



## **KARNATKA RADIOLOGY EDUCATION PROGRAM**

### **CEREBRAL Arterial ANATOMY OF THE BRAIN**

About fifteen percent (15%) of the daily cardiac output is utilized by the brain. Owing to the high oxygen and nutrient demand of the organ, it is supplied by two arterial systems:

The anterior circuit is supplied by a pair of internal carotid arteries

The posterior circuit is supplied by a pair of vertebrobasilar system.

Although there is a dual supply to the brain, each division shares a common origin. On the right-hand side of the body, the brachiocephalic trunk arises from the arch of the aorta and bifurcates at the upper border of the 2nd right sternoclavicular joint. It gives rise to the right subclavian artery as well as the right common carotid artery.

The left counterparts to these vessels are direct derivatives of the aortic arch. Both the left and right common carotid arteries subsequently bifurcate between the third and fourth cervical vertebra (between the superior horn of the thyroid cartilage and the hyoid bone) to give the internal and external carotid arteries .

#### **INTERNAL CAROTID ARTERY**

The internal carotid artery is one of two branches of the common carotid artery. It is responsible for supplying a large portion of the anterior and middle parts of the brain.

##### **Origin**

The common carotid artery bifurcates to form the internal carotid and the external carotid artery (ECA). Just superior to its origin, the ICA has a dilatation called the carotid bulb or sinus. The carotid body is a small collection of chemoreceptor cells situated just behind the bifurcation.

In most cases, the carotid bifurcation occurs between the levels of the C3 and C5 vertebrae, or between the levels of the hyoid bone and upper border of the thyroid cartilage. However, there is wide variation: the bifurcation can be higher than the hyoid or C2-3 level and as low as the cricoid cartilage or C6-7 level . Moreover, the level of the bifurcation may be asymmetric.

The internal carotid artery (ICA) runs from the neck, through the skull, and into the brain. It supplies blood to the brain, pituitary gland, and orbit.

### Neck

The ICA begins at the carotid bifurcation, which is just below the angle of the jaw  
The ICA travels up the neck, through the cervical segment

### Skull

The ICA enters the skull through the carotid canal, which is located in the temporal bone  
The ICA passes through the cavernous sinus, a large vein that drains blood from the brain  
The ICA exits the cavernous sinus through its roof

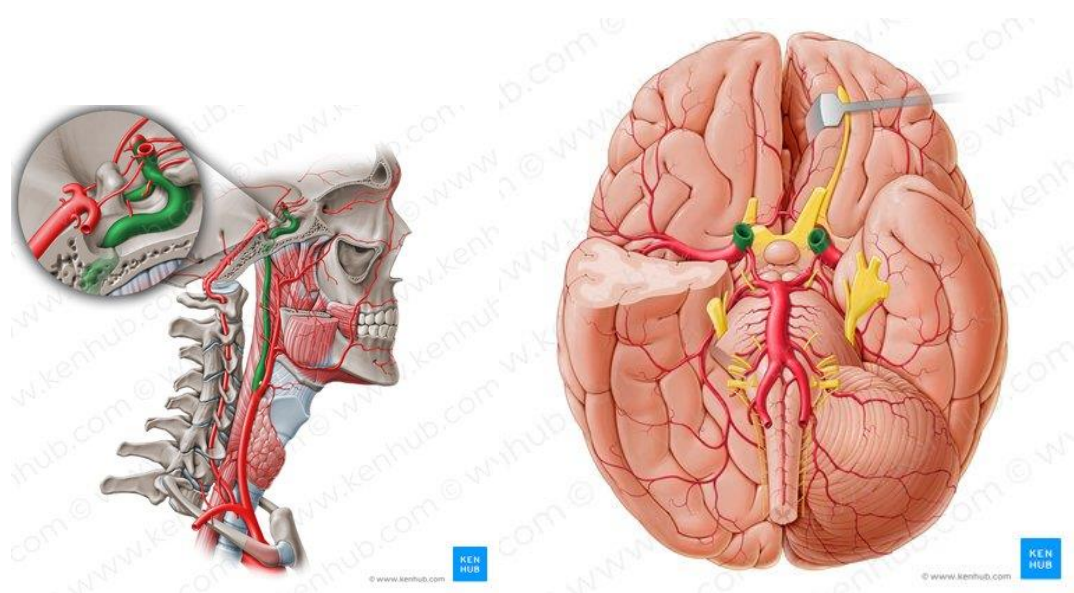
### Brain

*The ICA divides into the anterior cerebral artery (ACA) and middle cerebral artery (MCA) at the base of the brain*

*The ICA branches off the ophthalmic artery, which supplies blood to the eyes and some facial muscles.*

On reaching the anterior perforated substance the artery divides into 2 terminal branches:

1. Anterior cerebral artery
2. Middle cerebral artery

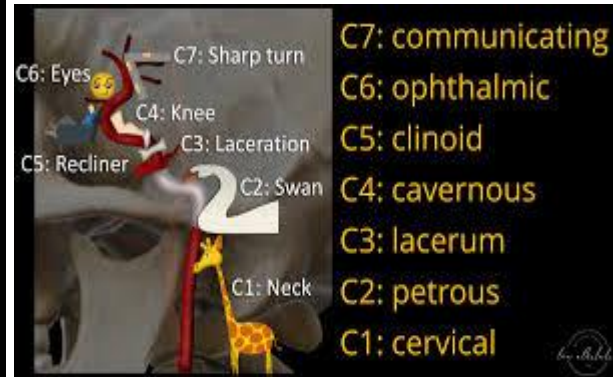
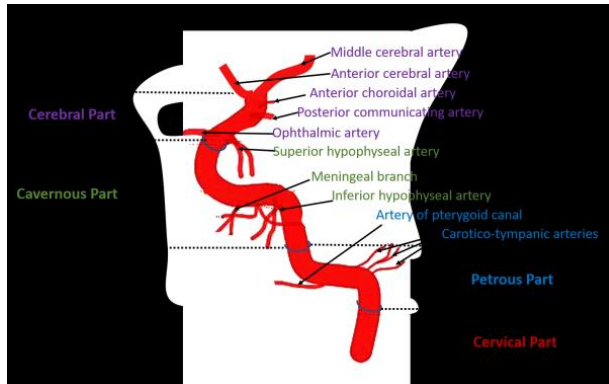


