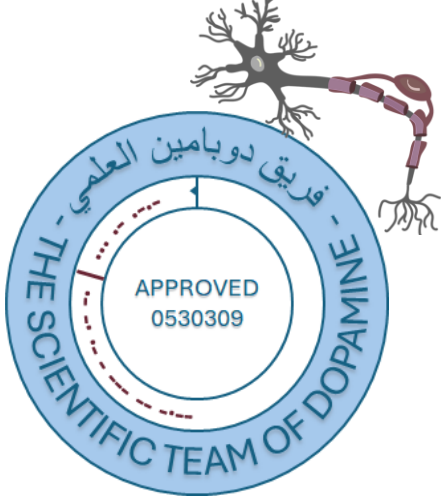


بسم الله الرحمن الرحيم

DOPAMINE SCIENTIFIC TEAM

Blood Supply of the Brainstem and Lesions

MID | Lecture 9

﴿ إِنِّي تَوَكَّلْتُ عَلَى ٱللَّهِ رَبِّي وَرَبِّكُمْ ۚ مَّا مِن دَآبَّةٍ إِلَّا هُوَ ءَاخِذٌۢ بِنَاصِيَتِهَآ ۚ إِنَّ رَبِّي عَلَىٰ صِرَٰطٍ مُّسْتَقِيمٍ ﴾

Done by: Abdulrahman Khw
Almothana Khalil

ANATOMY

رحلة اليقين مع سورة يس

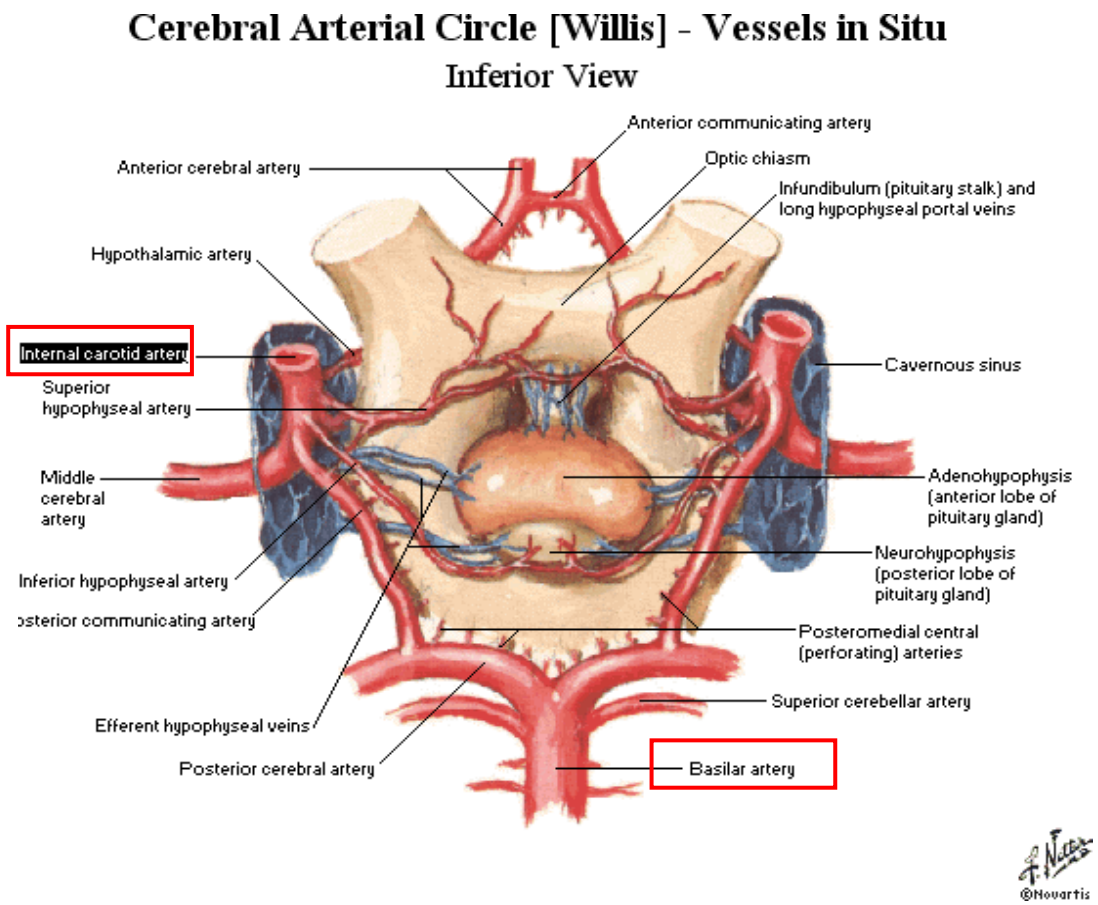
بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

وَءَايَةٞ لَّهُمۡ أَنَّا حَمَلۡنَا ذُرِّيَّتَهُمۡ فِي ٱلۡفُلۡكِ ٱلۡمَشۡحُونِ ﴿٤١﴾ وَخَلَقۡنَا لَهُم مِّن مِّثۡلِهِۦ مَا يَرۡكَبُونَ ﴿٤٢﴾

أي: ودليل لهم وبرهان، على أن الله وحده المعبود، لأنه المنعم بالنعم، الصارف للنقم، الذي من جملة نعمه {أَنَّا حَمَلْنَا ذُرِّيَّتَهُمْ} قال كثير من المفسرين: المراد بذلك: آباؤهم.

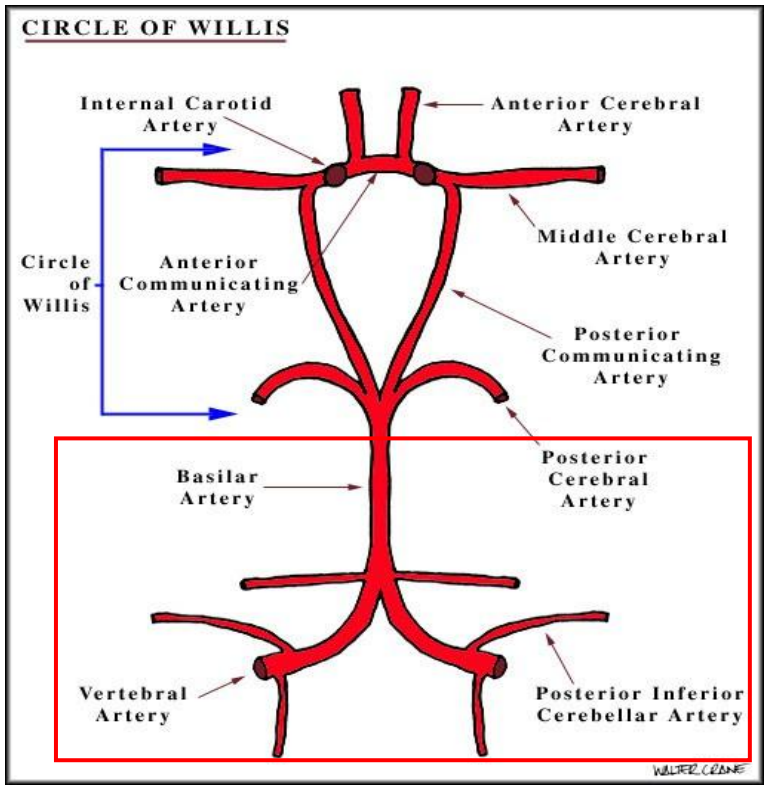
{وَخَلَقْنَا لَهُمْ} أي: للموجودين من بعدهم {مِنْ مِثْلِهِ} أي: من مثل ذلك الفلك، أي: جنسه {مَا يَرْكَبُونَ} به، فذكر نعمته على الآباء بحملهم في السفن، لأن النعمة عليهم، نعمة على الذرية. وهذا الموضع من أشكل المواضع عليَّ في التفسير، فإن ما ذكره كثير من المفسرين، من أن المراد بالذرية الآباء، مما لا يعهد في القرآن إطلاق الذرية على الآباء، بل فيها من الإيهام، وإخراج الكلام عن موضوعه، ما يأباه كلام رب العالمين، وإرادته البيان والتوضيح لعباده. وثَمَّ احتمال أحسن من هذا، وهو أن المراد بالذرية الجنس، وأنهم هم بأنفسهم، لأنهم هم من ذرية بني آدم، ولكن ينقض هذا المعنى قوله: {وَخَلَقْنَا لَهُمْ مِنْ مِثْلِهِ مَا يَرْكَبُونَ} إن أريد: وخلقنا من مثل ذلك الفلك، أي: لهؤلاء المخاطبين، ما يركبون من أنواع الفلك، فيكون ذلك تكريرا للمعنى، تأباه فصاحة القرآن. فإن أريد بقوله: {وَخَلَقْنَا لَهُمْ مِنْ مِثْلِهِ مَا يَرْكَبُونَ} الإبل، التي هي سفن البر، استقام المعنى واتضح، إلا أنه يبقى أيضا، أن يكون الكلام فيه تشويش، فإنه لو أريد هذا المعنى، لقال: وَآيَةٌ لَهُمْ أَنَّا حَمَلْنَاهم فِي الْفُلْكِ الْمَشْحُونِ، وَخَلَقْنَا لَهُمْ مِنْ مِثْلِهِ مَا يَرْكَبُونَ، فأما أن يقول في الأول: وحملنا ذريتهم، وفي الثاني: حملناهم، فإنه لا يظهر المعنى، إلا أن يقال: الضمير عائد إلى الذرية، والله أعلم بحقيقة الحال. فلما وصلت في الكتابة إلى هذا الموضع، ظهر لي معنى ليس ببعيد من مراد الله تعالى، وذلك أن من عرف جلالة كتاب الله وبيانه التام من كل وجه، للأمور الحاضرة والماضية والمستقبلة، وأنه يذكر من كل معنى أعلاه وأكمل ما يكون من أحواله، وكانت الفلك من آياته تعالى ونعمه على عباده، من حين أنعم عليهم بتعلمها إلى يوم القيامة، ولم تزل موجودة في كل زمان، إلى زمان المواجهين بالقرآن.

The Circle of Willis



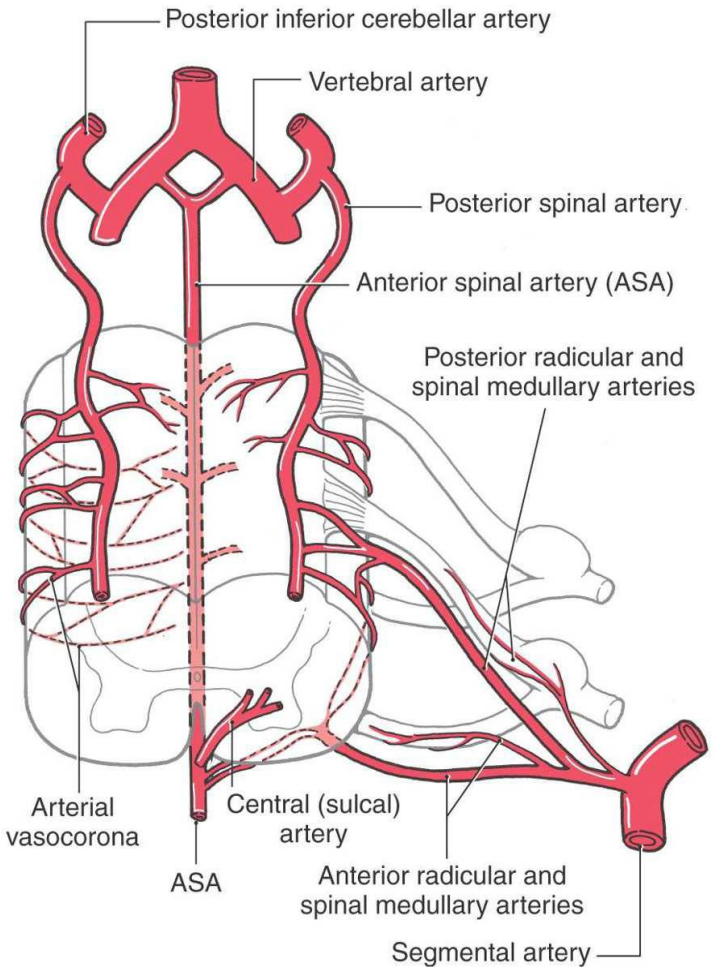
Formed by 2 arteries in the cranial cavity

1. **internal carotid artery**
2. **basilar artery** formed by the two vertebral arteries after entering through the foramen magnum.



