كلية المستقبل الجامعة قسم هندسة الطب الحياتي

المرحلة الثانية

HEAD & NECK

ANATOMY

(L7)

Neuroanatomy 2

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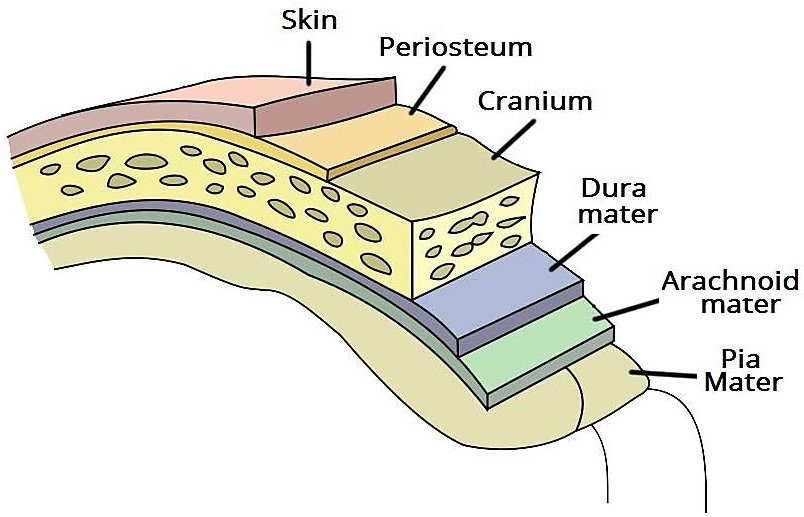
The Meninges

The meninges refer to the **membranous** coverings of the brain and spinal cord. There are three layers of meninges, known as the **dura** mater, **arachnoid** mater and **pia** mater.

These coverings have two major functions:

- Provide a **supportive framework** for the cerebral and cranial vasculature.
- Acting with cerebrospinal fluid to **protect** the CNS from mechanical damage.
- The meninges are often involved cerebral pathology, as a common site of **infection** (meningitis), and **intracranial bleeds**.



(Fig – Overview of the meninges, and their relationship to the skull and brain)

Dura Mater: is the **outermost** layer of the meninges and is located directly underneath the bones of the skull and vertebral column. It is thick, tough, and inextensible.

The dura mater consists of two **layered** sheets of connective tissue:

Periosteal layer and **Meningeal layer.** The **dural venous sinuses** are located between the two layers of dura mater. They are responsible for

the venous drainage of the cranium and empty into the **internal jugular** veins.

Dural Reflections

The meningeal layer of dura mater folds inwards upon itself to form four **dural reflections.** These reflections project into the cranial cavity, dividing it into several **compartments** – each of which houses a subdivision of the brain. The four dural reflections are:

Falx cerebri – projects downwards to separate the right and left cerebral hemispheres.

Tentorium cerebelli – separates the occipital lobes from the cerebellum.

Falx cerebelli – separates the right and left cerebellar hemispheres.

Diaphagma sellae – covers the hypophysial fossa of the sphenoid

bone. It contains a small opening for passage of the stalk of the pituitary gland.

