA strokes that spare the medulla**
- **Isolated vertigo**
 - mimics labyrinthitis and presents with vertigo and ataxia
 - clinical clues that suggest a posterior fossa stroke (rather than a peripheral vertigo syndrome) include age > 50, presence of vasculopathic risk factors, direction-changing nystagmus, and normal calorics

Medullary stroke syndromes

Wallenberg's syndrome

- the commonest brain stem stroke



PICA occlusion

dorsal lateral medullary syndrome

Wallenburg's syndrome

- Vertebral artery more commonly than PICA
- Anatomical structures and clinical features:

Inferior cerebellar peduncle and nuclei

ipsilateral ataxia, vertigo, vestibular nystagmus, nausea

Trigeminal nucleus and tract

ipsilateral facial decreased pain and temperature sense

Spinothalamic tract

contralateral body decreased pain and temperature sense

Descending sympathetic fibers

ipsilateral Horner's syndrome

Nucleus ambiguus

hoarseness, dysphagia

Nucleus solitarius

ipsilateral decreased taste

Variations on lateral medullary syndrome

- Facial sensory loss that is contralateral
 - Involvement of crossing fibers
- Ipsilateral facial paresthesias or heightened sensitivity
 - Shortly after onset
- Sensory loss in just the upper or lower contralateral body
 - Partial involvement of the spinothalamic tract
- Ipsilateral facial weakness
 - Fibers of the facial nerve that loop caudally into the medulla before exiting at the pontomedullary junction
- Loss of vertical orientation
 - Feel as if the whole world has turned **upside down or sideways**

PICA occlusion sparing the medulla

- vertigo
- headache
- gait ataxia
- limb ataxia
- horizontal nystagmus
- ipsilateral axial lateropulsion

Medial medullary syndrome

- Paramedian branches of vertebral and anterior spinal arteries
- Anatomical structures and clinical features:

Pyramidal tract

contralateral arm or leg weakness

Medial lemniscus

contralateral decreased position
and vibration sense

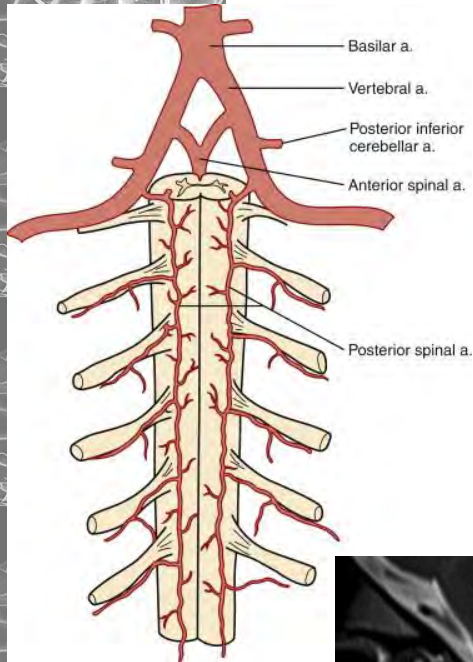
Hypoglossal nucleus
and exiting CN XII
fascicles

ipsilateral tongue weakness

Cerebellar infarction presenting isolated vertigo

- 10% of cerebellar strokes have isolated vertigo
- Almost all are due to infarction in partial PICA distribution

Anterior spinal artery infarction



- Flaccid paralysis in muscles supplied by that level
- Spastic paralysis in muscles supplied below that level
- Loss of pain and temperatures sensation below the affected level





posterior circulation strokes versus anterior circulation strokes:

- No difference in demographics
- No difference in risk factors
- No difference in stroke etiology
- Lower NIHSS scores
- More likely to experience headache
 - (PC 15%, AC 8.7%, $p = 0.013$)
- More likely to experience vomiting
 - (PC 17.8%, AC 3.5%, $p < 0.001$)



Symptoms and signs of posterior circulation ischemia

Symptoms

- Dizziness
- Vertigo
- Headache
- Vomiting
- Double vision
- Loss of vision
- Ataxia
- Numbness
- weakness

Signs

- Limb weakness
- Gait and limb ataxia
- Oculomotor palsies
- Oropharyngeal dysfunction

- <1% will present with only one symptom or sign

Savitz and Caplan. NEJM 352, 2005.