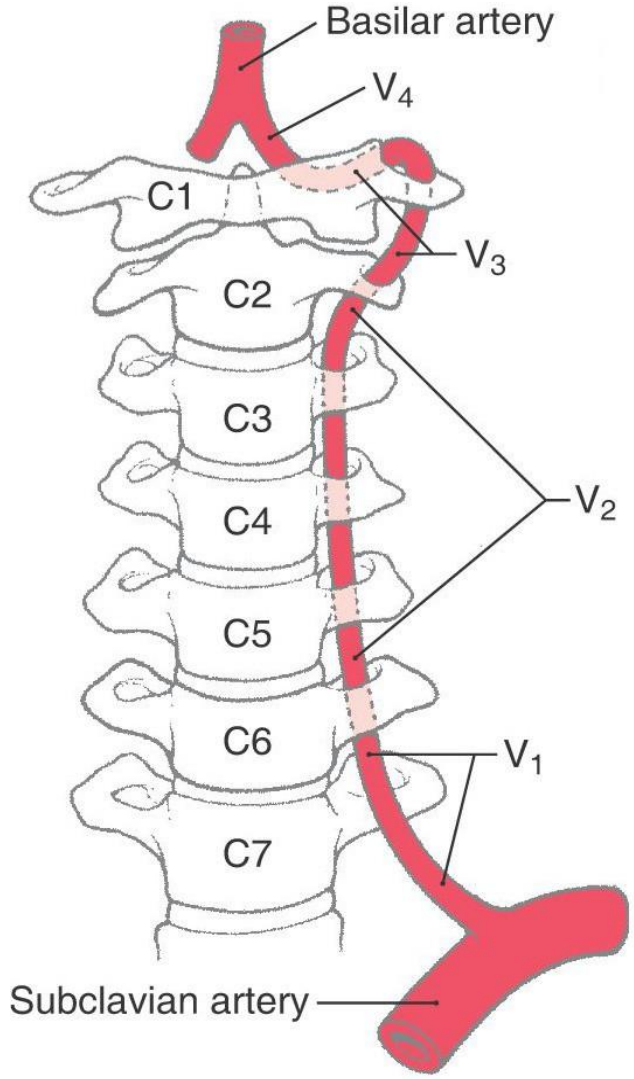
- **Region of interest (brainstem supply):**
  - The lower part → the two vertebral arteries forming the basilar artery.
- **Medulla oblongata & Pons supply:**
  - Branches of the vertebral arteries (anterior spinal artery, posterior inferior cerebellar artery)
  - Branches of the basilar artery
- **Midbrain supply:**
  - posterior cerebral artery
  - superior cerebellar artery
  - Basilar artery

Spinal Cord Blood Supply



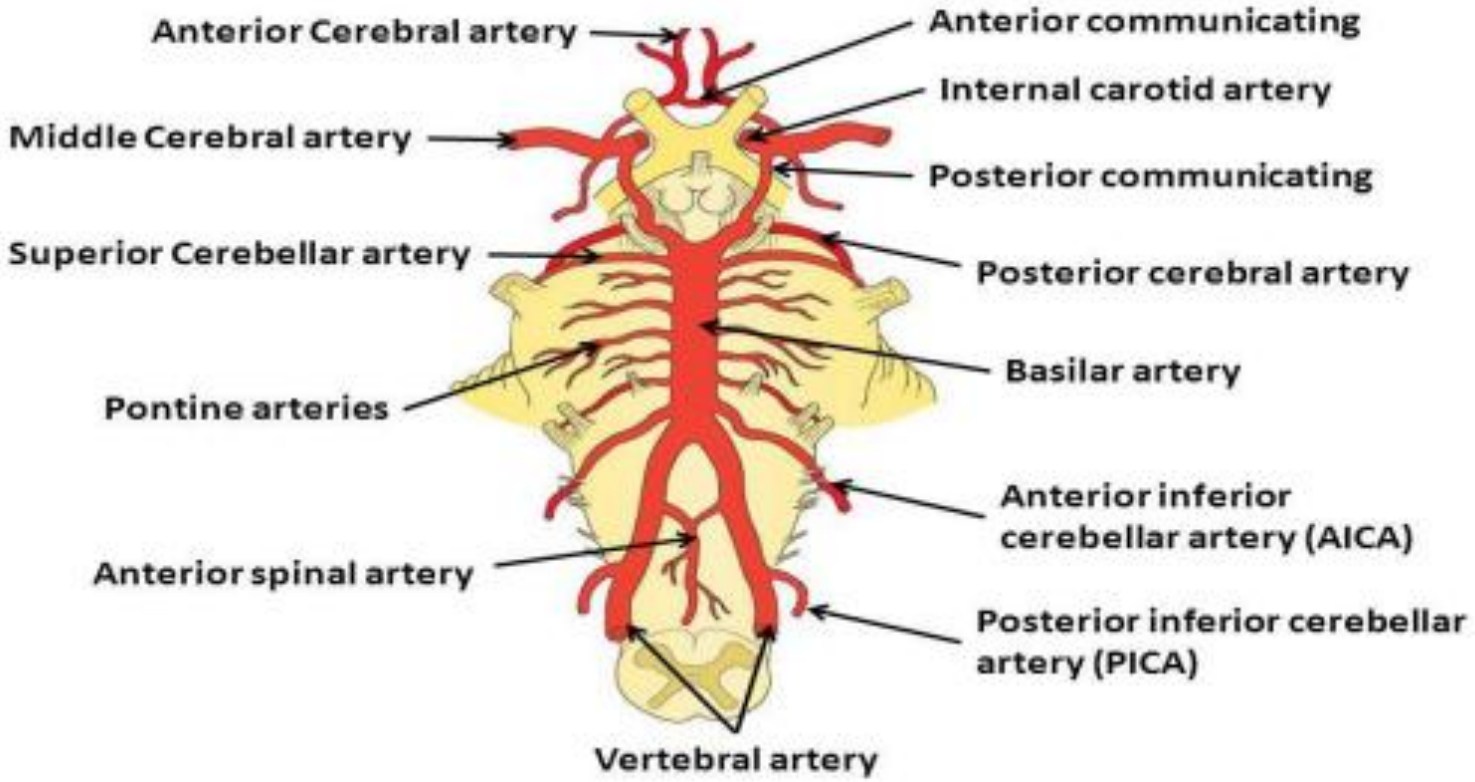
One the right image, the **vertebral artery** originates from the **subclavian artery** and ascends through the transverse foramina of the cervical vertebrae. At the level of C1, it curves upward, forward, and medially, then enters the foramen magnum. The two vertebral arteries unite intracranially to form the **basilar artery**.

The left image (posterior view) shows the two **vertebral arteries**. These give rise to the **anterior spinal artery**, a single vessel that descends along the anterior median fissure of the spinal cord and medulla; it is formed by two roots, one from each vertebral artery.
The vertebral artery also gives the **posterior inferior cerebellar artery** (PICA), which in turn gives rise to the **posterior spinal artery**.



Brain Stem Blood Supply

This image shows the brainstem and its arterial supply. The two **vertebral arteries** give rise to the **anterior spinal artery** and the **posterior inferior cerebellar artery** (PICA); PICA in turn gives the **posterior spinal artery**.
These arteries supply the medulla oblongata



The **basilar artery** runs along the basilar groove on the pons and gives off pontine arteries that supply the pons. It then divides into the two **posterior cerebral arteries**, which are connected to the **posterior communicating artery** to complete the circle of Willis.

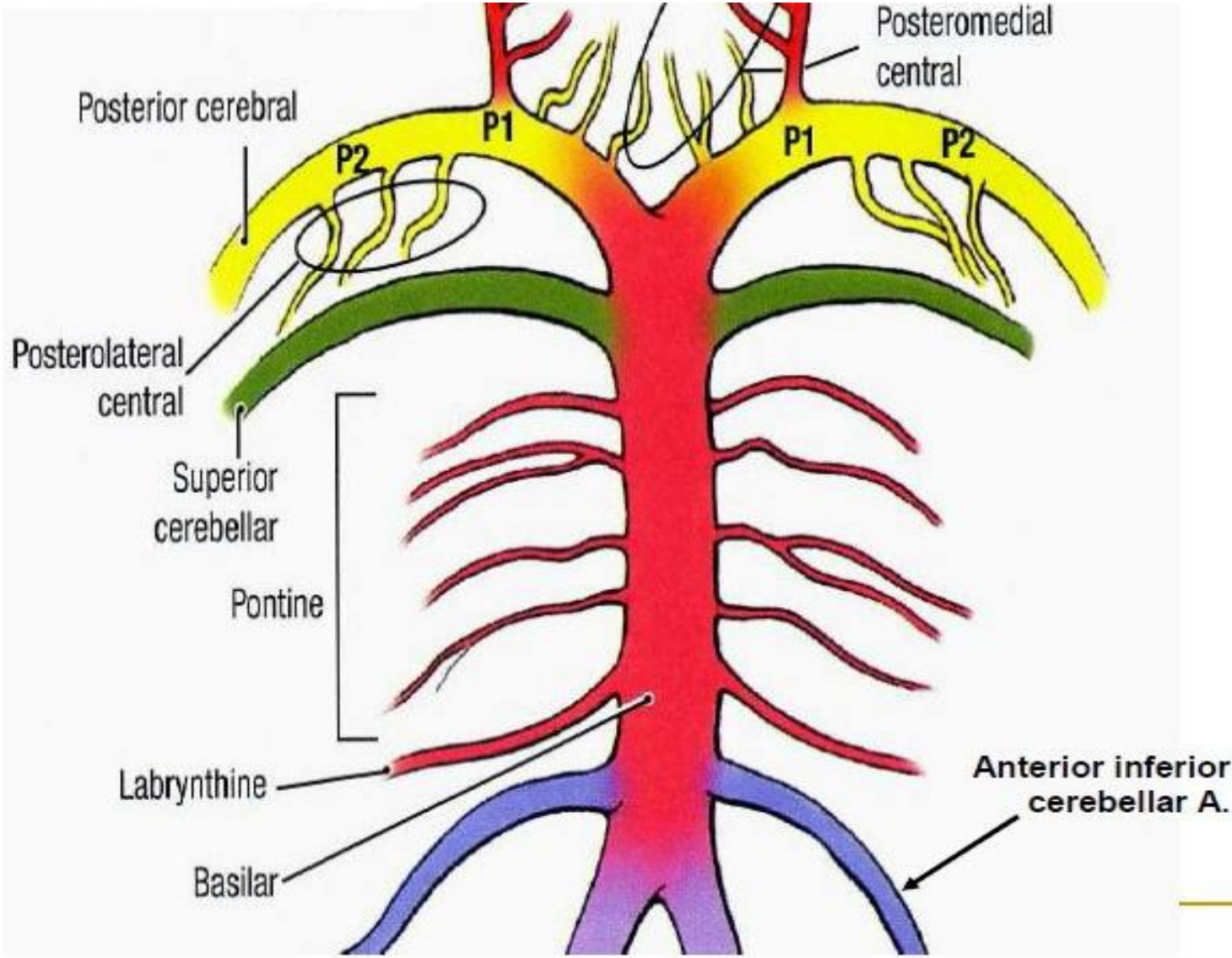
Basilar artery

- Formed by the **union** of the two vertebral arteries at the **lower border** of the **pons**
- Ascends on the front of the pons lodged in the **basilar groove**
- Ends at the **upper border** of the pons by dividing into 2 **Posterior cerebral arteries (PCA)**

Basilar artery

Branches of basilar artery

- anterior inferior cerebellar artery (AICA) supplies inferior surface of the cerebellum
- Pontine arteries supply pons
- superior cerebellar artery that branch off the basilar before its bifurcation into the posterior cerebral arteries supplies superior surface of cerebellum and pons



Medulla Oblongata Blood Supply

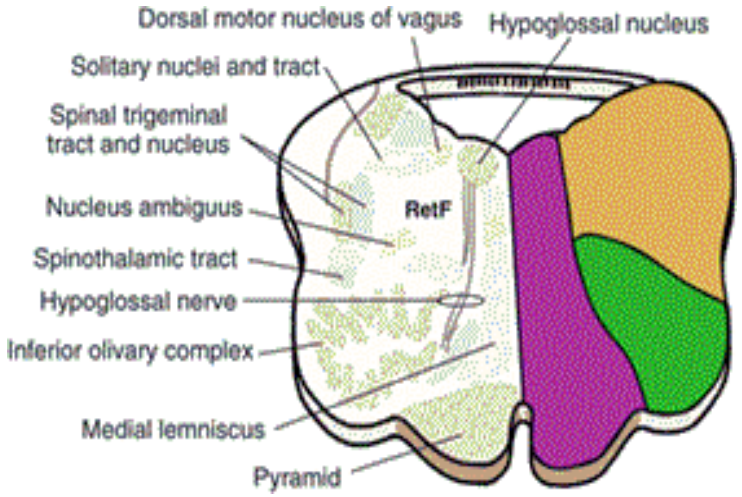
The lower section shows the **closed medulla** (central canal present), while the upper section shows the **open medulla** (4th ventricle present), with their arterial supply.

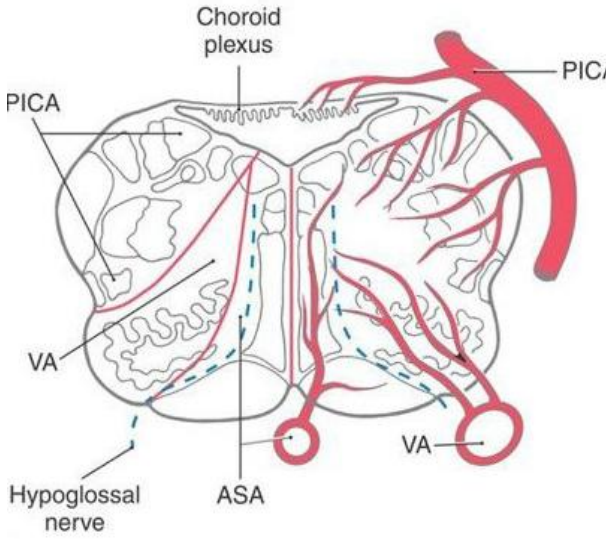
Anteriorly, the **anterior spinal artery** (ASA) lies in the anterior median fissure and supplies the **midline structures**. Just lateral to this territory, the **vertebral artery** supplies the adjacent region. The most lateral and posterior areas are supplied by the **posterior inferior cerebellar artery** (PICA) and the **posterior spinal artery** (PSA).

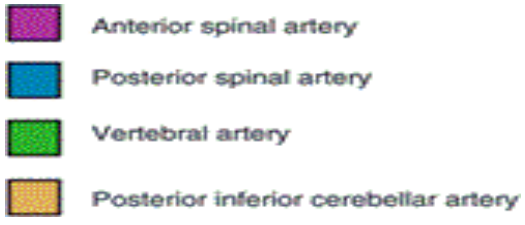
In the **closed medulla**, the PSA contributes to the posterior supply. However, in the **open medulla**, the PSA no longer contributes.