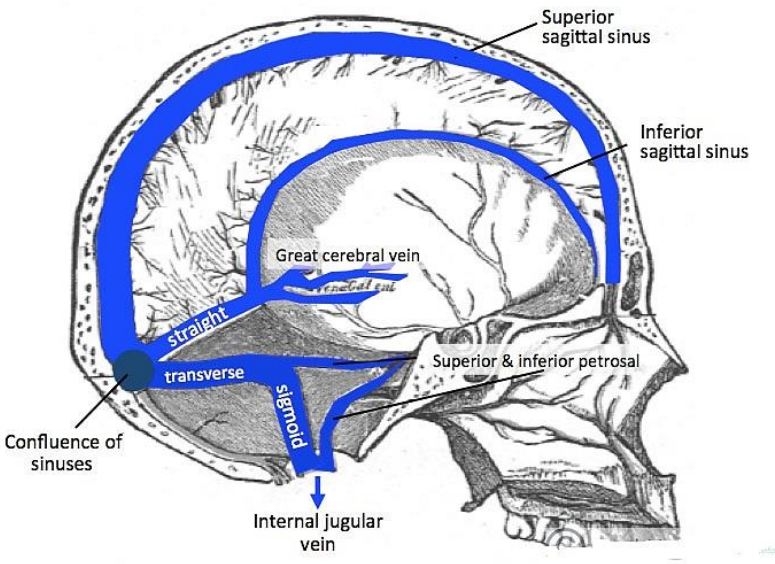
Dural Venous Sinuses

The dural venous sinuses lie between the **periosteal** and **meningeal** layers of the dura mater. They are best thought of as collecting pools of blood, which drain the central nervous system, the face, and the scalp. All the dural venous sinuses ultimately drain into the **internal jugular vein**. Unlike most veins of the body, the dural venous sinuses do not have valves.

There are eleven venous sinuses in total. The straight, superior, and inferior sagittal sinuses are found in the **falx cerebri** of the dura mater. They converge at the **confluence of sinuses** (overlying the **internal occipital protuberance**). The straight sinus is a continuation of the great cerebral vein and the inferior sagittal sinus.

From the confluence, the **transverse** sinus continues bi-laterally and curves into the **sigmoid** sinus to meet the opening of the internal jugular vein.

The **cavernous** sinus drains the ophthalmic veins and can be found on either side of the sella turcica. From here, the blood returns to the internal jugular vein via the **superior** or **inferior petrosal** sinuses.



The **cavernous sinus** is a paired dural venous sinus located within the cranial cavity. It is divided by septa into small 'caves' – from which it gets its name.

Each cavernous sinus has a close anatomical relationship with several **key structures** in the head, and is arguably the most clinically important venous sinus.

Anatomical Location and Borders

The cavernous sinuses are located within the middle cranial fossa, on either side of the **sella turcica** of the sphenoid bone (which contains the

pituitary gland). They are enclosed by the endosteal and meningeal layers of the dura mater.

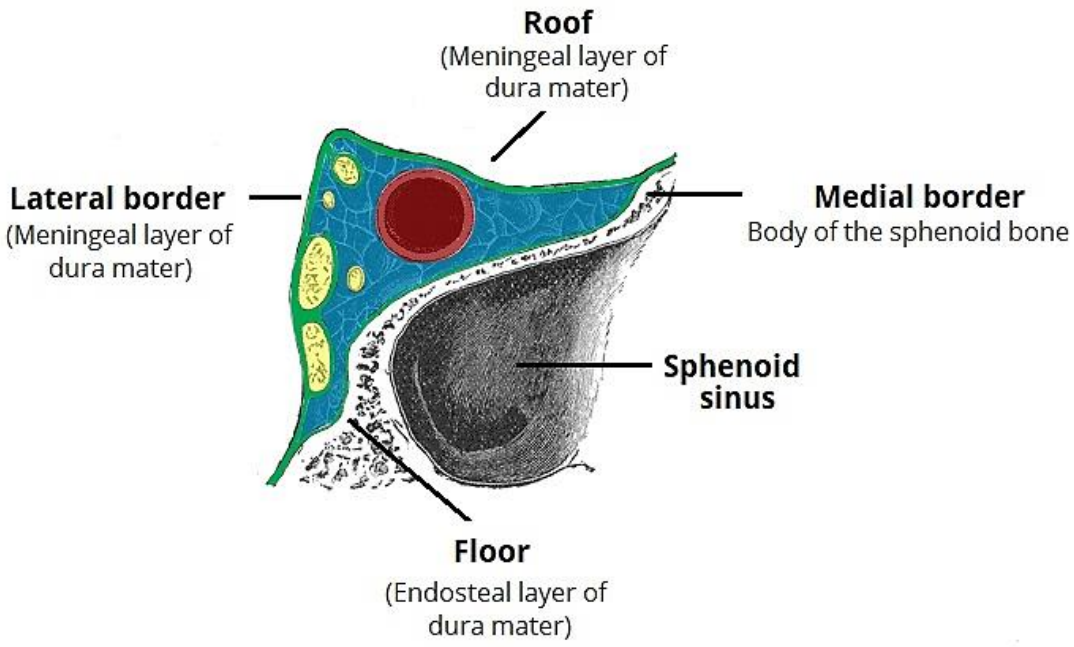
The borders of the cavernous sinus are as follows:

Anterior – superior orbital fissure.

