Brain stem & Spinal cord syndromes

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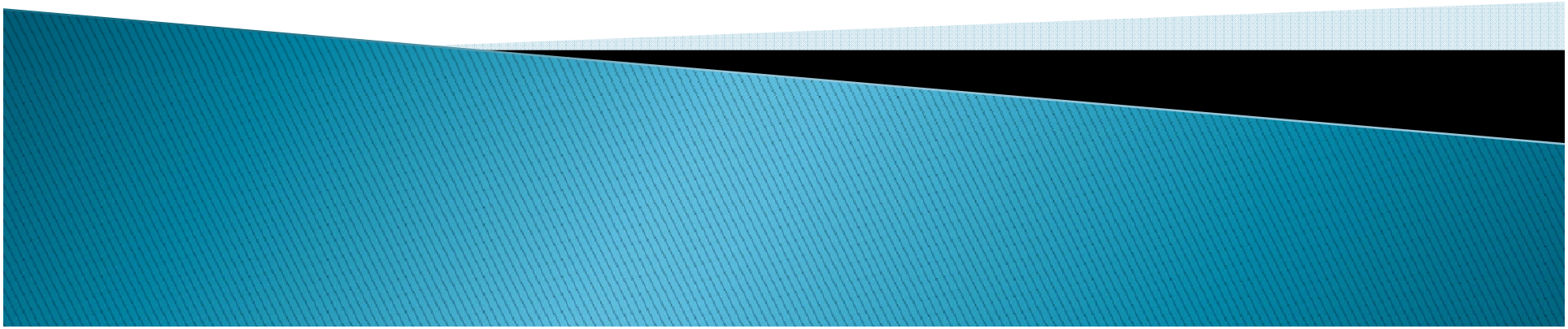
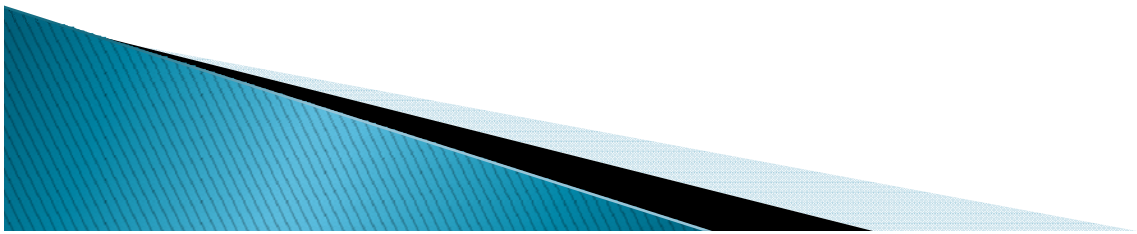
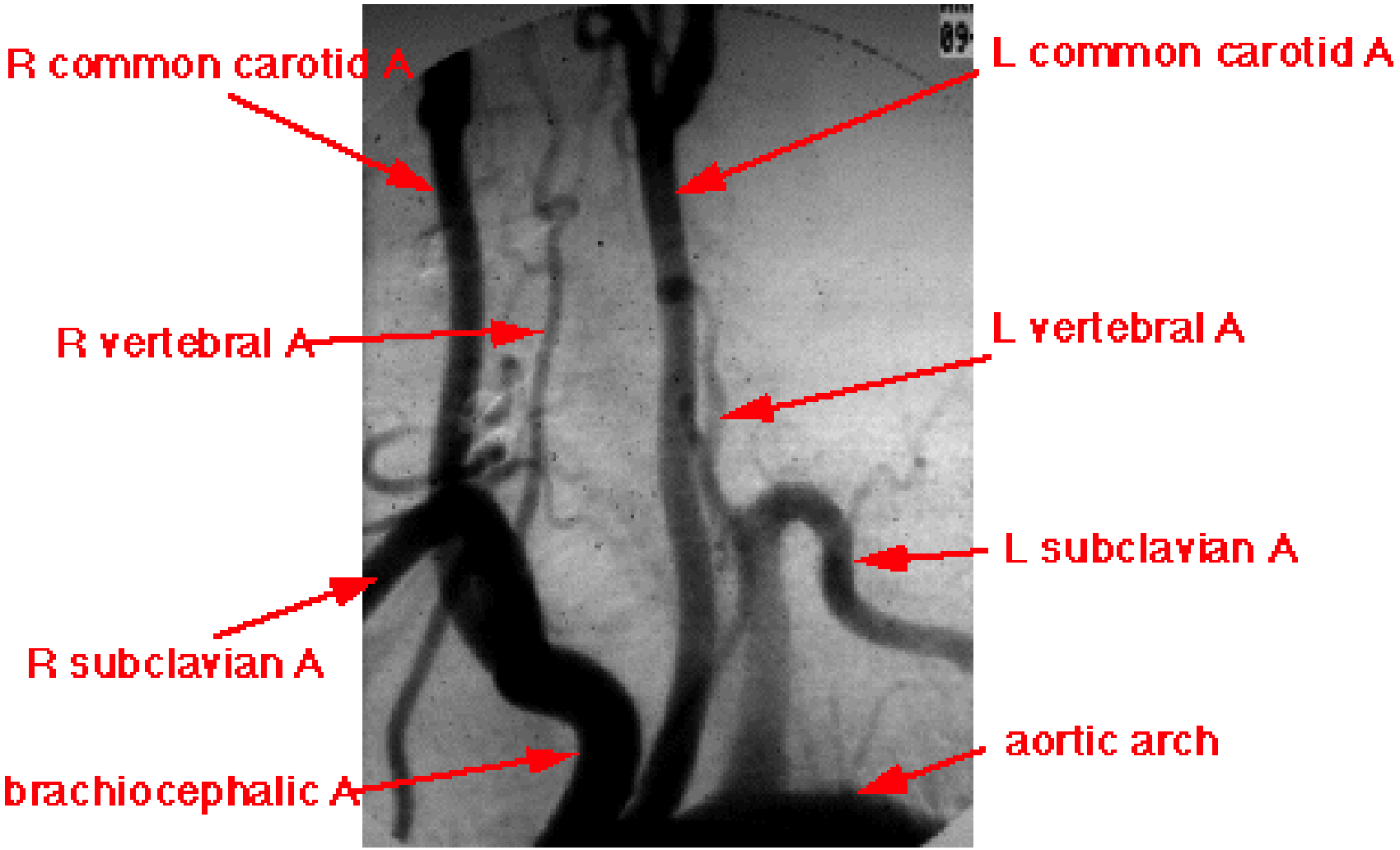


Objective

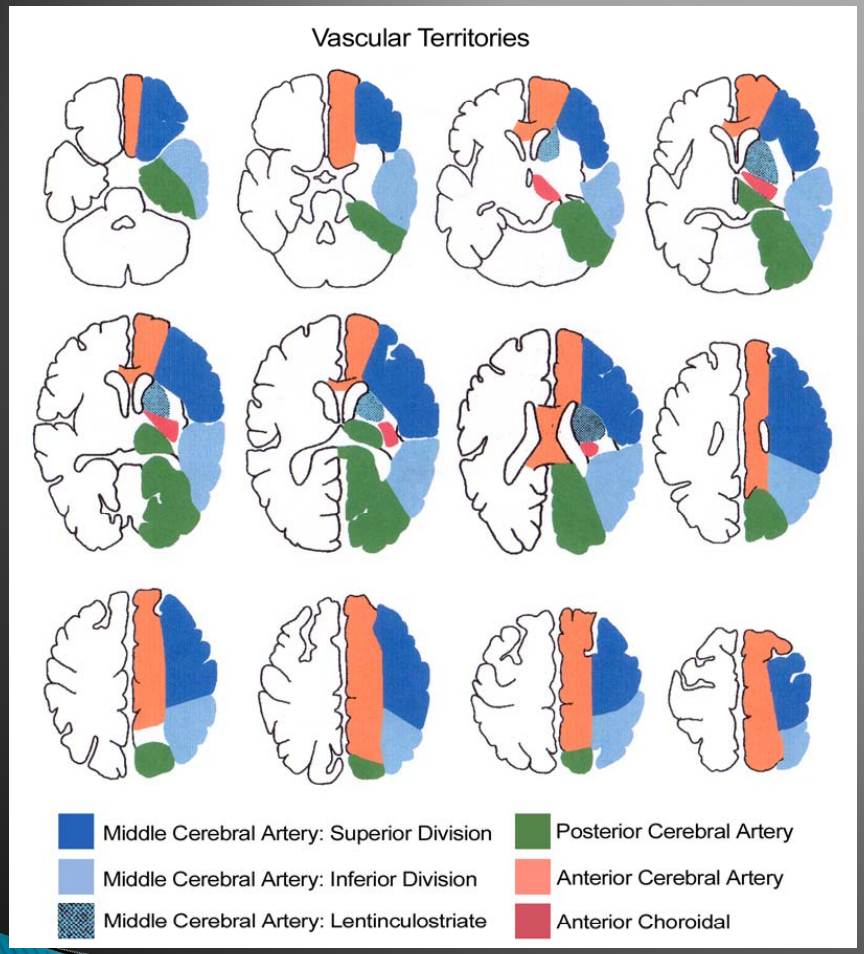
- Review brainstem blood supply
- Review brainstem sections
- Brainstem syndromes
- Spinal Cord blood supply
- Spinal cord syndromes