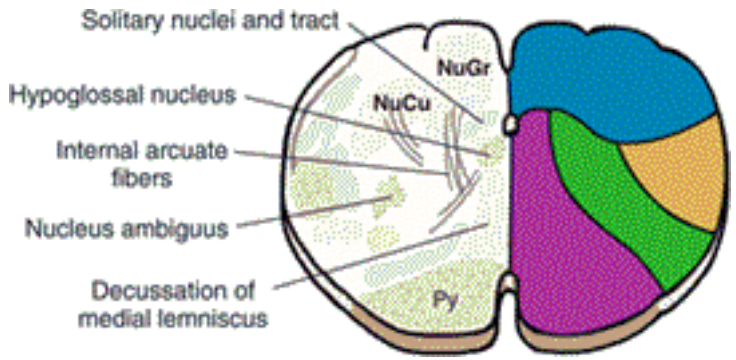
Summary:

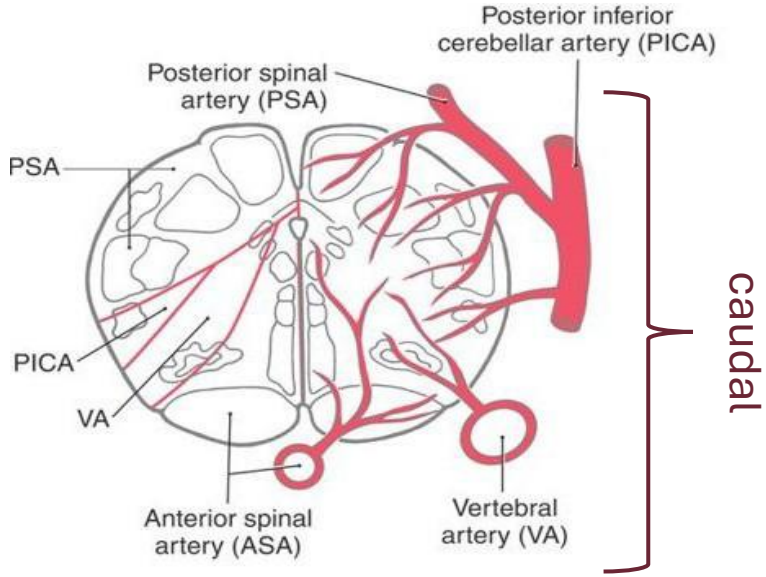
- Midline → ASA
- Paramedian (lateral to midline) → Vertebral artery
- Lateral/posterior → PICA (open medulla)
- Posterior (closed medulla only) → PSA







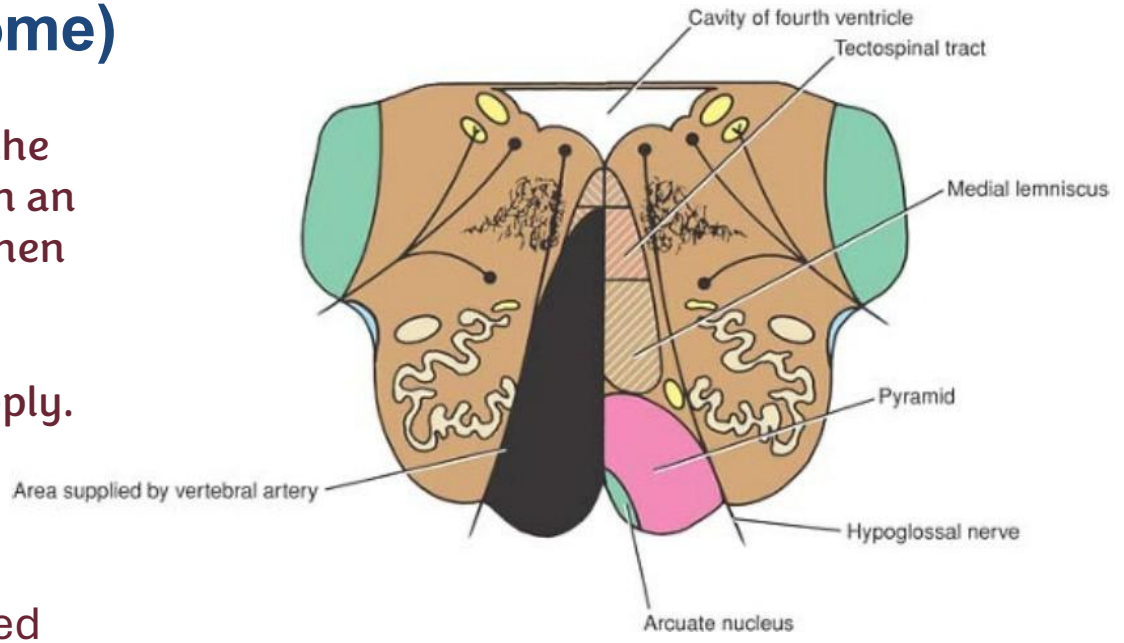




Medial medullary syndrome (Dejerine syndrome)

It is caused by a lesion of the **anterior spinal artery**, which supplies the region close to the **midline**. The artery gives **paramedian** branches in an alternating fashion –at one level to the right, at the next to the left, then right again, and so on.

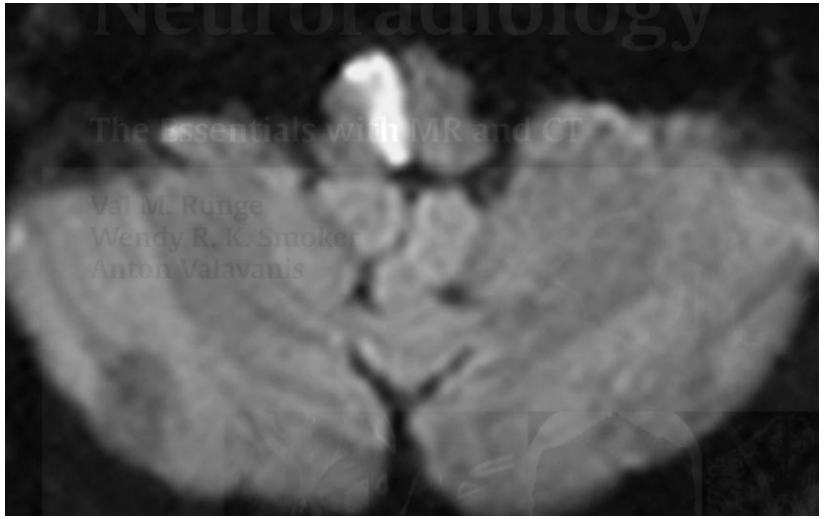
In the image, the dark area represents the side with loss of blood supply.



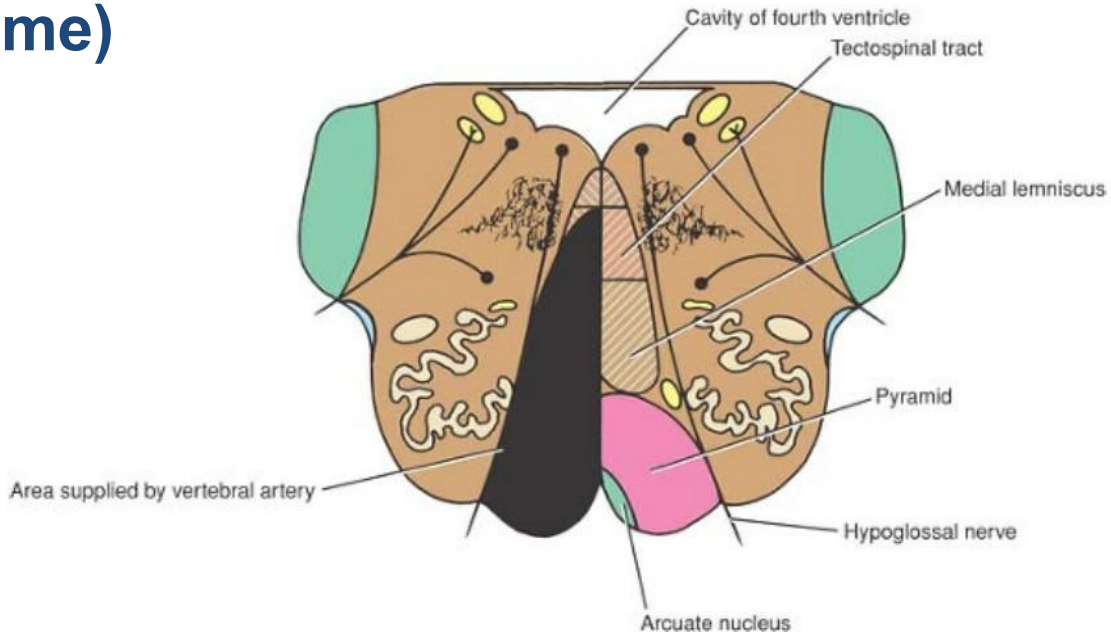
- Symptoms (related to the structures on the midline)
  - Contralateral hemiparesis (pyramidal and corticospinal damage), weakness in muscles, paralysis may happen based on severity

    Notice that the anterior aspect of the midline is occupied by the pyramids (corticospinal tracts), it is contralateral because at this level decussation hasn't happened yet.
  - Contralateral loss of proprioception and vibratory sense (medial lemniscus)

    remember that decussation happened so the medial lemniscus on the left carries information about the right side of the body.
  - Deviation of the tongue to the ipsilateral side when it is protruded (hypoglossal root or nucleus injury)



Medial medullary syndrome (Dejerine syndrome)
Cont'd



This syndrome is characterized by Alternating hemiplegia
Note: Alternating hemiplegia means;

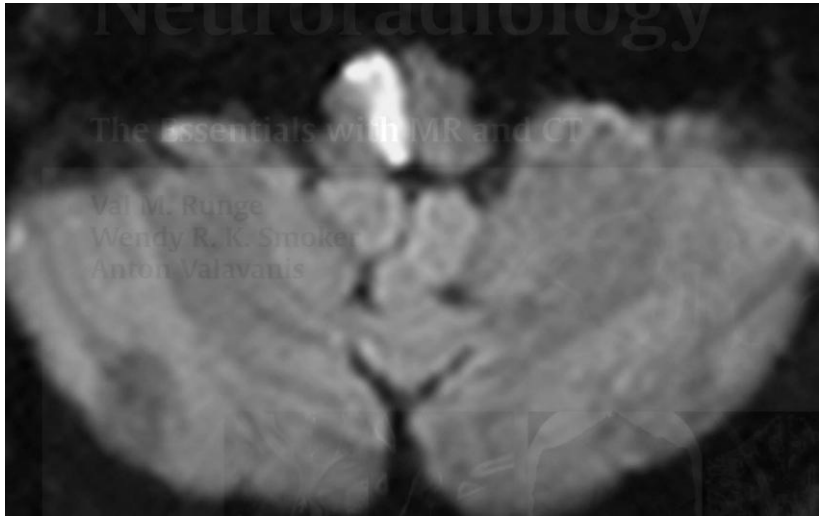
1- The upper and lower limbs are paralyzed in the contralateral side of lesion = upper motor neuron lesion (decussation).

2- while the face is paralyzed in the ipsilateral side of lesion = lower motor neuron lesion (no decussation).

Symptoms related to cranial nerve (ipsilaterally)

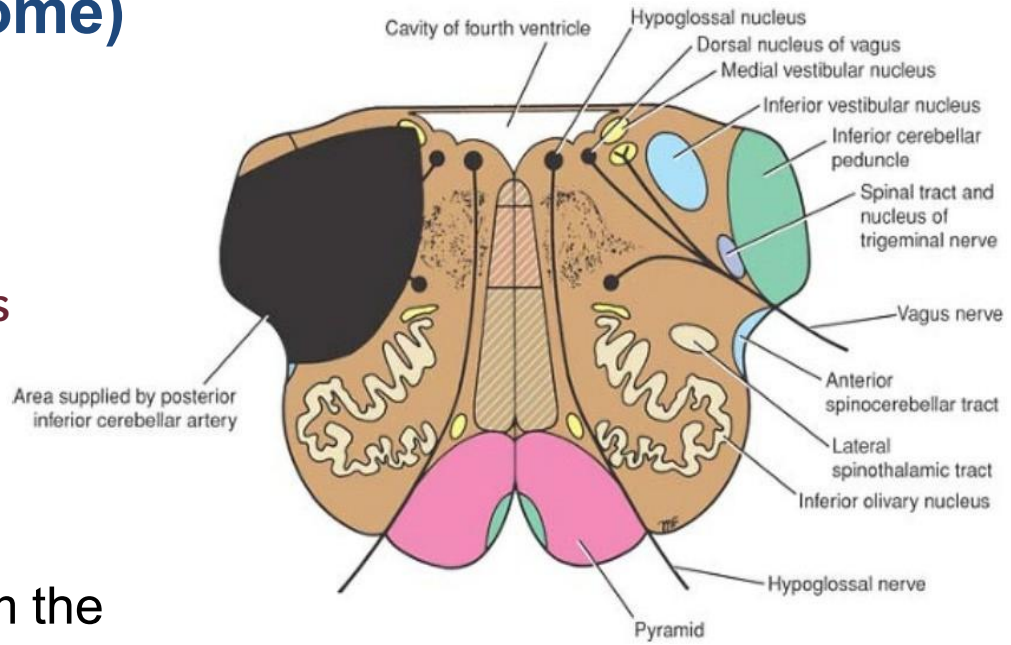
Hence a hallmark in brain stem lesions is **long tracts** (related to the **body**) are affected **contralaterally**, while **short tracts** (related to the **face**) are affected **ipsilaterally**, with some exceptions mentioned later in this lecture.

The white area in the second picture represents the lesion which is at the midline.

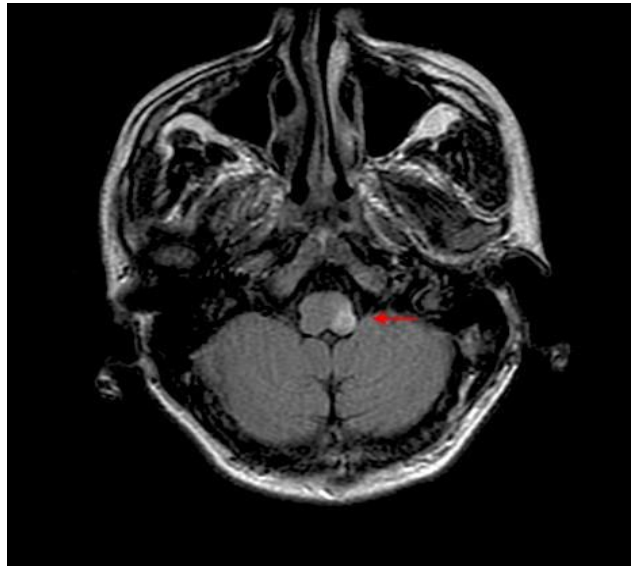


Lateral medullary syndrome (Wallenberg syndrome) or PICA syndrome

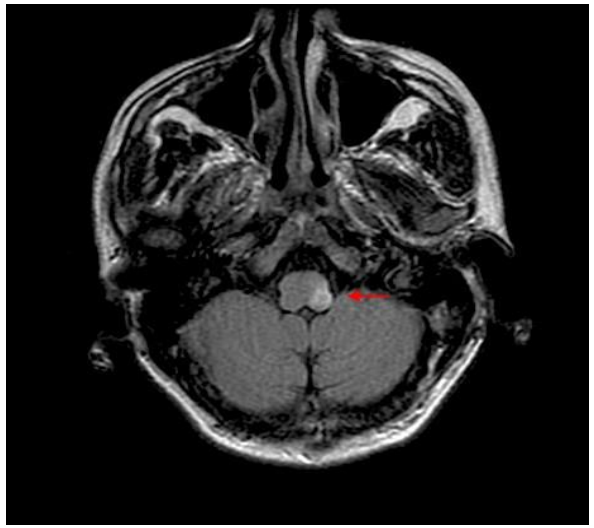
It is caused by a lesion in **PICA** which supplies the area close to **lateral** areas.
The dark area is affected (supplied by PICA), in the radiograph it is the area with a red arrow on it.



