Cranial cavity

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The brain in the skull is surrounded by three membranes or meninges:

1- **DURA MATER**

2- **ARACHNOID MATER**

3- **PIA MATER**
Made of two layers:

a-The periosteal layer
b-The meningeal layer

These are closely united except along where they separate to form

1- **VENOUS SINUSES**
2- **DURAL FOLDS**

Contains meningeal arteries
A-The periosteal layer

- Is the **ordinary periosteum** covering the inner surface of the skull bones

- **It does not extend** through the foramen magnum

- Around the margins of all the foramina in the skull it becomes continuous with the periosteum on the outside of the skull bones

- At the sutures it is continuous with the sutural ligaments.
B-The meningeal layer

- Is the dura mater proper
- It is a dense, strong, fibrous membrane
- Covers the brain and is continuous through the foramen magnum with the dura mater of the spinal cord
- It provides tubular sheaths for the cranial nerves as they pass through the foramina in the skull
- Outside the skull the sheaths fuse with the epineurium of the nerves
The two layers of dura separate from each other at numerous locations to form two unique types of structures:

1- **Dural folds (partitions):** incompletely separates parts of the brain
2- **Venous sinuses:** Intracranial (dural) venous sinuses

The meningeal layer sends inward

**FOUR SEPTA**

1- Falx cerebri
2- Falx cerebelli
3- Tentorium cerebelli
4- Diaphragma sellae
The meningeal layer sends inward SEPTA.
Occipital lobe

Cerebellum

Horizontal fold of dura
1-Falx cerebri

- Is a sickle-shaped fold of dura mater
  - Lies in the midline between the two cerebral hemispheres
  - In front is attached to the crista galli and frontal crest
    - Its posterior part blends in the midline with the upper surface of the Tentorium cerebelli
The upper fixed border of falx cerebri is attached at midline to internal surface of skull cap.
Tentorium cerebelli

- Is a tent-shaped fold of dura mater (horizontal projection)
- Roofs over the posterior cranial fossa
- Divides the cranial cavity into:
  1. SUPRATENTORIAL
  2. INFRATENTORIAL
- Separates the cerebellum from the occipital lobes

Ends anteriorly at the anterior and posterior clinoid processes

Tentorial notch is an oval opening in the midline

It is attached by its convex border
  **behind:** to the occipital bone along the grooves for the transverse sinuses
  **in front:** to the superior border of the petrous part of the temporal bone on either side, enclosing the superior petrosal sinuses
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Anterior and posterior clinoid processes

Superior borders of the petrous part of the temporal bone (enclosing the superior petrosal sinuses)

Occipital bone (Grooves for the transverse sinuses)
3- Falx Cerebelli
- Is a small vertical fold of dura mater
- Attached:
  - Posteriorly to internal occipital crest
  - Superiorly to tentorium cerebelli
- Lies in the midline between the two cerebellar hemispheres

4- Diaphragma sellae
- Is a small horizontal fold of dura mater that forms the roof for the sella turcica
- A small opening in its center allows passage of the stalk of the pituitary gland (connecting the pituitary gland with the base of the brain)
Sella turcica
Hypophyseal fossa

Diaphragma sellae
Is attached to the 4 clinoid processes
The falx cerebri and the falx cerebelli are attached to the upper and lower surfaces of the tentorium, respectively.
- The **superior sagittal sinus** runs in the upper **margin of falx cerebri**
- The **inferior sagittal sinus** runs in the lower **margin of falx cerebri**
- The **straight sinus** runs along the falx cerebri attachment to the **tentorium cerebelli**
The **superior petrosal sinus** runs along the attachment of tentorium cerebelli to the superior border of petrous bone

The **transverse sinus** runs along the attachment of tentorium cerebelli to the occipital bone
- The **superior petrosal sinus** along the attachment of tentorium cerebelli to the superior border of petrous bone
- The **transverse sinus** runs along the attachment of tentorium cerebelli to the occipital bone
The Venous Blood Sinuses

- They are intracranial blood filled spaces
- Run between the layers of the dura mater or the dural fold
- They are lined by endothelium
- Their walls are thick and composed of fibrous tissue
- Valveless
- They have no muscular tissue
- They receive tributaries from the brain, the diploe of the skull, Emissary veins, meninges, the orbit, and the internal ear
- Eventually lead to internal jugular vein
The internal jugular vein leaves the skull by passing through jugular foramen

The internal jugular vein
The superior sagittal sinus

- Lies in the upper fixed border of the falx cerebri
- It becomes continuous with the right transverse sinus.
In the midline is a shallow sagittal groove containing the SUPERIOR SAGITTAL SINUS.