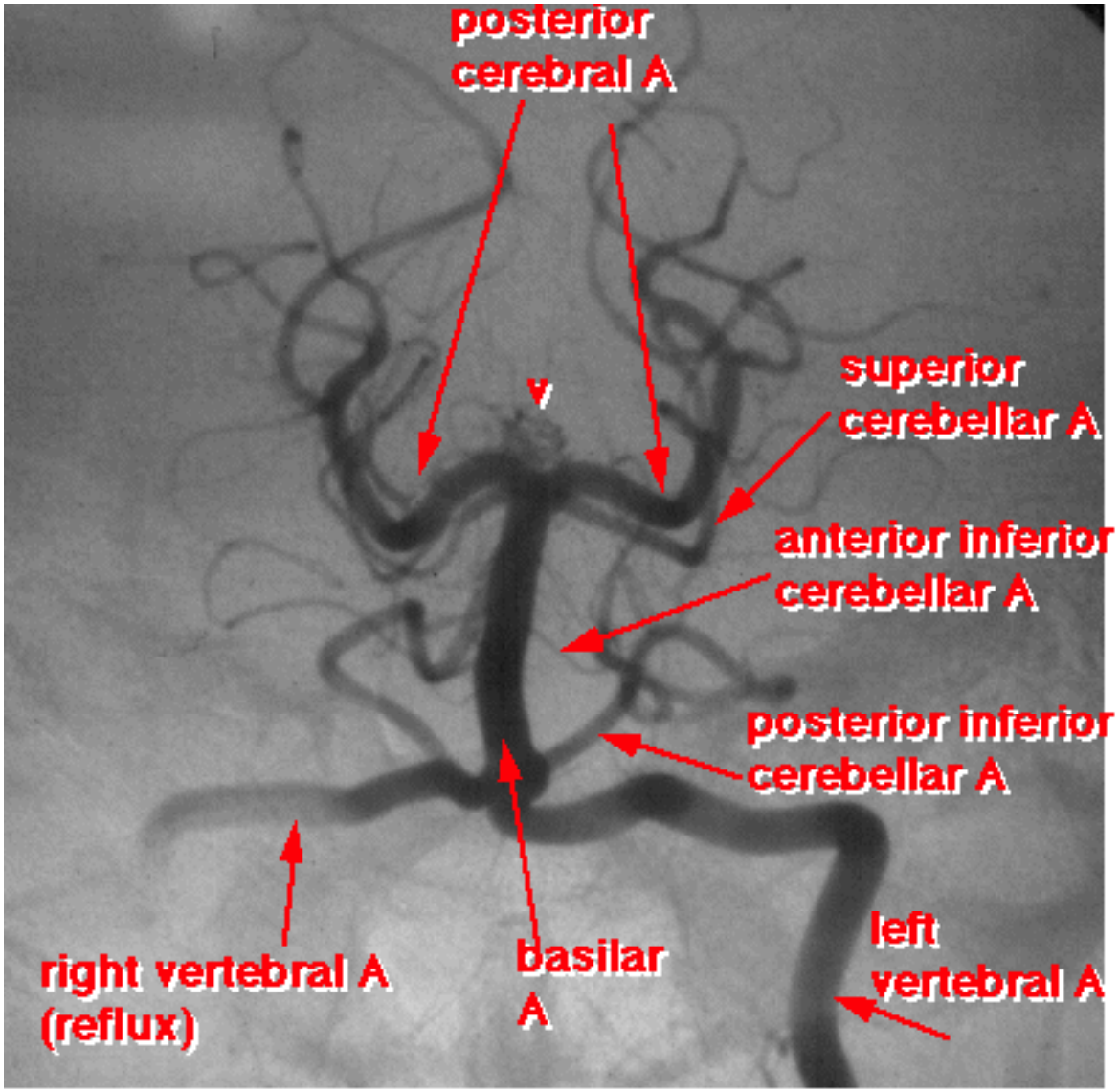


angiogram of the aortic arch

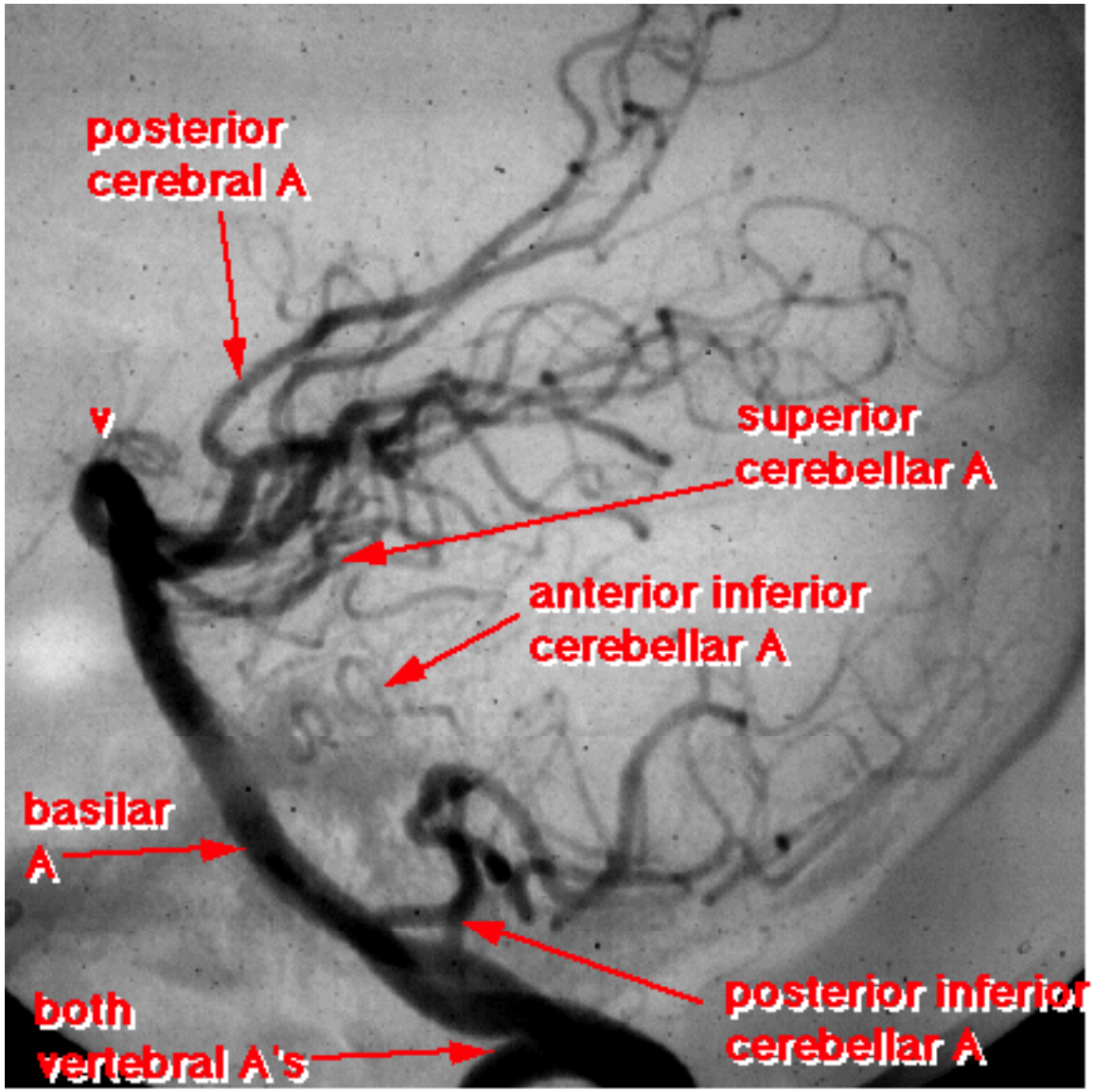
Vascular territories



- The brainstem houses
- cranial nerves
- reticular activating system, and
- a series of ascending and descending tracts.



v =perforators off the top of the basilar



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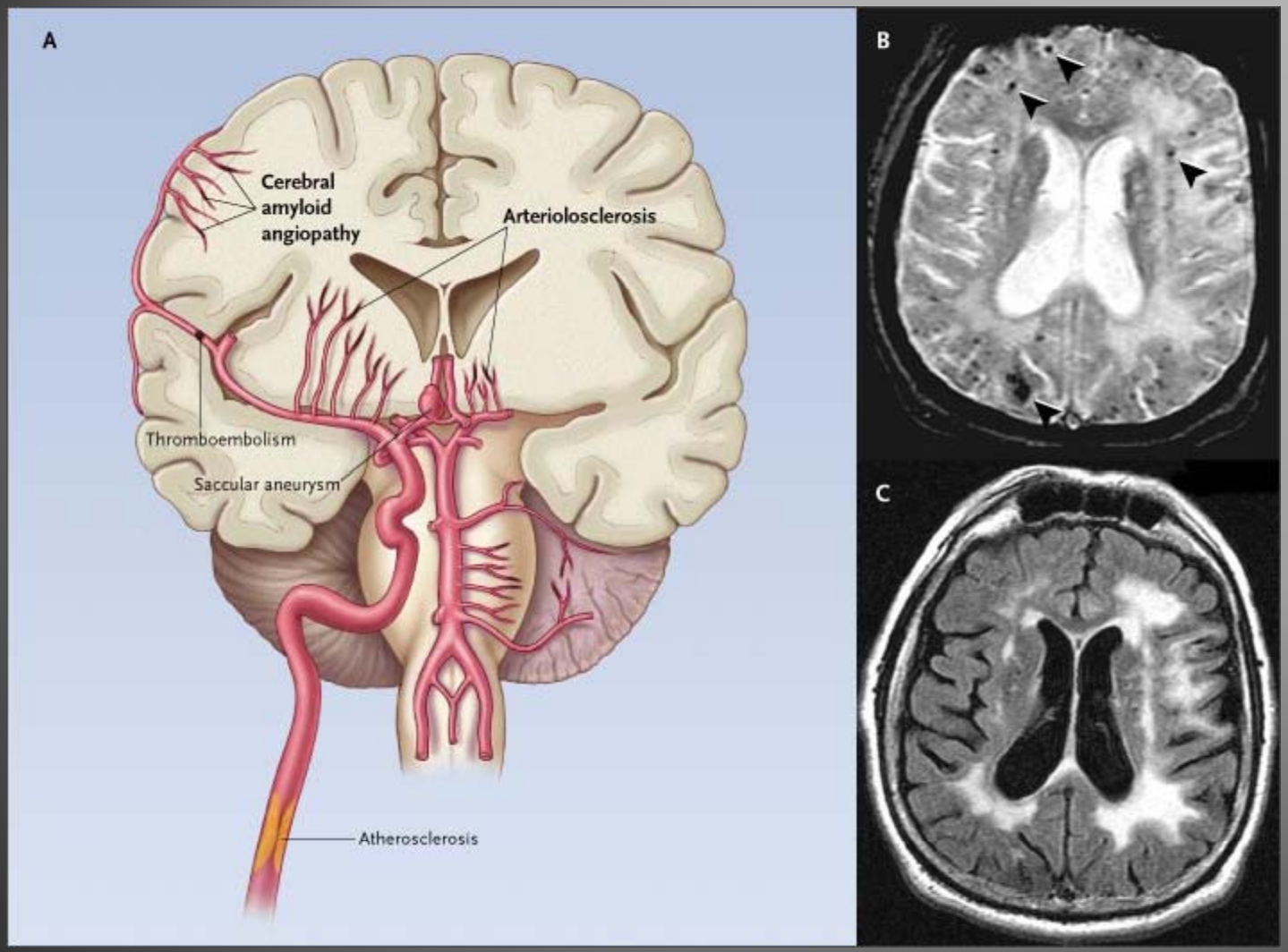
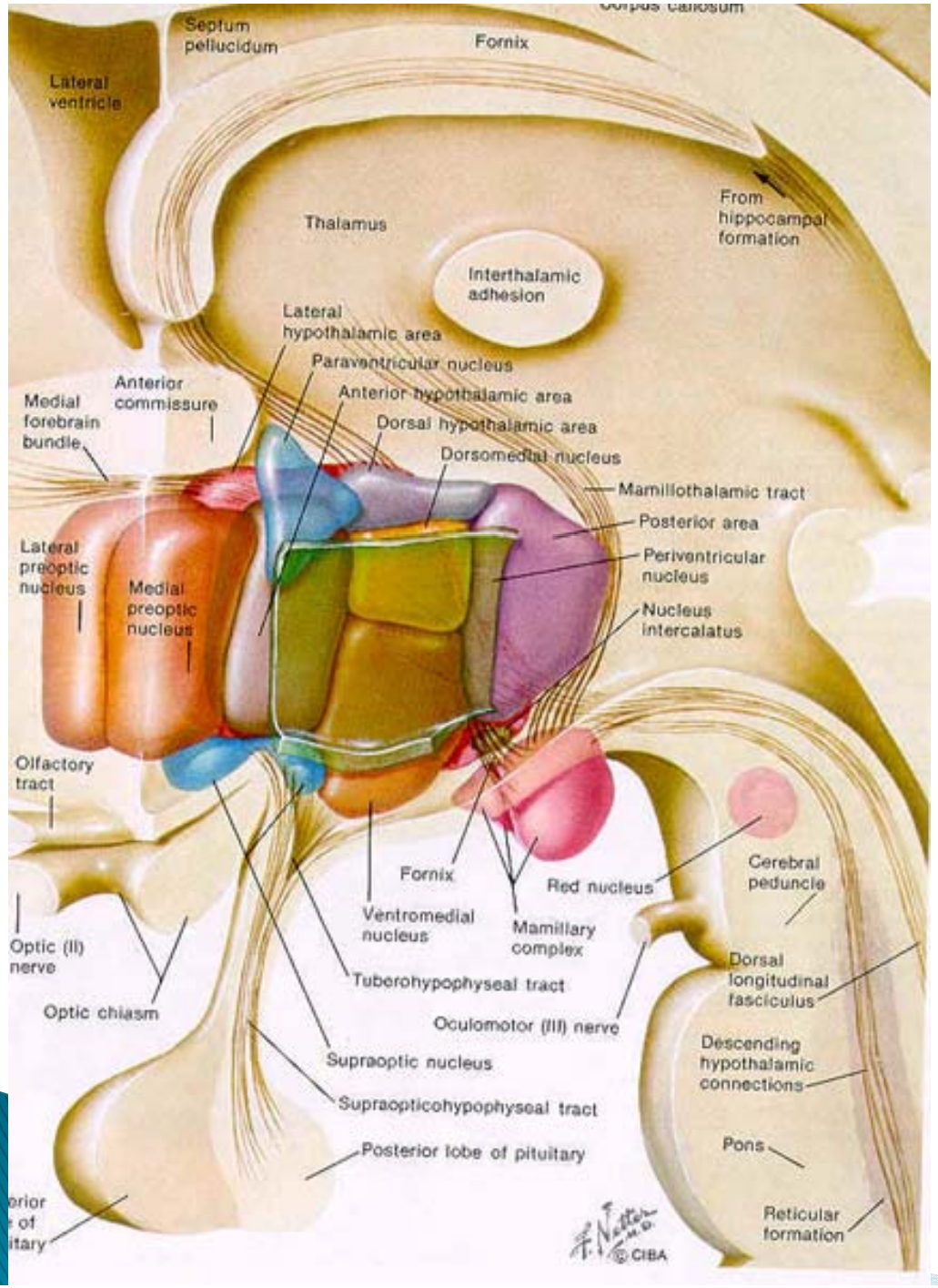