- Symptoms
  - contralateral loss of pain and temperature sensation from the body (anterolateral system), decussation already happened at this level so the ALS on the left carries information about the right side of the body.
  - ipsilateral loss of pain and temperature sensation from the face (spinal trigeminal tract and nucleus),
  - Vertigo (dizziness) and nystagmus (vestibular nuclei), Nystagmus is irregular movements of the eyeballs (the vestibular nucleus connected to the cranial nerves supplying the eye muscles)



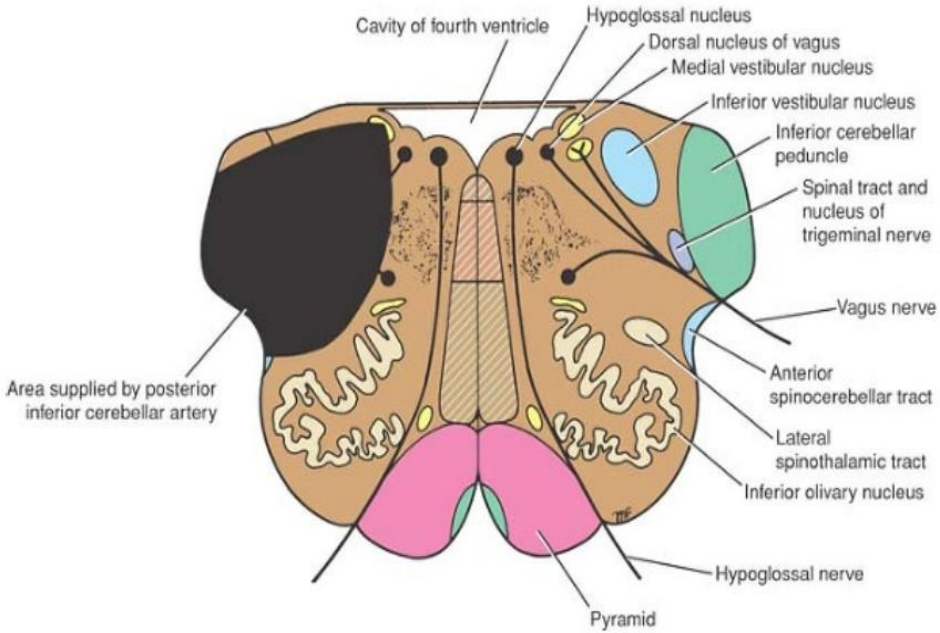
Lateral medullary syndrome (Wallenberg syndrome) or PICA syndrome cont'd



- Symptoms
  - loss of taste from the ipsilateral half of the tongue (solitary tract and nucleus), Nucleus tractus solitarius is a sensory nucleus for 2 types of sensations, visceral sensory and taste. This nucleus receives taste sensations from the same side through 3 cranial nerves (7th and 9th and 10th)
  - Hoarseness and dysphagia (nucleus ambiguus or roots of cranial nerves IX and X), Nucleus ambiguus is a motor nucleus for 3 cranial nerves (9th, 10th and 11th) and has the lower motor neurons supplying the muscles of the larynx and pharynx. (muscles are affected ipsilaterally)
  - **Ipsilateral Horner syndrome:** hypothalamospinal fibers

    lateral (medullary) reticulospinal tract has descending autonomic regulating fibers that provide a pathway by which the hypothalamus can control the sympathetic.

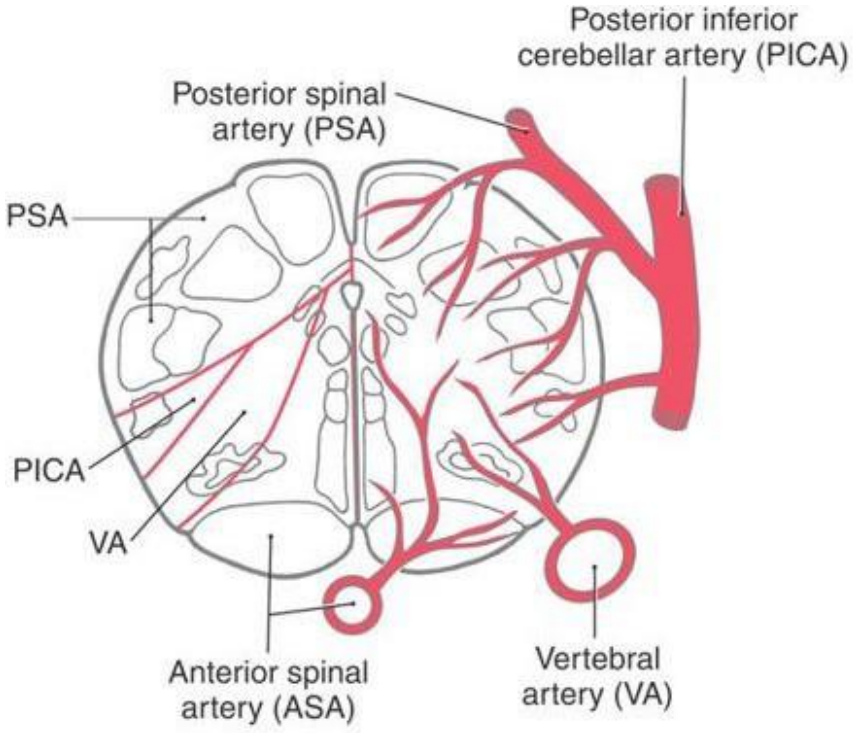
    If these fibers are cut then symptoms similar to Horner syndrome will develop like ptosis, miosis (constriction of pupil) and anhidrosis, all related to sympathetic injury.



Vascular lesions of the posterior spinal artery

- PSA is a branch of PICA, and there are two, one on each side

- Symptoms
  - ipsilateral loss of proprioception and vibratory sense (related to PCML system specifically nucleus gracilis and cuneatus).
  - ipsilateral loss of pain and temperature sensation from the face (lateral to the nucleus cuneatus is the trigeminal nucleus and is affected).

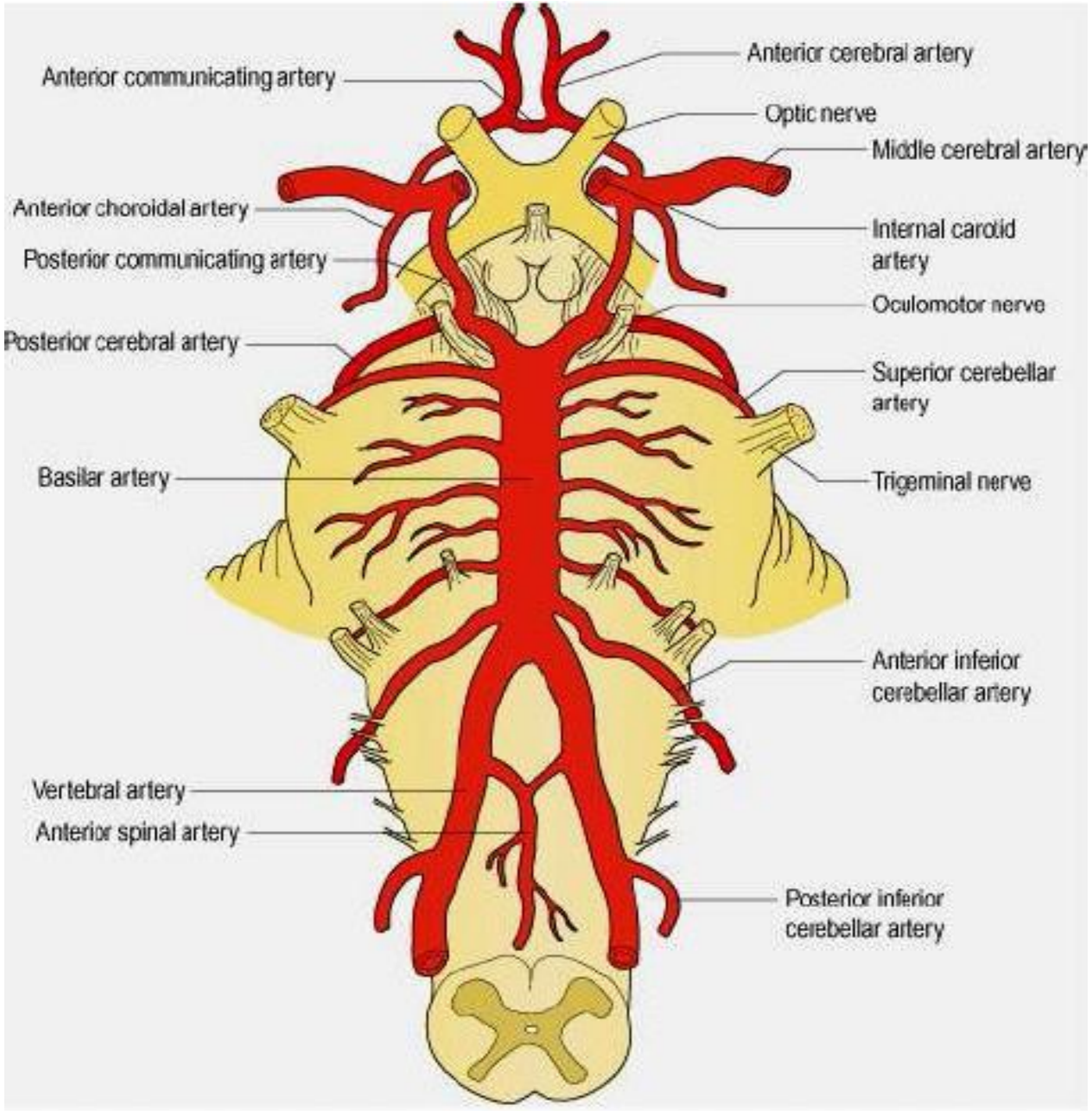


Pons Blood Supply

The **basilar artery** runs along the basilar groove on the pons, giving off the **anterior inferior cerebellar artery**, **superior cerebellar artery**, and **pontine arteries**, and terminates by dividing into the two **posterior cerebral arteries**.

The **pons blood supply** can be examined at two levels:

- **Inferior (caudal) level** → near the pontomedullary junction
- **Superior (midpontine) level** → where the trigeminal nuclei are visible

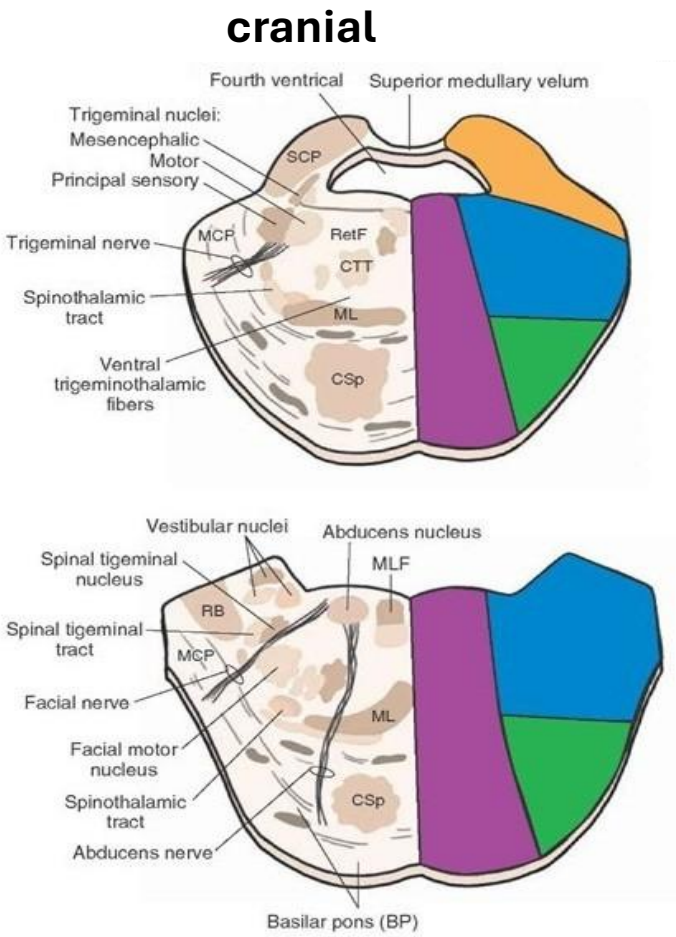


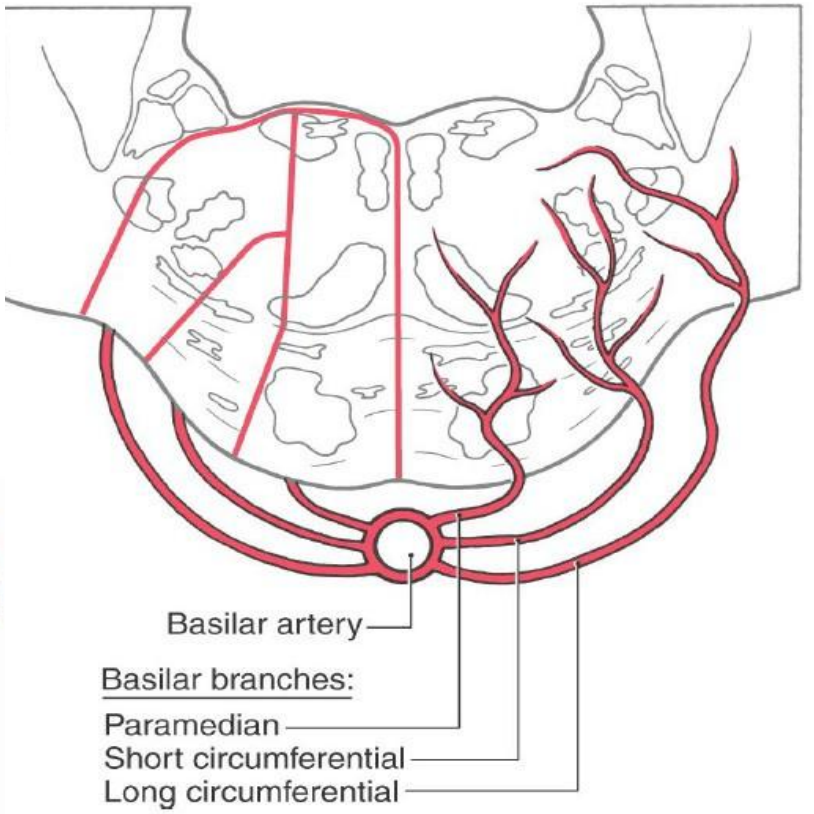
Pons Blood Supply, cont'd

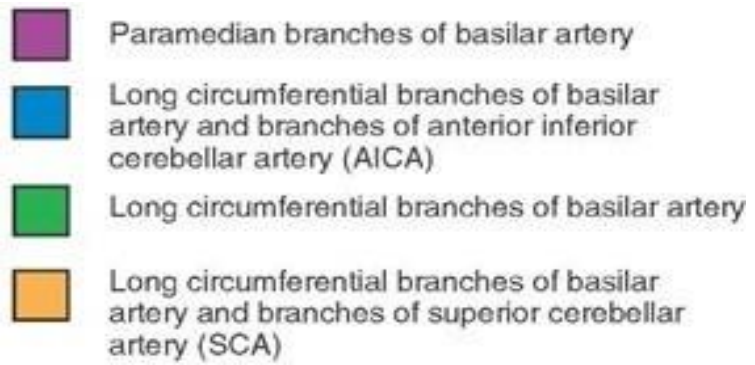
The **pons** is mainly supplied by:

- **Paramedian branches** from the **basilar artery**, which lie close to the midline and supply **midline structures** (purple in the figure).
- **Circumferential branches** from the basilar, supplying **lateral structures** (green and blue); some sources divide these into short and long circumferential branches.
- **anterior inferior cerebellar artery** also contributes to the lateral (blue) territory via circumferential arteries.