NIHSS and posterior circulation

NIHSS

1a - LOC

0 - Alert 1 - Drowsy 2 - Stupor 3 - Comatose

1b - LOC

0 - Both 1 - One 2 - Neither

1c - LOC Commands

0 - Both 1 - One 2 - Neither

2 - Best Gaze

0 - NL 1 - Partial 2 - Forced Gaze

3 - Visual Fields

0 - NL 1 - Partial 2 - Complete 3 - Bilateral

4 - Facial Paresis

0 - NL 1 - Minor 2 - Partial 3 - Complete

5 - 8 Motor

___ ___ 5 - Right Arm

___ ___ 6 - Left Arm

___ ___ 7 - Right Leg

___ ___ 8 - Left Leg

Key

0 - No Drift

1 - Drift

2 - Some Effort vs. Gravity

3 - No Effort vs. Gravity

4 - No Movement

x - Untestable

9 - Limb Ataxia

0 - Absent 1 - 1 Limb 2 - 2+ Limbs x - Untestable

10 - Sensory

0 - NL 1 - Partial 2 - Dense loss

11 - Best Language / Aphasia

0 - NL 1 - Mild / Mod 2 - Severe 3 - Mute

12 - Dysarthria

0 - NL 1 - Mild / Mod 2 - Severe x - Untestable

13 - Neglect / Inattention

0 - None 1 - Partial 2 - Complete



Reticular activation system



CN III, VI palsy, INO



Occipital lobes



Nonspecific, may be out of proportion to limb weakness



Nonspecific, unless quadriparetic



Cerebellum and pathways



If not multimodality



Alexia without agraphia, anomia aphasia



Nonspecific, anarthria may be mistaken for expressive aphasia



NIHSS and posterior circulation stroke

- the median NIHSS score on admission is 5-7 points lower in patients with PC strokes than AC strokes
- Symptoms which receive no score
 - Diplopia – OR for PC vs AC stroke 3.65
 - Nystagmus
 - Dizziness – OR for PC vs AC stroke 10.45
 - Nausea – OR for PC vs AC stroke 16.82
 - Headache
 - Hearing
 - Dysphagia
 - Gait instability
 - Hand weakness




Posterior circulation stroke and thrombolysis

- No focused RCT
 - Represents 12-19% of trial subjects
- Lower sICH rate than anterior circulation stroke
- Guidelines do not discriminate by distribution or etiology
- Standard-of-care for patients in first 4.5 hours of onset (or LSN)
- May be as effective as intra-arterial therapy
- May be harder to identify patients who meet inclusion criteria
 - Think it is a stroke?
 - Think there is associated disability?




Outcome after stroke with mild deficits

- up to 15% experience early worsening of signs and symptoms
- approximately 30% have some degree of disability at 3 months
- A meta-analysis of 9 trials of intravenous alteplase in acute ischemic stroke showed a significant reduction in functional disability at 3 months for patients with mild stroke.




Low NIHSS and/or perceived mild symptoms

- Among patients presenting within 2 hours of stroke who were **not treated with tPA** due to mild or rapidly improving stroke symptoms, **28% could not ambulate without assistance at discharge** and did not get discharged to home.
 - **Even NIHSS = 0 stroke patients can be disabled**
 - 25% had mRS ≥ 3 on discharge
 - 25% had disposition other than home