A
Cerebral amyloid angiopathy
Arteriolosclerosis
Thromboembolism
Saccular aneurysm
Atherosclerosis
B
C


Septum pellucidum
Fornix
Lateral ventricle
From hippocampal formation
Thalamus
Interthalamic adhesion
Lateral hypothalamic area
Paraventricular nucleus
Anterior commissure
Anterior hypothalamic area
Medial forebrain bundle
Dorsal hypothalamic area
Dorsomedial nucleus
Mamillothalamic tract
Posterior area
Lateral preoptic nucleus
Periventricular nucleus
Medial preoptic nucleus
Nucleus intercalatus
Olfactory tract
Fornix
Red nucleus
Cerebral peduncle
Ventromedial nucleus
Mamillary complex
Optic (II) nerve
Tuberohypophyseal tract
Dorsal longitudinal fasciculus
Optic chiasm
Oculomotor (III) nerve
Descending hypothalamic connections
Supraoptic nucleus
Supraopticohypophyseal tract
Pons
Posterior lobe of pituitary
Reticular formation
© CIBA

Clinical symptoms

- Dimness of vision
- Diplopia
- Deafness
- Dizziness
- Dysarthria
- Dysphagia
- Dysphonia

Vertebro basilar syndromes (VBATD)

- 25% of strokes & TIAs occur in the vertebrobasilar distribution
- Embolic in 9-40% of reported cases.
- 50% report TIAs in the days or weeks (rarely months) prior to onset of the permanent deficit.
- The early risk (within 7 days) of recurrent stroke or TIA progression to stroke is higher with VBATD
- Basilar artery syndrome presents as a locked-in state with mortality of 75-85 %

POINT study

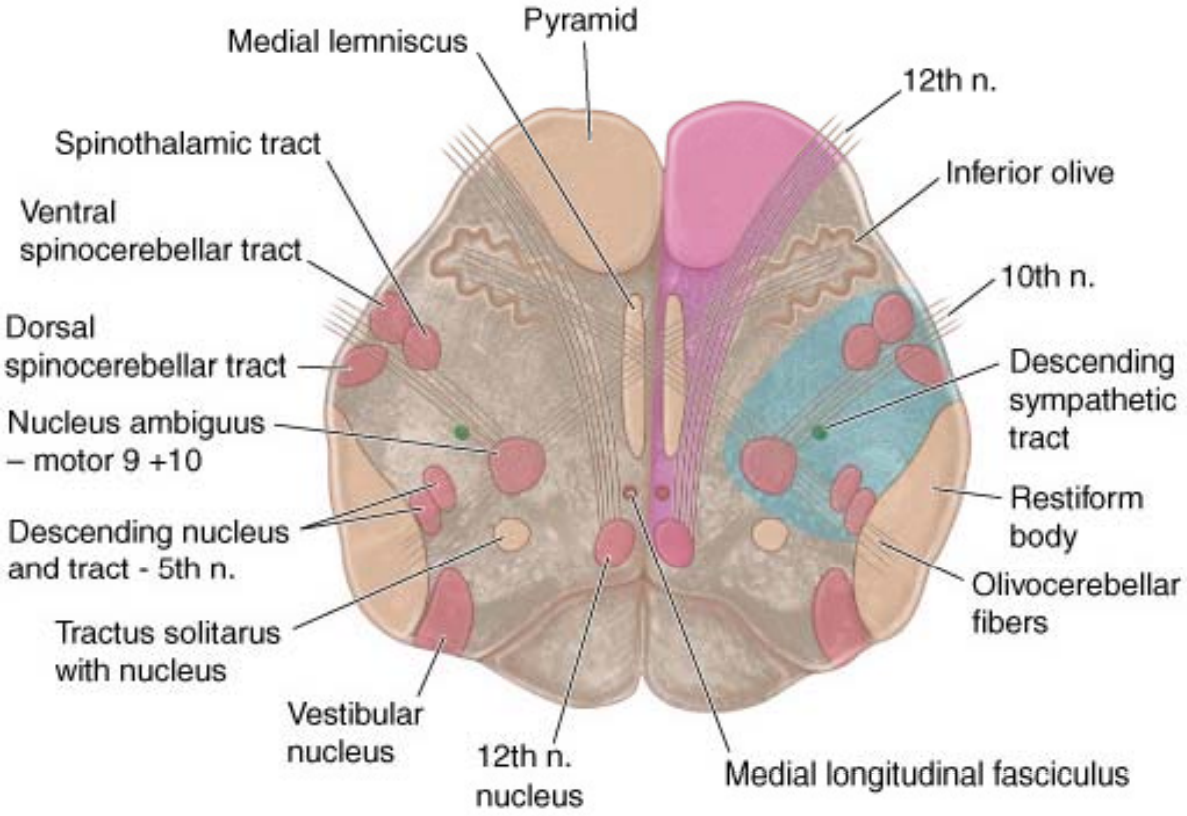
- Platelet-Oriented Inhibition in New TIA and Minor Ischemic Stroke (POINT)Trial
- a Randomized, Double-blind, Multicenter Clinical Trial
- To determine whether clopidogrel 75 mg/day by mouth after a loading dose of 600 mg of clopidogrel is effective in preventing major ischemic vascular events (ischemic stroke, myocardial infarction, and ischemic vascular death) at 90 days when initiated within 12 hours of TIA or minor ischemic stroke onset in patients receiving aspirin 50-325 mg/day (with a dose of 162 mg daily for 5 days followed by 81 mg daily strongly recommended).

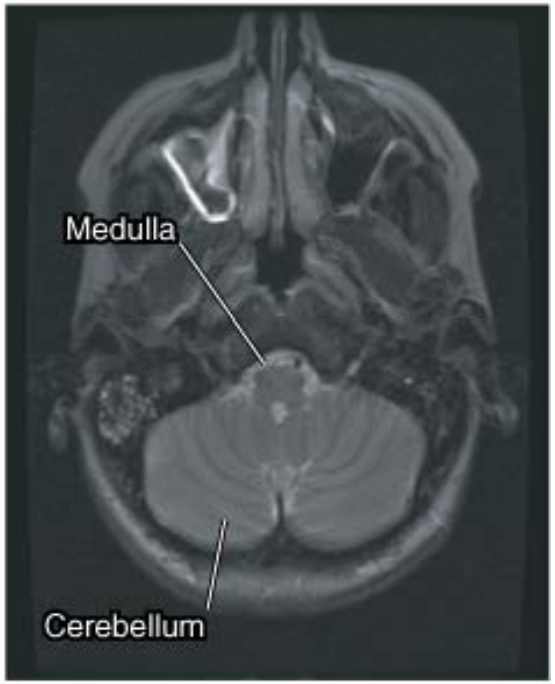
POINT : Inclusion Criteria

- Neurologic deficit (exam finding or symptom unconfirmable on exam) attributed to focal brain ischemia, with complete resolution of the deficit within 12 hours of symptom onset; ability to randomize within 12 hours of symptom onset;
  ABCD2 score >3; Head CT or MRI ruling out hemorrhage or other pathology, such as vascular malformation, tumor, or abscess, that could explain symptoms or contraindicate therapy.

POINT : ABCD2 score

- A (Age); 1 point for age $\geq$60 years,
- B (Blood pressure $\geq$ 140/90 mmHg); 1 point for hypertension at the acute evaluation,
- C (Clinical features); 2 points for unilateral weakness, 1 for speech disturbance without weakness, and
- D (symptom Duration); 1 point for 10–59 minutes, 2 points for $\geq$60 minutes.
- D (Diabetes); 1 point





Medullary syndrome:

Lateral Medial

Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: http://www.accessmedicine.com

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Signs and symptoms: *Structures involved*

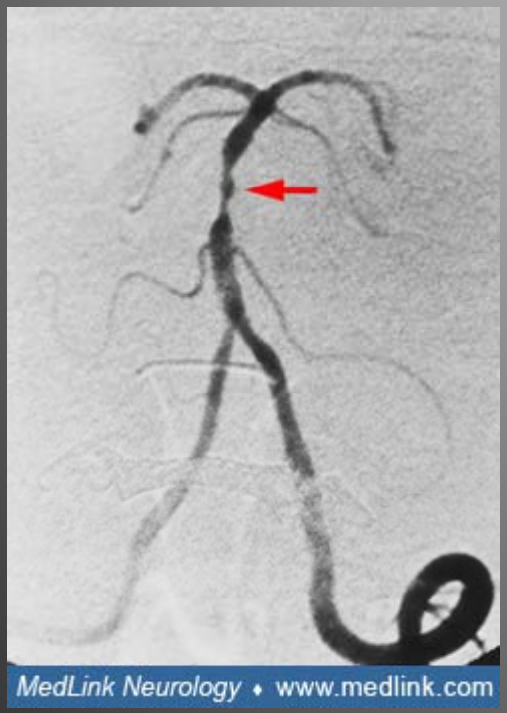
- 1. Medial medullary syndrome (occlusion of vertebral artery or of branch of vertebral or lower basilar artery)
- On side of lesion
- Paralysis with atrophy of half the tongue: *Ipsilateral twelfth nerve*
- On side opposite lesion
- Paralysis of arm and leg, sparing face; impaired tactile and proprioceptive sense over half the body: *Contralateral pyramidal tract and medial lemniscus*
- Inferior Alternating Hemiplegia

Dejerine syndrome

Lateral medullary syndrome

Occlusion of any of five vessels may be responsible—vertebral, posterior inferior cerebellar, superior, middle, or inferior lateral medullary arteries
Total unilateral medullary syndrome - Combination of medial and lateral syndromes
Lateral pontomedullary syndrome: Combination of lateral medullary and lateral inferior pontine syndrome

- On side of lesion
- Pain, numbness, impaired sensation over half the face: *Descending tract and nucleus fifth nerve*
- Ataxia of limbs, falling to side of lesion: *Uncertain—restiform body, cerebellar hemisphere, cerebellar fibers, spinocerebellar tract (?)*
- Nystagmus, diplopia, oscillopsia, vertigo, nausea, vomiting: *Vestibular nucleus*
- Horner's syndrome (miosis, ptosis, decreased sweating): *Descending sympathetic tract*
- Dysphagia, hoarseness, paralysis of palate, paralysis of vocal cord, diminished gag reflex: *Issuing fibers ninth and tenth nerves*
- Loss of taste: *Nucleus and tractus solitarius*
- Numbness of ipsilateral arm, trunk, or leg: *Cuneate and gracile nuclei*
- Weakness of lower face: *Genuflected upper motor neuron fibers to ipsilateral facial nucleus*
- On side opposite lesion
- Impaired pain and thermal sense over half the body, sometimes face: *Spinothalamic tract*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SAMMPRIS ?