At the **upper (midpontine) level**, corresponding to the **trigeminal nucleus**, circumferential branches from the **superior cerebellar artery** help supply the **posterior part** of the pons.



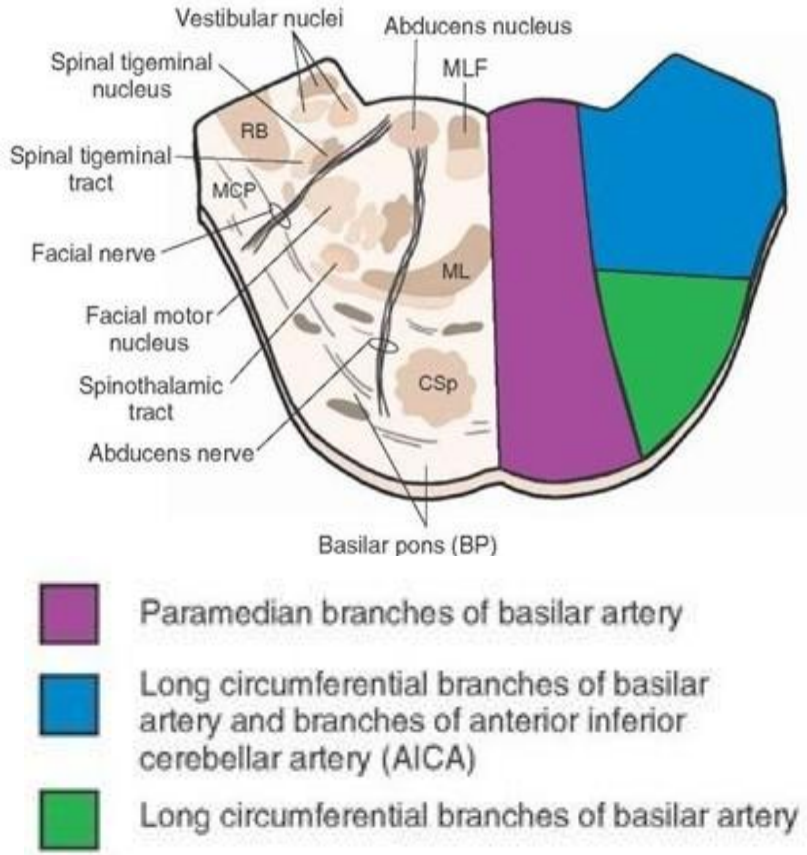




Lesions affecting the caudal part of pons:

Foville syndrome

- Due to: Occlusion of the **paramedial** branches
- ipsilateral abducens nerve paralysis (the abducent nucleus is found close to the floor of the 4th ventricle and the abducent nerve moves anteriorly and emerges from the pontomedullary junction close to the midline). Leading to internal strabismus
- contralateral hemiparesis, The anterior part of the purple color is the basilar part which contains corticospinal fibers and these fibers decussate in the lower part of the medulla so fibers on the right supply left side
- variable contralateral sensory loss reflecting various degrees of damage to the medial lemniscus



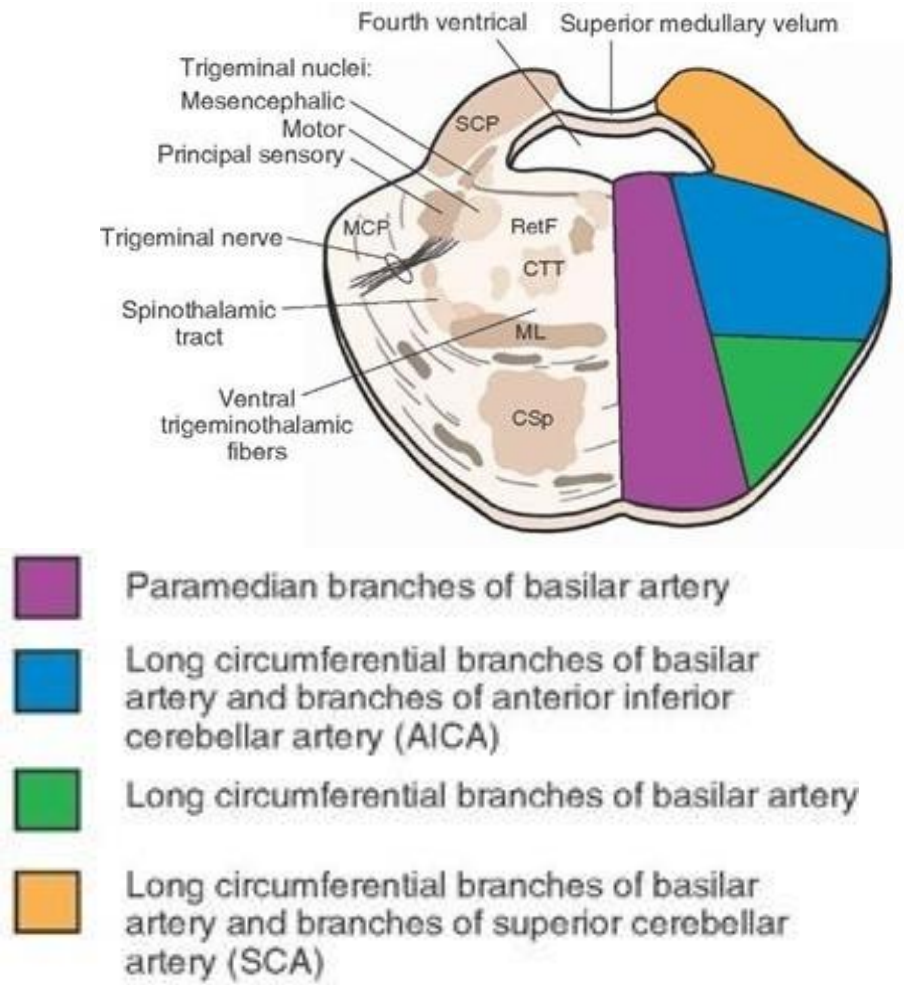
Millard-Gubler syndrome (or Gubler syndrome)

- If the area of damage is shifted somewhat laterally to include the root of the **facial nerve along with corticospinal fibers, the patient has a contralateral** hemiparesis and an ipsilateral paralysis of the facial muscles.

Syndrome of the midpontine base

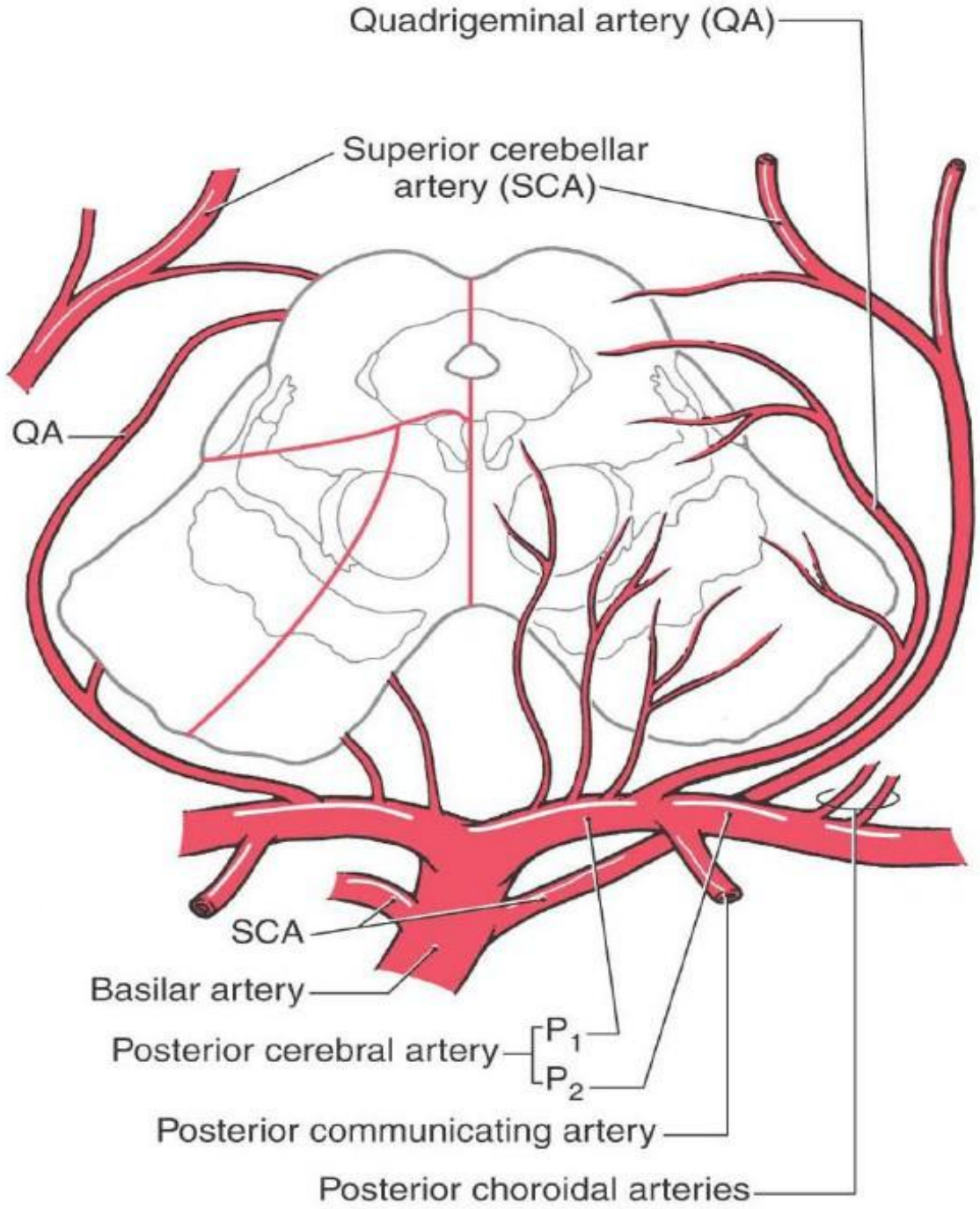
- Due to occlusion of the paramedial branches and short circumferential branches.
- Corticospinal fibers (which are passing through the basilar part) are affected causing contralateral hemiparesis.
- Sensory and motor trigeminal roots (trigeminal nuclei, the motor nuclei medially and slightly laterally the sensory nucleus) are affected causing ipsilateral loss of pain and thermal sense and paralysis of the masticatory muscles.
- Fibers of the middle cerebellar peduncle (ataxia).

Hallmark of brainstem vascular lesions, ipsilateral cranial nerve sign coupled with a contralateral long tract sign.



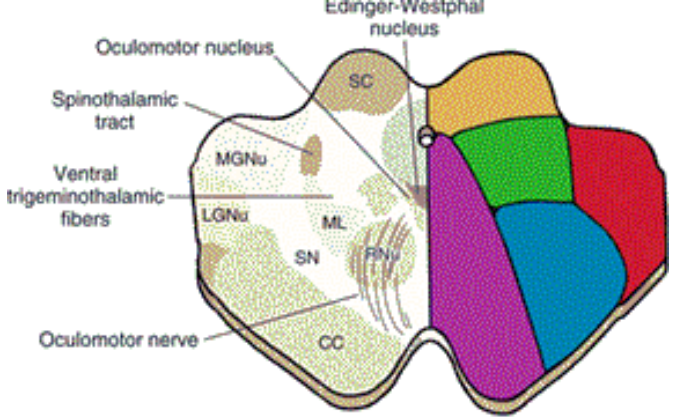
Blood Supply of the Midbrain

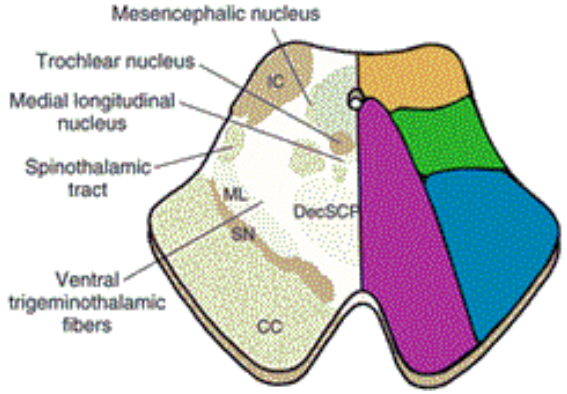
- Basilar artery
  - Quadrigeminal(1)
  - Superior cerebellar arteries
  - Direct branches
- Internal carotid(2): anterior choroidal artery
- Posterior cerebral artery: medial posterior choroidal artery



(1) The quadrigeminal artery arises from either the posterior cerebral or directly from the bifurcation of the basilar artery.