Low NIHSS and/or perceived mild symptoms

- Disability is in the “eye of the beholder.”
 - **Ask patients with perceived minor deficits if the symptoms/deficits, if persistent, would be disabling.**
 - **Test ability to walk and use both hands** for two-handed tasks before deciding the patient has absence of disabling deficits.
 - Consider that a **visual field cut may preclude driving.**
- **Alteplase/tPA has been proven to reduce the odds of disability.** For patients with mild but disabling stroke symptoms, IV alteplase is indicated within 3 h from symptom onset of ischemic stroke.
- The risk of hemorrhage is about half that of patients treated in the NINDS randomized clinical trial of tPA for stroke. **The risk of symptomatic ICH with worsening of NIHSS by at least 4 points was 1.3% in PRISMS.**



Low NIHSS and/or perceived mild symptoms


From AHA/ASA Guidelines:

- “There should be **no exclusion** for patients with **mild but nonetheless disabling stroke symptoms**, in the opinion of the treating physician, from treatment with IV alteplase because there is proven clinical benefit for those patients.† (*Class I; LOE B-R*)‡”
- “Within 3 h from symptom onset, treatment of patients with mild ischemic stroke symptoms that are judged as nondisabling may be considered. Treatment risks should be weighed against possible benefits; however, more study is needed to further define the risk-to-benefit ratio.† (*Class IIb; LOE C-LD*)‡”
- “For otherwise eligible patients with **mild stroke presenting in the 3-to 4.5-hour window**, treatment with IV alteplase may be **reasonable**. Treatment risks should be weighed against possible benefits.”
- “For otherwise eligible patients with mild stroke presenting in the 3- to 4.5-h window, IV alteplase may be as effective as treatment in the 0- to 3-h window and may be a reasonable option. Treatment risks should be weighed against possible benefits. (*Class IIb; LOE B-NR*)||”



Tier 2 examination

- Attention –
 - Simple – count 20 -> 1
 - Complex – recite months December -> January
- Cognition
 - Mental math – add 2 quarters, 2 dimes, 2 nickels, 2 pennies
- Swallow
 - Bedside dysphagia screen
 - SLP evaluation, if available
- Two-handed tasks
 - Tie shoes
 - Shuffle deck of cards
- Gait



The 5 Ds:

- Dizziness
- Diplopia
- Dysarthria
- Dysphagia
- Dystaxia

Dizziness PLUS



Dizziness and Vertigo

- Nearly 7.5 million patient visits per year
- Stroke as etiology – 3.2%
 - If vertigo lasts >24 hrs -> 10%
 - Majority due to partial PICA territory infarction
 - If head movement exacerbates vertigo:
 - No latency – more likely stroke
 - Latency – more likely peripheral
 - Negative head thrust
 - Pupillary abnormalities, dysconjugate gaze, dysmetria, motor weakness, depressed LOC, vertical nystagmus or direction-changing nystagmus