Posterior – petrous part of the temporal bone.

Medial – body of the sphenoid bone.

Lateral – meningeal layer of the dura mater running from the roof to the floor of the middle cranial fossa.



Contents

Several important structures pass through the cavernous sinus to enter the **orbit**. They can be sub-classified by whether they travel through the sinus itself, or through its lateral wall:

Travels through cavernous sinus:

Abducens nerve (CN VI)

Carotid plexus (post-ganglionic sympathetic nerve fibres)

Internal carotid artery (cavernous portion)

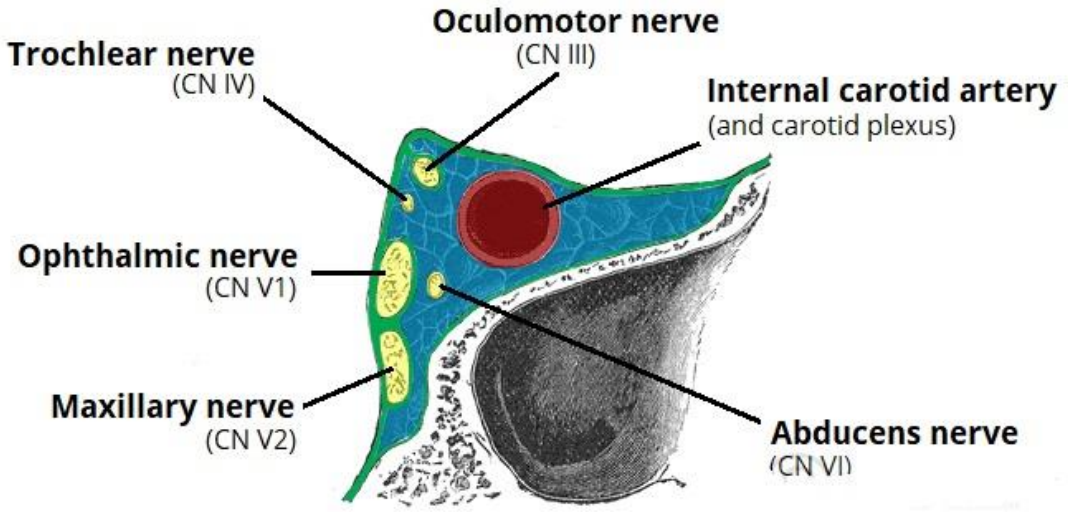
Travels through lateral wall of cavernous sinus:

Oculomotor nerve (CN III)

Trochlear nerve (CN IV)

Ophthalmic (V1) and maxillary (V2) branches of the trigeminal nerve

The cavernous sinus is the only site in the body where an artery (internal carotid) passes completely through a venous structure. This is thought to allow for **heat exchange** between the warm arterial blood and cooler venous circulation.



It is important to note that the superior ophthalmic vein forms an anastomosis with the **facial vein**. Therefore, the ophthalmic veins represent a potential route by which infection can spread from an extracranial to an intracranial site. The cavernous sinuses empty into the **superior** and **inferior petrosal sinuses**, and ultimately, into the internal jugular vein. The left and right cavernous sinuses are connected in the midline by the anterior and posterior **intercavernous sinuses**. They travel through the sella turcica of the sphenoid bone.