The upper fixed border of falx cerebri is attached at midline to internal surface of skull vault.

On each side of the groove are several small pits, called GRANULAR PITS.
The superior sagittal sinus
Receives
1- Superior cerebral veins
2- Meningeal veins
3- Two parietal emissary veins
4- Emissary vein through foramen cecum
4- Arachnoid villi
**Parietal foramina** transmit emissary veins from scalp to the superior sagittal sinus

**Foramen caecum:** may transmit emissary vein from the nose to the superior sagittal sinus (Cecum: blind)
The inferior sagittal sinus

- Lies in the free lower margin of the falx cerebri
- It runs backward and joins the great cerebral vein to form the straight sinus

The straight sinus

- Lies at the junction of the falx cerebri with the tentorium cerebelli
- Formed by the union of the inferior sagittal sinus with the great cerebral vein
- It drains into the left transverse sinus
The transverse sinus

- The right transverse sinus is usually a continuation of the superior sagittal sinus
- The left transverse sinus is usually a continuation of the straight sinus

- Each transverse sinus lies along the attachment of tentorium cerebelli to the occipital bone
- Each sinus ends by becoming the sigmoid sinus
Superior sagittal sinus
Occipital lobe
Transverse sinus
Cerebellum
The sigmoid sinuses

- (left & right)
- Drain from the transverse sinus and superior petrosal sinus and continues as internal jugular vein

The occipital sinus

- Lies in the attached margin of the falx cerebelli
Sulcus for the **Inf. Petrosal sinus**  
(Incorrect border of petrous bone)

Sulcus for the **Sup. Petrosal sinus**  
(Superior border of petrous bone)

Groove for the **sigmoid sinus**

Groove for the **transverse sinus**  
(On each side of the internal occipital protuberance)

**Occipital sinus** runs along the internal occipital crest
The sigmoid sinus continues as internal jugular vein.

- Superior sagittal sinus----right transverse sinus
- Inferior sagittal sinus---straight sinus----left transverse sinus
- Transverse sinus + superior petrosal sinus= sigmoid sinus
- Inferior petrosal sinus drains directly into internal jugular vein
Anterior compartment: inferior petrosal sinus
Middle compartment: 9\textsuperscript{th}, 10\textsuperscript{th} and 11\textsuperscript{th} nerves
Posterior compartment: internal jugular vein

At the root of the neck, it unites with the subclavian vein to form the **brachiocephalic vein**

Right and left brachiocephalic veins unite to form the **superior vena cava**
Note

- The superior petrosal sinus runs along the upper border of the petrous part of the temporal bone

- The inferior petrosal sinus runs along the lower border of the petrous part of the temporal bone
Cavernous sinuses

- Lies on the lateral side of the body of the sphenoid bone

Very important clinically because of their connections and the structures pass through them.
Cavernous sinuses lie on the lateral side of the body of the sphenoid bone.
Intercavernous sinuses

Anteriorly, the sinus receives

1. Ophthalmic veins
2. The central vein of the retina

The sinus drains posteriorly into:

Superior petrosal sinus
Inferior petrosal sinus

Then
Superior petrosal sinus and
Transverse sinus drain into sigmoid sinus

Inferior petrosal sinus passes through jugular foramen to drain directly into Internal jugular vein

Intercavernous sinuses
CONNECTIONS OF CAVERNOUS SINUS

1- **Ophthalmic veins** connect cavernous sinus with the facial vein

2- **Emissary veins** connect cavernous sinus with pterygoid plexus of veins in the infratemporal fossa

These two connections are an important route for the spread of infection from the face
The deep facial vein connects the facial vein with the pterygoid venous plexus.
Important Structures Associated With the Cavernous Sinuses
1-Internal carotid artery
2-Sixth cranial nerve

In the lateral wall
1- Third cranial nerve
2- Fourth cranial nerve
3- Ophthalmic and maxillary divisions of the fifth cranial nerve
4- The pituitary gland, which lies medially in the sella turcica

Note:
The mandibular division is not associated with cavernous sinus

!!!!!!
The pituitary gland is a small, oval structure attached to the undersurface of the brain by the infundibulum. The gland is well protected in the sella turcica of the sphenoid bone.
Facial vein