HINTS

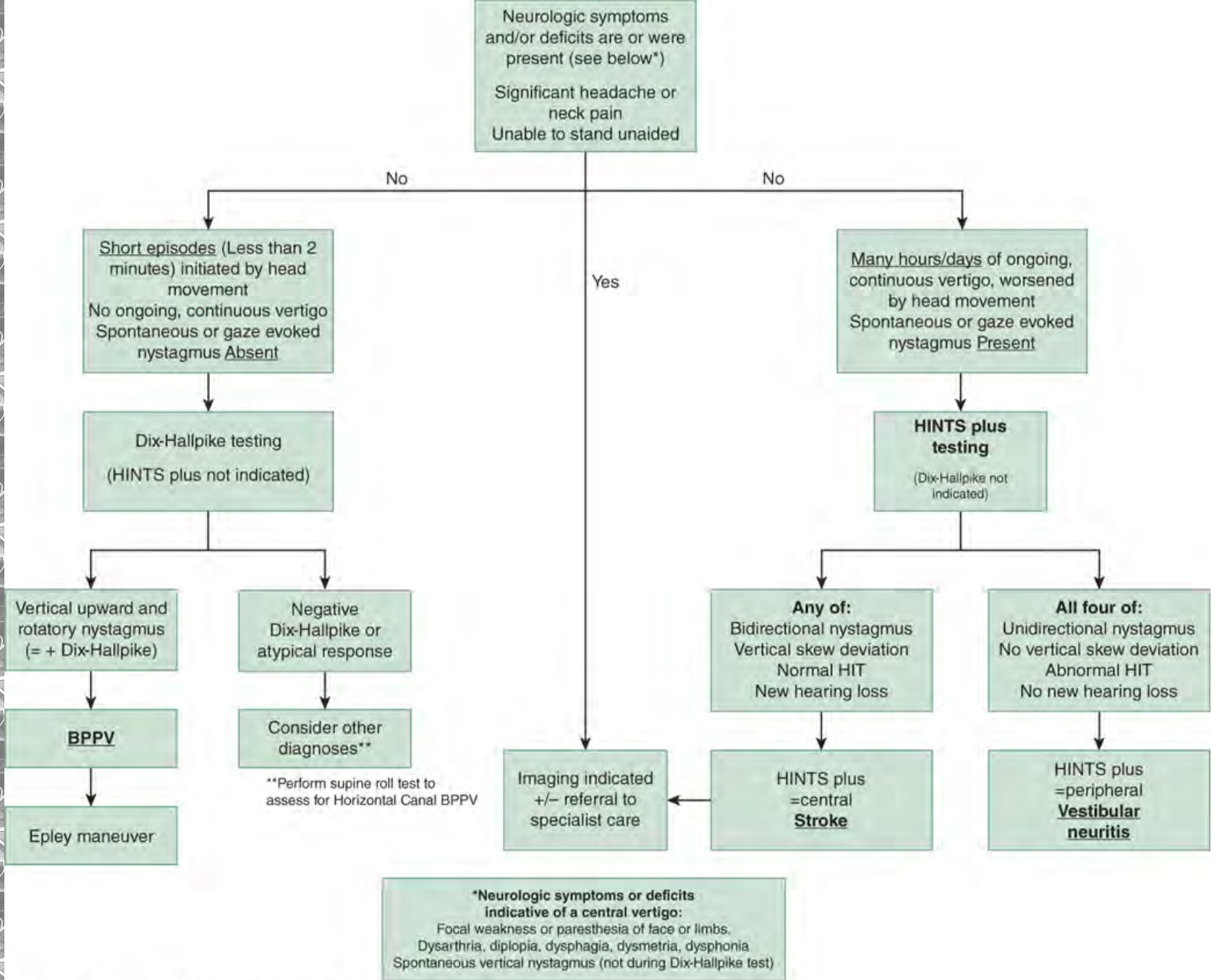
- three-step bedside evaluation
 - horizontal head impulse testing
 - nystagmus evaluation
 - testing of skew
- easily performed in about 1 min.
- Support for stroke –
 - negative (normal) head impulse = Impulse Normal
 - Alternating/direction-changing nystagmus = Fast-phase Alternating
 - presence of skew (refixation on cover–uncover testing) = Refixation on Cover Test
 - If all 3 above = INFARCT = sensitivity and specificity of 100 and 96%, respectively, for detecting stroke.
- In addition, the presence of skew deviation is highly specific for brain stem dysfunction – present 17% of brainstem strokes