New classification	Cervical part, petrous part, cavernous part, intracranial part
Cincinnati classification	C1 – Cervical Segment C2 – Petrous Segment C3 – Lacerum Segment C4 – Cavernous Segment C5 – Clinoid Segment C6 – Ophthalmic (Supraclinoid) Segment C7 – Communicating (Terminal) Segment <i>Mnemonic (C2-C7): Please Let Children Consume Our Candy</i>

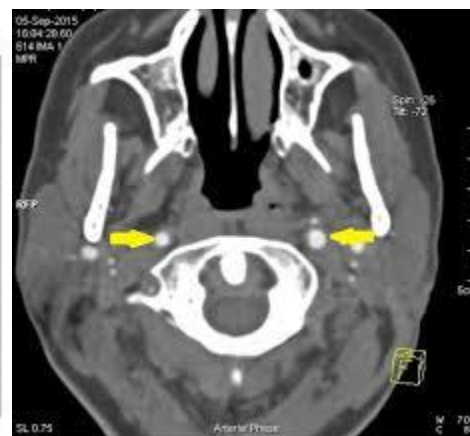
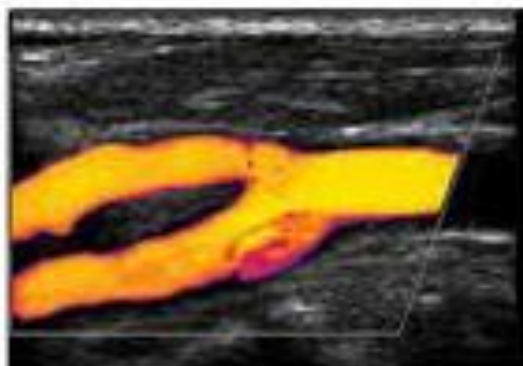
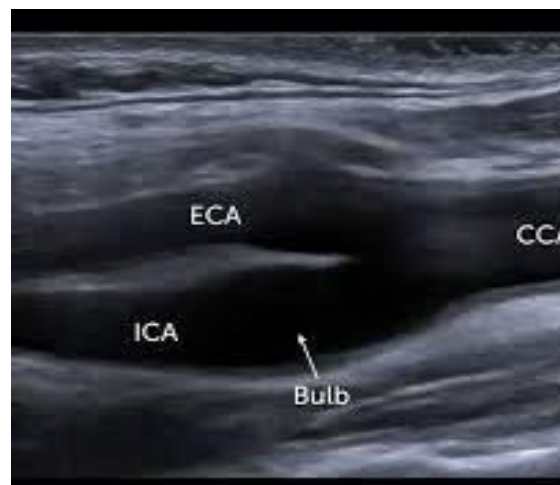
## Branches

Except for the terminal segment (C7), the odd-numbered segments usually have no branches. The even-numbered segments (C2, C4, C6) often have branches, although they are inconstant and usually small, and are therefore often not visualized even on high-resolution digital subtraction angiography. The exception is the ophthalmic artery, which is seen in nearly all cases .

- **C1: cervical segment, branches none**
- **C2: petrous (horizontal) segment**
  - caroticotympanic artery
  - Vidian artery
- **C3: lacerum segment, none**
- **C4: cavernous segment**
  - meningo-hypophyseal trunk
  - inferolateral trunk
  - capsular arteries (of McConnell) (variable)
- **C5: clinoid segment, none**
- **C6: ophthalmic (supraclinoid) segment**
  - ophthalmic artery
  - superior hypophyseal artery
- **C7: communicating segment**
  - posterior communicating artery
  - anterior choroidal artery
  - anterior cerebral artery
  - middle cerebral artery



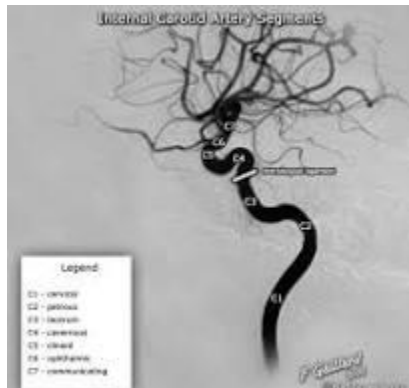
B-mode transverse view of carotid arteries