Clinical Significance - Cavernous Sinus Thrombosis

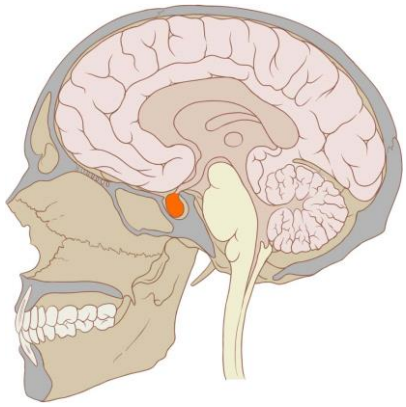
Cavernous sinus thrombosis (CST) refers to the formation of a **clot** within the cavernous sinus.The most common cause of CST is **infection**, which typically spreads from an extracranial location such as the orbit,

paranasal sinuses, or the 'danger zone' of the face. Infection is able to spread in this manner due to the anastomosis between the facial vein and superior ophthalmic veins. Common clinical features include headache, unilateral periorbital oedema, proptosis (eye bulging), photophobia and cranial nerve palsies. The **abducens nerve** (CN VI) is most commonly affected.

The Pituitary Gland

The pituitary gland (the hypophysis) is a major gland of the endocrine system. It secretes hormones that control the actions of other endocrine organs and various tissues around the body.

Anatomical Position and Relations



The pituitary gland.

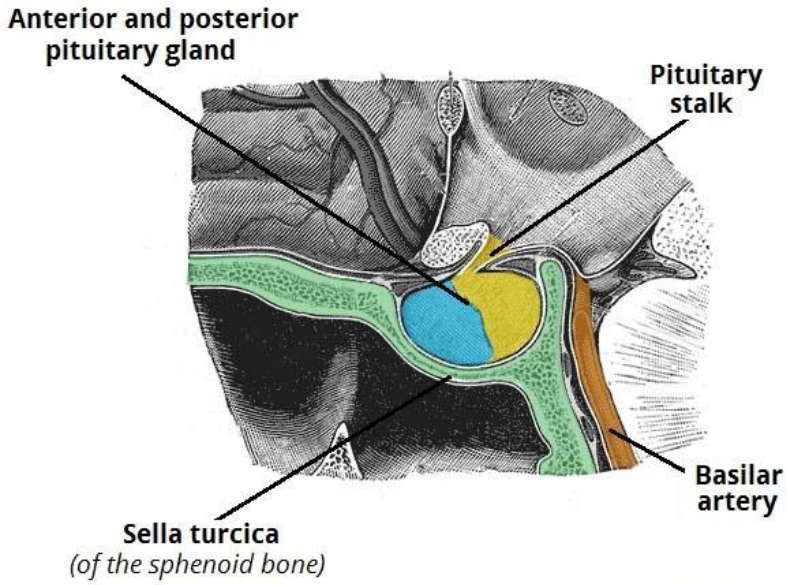
The pituitary gland is a pea-sized oval structure, suspended from the underside of the brain by the **pituitary stalk** (known as the infundibulum). It sits within a small depression in the sphenoid bone, known as the **sella turcica** (''Turkish saddle''). The superior surface of the gland is covered by a reflection of the dura mater – the **diaphragma sellae**. This membrane has a central opening which allows passage of the infundibulum. The gland has several key anatomical relations:

Anteriorly – sphenoid sinus (the pituitary gland is accessed surgically via the sphenoid sinus, known as a trans-sphenoidal approach).

Posteriorly – posterior intercavernous sinus, dorsum sellae (posterior wall of the sella turcica), basilar artery and the pons.

Superiorly – diaphragma sellae (fold of dura mater that covers the pituitary gland), optic chiasm.

Inferiorly – sphenoid sinus. **Laterally** – cavernous sinus.



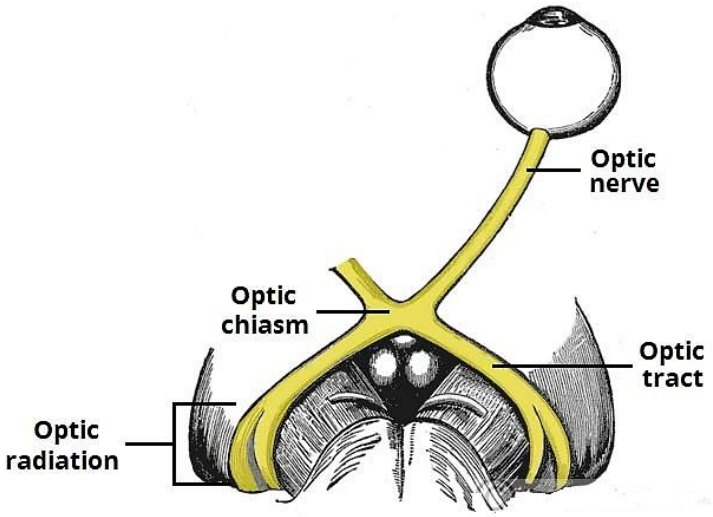
Clinical Significance: Pituitary Adenoma