SAMMPRIS

- Stenting vs. Aggressive Medical Management for Preventing Recurrent Stroke in Intracranial Stenosis
- To compare the safety and effectiveness of either Intensive Medical Therapy PLUS Stenting or Intensive Medical Therapy ONLY in preventing stroke, heart attacks or death
- TIA or non-severe stroke within 30 days of enrollment attributed to 70-99% stenosis of a major intracranial artery

(A) Head MRI, T2-weighted sequence shows a left medial medullary infarction with partial extension to the inferior cerebellar peduncle. (B) Cerebral angiogram shows left vertebral artery occlusion and high grade right vertebral artery stenosis.

Lateral and Medial Medullary Infarction

A Comparative Analysis of 214 Patients

W. Kameda, MD; T. Kawanami, MD; K. Kurita, MD; M. Daimon, MD; T. Kayama, MD; T. Hosoya, MD; T. Kato, MD; for the Study Group of the Association of Cerebrovascular Disease in Tohoku

Background and Purpose—No large-scale study has ever compared the clinical and radiological features of lateral medullary infarction (LMI) and medial medullary infarction (MMI). The aim of this study was to investigate them through the use of cooperatively collected cases.

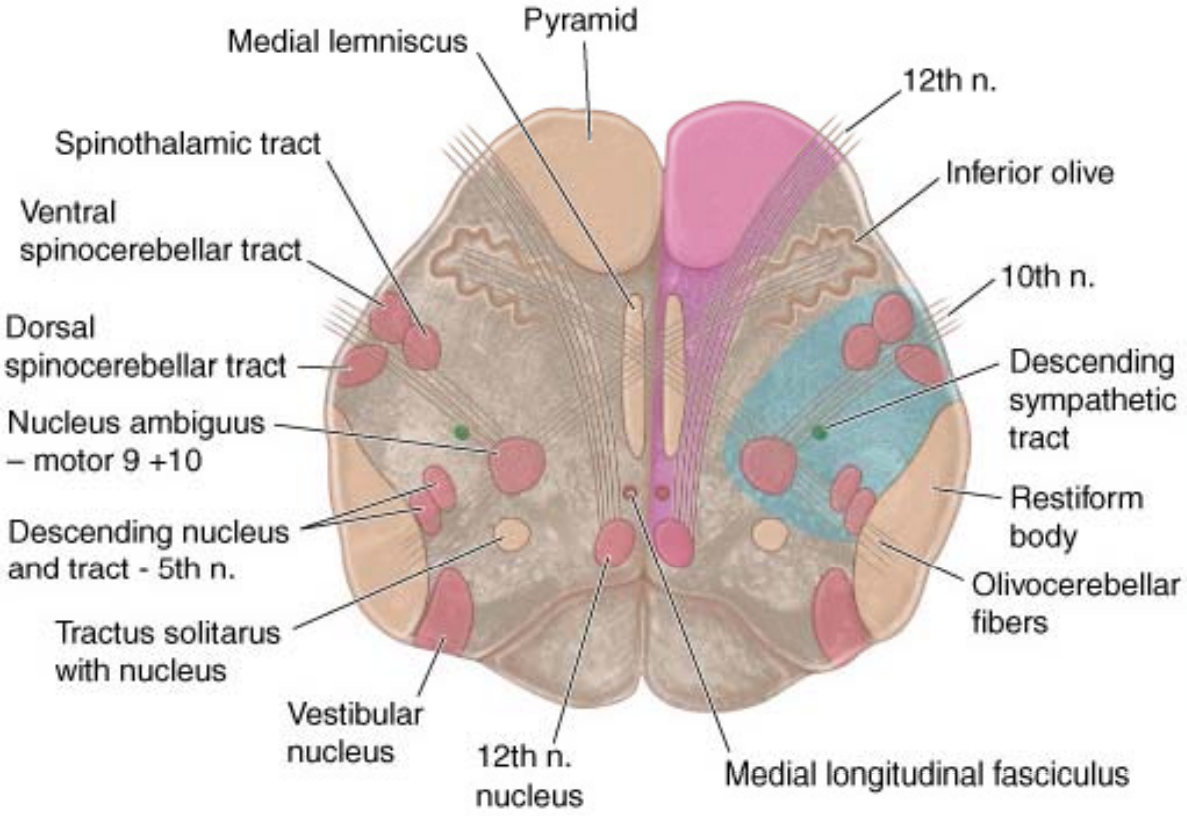
Methods—Medical information on all patients from 1996 to 2000 with medullary infarction (MI) proven by brain MR images at 35 stroke centers in the Tohoku district, Japan, was collected, and their clinical and radiological features were analyzed.

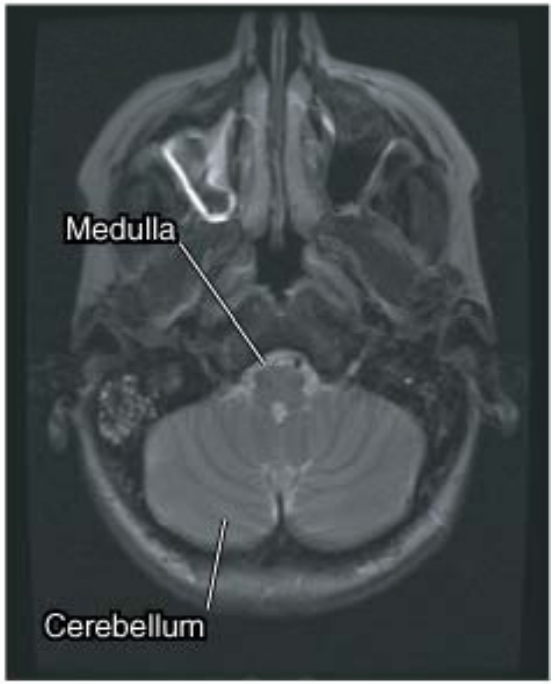
Results—A total of 214 cases of MI were registered. They included 167 cases (78%) of LMI, 41 (19%) of MMI, and 6 (3%) of LMI plus MMI. The mean age of onset and the male-to-female ratio were 60.7 years and 2.7:1 in LMI and 65.0 years and 3.6:1 in MMI, respectively. The middle medulla was most frequently affected in LMI, and the upper medulla was most frequently affected in MMI. Dissection of the vertebral artery was observed in 29% of LMI and 21% of MMI. Prognosis, assessed by the Barthel Index, was favorable in both LMI and MMI. Diabetes mellitus was more frequently associated with MMI than with LMI.

Conclusions—The present study surveyed a large number of MI cases and revealed that (1) the mean age of onset of MMI is higher than that of LMI, (2) the dissection of the vertebral artery is an important cause not only of LMI but also of MMI, and (3) diabetes mellitus is frequently associated with MMI. **(*Stroke*. 2004;35:694-699.)**

TABLE 2. Neurologic Symptoms and Signs of LMI and MMI

LMI	%	MMI	%
Sensory dysfunction	89	Limb weakness	93
Dysarthria	75	Sensory dysfunction	68
Vertigo/dizziness	73	Diminished pharyngeal reflex	56
Horner's syndrome	72	Vertigo/dizziness	56
Cerebellar ataxia	69	Dysarthria	53
Diminished pharyngeal reflex	64	Nystagmus	51
Nausea or vomiting	58	Nausea or vomiting	44
Nystagmus	57	Cerebellar ataxia	33
Dysphagia	57	Facial palsy	30
Headache	47	Lingual palsy	30
Limb weakness	25	Dysphagia	29
Facial palsy	18	Consciousness disturbance	24
Consciousness disturbance	16	Horner's syndrome	16
Hiccup	15	Headache	13
Lingual palsy	9	Central respiratory dysfunction	5
Limitation of ocular movement	6	Taste disorder	3
Central respiratory dysfunction	2	Limitation of ocular movement	2





Medullary syndrome:

Lateral Medial

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Harrison's Principles of Internal Medicine,