## C1 Cervical branch



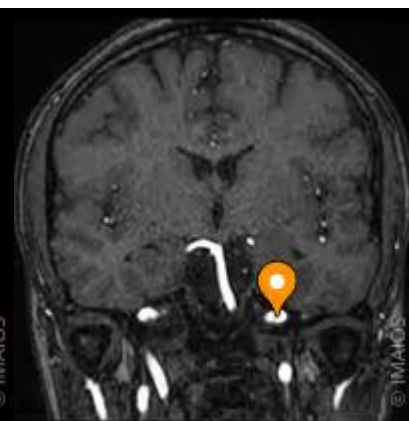
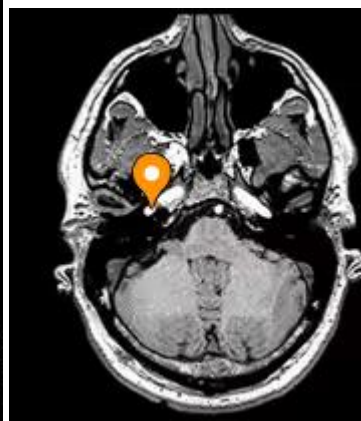
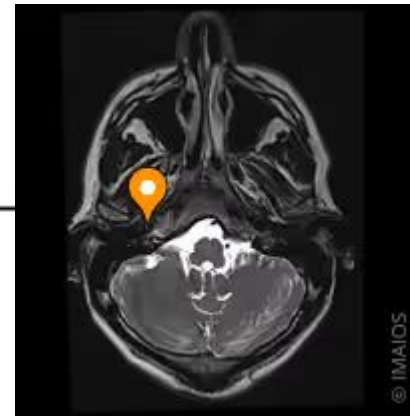
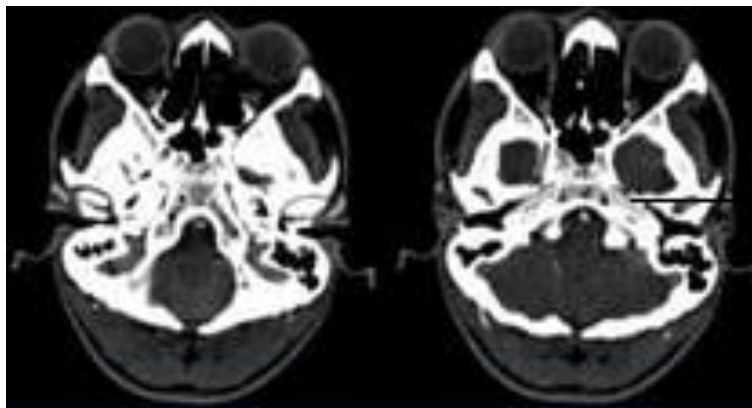
### Cervical segment C1

- Begins in the neck at the carotid bifurcation where the CCA divides into internal & external
- Goes within the carotid sheath with IJV & vagus
- Encircled with PGSN
- Ends where the ICA enter carotid canal of petrous bone

## C2 segment – Petrous part of ICA

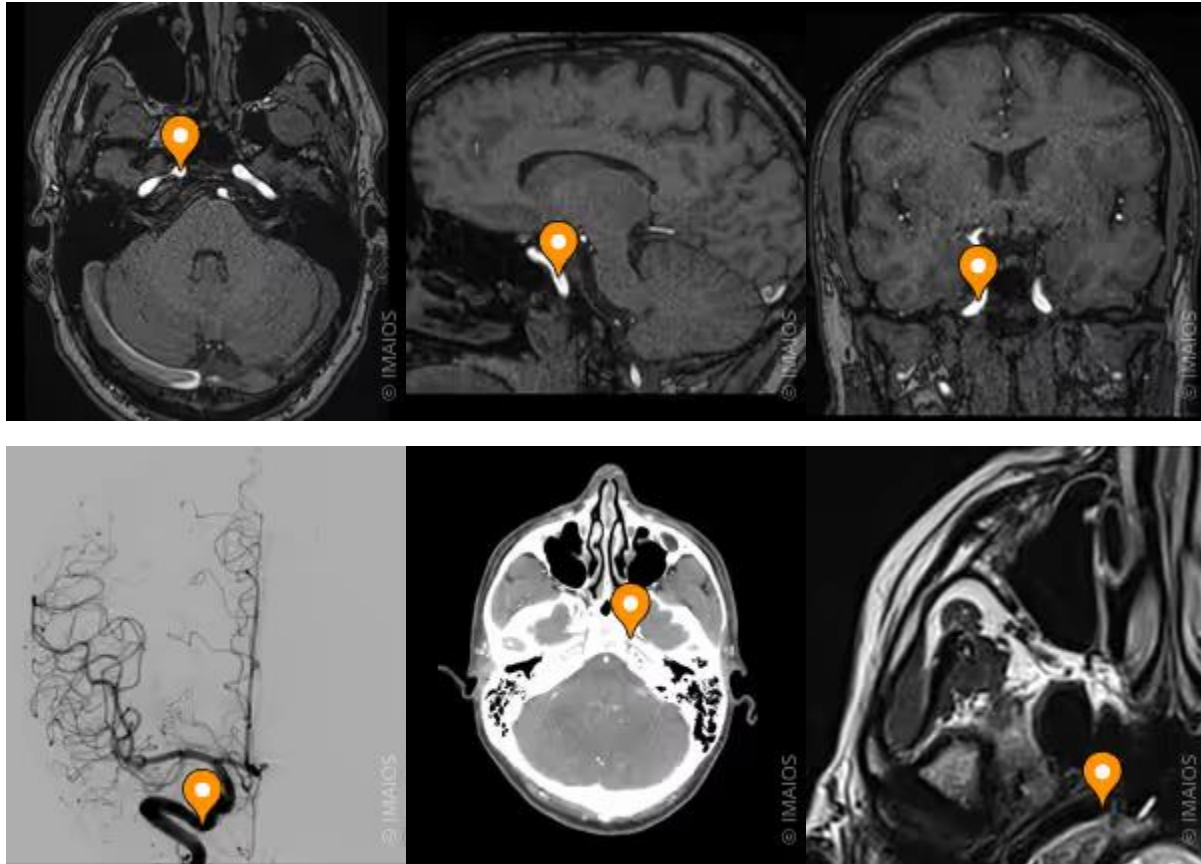
The petrous segment, or C2, of the internal carotid, is that which is inside the petrous part of the temporal bone. This segment extends until the foramen lacerum.