(2) Not shown here; see the figure on *slide 14*.





Anteromedial (paramedian) branches of basilar bifurcation and posterior cerebellar artery (paramedian branches)

Anterolateral (short circumferential) branches of the quadrigeminal and medial posterior choroidal arteries

Lateral branches of quadrigeminal (level of inferior colliculus) and posterior medial choroidal arteries (level of superior colliculus)

Quadrigeminal and superior cerebellar arteries (level of inferior colliculus), quadrigeminal and posterior medial choroidal arteries (level of superior colliculus)

Thalamogeniculate artery from **posterior cerebral artery**

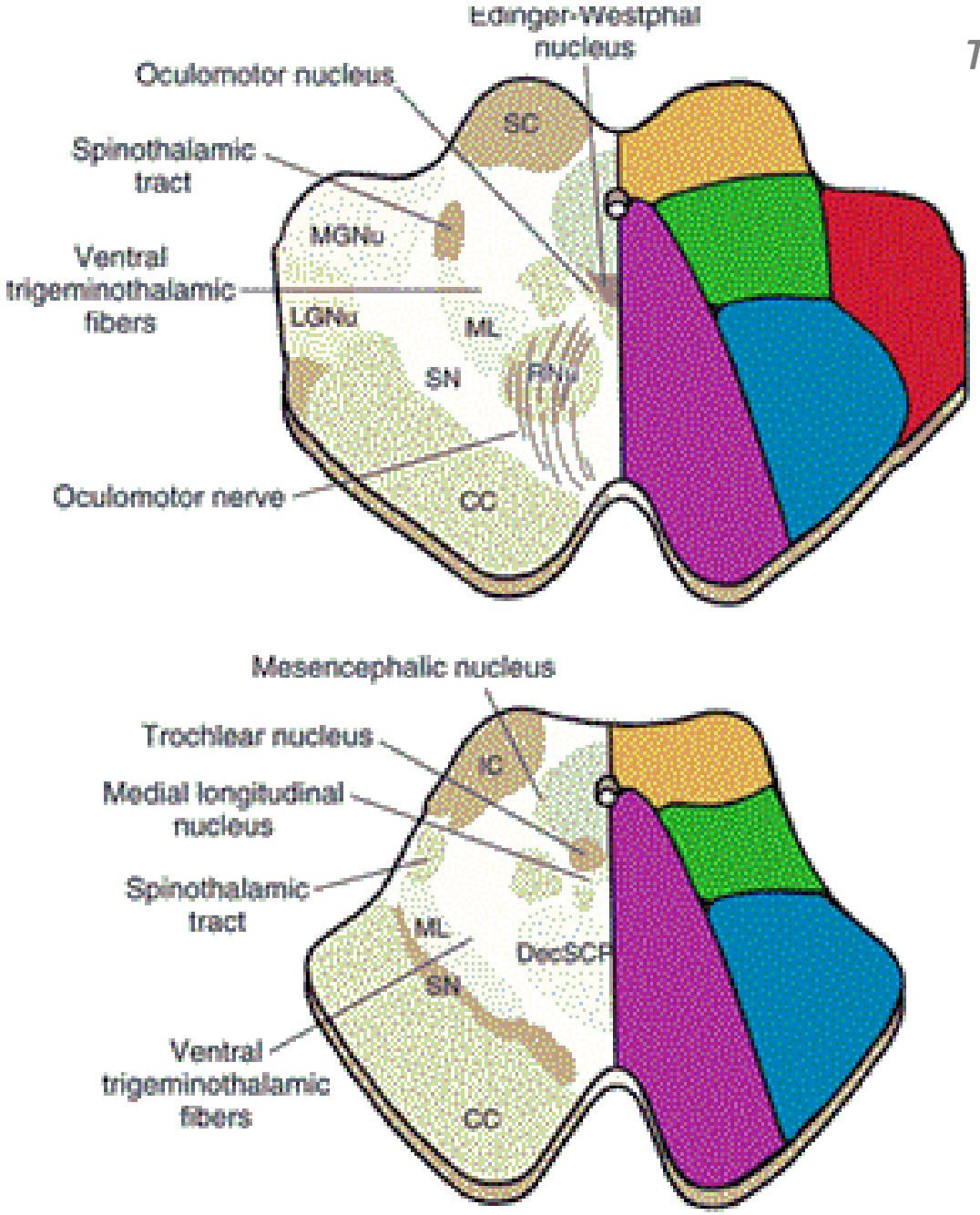
Read these, then focus on next slide

paramedian branches
are the oculomotor, trochlear, and Edinger-Westphal nuclei; the exiting oculomotor fibers; the red nucleus; and medial aspects of the substantia nigra and crus cerebri
Medial regions of the midbrain receive numerous small branches from posterior cerebral artery and from the posterior communicating artery

Ventrolateral regions of the midbrain are served by penetrating branches of the **quadrigeminal artery the anterior choroidal artery, and the medial posterior choroidal artery.** The region served by these branches includes the lateral parts of the
crus and substantia nigra and the medial lemniscus

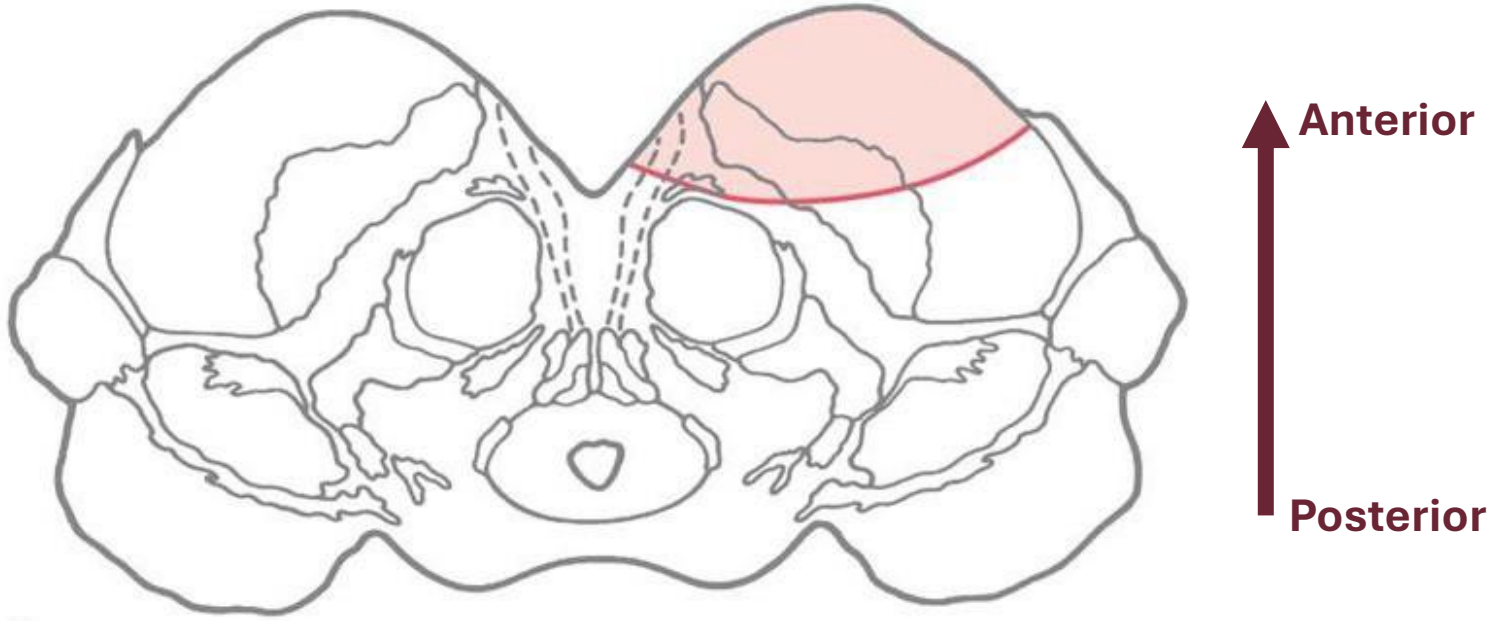
The posterior midbrain is served primarily by the **quadrigeminal artery** which typically arises from posterior cerebral artery Much of the periaqueductal gray, the nuclei of the superior and inferior colliculi, the anterolateral system, and the brachium of the inferior colliculus are served by quadrigeminal branches. Additional blood supply medial branches of the superior cerebellar artery

The highlighted were mentioned by the prof.



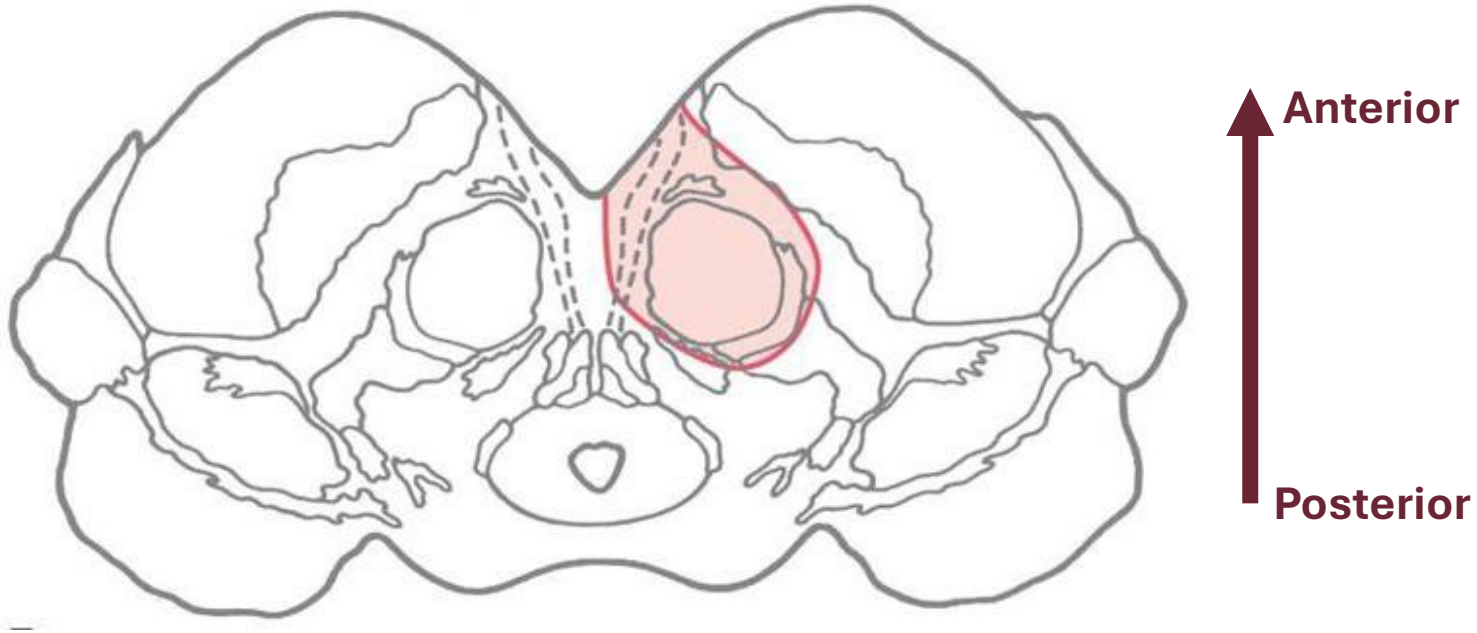
- Anteromedial (paramedian) branches of basilar bifurcation and posterior cerebellar artery (paramedian branches)
- Anterolateral (short circumferential) branches of the quadrigeminal and medial posterior choroidal arteries
- Lateral branches of quadrigeminal (level of inferior colliculus) and posterior medial choroidal arteries (level of superior colliculus)
- Quadrigeminal and superior cerebellar arteries (level of inferior colliculus), quadrigeminal and posterior medial choroidal arteries (level of superior colliculus)
- Thalamogeniculate artery **from posterior cerebral**

Weber Syndrome



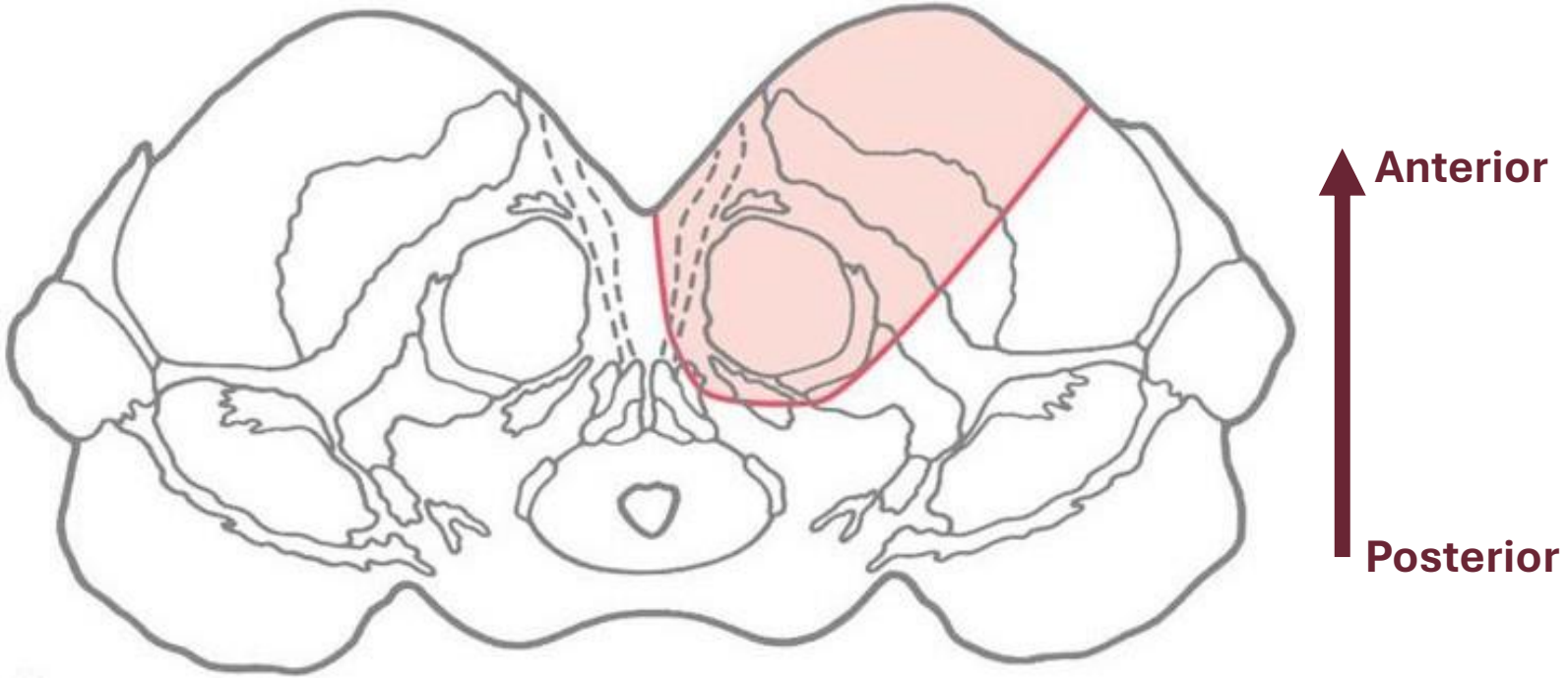
- Due to: Occlusion of vessels serving the **medial portions of the midbrain** involving the **oculomotor nerve** and the **crus cerebri**.
- Ipsilateral paralysis of all extraocular muscles (CN III) except the lateral rectus and superior oblique
- Paralysis of the contralateral extremities (yet nondecussated corticospinal tracts in crus cerebri)
- Ipsilateral dilatation of pupil (parasympathetic component of CN III)
- Contralateral weakness of the facial muscles of the lower half of the face; it is contralateral although cranial because the fibers affected are corticonuclear UMNs heading toward the motor nucleus of facial nerve, not LMNs heading toward effector muscles.
- Contralateral deviation of the tongue when it is protruded; same as the previous point, but the affected effector is the genioglossus instead of lower facial muscles.