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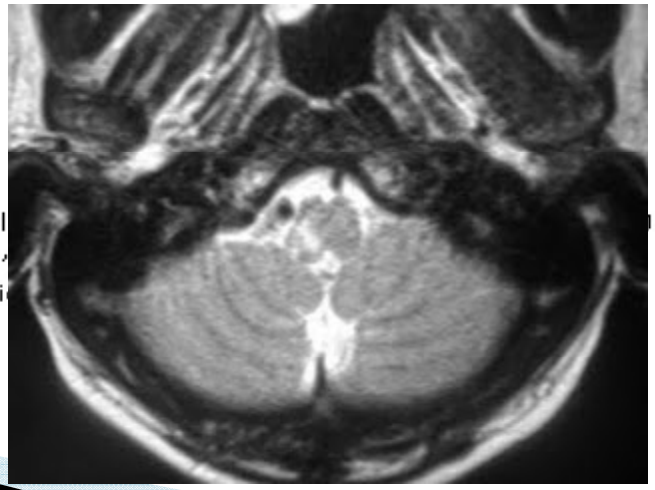
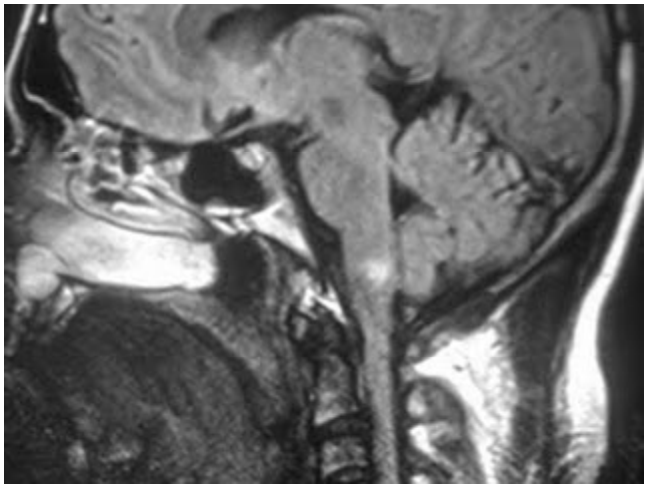
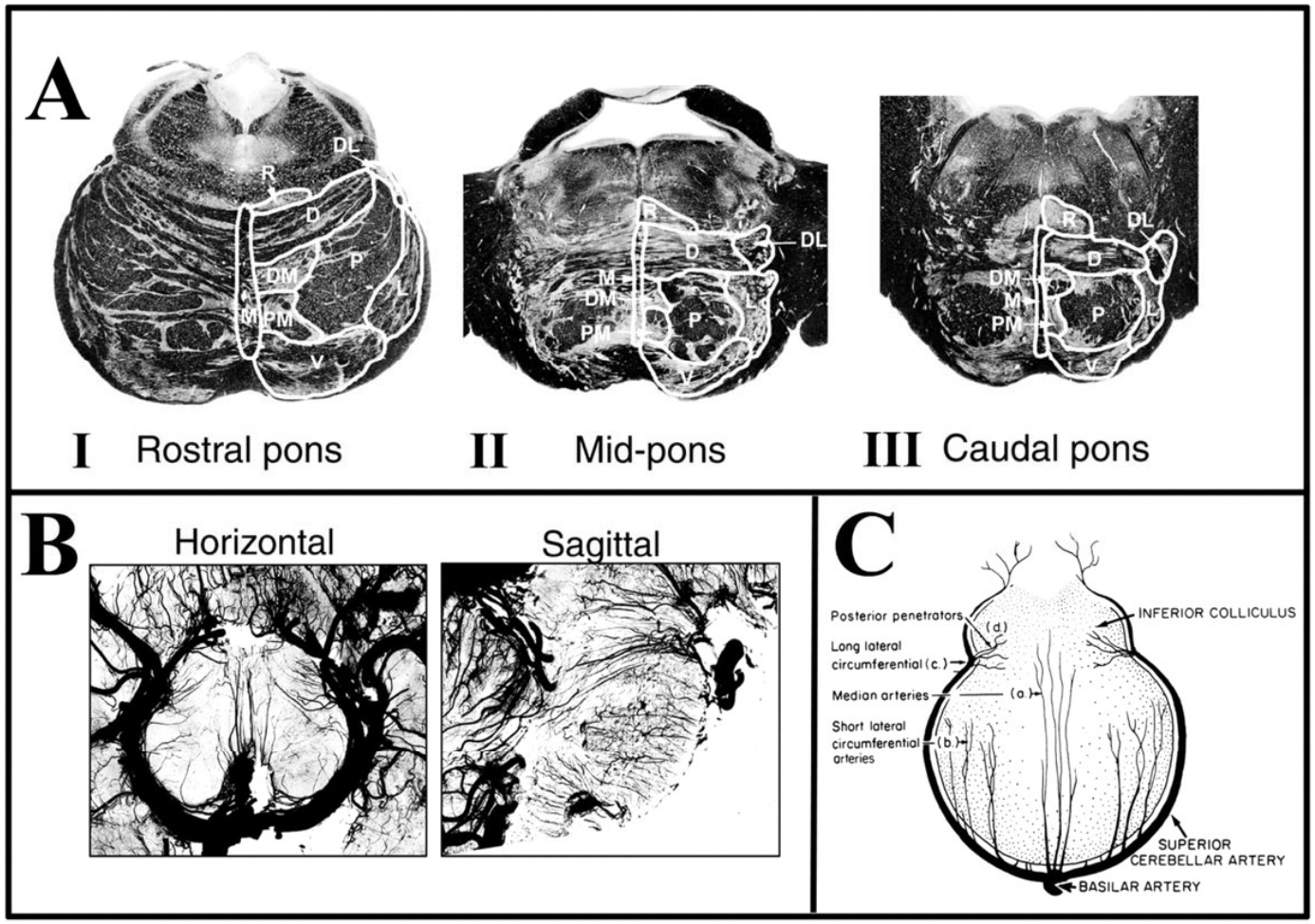




Basilar pontine nuclei in human



Schmahmann, J. D. et al. Brain 2004 127:1269-1291; doi:10.1093/brain/awh138

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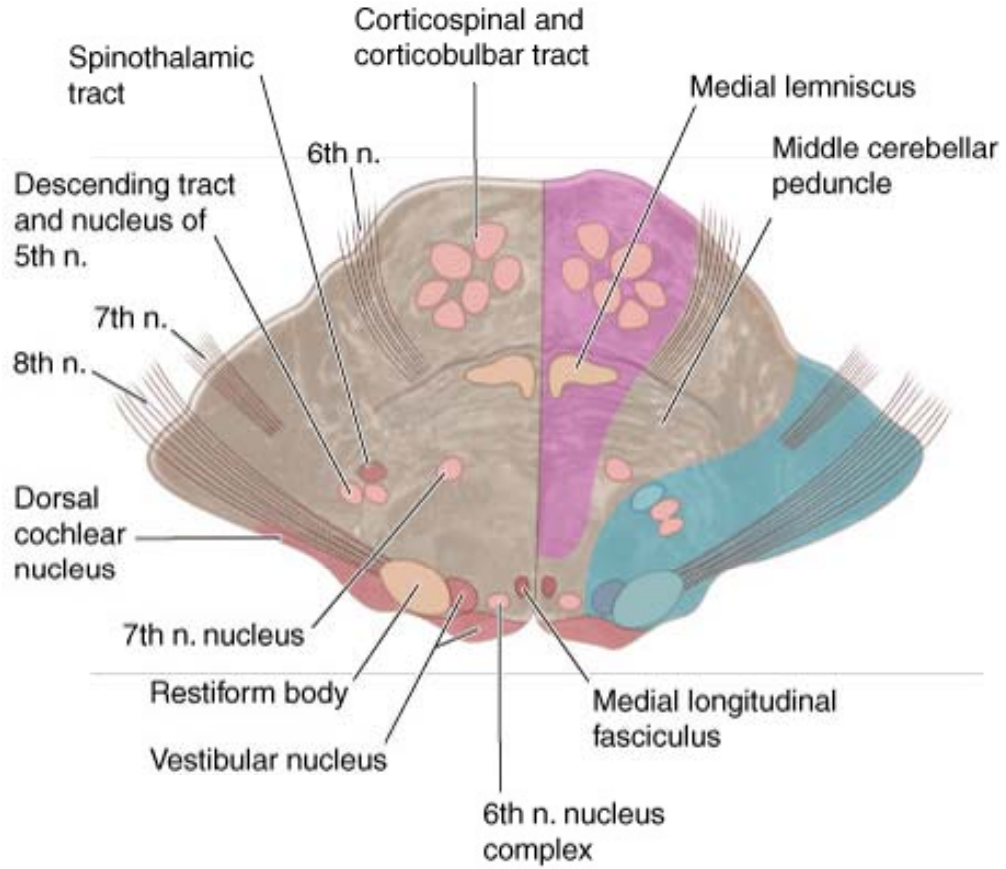

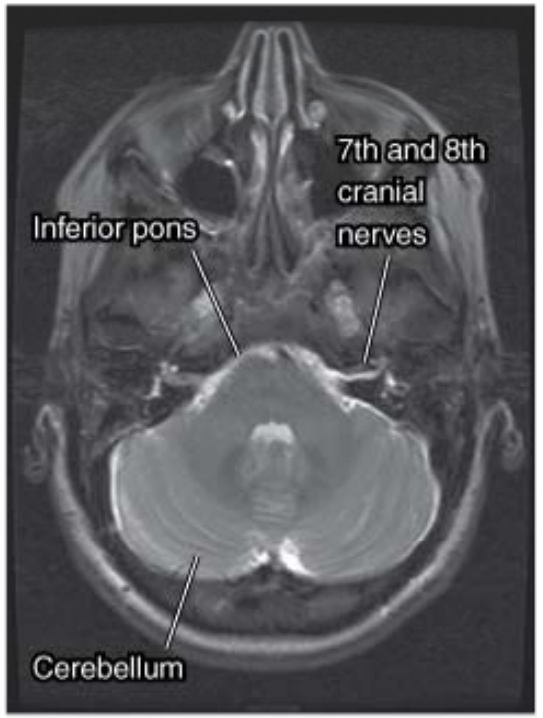

Inferior pontine syndrome:

Lateral Medial

Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: http://www.accessmedicine.com

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Medial inferior pontine syndrome (occlusion of paramedian branch of basilar artery)

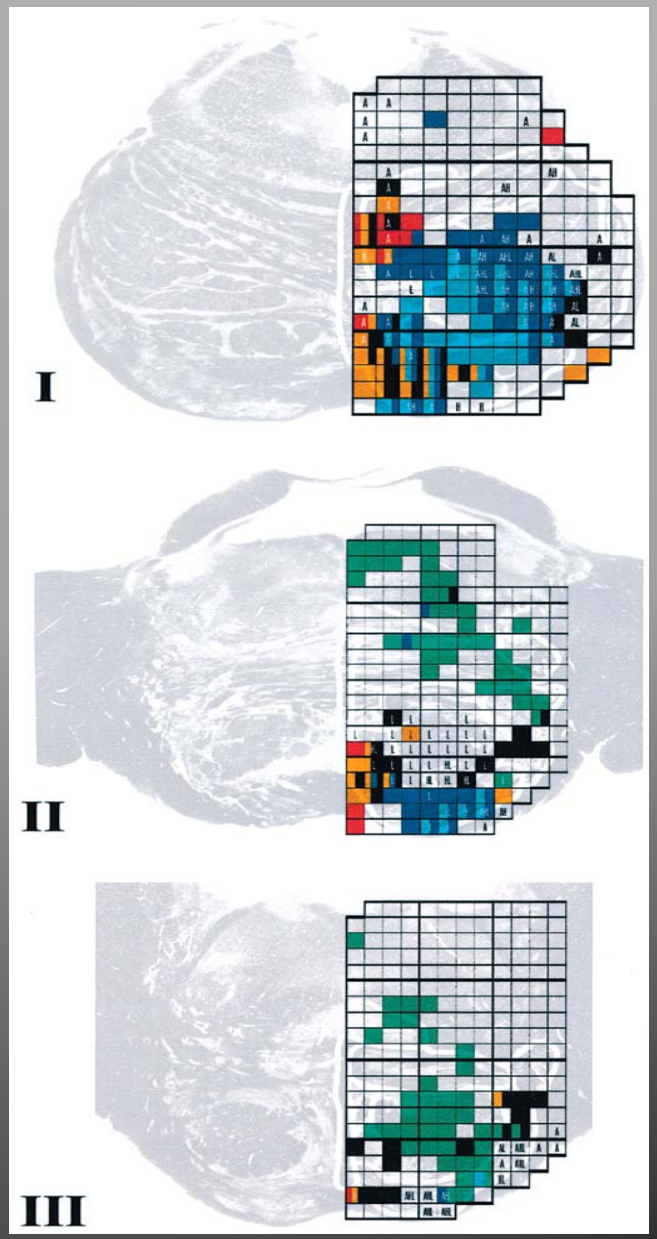
- On side of lesion
- Paralysis of conjugate gaze to side of lesion (preservation of convergence): *Center for conjugate lateral gaze*
- Nystagmus: *Vestibular nucleus*
- Ataxia of limbs and gait: Likely *middle cerebellar peduncle*
- Diplopia on lateral gaze: *Abducens nerve*
- On side opposite lesion
- Paralysis of face, arm, and leg: *Corticobulbar and corticospinal tract in lower pons*
- Impaired tactile and proprioceptive sense over half of the body: *Medial lemniscus*