Branches are Vidian and Caroticotympanic



### C3 segment

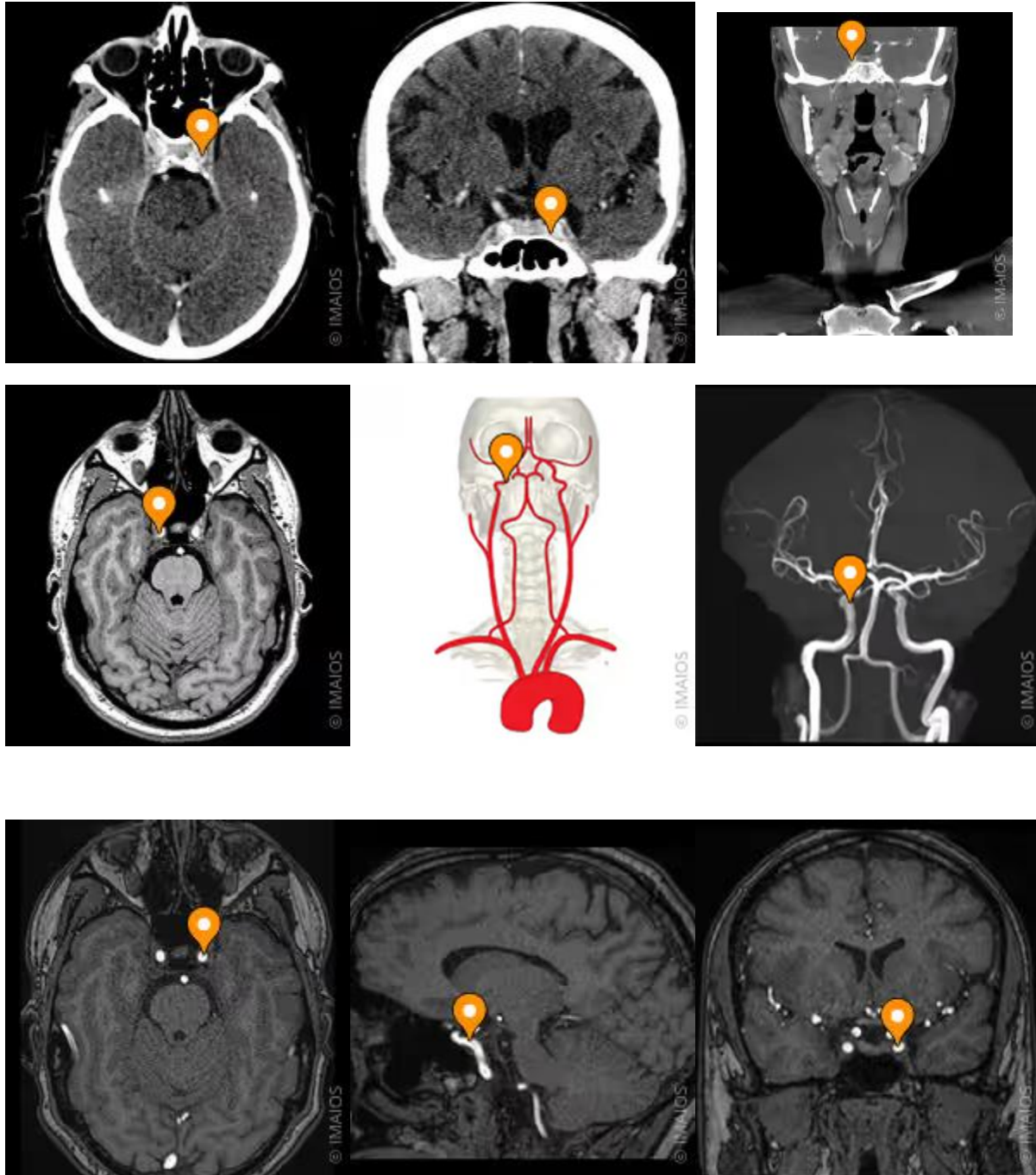
The lacerum segment, or C3, is a short segment that begins above the foramen lacerum and ends at the petrolingual ligament, a reflection of periosteum between the lingula and petrous apex (or petrosal process) of the sphenoid bone.



## C4 segment Cavernous part of ICA

The cavernous part, or C4, of the internal carotid artery begins at the petrolingual ligament and extends to the proximal dural ring, which is formed by the medial and inferior periosteum of the anterior clinoid process. The cavernous segment is surrounded by the cavernous sinus.