Claude Syndrome



- Due to: Occlusion of vessels serving the **central area of the midbrain** including the **oculomotor nerve** and the **red nucleus**
- ipsilateral paralysis of most eye movements; the eye is directed down and out
- Ipsilateral dilatation of pupil
- contralateral ataxia, tremor, and incoordination; the red nucleus is affected; it has a major role in muscle coordination via the globose-emboliform-rubral pathway, connecting to the contralateral cerebellar hemisphere.

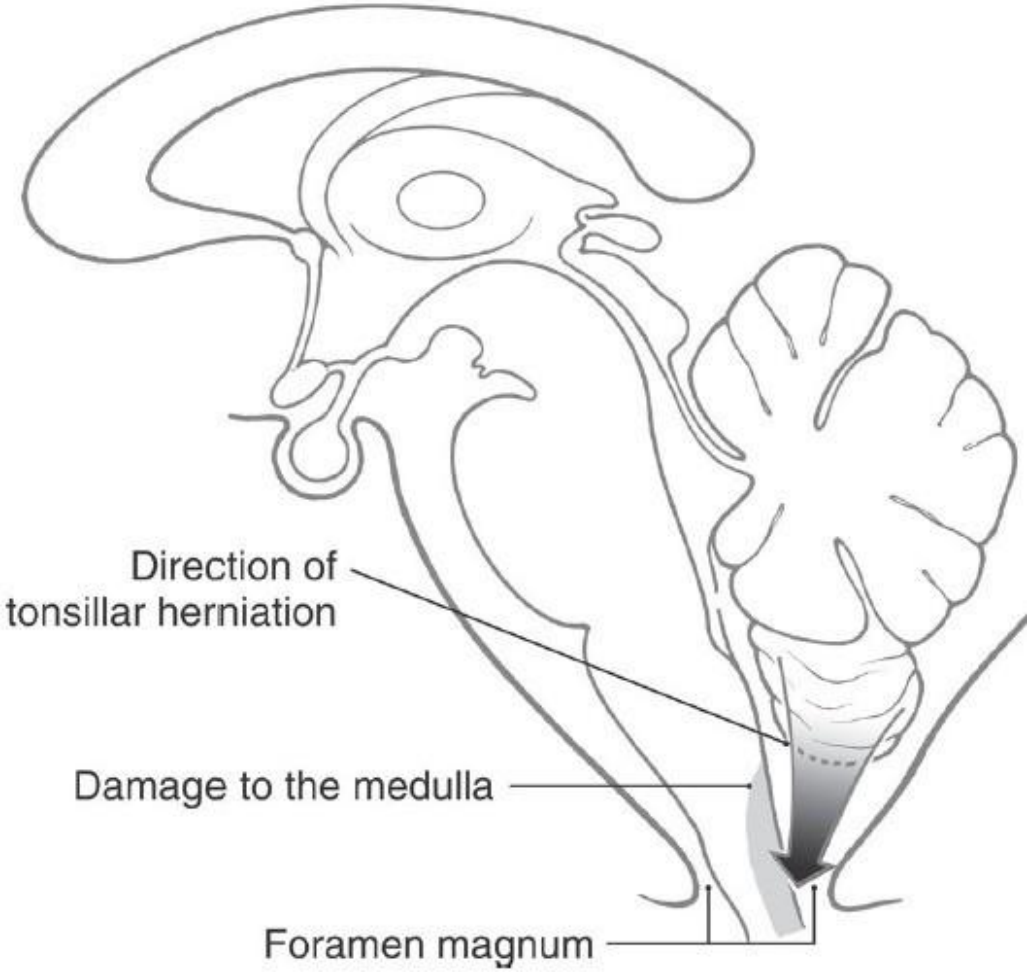
Benedikt Syndrome



- **Large lesion that includes the territories of <u>both</u> the Weber and Claude syndromes**

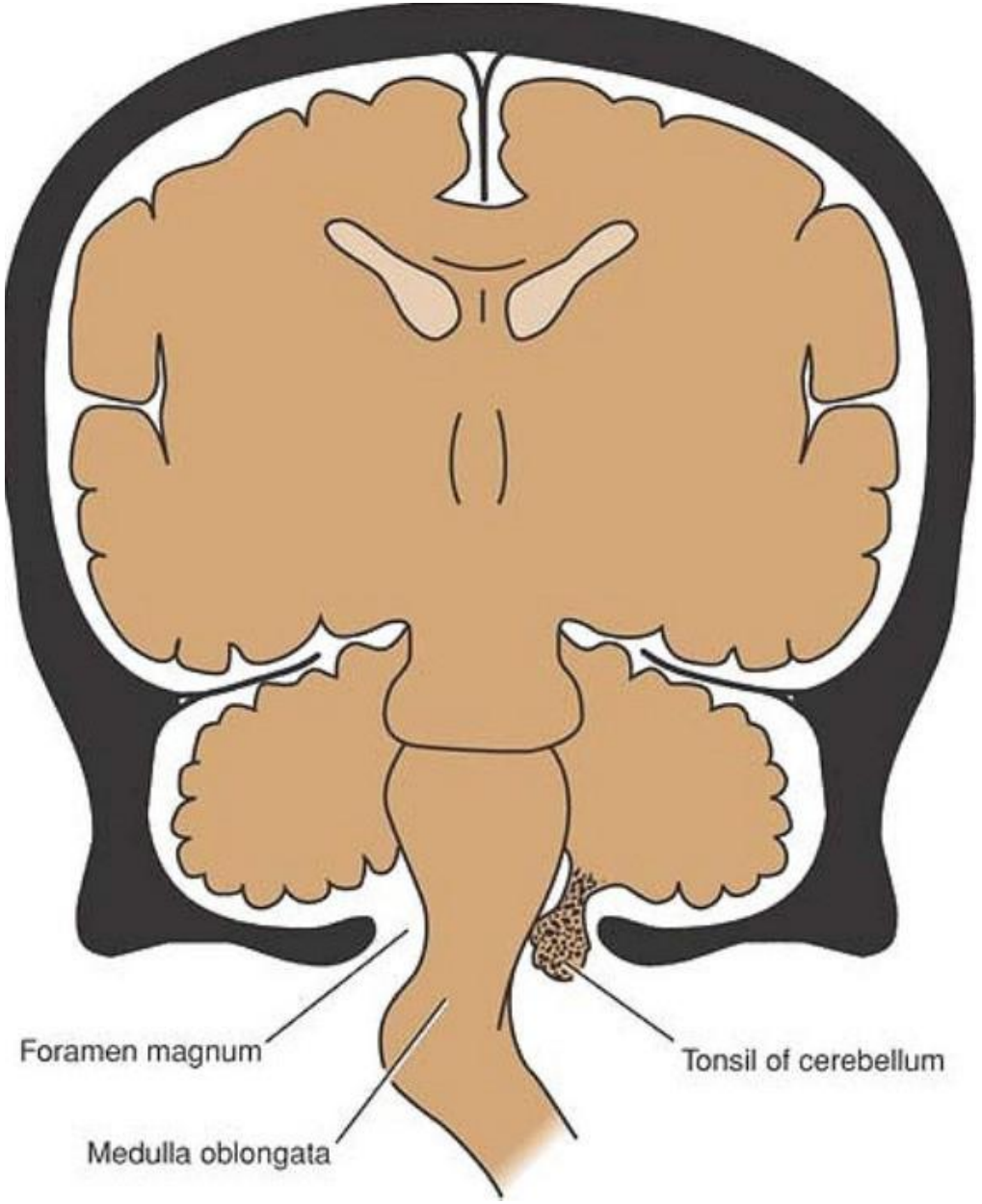
TONSILLAR HERNIATION

- ❑ Causes:
- ➢ mass in the posterior fossa (tumor, hemorrhage)
- ➢ **increase in intracranial pressure**
- ➢ Regardless of the exact cause, the problem is that the herniated part would exert pressure onto the medulla oblongata and vital centers in it, either directly or by compromising blood supply.
- ➢ The major concern in acute herniation is damage to the **ventrolateral reticular area (**heart rate and respiration)
- ❑ Symtoms
- ➢ sudden change in heart rate and respiration
- ➢ **hypertension**
- ➢ **hyperventilation**
- ➢ rapidly decreasing levels of consciousness
- ➢ If severe → death