A pituitary adenoma is a neoplasm of the pituitary gland. These tumours are usually benign. As the tumour increases in size, it can compress surrounding structures, such as the **optic chiasm**. A lesion of the optic chiasm characteristically produces a visual defect known as a bitemporal hemianopia. A pituitary tumour can also cause excessive hormone production, or insufficient hormone production (by destroying the normal glandular tissue). Definitive treatment of a pituitary adenoma is via **trans-sphenoidal surgery**. This technique involves gaining access to the gland via the nasal cavity and sphenoid sinus (which is located immediately inferiorly to the gland).

The Optic Nerve (CN II) and Visual Pathway

The optic nerve (CN II) is the second cranial nerve, responsible for transmitting the special sensory information for vision. It is developed from the optic vesicle, an outpocketing of the forebrain. The optic nerve can therefore be considered part of the central nervous system, and examination of the nerve enables an assessment of intracranial health. Due to its unique anatomical relation to the brain,

the optic nerve is surrounded by the cranial meninges (not by epi-, peri- and endoneurium like most other nerves).



Anatomical Course

The anatomical course of the optic nerve describes the transmission of special sensory information from the retina of the eye to the primary visual cortex of the brain. It can be divided into extracranial (outside the cranial cavity) and intracranial components.

Extracranial

The optic nerve is formed by the convergence of axons from the retinal ganglion cells. These cells in turn receive impulses from the photoreceptors of the eye (the rods and cones).

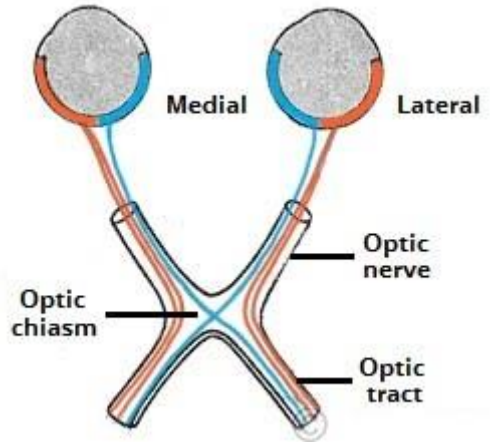
After its formation, the nerve leaves the bony orbit via the optic canal, a passageway through the sphenoid bone. It enters the cranial cavity, running along the surface of the middle cranial fossa (in close proximity to the pituitary gland).

Intracranial (The Visual Pathway)

Within the middle cranial fossa, the optic nerves from each eye unite to form the optic chiasm. At the chiasm, fibres from the nasal (medial) half of each retina cross over to the contralateral optic tract, while fibres from the temporal (lateral) halves remain ipsilateral:

Left optic tract – contains fibres from the left temporal (lateral) retina, and the right nasal (medial) retina.

Right optic tract – contains fibres from the right temporal retina, and the left nasal retina.



Each optic tract travels to its corresponding cerebral hemisphere to reach the lateral geniculate nucleus (LGN), a relay system located in the thalamus; the fibres synapse here. Axons from the LGN then carry visual information via a pathway known as the optic radiation.

Clinical Relevance: Pituitary Adenoma

A pituitary adenoma is a tumour of the pituitary gland. Within the middle cranial fossa, the pituitary gland lies in close proximity to the **optic chiasm**. Enlargement of the pituitary gland can therefore affect the functioning of the optic nerve. Compression to the optic chiasm particularly affects the fibres that are crossing over from the nasal half of each retina. This produces visual defect affecting the peripheral vision in both eyes, known as a **bitemporal hemianopia**.

Bitemporal hemianopia, affecting the lateral visual fields in both eyes.