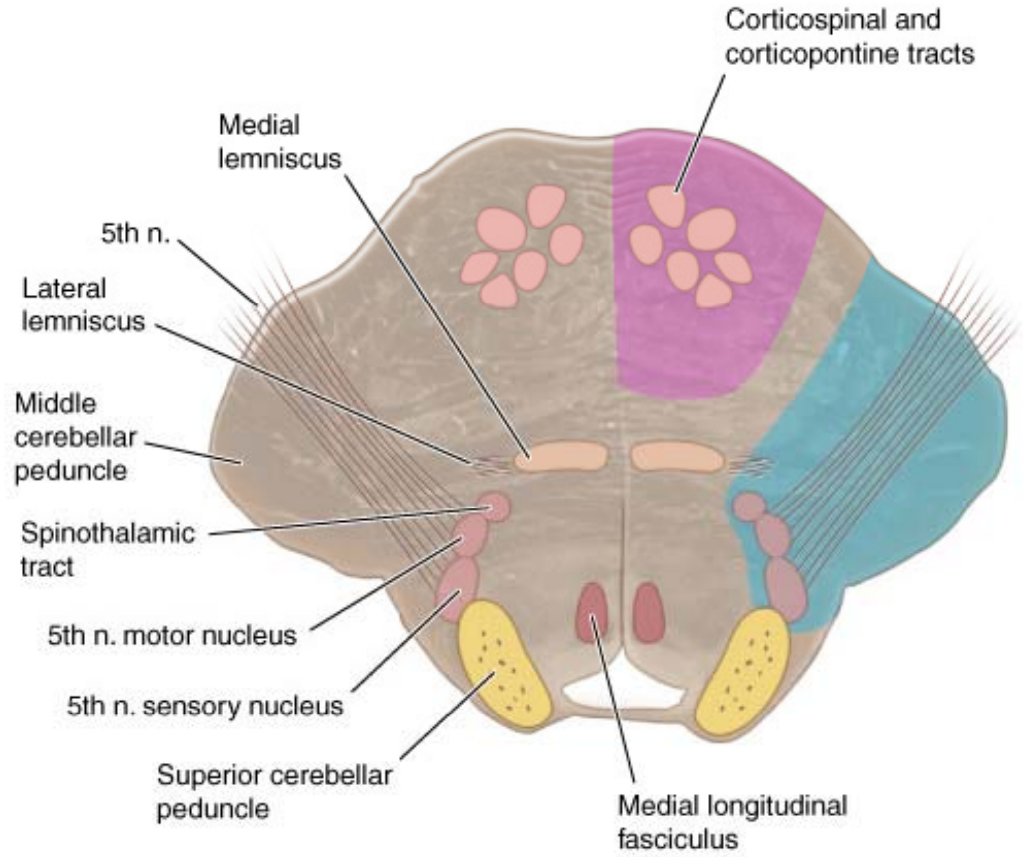
Lateral inferior pontine syndrome (occlusion of anterior inferior cerebellar artery)

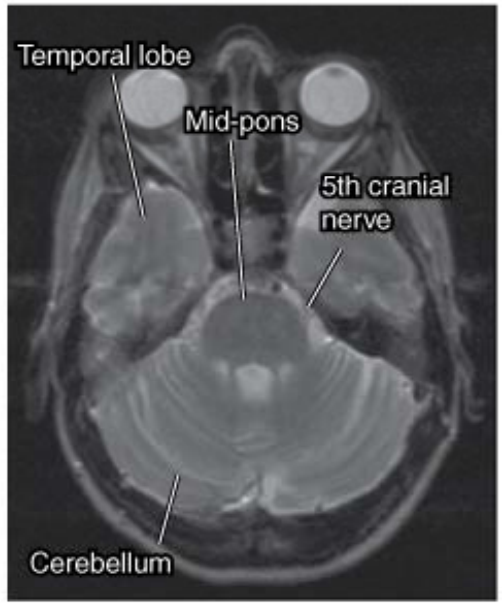
- On side of lesion
- Horizontal and vertical nystagmus, vertigo, nausea, vomiting, oscillopia: *Vestibular nerve or nucleus*
- Facial paralysis: *Seventh nerve*
- Paralysis of conjugate gaze to side of lesion: *Center for conjugate lateral gaze*
- Deafness, tinnitus: *Auditory nerve or cochlear nucleus*
- Ataxia: *Middle cerebellar peduncle and cerebellar hemisphere*
- Impaired sensation over face: *Descending tract and nucleus fifth nerve*
- On side opposite lesion
- Impaired pain and thermal sense over half the body (may include face): *Spinothalamic tract*
- *Marie Foix syndrome*

Basis pontis strokes_ Color-coded composite summary diagram

- Topographic map of motor representations in the human pons derived from analysis of basilar pontine stroke.
- Pontine levels I–III.
- Face, red;
- dysarthria, orange;
- hand dexterity, dark blue;
- arm dysmetria, light blue;
- leg dysmetria, green;
- gait, black.
- A = arm strength; H = hand strength; L = leg strength.







Midpontine syndrome:

Lateral Medial

Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: http://www.accessmedicine.com

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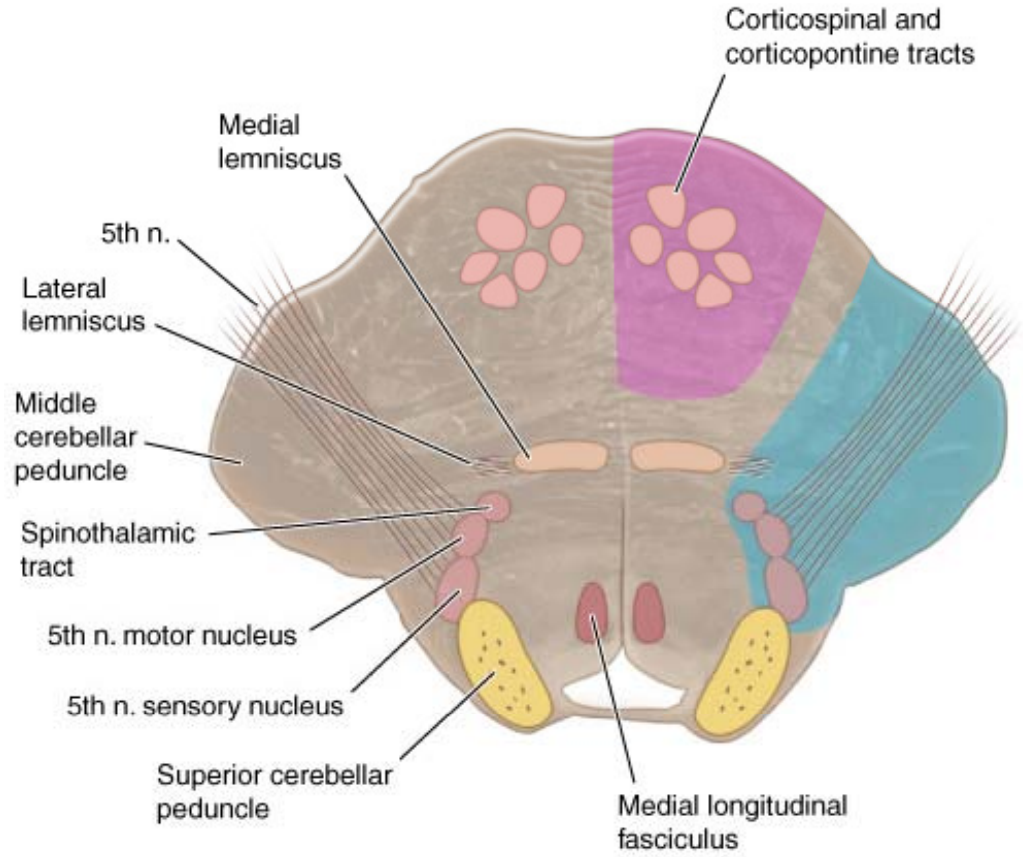
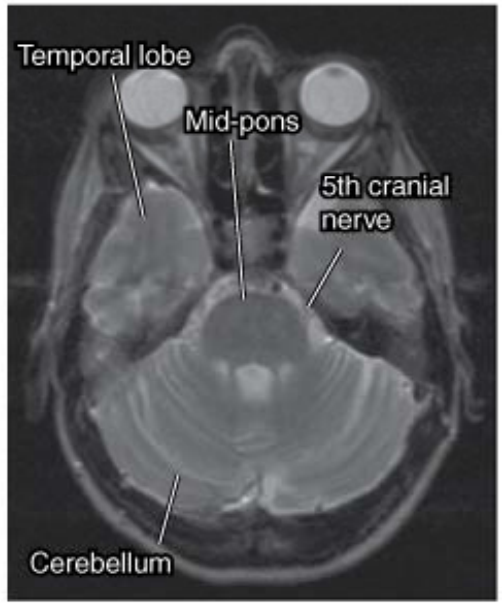
Medial midpontine syndrome (paramedian branch of midbasilar artery)

- On side of lesion
- Ataxia of limbs and gait (more prominent in bilateral involvement): *Pontine nuclei*
- On side opposite lesion
- Paralysis of face, arm, and leg: *Corticobulbar and corticospinal tract*
- Variable impaired touch and proprioception when lesion extends posteriorly: *Medial lemniscus*
- Middle Alternating Hemiplegia

Lateral midpontine syndrome (short circumferential artery)

- On side of lesion
- Ataxia of limbs: *Middle cerebellar peduncle*
- Paralysis of muscles of mastication: *Motor fibers or nucleus of fifth nerve*
- Impaired sensation over side of face: *Sensory fibers or nucleus of fifth nerve*
- On side opposite lesion
- Impaired pain and thermal sense on limbs and trunk: *Spinothalamic tract*





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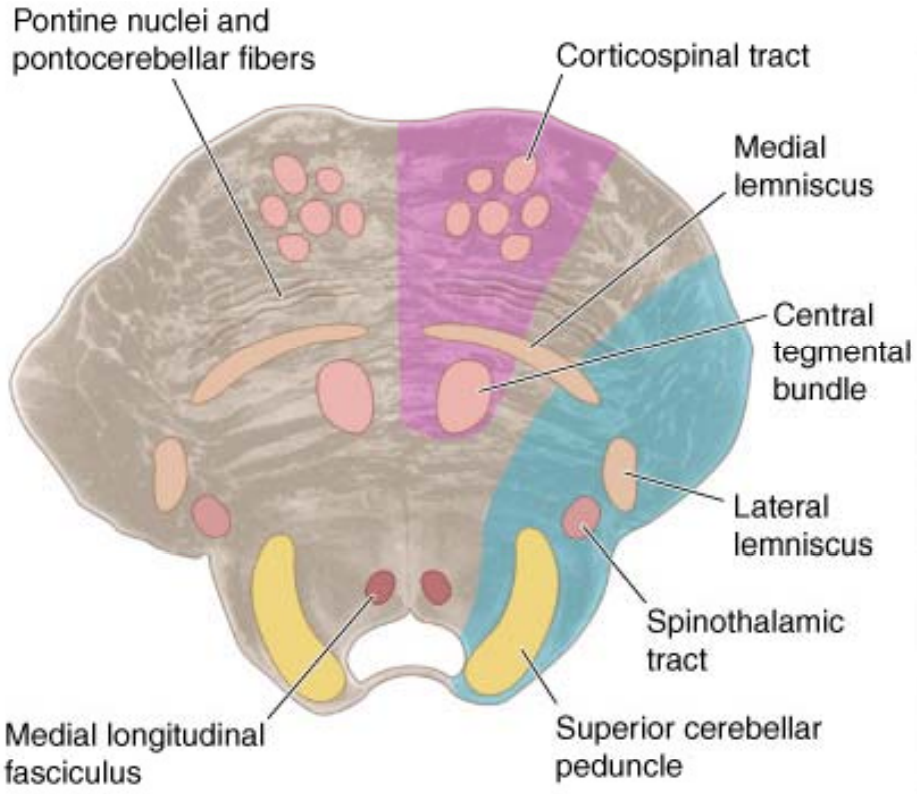