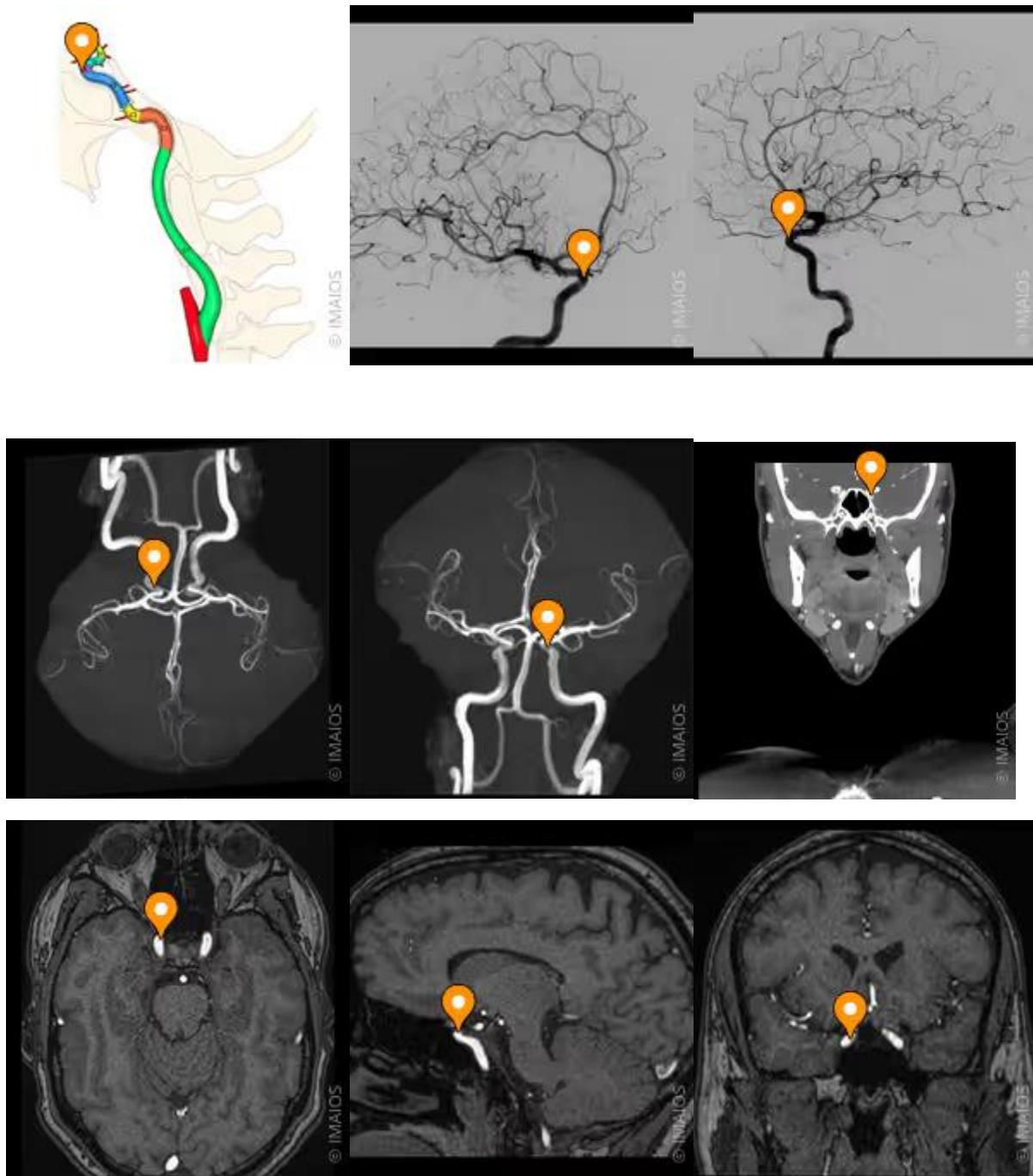
The main branches of the intracavernous ICA are the meningohipophyseal trunk - MHT and the inferolateral trunk ILT.





## C5 segment of ICA – Clinoid segment

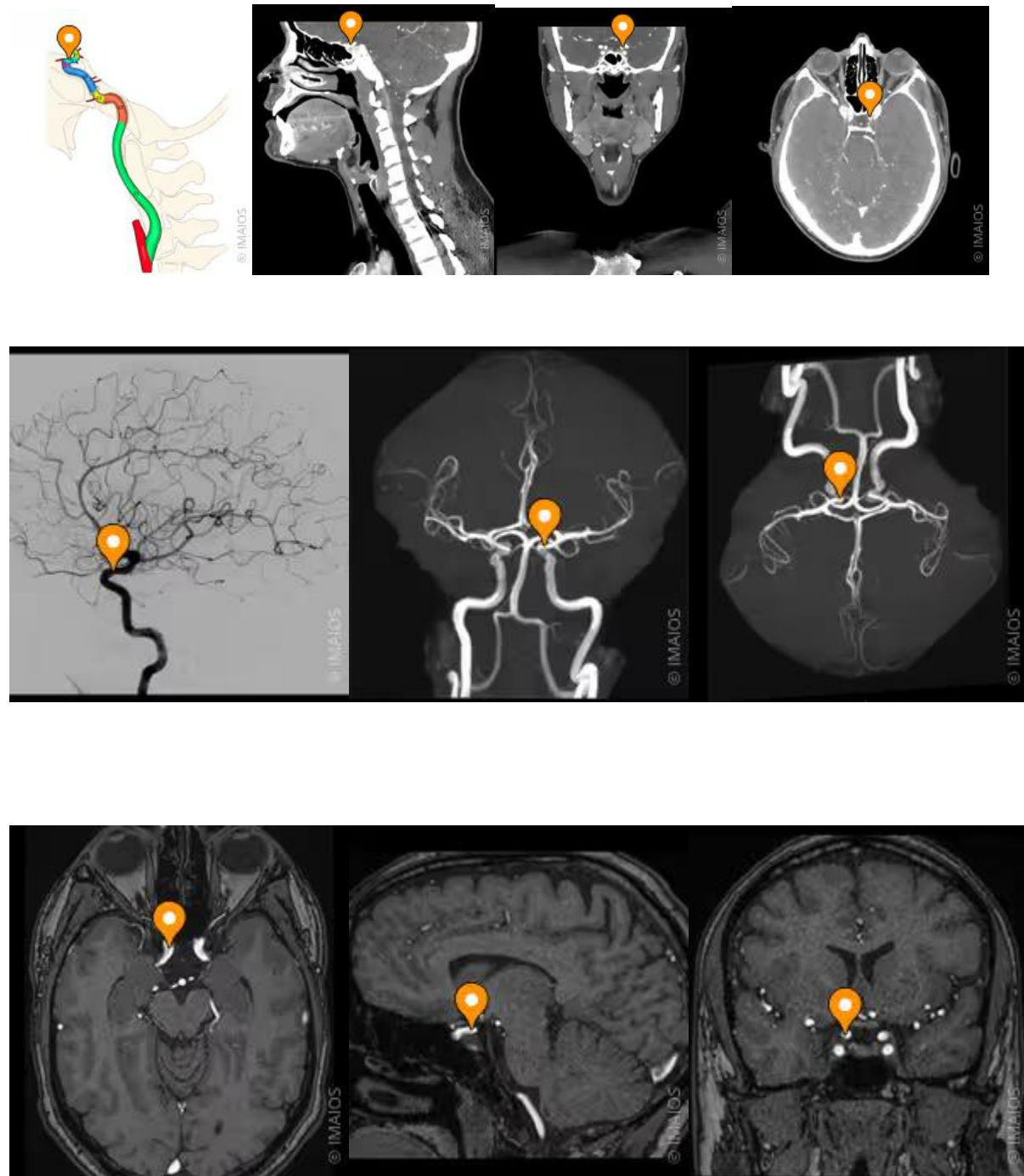
The clinoid segment, or C5, is another short segment of the internal carotid that begins after the artery exits the cavernous sinus at the proximal dural ring and extends distally to the distal dural ring, after which the carotid artery is considered 'intra-dural' and has entered the subarachnoid space.