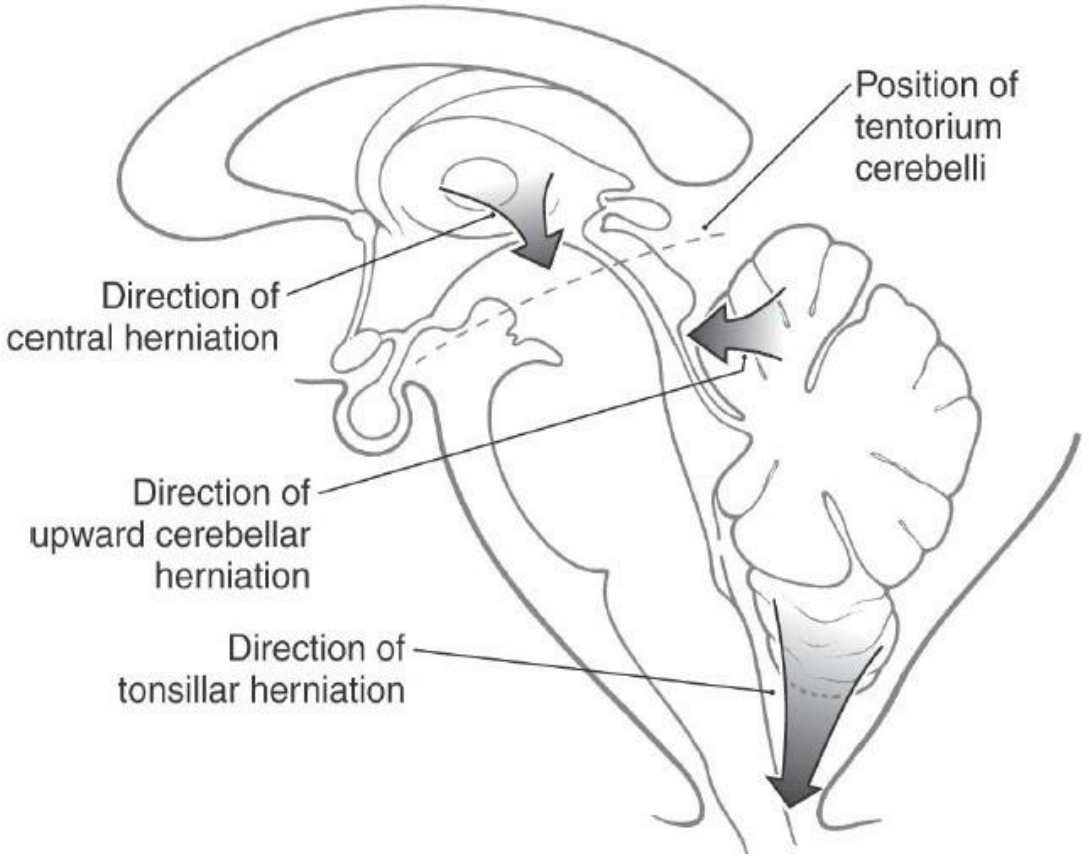
Arnold-Chiari Phenomenon

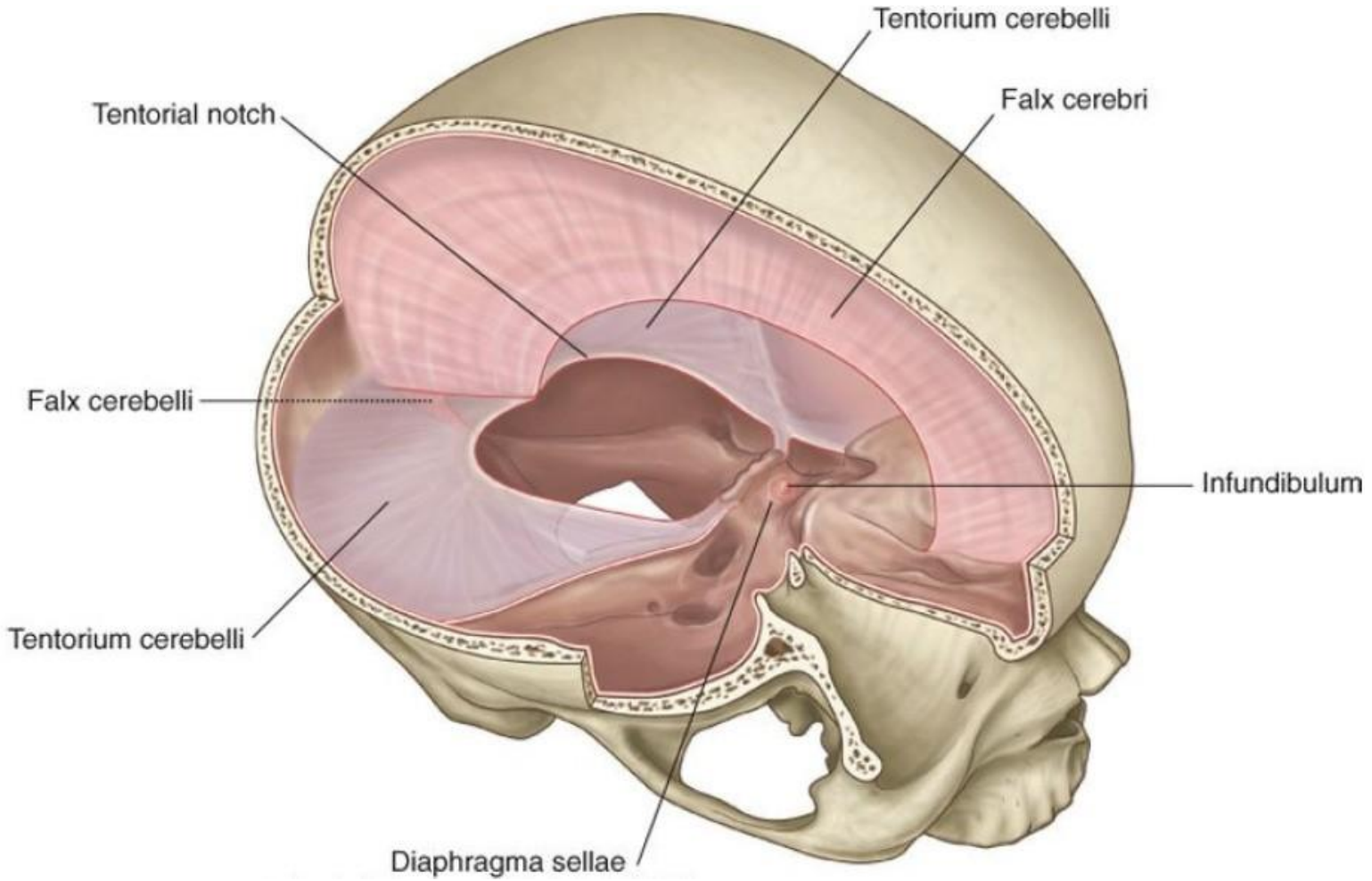
- Congenital anomaly in which there is a herniation of the tonsils of the cerebellum and the medulla oblongata through the foramen magnum into the vertebral canal
- Treatment is surgical, and early detection and management is associated with good prognosis; however, it can progress to typical tonsillar herniation with life-threatening complications if left untreated or delayed.



Central Herniation

- space occupying lesion in the hemisphere (supratentorial compartment) elevates intracranial pressure and forces the diencephalon downward through the tentorial notch and into the brainstem
- Symptoms: change in respiration, eye movements are irregular,
  - As the damage progresses downward into the brainstem, there is significant change in respiration
  - Tachypnea and apnea
  - profound loss of motor and sensory functions,
  - probable loss of consciousness.
  - Rigidity; decorticate then decerebrate (if it crosses the red nucleus line), with the latter indicating possible involvement of vital centers.

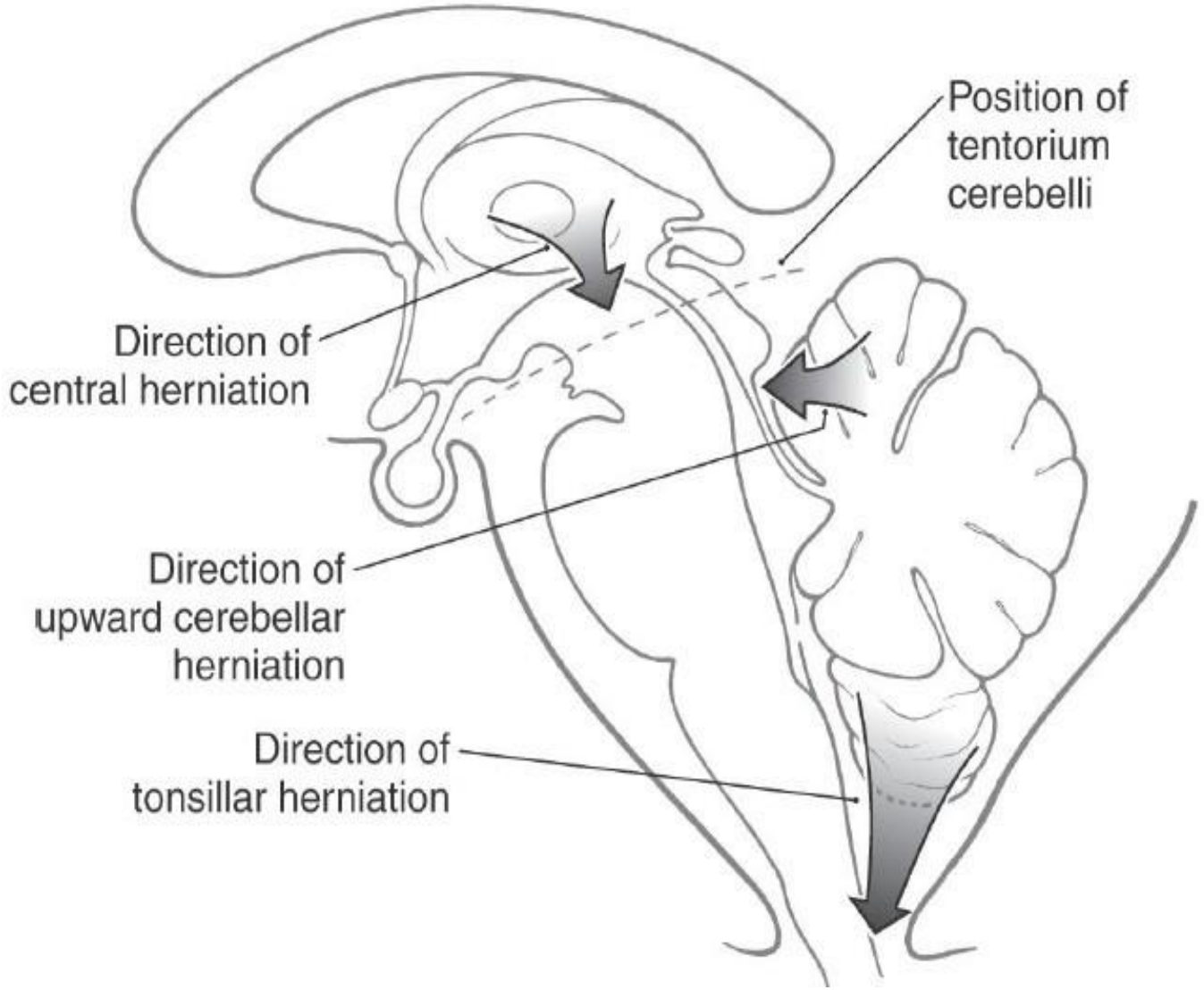




- Falx cerebri: crescent-shaped, Attachments:
  - Anterior: crista galli, Posterior: tentorium cerebelli
- Tentorium cerebelli: horizontal, Attachments:
  - Anteriolateral: superior border of the petrous. Posterior: occipital bone, Anteriolmedial: free, tentorial notch

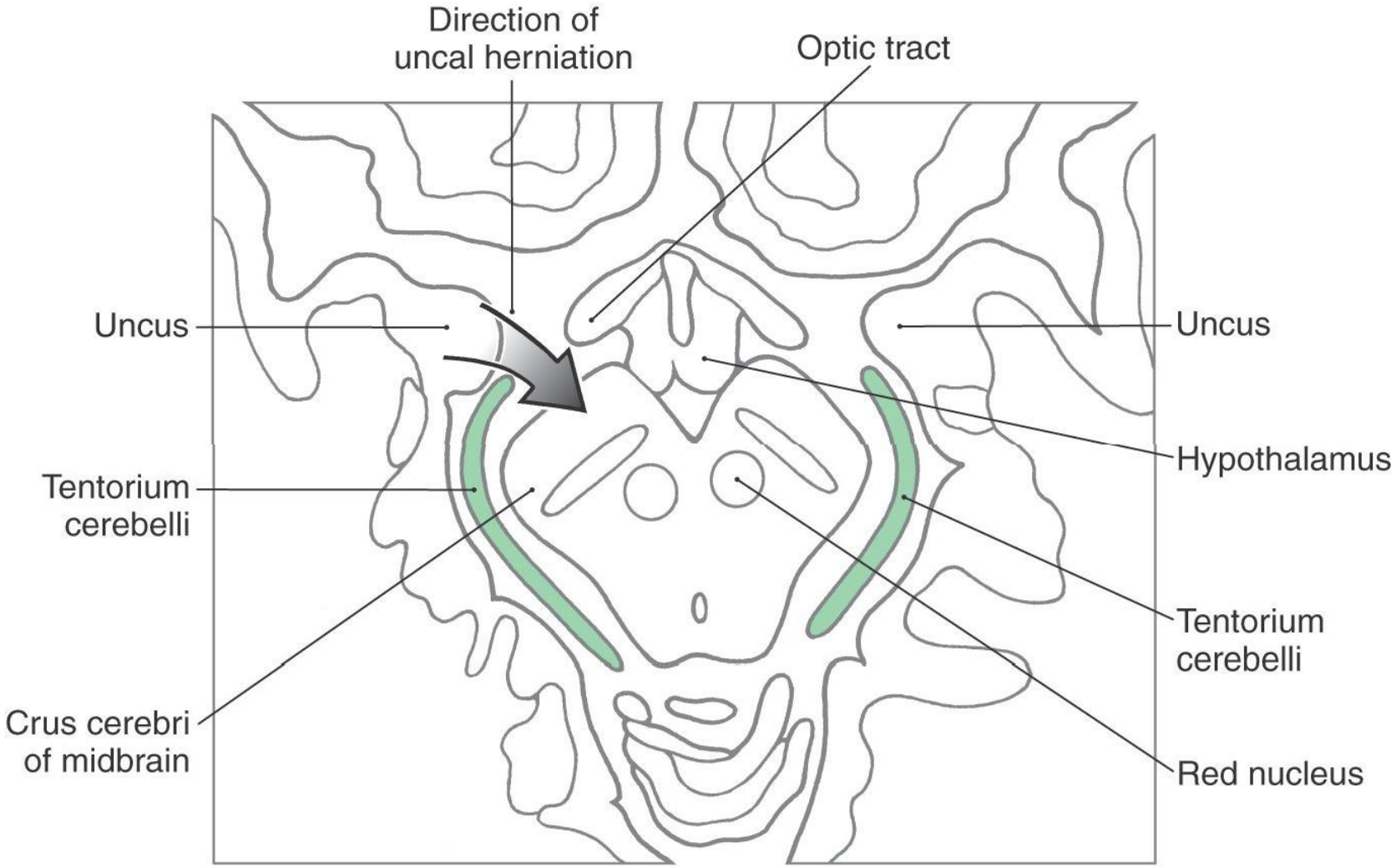
Upward Cerebellar Herniation

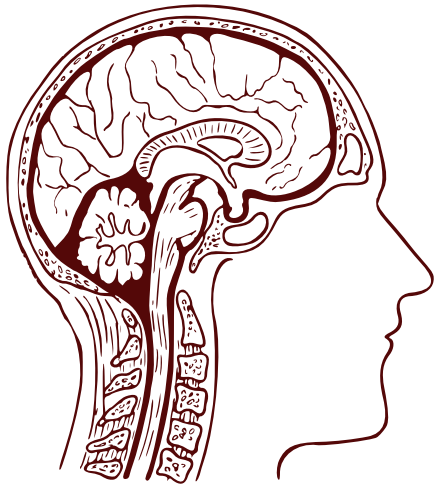
- A mass in the posterior fossa may force portions of the cerebellum upward through the tentorial notch (upward cerebellar herniation) and compress the midbrain
- The result may be occlusion of branches of the superior cerebellar artery with resultant infarction of cerebellar structures or **obstruction of the cerebral aqueduct and hydrocephalus.**
- The latter is seen as signs characteristic of an increase in intracranial pressure
- vomiting, headache, lethargy, decreased levels of consciousness).

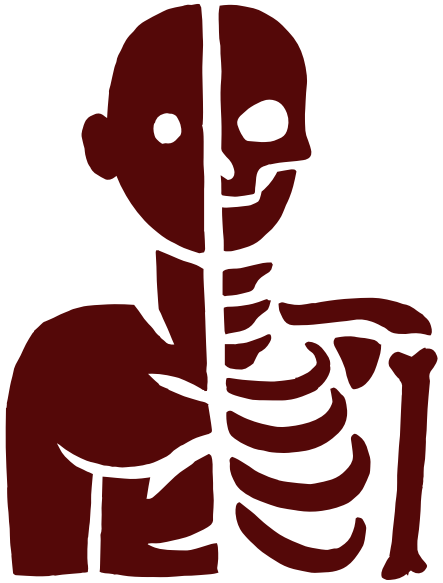


Uncal Herniation

- movement the anteromedial portion of temporal lobe (uncus) downward over the edge of the tentorium cerebelli
- **Early signs:**
  - dilated pupil ipsilateral to the herniation
  - abnormal eye movements ipsilateral to the herniation
  - double vision
  - Weakness of the extremities (corticospinal fiber involvement) opposite to the dilated pupil.
- **Later:**
  - respiration is affected







ANATOMY QUIZ LECTURE 9

External Resources

رسالة من الفريق العلمي

اللهم إن عمر عطية في ذمتك وحبل جوارك، فقِه من فتنة القبر وعذاب النار،
أنت أهل الوفاء والحق، فاغفر له وارحمه إنك أنت الغفور الرحيم.

1. https://doctor2022.jumedicine.com/wp-content/uploads/sites/14/2025/02/Mo-11.pdf

Special thanks to whoever wrote this sheet

من فاته العشر والعشر، فلا يفوت العشر الأواخر

دعواتكم

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			