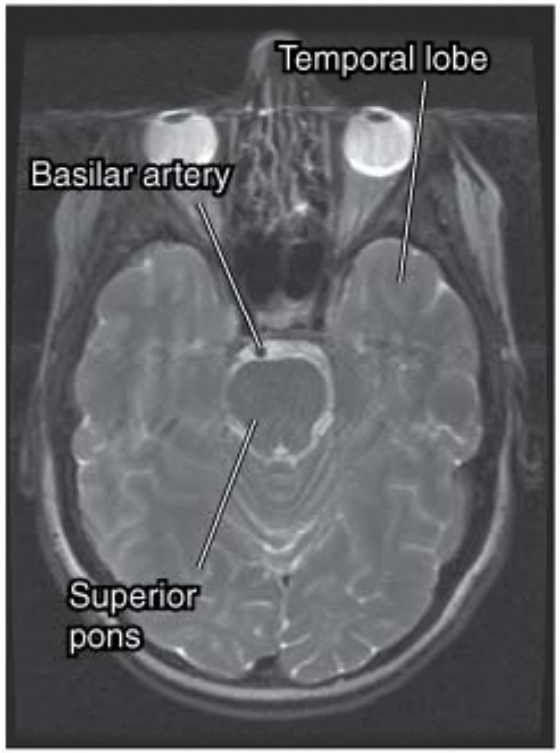

Superior pontine syndrome:

Lateral Medial

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Medial superior pontine syndrome (paramedian branches of upper basilar artery)

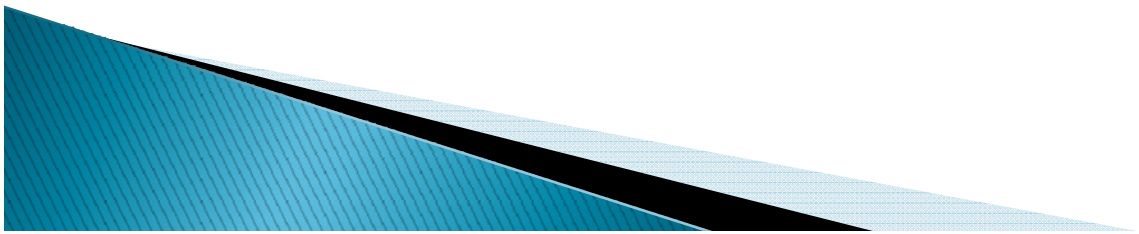
- On side of lesion
- Cerebellar ataxia (probably): *Superior and/or middle cerebellar peduncle*
- Internuclear ophthalmoplegia: *Medial longitudinal fasciculus*
- Myoclonic syndrome, palate, pharynx, vocal cords, respiratory apparatus, face, oculomotor apparatus, etc.: *Localization uncertain—central tegmental bundle, dentate projection, inferior olivary nucleus*
- On side opposite lesion
- Paralysis of face, arm, and leg: *Corticobulbar and corticospinal tract*
- Rarely touch, vibration, and position are affected: *Medial lemniscus*

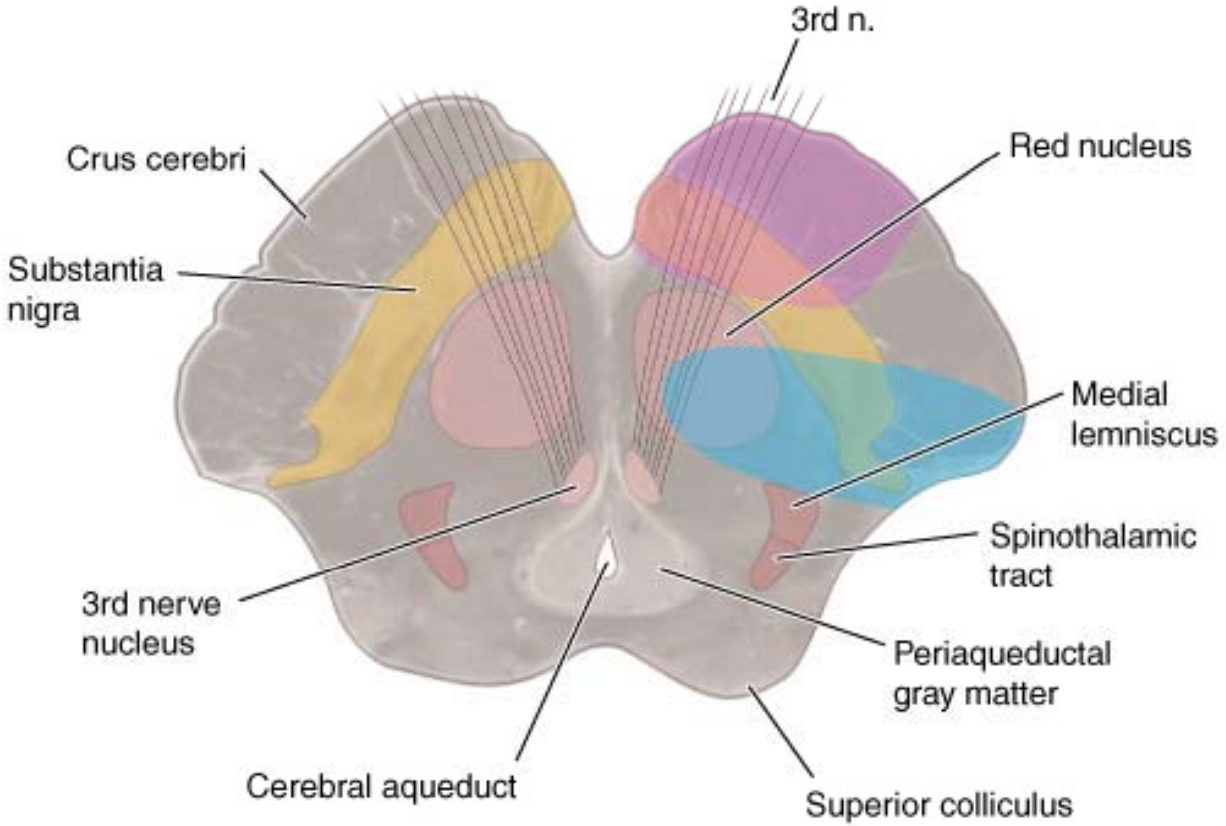
Lateral superior pontine syndrome (syndrome of superior cerebellar artery)

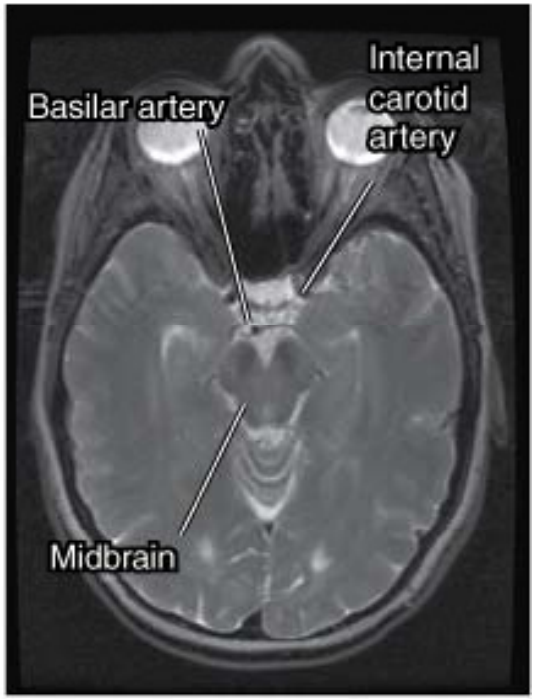
- On side of lesion
- Ataxia of limbs and gait, falling to side of lesion: *Middle and superior cerebellar peduncles, superior surface of cerebellum, dentate nucleus*
- Dizziness, nausea, vomiting; horizontal nystagmus: *Vestibular nucleus*
- Paresis of conjugate gaze (ipsilateral): *Pontine contralateral gaze*
- Skew deviation: *Uncertain*
- Miosis, ptosis, decreased sweating over face (Horner's syndrome): *Descending sympathetic fibers*
- Tremor: Localization unclear—*Dentate nucleus, superior cerebellar peduncle*
- On side opposite lesion
- Impaired pain and thermal sense on face, limbs, and trunk: *Spinothalamic tract*
- Impaired touch, vibration, and position sense, more in leg than arm (there is a tendency to incongruity of pain and touch deficits): *Medial lemniscus (lateral portion)*

Basilar artery--paramedian pontine perforators

- Ipsilateral 6th nerve palsy
- +/- 7th nerve palsy (Millard-Gubler syndrome), internuclear ophthalmoplegia, horizontal gaze palsy, one-and-a-half syndrome







Midbrain syndrome:

Lateral Medial

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Medial midbrain syndrome (paramedian branches of upper basilar and proximal posterior cerebral arteries)

- On side of lesion
- Eye "down and out" secondary to unopposed action of fourth and sixth cranial nerves, with dilated and unresponsive pupil: *Third nerve fibers*
- On side opposite lesion
- Paralysis of face, arm, and leg: *Corticobulbar and corticospinal tract descending in crus cerebri*

Lateral midbrain syndrome (syndrome of small penetrating arteries arising from posterior cerebral artery)

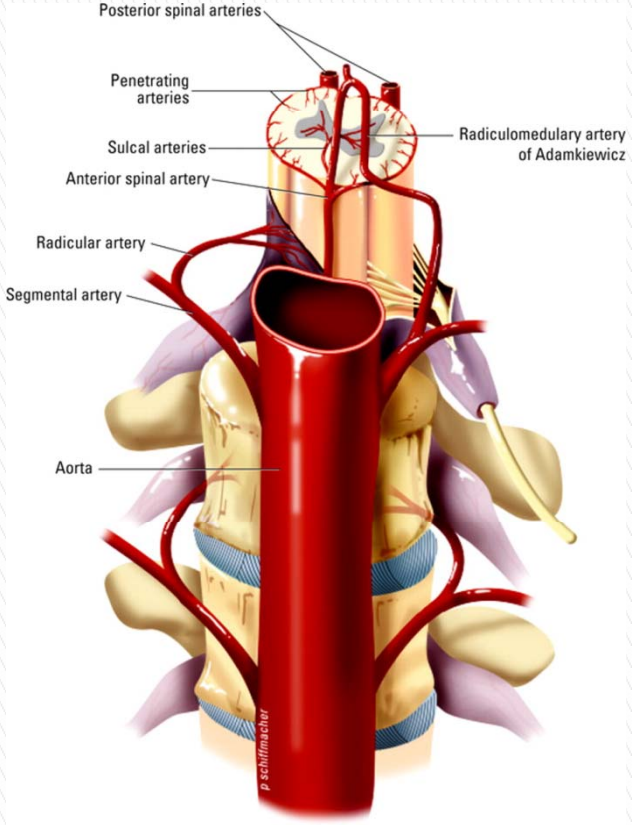
- On side of lesion
- Eye "down and out" secondary to unopposed action of fourth and sixth cranial nerves, with dilated and unresponsive pupil: *Third nerve fibers and/or third nerve nucleus*
- On side opposite lesion
- Hemiataxia, hyperkinesias, tremor: *Red nucleus, dentatorubrothalamic pathway*

(A) Brain MRI, FLAIR sequence shows left paramedian mesencephalic infarction.
(B) (B) MRA shows reduced flow in the right vertebral artery and right posterior cerebral artery (P1 segment).