Superior and inferior ophthalmic veins

Cavernous sinus

Note: venous communication (via the ophthalmic veins) between the **facial vein** and the **cavernous sinus**

Danger triangle of the face

Cavernous sinus syndrome
Cavernous sinus syndrome

- Sepsis from the central portion of the face or paranasal sinuses

**Clinical manifestations:**
- Ophthalmoplegia with diminished pupillary light reflexes
- Venous congestion leading to periorbital edema
- Exophthalmos
- Pain or numbness of the face

Subsequent infection or inflammation in the cavernous sinus can result in damage to any of the cranial nerves that pass through it
Exophthalmos is a bulging of the eye anteriorly out of the orbit.

Ophthalmoplegia is the paralysis or weakness of the eye muscles.
Mainly from the **middle meningeal artery**

- Arises from the maxillary artery in the infratemporal fossa.
- It passes through the foramen spinosum to lie between the meningeal and periosteal layers of dura.
Maxillary artery

Middle meningeal artery

Superficial temporal artery

External carotid artery

Maxillary artery
VAULT OF THE SKULL
Inferior view

The internal surface of the vault presents:

Grooves for the middle meningeal artery
The anterior (frontal)
- Passes in an almost vertical direction to reach the vertex of skull
- Crosses the pterion during its course

The posterior (parietal)
- Passes in a posterosuperior direction

Middle meningeal artery passes through the foramen spinosum
**Pterion**: is an area located on the floor of the temporal fossa where 4 bones meet at an H-shaped structure.

1- Frontal  
2- Parietal  
3- Squamous part of temporal bone  
4- Greater wing of sphenoid

The pterion is the thinnest part of the lateral wall of the skull. It overlies the anterior division of the middle meningeal artery and vein.

Epidural bleeding
Pterion surface marking
(2.5 to 4 cm) above the midpoint of the zygomatic arch
Dural Nerve Supply
Branches of the trigeminal, vagus, and upper cervical nerves

The dura is sensitive to stretching, which produces the sensation of headache.

Stimulation of the sensory endings of the trigeminal nerve above the level of the tentorium cerebelli produces referred pain to an area of skin on the same side of the head (trigeminal distribution).

Stimulation of the dural endings below (posterior cranial fossa) the level of the tentorium produces referred pain to the back of the neck and back of the scalp along the distribution of the greater occipital nerve.

Meningitis and stiff neck
Remember

Referred pain refers to the phenomenon of feeling pain in a region that is not actually the source of the pain.
The arachnoid mater is a delicate membrane covering the brain and lying between THE PIA MATER INTERNALLY and THE DURA MATER EXTERNALLY.

It is separated from the dura by a potential space, THE SUBDURAL SPACE, and from the pia by THE SUBARACHNOID SPACE, which is filled with cerebrospinal fluid.
Arachnoid Mater of the Brain

- In certain areas the arachnoid projects into the venous sinuses to form arachnoid villi.

- The arachnoid villi are most numerous along the superior sagittal sinus.

- Aggregations of arachnoid villi are referred to as **arachnoid granulations**.

- Arachnoid villi serve as sites where the cerebrospinal fluid diffuses into the bloodstream.
- The cerebrospinal fluid (CSF) is produced within the ventricles of the brain.

- It escapes from the ventricular system of the brain through the three foramina and so enters the subarachnoid space.

- It now circulates both upward over the surfaces of the cerebral hemispheres and downward around the spinal cord.

- Eventually, the fluid enters the bloodstream by passing into the arachnoid villi and diffusing through their walls.

The spinal subarachnoid space extends down as far as the second sacral vertebra.
Ventricles of the brain
On each side of the superior sagittal groove are several small pits, called **GRANULAR PITS (Foveolae)**. **GRANULAR PITS** are indentation of the skull formed by arachnoid granulations.
Neonatal Skull

- **Fontanelles**: unossified membranous intervals
- **Anterior fontanelle**: (diamond) closed by 18 months
- **Posterior fontanelle**: (triangular) closed by 12 months
- Important clinically, *why?*
Clinical Features of the Neonatal Skull