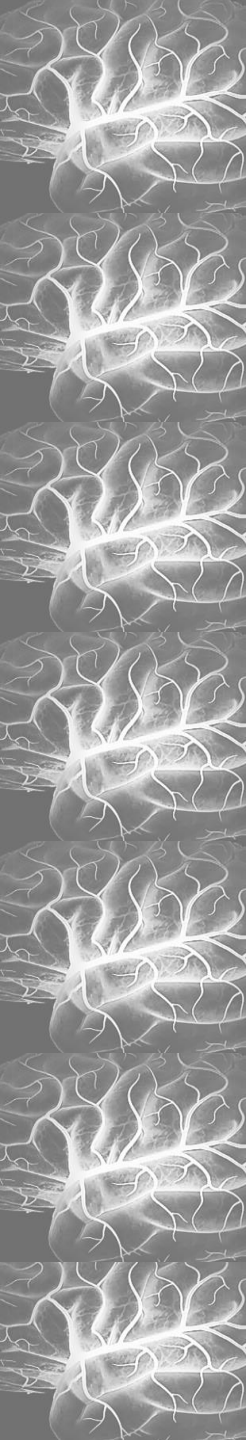




HINTS to determine INFARCT

- 101 consecutive patients with vertigo, nystagmus, nausea/vomiting, head-motion intolerance, unsteady gait with ≥ 1 stroke risk factor
- 25% peripheral cause
- 75% central cause (91% ischemic stroke)
- HINTS was more sensitive for stroke than early MRI





Limitations of neuroimaging in posterior circulation stroke

- CT scan reduced sensitivity and specificity
 - Skull base artifact
- False negative MRI – DWI stroke
 - 701 patients
 - 16 patients DWI-negative MRI
 - Half of DWI-negative strokes were posterior circulation
 - Isolated INO (n=5)
 - Lateral medullary (n=3)