## C6 segment of ICA – Supraclenoid segment/Ophthalmic segment

The ophthalmic artery is the first large branch off the internal carotid artery just as it emerges from the cavernous sinus. The optic nerve within its canal is supplied by pial branches of the ophthalmic artery.

Branches 1. ophthalmic artery - (OphA) and its branches (anterior and posterior ethmoidal arteries [A&PEthAs] and central retinal artery [CRA]) , 2. Superior Hypophyseal artery.

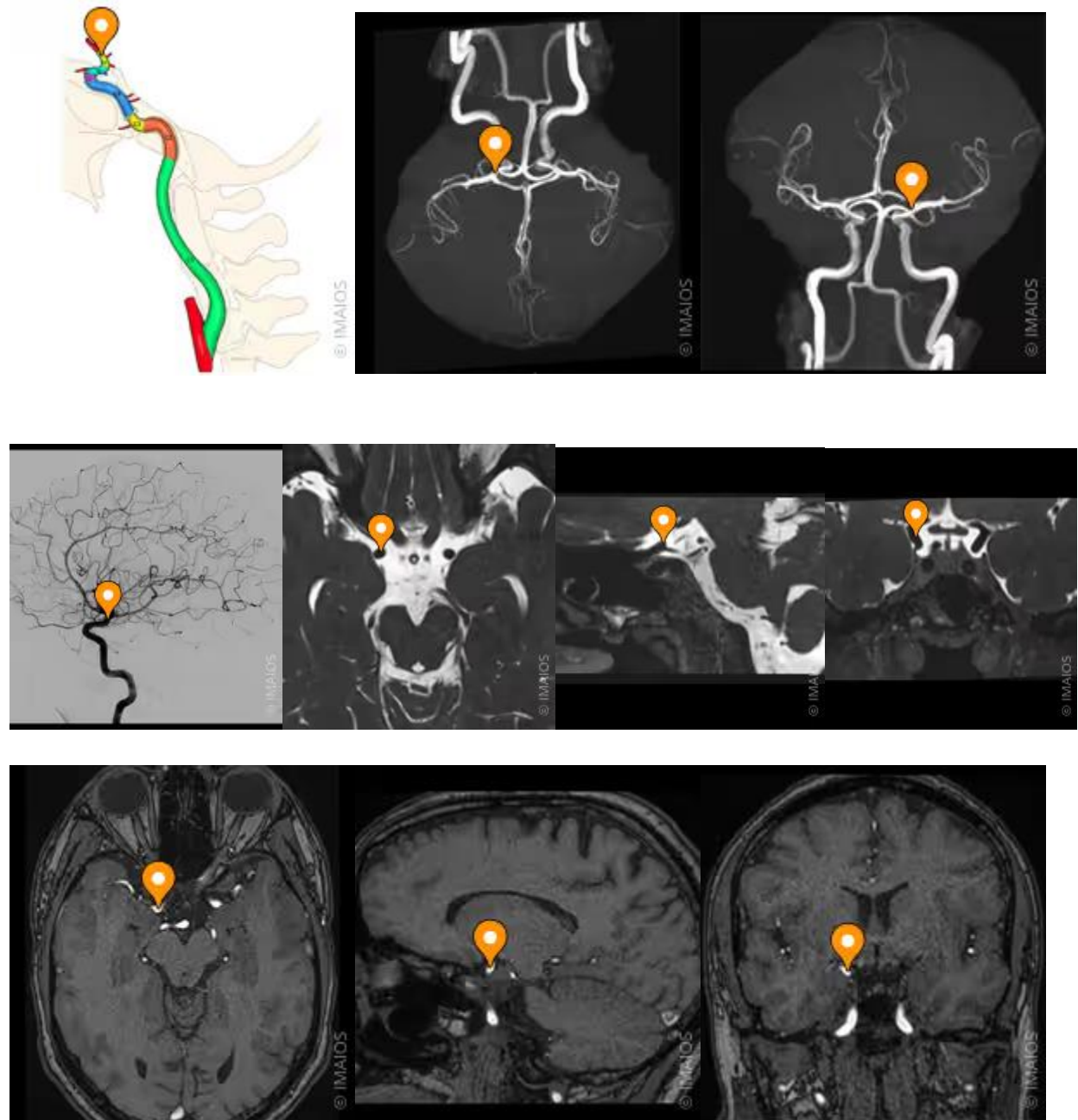


## C7 segment of ICA – Communicating

The communicating segment, or terminal segment, or C7, of the internal carotid artery passes between the optic and oculomotor nerves to the anterior perforated substance at the medial extremity of the lateral cerebral fissure. Angiographically, this segment extends from the origin of the posterior communicating artery to the bifurcation of the internal carotid artery.

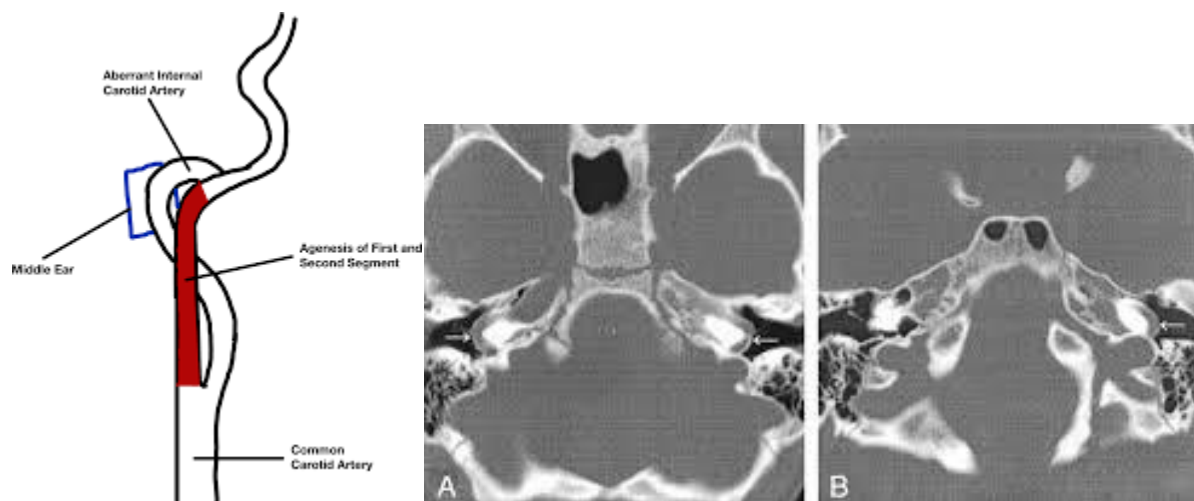
The named branches of the communicating segment are:

- the posterior communicating artery
- the anterior choroidal artery



## Normal ICA variants

- aberrant ICA
  - congenital absence of the ICA
  - retropharyngeal course, called kissing carotids when bilateral
  - persistent carotid-vertebrobasilar anastomoses