**FONTANELLES**
Palpation of the fontanelles enables the physician to determine
1. The progress of growth in the surrounding bones
2. The degree of hydration of the baby
   - If the fontanelles are depressed below the surface, the baby is dehydrated.
   - A bulging fontanelle indicates raised intracranial pressure.
Samples of cerebrospinal fluid can be obtained by passing a long needle obliquely through the anterior fontanelle into the subarachnoid space.
Facial nerve can be damaged by forceps in a difficult delivery. **Why?**

In the newborn infant, the mastoid process is not developed, and the facial nerve, as it emerges from the stylomastoid foramen, is close to the surface. Thus, it can be damaged by forceps in a difficult delivery.
Intracranial Hemorrhage

Epidural hemorrhage
Subdural hemorrhage
Subarachnoid hemorrhage
Intracerebral hemorrhage
1. Loose connective tissue (danger area)
   - In scalp injuries, this is the layer in which separation occurs.
   - Infection can easily spread in this layer.
   - Blunt trauma can result in hemorrhage in this layer (blood can spread forward into the face, resulting in "black eyes").

2. Rupture of the middle meningeal artery (branches) by fracture of the inner table of bone results in extradural hematoma. Under pressure, the blood progressively separates dura from the bone.

3. Tear to cerebral vein where it crosses dura to enter cranial venous sinus can result in subdural hematoma. The tear separates a thin layer of meningeal dura from that which remains attached to the periosteal layer. As a result, the hematoma is covered by an inner limiting membrane derived from part of the meningeal dura.

4. Aneurysm
   - Ruptured aneurysms of vessels of the cerebral arterial circle hemorrhage directly into the subarachnoid space and CSF.
The most common artery to be damaged is the anterior division of the **middle meningeal artery**.

Results from a blow to the side of the head, resulting in fracture of the skull in the region of **Pterion**.

Bleeding occurs and strips up the meningeal layer of dura from the periosteal layer (lining of skull bone).

The intracranial pressure rises, and the enlarging blood clot exerts local pressure on the underlying motor area.
Lucid interval

- Lucid interval is a temporary improvement in a patient's condition after a traumatic brain injury, after which the condition deteriorates.
- It occurs after the patient is knocked out by the initial concussive force of the trauma, then lapses into unconsciousness again after recovery when bleeding causes the hematoma to expand past the point at which the body can no longer compensate.

A lucid interval is especially indicative of an epidural hematoma.

An estimated 20 to 50% of patients with epidural hematoma experience such a lucid interval. It can last minutes or hours.

Lucid interval (no symptoms) for a few hours followed by death ("talk and die syndrome")

To stop the hemorrhage, the torn artery or vein must be ligated or plugged. The burr hole through the skull wall should be placed about 1 to 1.5 in. (2.5 to 4 cm) above the midpoint of the zygomatic arch.
Subdural hemorrhage

Results from tearing of the cerebral veins at their point of entrance into the superior sagittal sinus (bridging veins)

The cause is usually excessive anteroposterior displacement of the brain within the skull. **A violent shaking** of the head (e.g., child abuse or car accident) and commonly occurs in alcoholics and elderly.

Blood accumulates in the potential space between the dura and the arachnoid.
<table>
<thead>
<tr>
<th>Epidural</th>
<th>Subdural</th>
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<tbody>
<tr>
<td>Between the skull and dura matter (between</td>
<td>Between dura and arachnoid matter</td>
</tr>
<tr>
<td>the periosteal and meningeal layers of</td>
<td></td>
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<tr>
<td>dura matter</td>
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<tr>
<td>Rupture to meningeal vessels (middle</td>
<td>Rupture to cerebral veins (bridging veins)</td>
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<tr>
<td>meningeal A)</td>
<td>while approaching the venous sinus</td>
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<tr>
<td></td>
<td>(superior cerebral veins)</td>
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<tr>
<td>Lense shaped (Biconvex)</td>
<td>Crescent shaped</td>
</tr>
<tr>
<td>Well localized</td>
<td>Poorly localized</td>
</tr>
<tr>
<td>Mostly arterial</td>
<td>Mostly venous</td>
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Subarachnoid hemorrhage

Extravasation of blood into the subarachnoid space between the pia and arachnoid

Occurs in the setting of a ruptured cerebral aneurysm or arteriovenous malformation

The diagnosis is established by withdrawing heavily blood-stained cerebrospinal fluid through a lumbar puncture (spinal tap).

Note: cerebral arteries, veins and cranial nerves pass through the subarachnoid space
Cerebral hemorrhage

- Caused by bleeding within the brain tissue itself
- Most commonly caused by hypertension