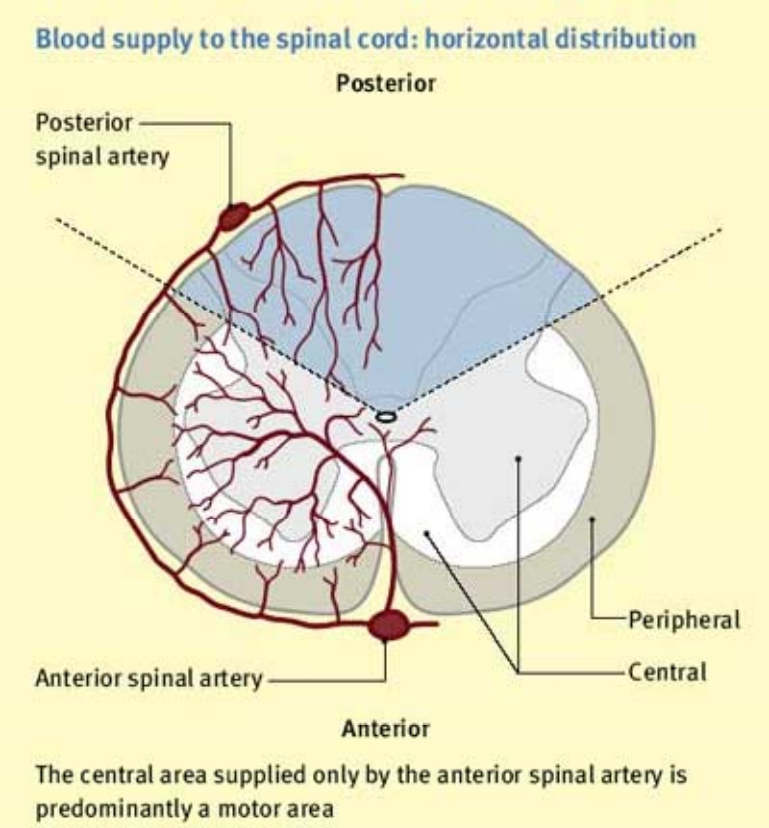
- Ipsilateral 3rd nerve palsy (Weber syndrome)
- +/- Supranuclear vertical gaze palsy
- +/- Sensory deficit

Spinal cord syndromes

- Cord supplied by three arteries that course vertically over its surface
- a single anterior spinal artery and paired posterior spinal arteries.
- the anterior spinal artery is fed
  - the vertebral arteries,
  - by radicular vessels that arise at C6, at an upper thoracic level, and
  - most consistently, at T11–L2 (artery of Adamkiewicz).



Spinal cord supply



- At each segment, paired penetrating vessels branch from the anterior spinal artery to supply the anterior two-thirds of the spinal cord;
- the posterior spinal arteries, which often become less distinct below the midthoracic level, supply the posterior columns.

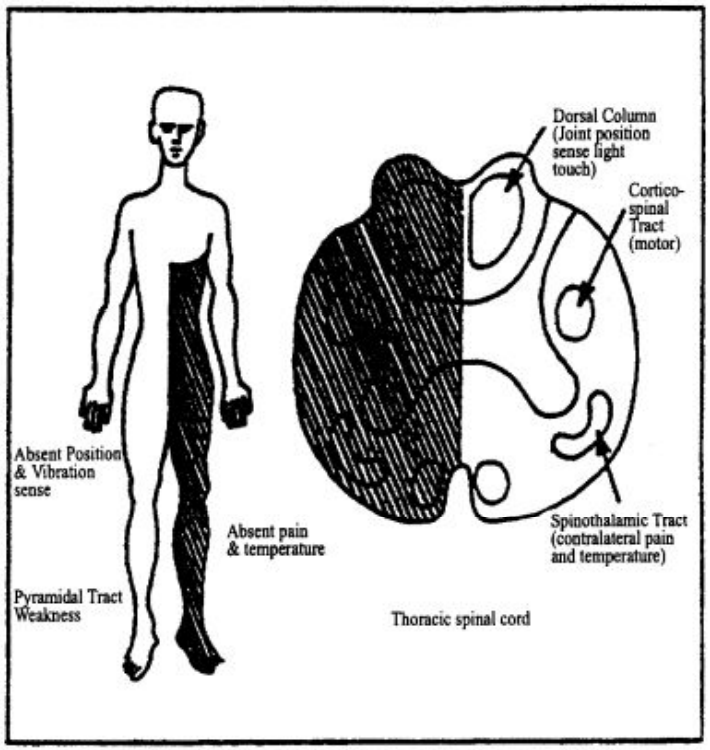


Figure 2-27: Brown-Séquard Syndrome (Unilateral hemi-cord lesion).

Spinal cord syndromes

- Acute infarction in the territory of the *anterior spinal artery* ("anterior cord syndrome")
- paraplegia or quadriplegia
- dissociated sensory loss affecting pain and temperature sense but sparing vibration and position sense
- loss of sphincter control.
- Onset may be sudden and dramatic but more typically is progressive over minutes or a few hours.
- Sharp midline or radiating back pain localized to the area of ischemia is frequent.
- Areflexia due to spinal shock is often present initially
- with time, hyperreflexia and spasticity appear

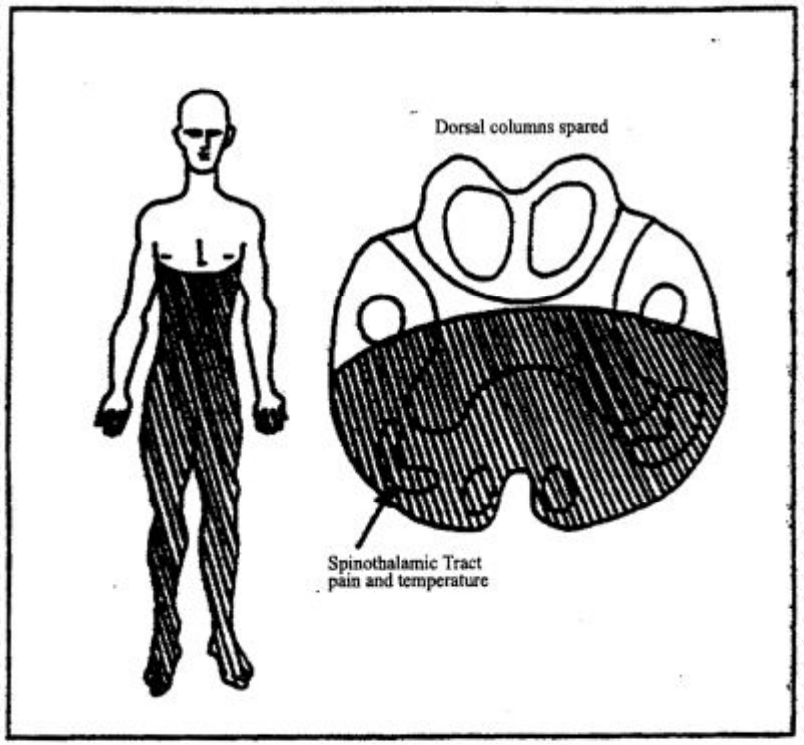
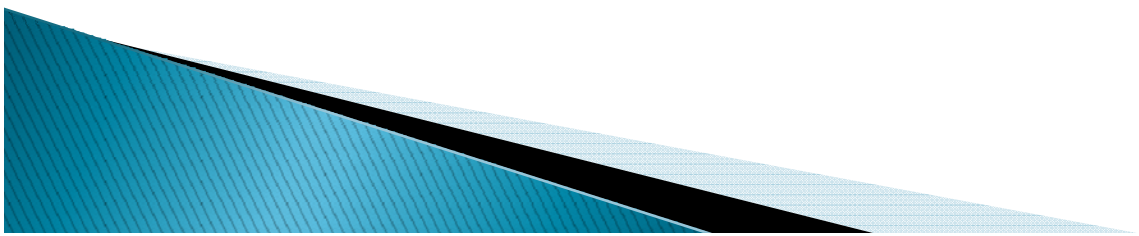


Figure 2-28: Anterior Spinal Artery Infarction.

- Less common is infarction in the territory of the *posterior spinal arteries*
- loss of posterior column function.

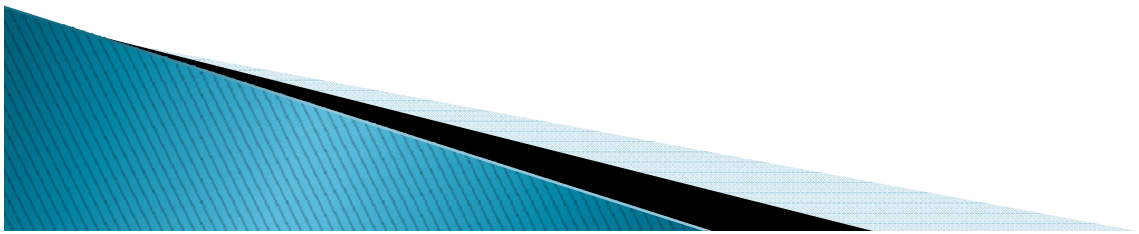
Spinal cord infarctions

- In a substantial number of cases no cause can be found, and thromboembolism in arterial feeders is suspected.
- aortic atherosclerosis
- dissecting aortic aneurysm (manifest as chest or back pain with diminished pulses in legs)
- vertebral artery occlusion or dissection in the neck
- profound hypotension from any cause.
- Cardiogenic emboli, vasculitis related to collagen vascular disease [particularly SLE and the antiphospholipid antibody syndrome and
- surgical interruption of aortic aneurysms.
- Occasional cases develop from *embolism of nucleus pulposus* material into spinal vessels, usually from local spine trauma.
- MRI may fail to demonstrate limited infarctions of the cord, especially in the first day, but as often it is abnormal at the affected level.



Spinal cord syndromes

- Spinal cord ischemia can occur at any level
- Presence of Adamkiewicz artery creates a watershed of marginal blood flow in the upper thoracic segments.
- With systemic hypotension, greatest ischemic risk :usually T3-T4
- also between the anterior and posterior spinal artery territories - rapidly progressive syndrome over hours of weakness and spasticity with little sensory change.
- Acute anticoagulation is probably not indicated if due to presumed thromboembolism
- Exceptions :
  - unusual TIA
  - incomplete infarction with a stuttering or progressive course
  - APL is treated with anticoagulation.
- Drainage of spinal fluid has reportedly been successful in some cases of cord infarction but has not been studied systematically.



Thanks

- Brainstem blood supply
- Brainstem sections
- Brainstem syndromes
- Spinal Cord blood supply
- Spinal cord syndromes