  - lateralized internal carotid artery
- Aberrant internal carotid artery is a variant of the internal carotid artery and represents a collateral pathway resulting from involution of the normal cervical portion (first embryonic segment) of the internal carotid artery



- Congenital absence of the internal carotid artery (ICA) is a rare anomaly that occurs in less than 0.01% of the population. It encompasses agenesis, aplasia, and hypoplasia .

The most common type of collateral flow is through the circle of Willis, through the anterior communicating artery (ACom) and posterior communicating artery (PCom). Less commonly, collateral flow is provided via persistent embryonic vessels or from transcranial collaterals originating from the external carotid artery (ECA) system.





- **Retropharyngeal course**, The term **kissing carotids** refers to tortuous and elongated carotid arteries which touch in the midline. They can be found in:

**Retropharynx /intrasphenoid1**

**within the pituitary fossa**

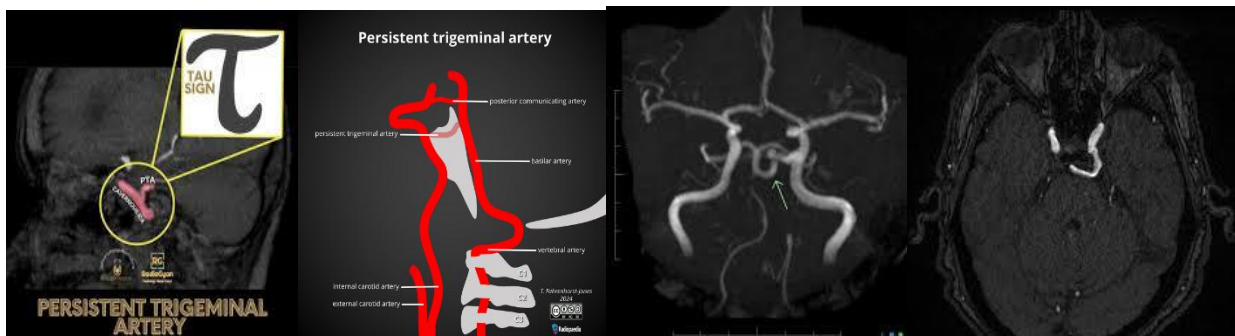
**within sphenoid sinuses**

**within sphenoid bones**

The significance of kissing carotids is two-fold: may mimic intrasellar pathology  
catastrophic if unknown or unreported before transsphenoidal or retropharyngeal surgery