Posterior circulation stroke

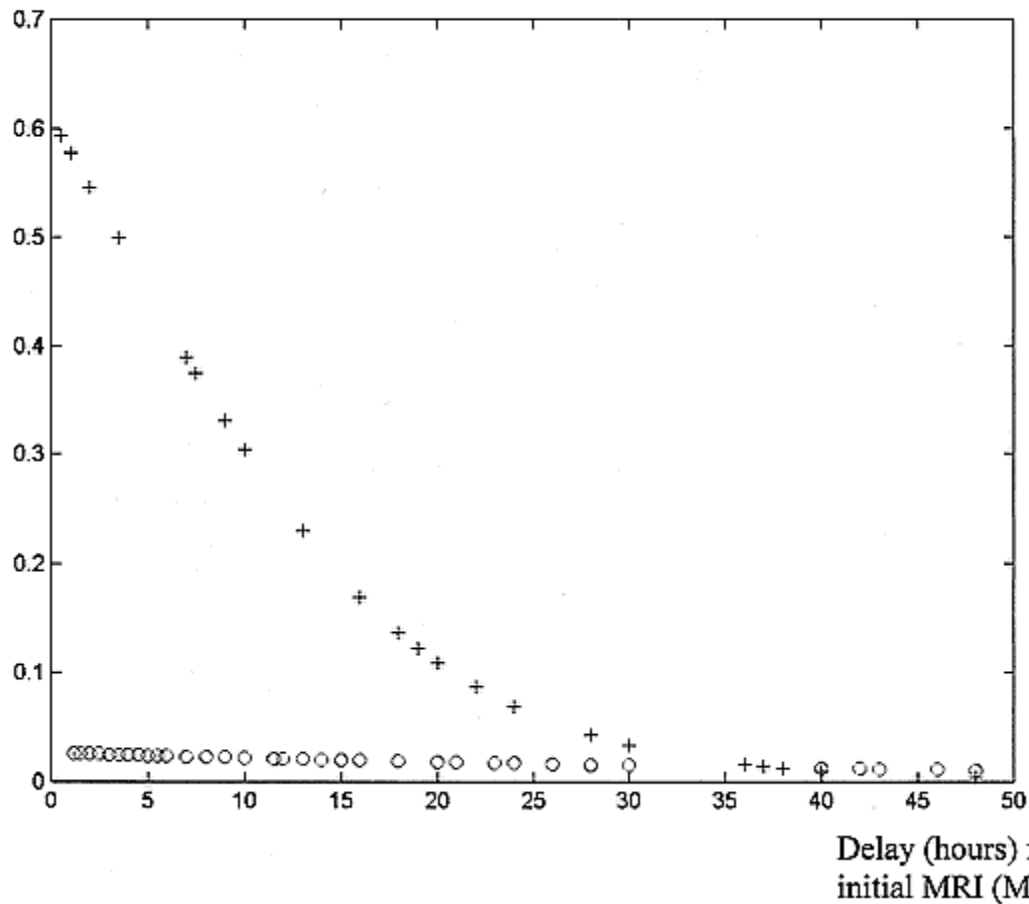
Advanced imaging

- 1846 patients with PCS
 - 850 (46%) presented with acute dizziness/vertigo
 - 35 patients (4.1%) initially had negative MRI-DWI
 - 16/35 had focal neurological signs
 - 18/34 had profound imbalance
 - 21/35 had spontaneous nystagmus
 - 18/35 strokes were in lateral medulla
 - 83% were small
 - 54% had large vessel etiology

Posterior circulation stroke

Advanced imaging

Probability of false
negative DWI





Posterior circulation stroke and IV thrombolysis

- No difference in onset to ED arrival
- No difference in ED arrival to ED doctor
- Significant delay in door-to-neurological expertise
- No difference in neurological expertise to needle
- Significant delay in door-to-needle



Stroke mimic and thrombolysis

- Ischaemic stroke was confirmed in 625 patients (93%), and 48 patients (7%) were stroke mimics.
- No stroke mimic had a symptomatic intracerebral haemorrhage.
 - 12 (25%) were determined functional with inorganic symptoms (functional mimics)
 - 8 (17%) were due to epileptic seizures
 - 10 (21 %) received symptom diagnoses (ie, a descriptive diagnosis without a determined aetiology) such as visual loss, eye muscle paresis, non-specific headache and paresis without cause
 - 4 (8%) were diagnosed as alcohol intoxication
 - 3 (6%) with migraine
 - 3 (6%) with vertigo
 - 2 (4%) with Bell's palsy
 - 2 (4%) with hypotension
 - 2 (4%) with intracerebral tumour
 - 1 (2%) with pain-related paresis
 - 1 (2%) ischemic heart disease



Stroke mimic and thrombolysis

- Among 512 treated patients, 21% (n=69) were found not to have an infarct on follow-up imaging.
- No symptomatic ICH

2018 AHA/ASA Guidelines for Early Management of Acute Ischemic Stroke

Stroke mimics

The risk of symptomatic intracranial hemorrhage in the stroke mimic population is quite low; thus, starting IV alteplase is probably recommended in preference over delaying treatment to pursue additional diagnostic studies.† (Class IIa; LOE B-NR)



Thrombectomy in posterior circulation stroke

REVASK - prospective multicenter Registry on Revascularization in Ischemic Stroke Patients

- 139 PCS compared with 961 ACS patients treated with thrombectomy
- Lower risk of sICH (0% vs 3%, $p=0.010$)
- Similar effectiveness mRS 0-2 (38% vs 42%, $p=0.392$)



Thrombectomy in posterior circulation stroke

MUSC - prospective Registry Ischemic Stroke Patients

- 56 PCS compared with 380 ACS patients treated with thrombectomy
- Similar risk of sICH
- Similar effectiveness mRS 0-2 (42.9% vs 43.2%, $p=0.966$)

2018 AHA/ASA Guidelines for the Early Management of AIS

Although the benefits are uncertain, the use of mechanical thrombectomy with stent retrievers may be reasonable for carefully selected patients with AIS in whom treatment can be initiated (groin puncture) within 6 hours of symptom onset and who have causative occlusion of the anterior cerebral arteries, vertebral arteries, basilar artery, or posterior cerebral arteries.

IIb

C-EO



Posterior circulation stroke

Major points

- Lots of vessels at risk -> lots of presentations
 - Because about 50% PC stroke due to embolism, more than one vessel may lead to presentation which does not fit a classic syndrome
- Sudden onset of focal neurological deficits = vascular, electrical or traumatic
- Many PC stroke symptoms do not score points on NIHSS, but that doesn't mean they are not disabling
- Recognize 5 Ds of PC stroke – dizziness + any other D increases odds of stroke vs benign cause of dizziness
- Become proficient in HINTS as may be more sensitive/specific for stroke than MRI