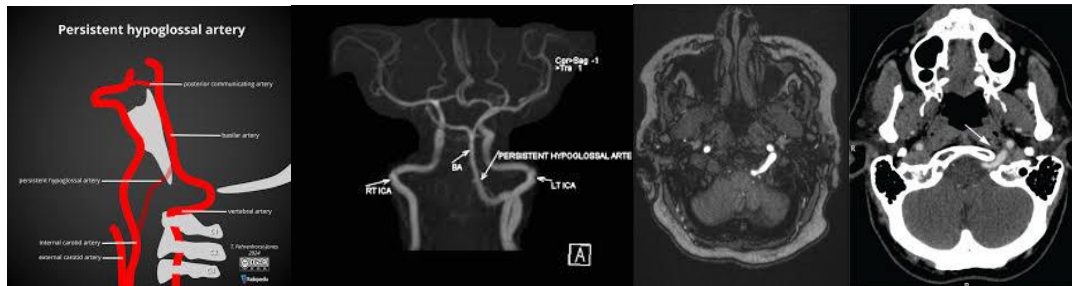
- **The persistent carotid-vertebrobasilar anastomoses** are variant anatomical arterial communications between the anterior and posterior circulations due to abnormal embryological development of the vertebrobasilar system. They are named, with the exception of the proatlantal artery, using the cranial nerves with which they run.
- **Persistent primitive trigeminal artery (PPTA)** is the most common type of the four persistent carotid-vertebrobasilar anastomoses. It is present in 0.1-0.6% of cerebral angiograms and is usually unilateral





- Persistent hypoglossal artery is one of the persistent carotid-vertebrobasilar anastomoses. It is present in 0.02-0.26% of individuals and overall, is second in frequency to the trigeminal artery which is present approximately six times as often.

It arises from the distal cervical internal carotid artery segment, usually between the C1 and C3 vertebral level. After passing through an enlarged hypoglossal canal, it joins the basilar artery inferiorly. If large, the ipsilateral vertebral artery and posterior communicating artery are often hypoplastic or absent.



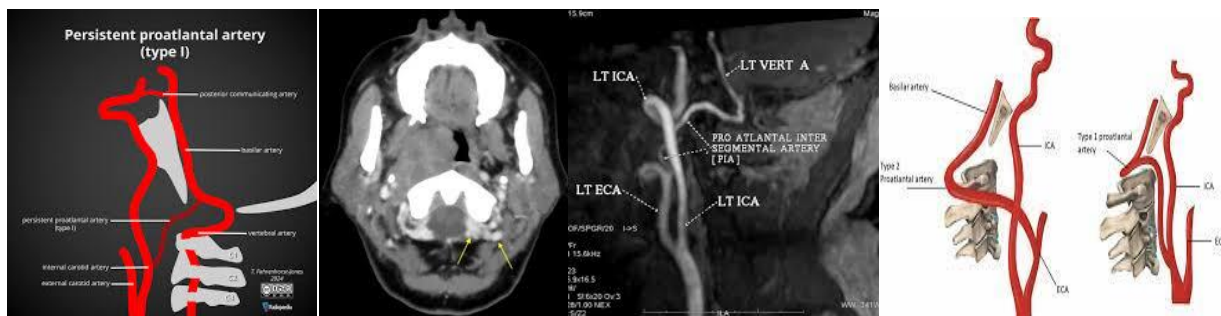
- The proatlantal artery is one of the persistent carotid-vertebrobasilar anastomoses.

There are two types, depending on its origin:

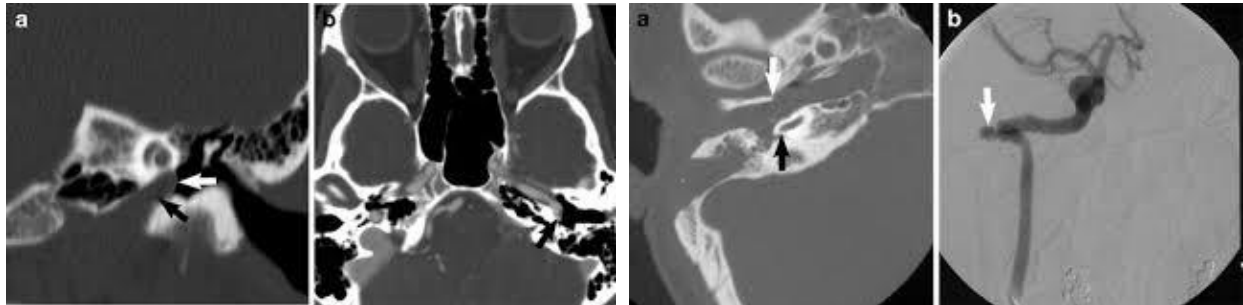
type I: (~55%) corresponds to the first segmental artery, arises from the internal carotid artery also known as the proatlantal intersegmental artery

type II: (~40%) corresponds to the second segmental artery arises from the external carotid artery rarely (~5%) it arises from the common carotid artery

Irrespective of their origin, the artery passes through the foramen magnum and joins the vertebral artery. If large then the ipsilateral vertebral artery is small or absent.



- The lateralized internal carotid artery is an anatomic variation of the course of the petrous segment of the internal carotid artery (ICA). It can be visualized on CT by its more posterolateral entrance to the skull base and protrusion into the anterior mesotympanum



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Ref: <https://radiopaedia.org/articles/intracranial-arteries-variants-1> , Radiological vascular anatomy of brain – Dr Dev Lakhera , <https://www.imaio.com/en>