MENINGES

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KGMC

Three layers of membranes known as meninges cover brain and spinal cord. They include

1. Pia mater (innermost)
2. Arachnoid mater
3. Dura mater (outermost)

CSF is present between pia and arachnoid mater.

PIA MATER

Pia mater is delicate and highly vascular. It closely covers all surfaces of CNS. Pia mater makes a special structure around the spinal cord called **denticulate ligament.** On each side, there are 21 denticulate ligaments. The denticulate ligaments are bilateral triangular lateral extensions of pia mater that anchor the spinal cord to the dura mater.

ARACHNOID MATER

Arachnoid mater is non vascular. The space between pia and arachnoid mater is called **subarachnoid space** and it contain CSF.

Lower end of spinal cord is called conus medularis. Pia mater extends upto conus medularis but dura and arachnoid mater goes further down. Only a small string of pia mater extends down from conus medularis (upto S2). This string of pia mater is called **filum terminale.**

In adult person, the spinal cord terminates at the level of lower border of L_2. Usually we take a sample of CSF through the lumbar puncture at L_5. Here CSF can be drawn out without causing any injury to the spinal cord.

DURA MATER

Brain substance itself is not sensitive to pain but dura mater is sensitive to pain. Dura mater makes three main important folds:

1. Falx cerebri
2. Tentorium cerebelli
3. Diaphragm sellae

These folds prevent excessive movement of brain within brain cavity.

NERVE SUPPLY TO DURA MATER

Trigeminal ganglion has three divisions i.e. ophthalmic, maxillary and mandibular.

The ophthalmic division give branches to dura mater in anterior cranial fossa. The maxillary division give branches to dura mater in middle cranial fossa.

If there is some tumor or some injury in supra tentorial area involving the supra tentorial meninges or disturbing the supra tentorial dura mater, the pain will be referred in areas supplied by ophthalmic division or maxillary division.

Dura mater of posterior cranial fossa receives a branch from vagus nerve or meningeal branch from C_1, C_2, C_3 cranial nerves. Pathologic lesions in posterior cranial fossa will give referred pain in the back of head and neck.

DURA MATER LAYERS

1. Periosteal layer (close to skull)
2. Meningeal layer

At some places, meningeal layer is not attached to periosteal layer and makes a space which is lined by endothelial cells. This space through which blood is running is called dura sinus.

Apart from venous dural sinuses, the periosteal and meningeal layers are very close to each other but sometimes due to pathologic conditions, space may be created.

Meningeal arteries and veins run between periosteal and meningeal dura mater.

EPIDURAL SPACES

Two types of epidural space:

1. Cranial epidural space
2. Vertebral epidural space

Cranial epidural space is not an actual space, it is a potential space between periosteal and meningeal layer of dura mater.

Vertebral epidural space is an actual space. Normally this actual space is loose areolar connective tissue with some lymphatics and some venous plexus.

CISTERNS

In some areas, CSF filled cavity is large and is called cistern e.g. cerebello medullary cistern, interpudencular cistern, superior cistern etc.

EPIDURAL HEMORRHAGE

Epidural or extradural hemorrhage is a collection of blood that forms between skull and dura mater as a result of injury to an artery. The most common cause of epidural hemorrhage is injury to the skull, most commonly to the temple especially if it involves the **rupture of anterior branch of middle meningeal artery and vein**. A lucid interval is especially indicative of an epidural hematoma.

A **lucid interval** is the period of time between regaining consciousness after a short period of unconsciousness resulting from a head injury and deteriorating after the onset of neurological signs and symptoms caused by that injury. In other words, the patient can be conscious and appear normal right after an injury, but as the blood accumulates the headache will worsen and mental status will decline as the intracranial pressure rises.

If epidural hematoma is suspected, immediate CT scan should be done. In almost all cases, epidural hematomas are seen on CT scans of the brain. They are typically bi-convex in shape. Epidural hematoma do not cross suture lines because of tight adherence of the dura to the calvarium and thus has a biconvex or elliptical appearance.

SUBDURAL HEMORRHAGE

Tearing of **bridging veins** during rapid or sudden changes in velocity (deceleration injury) thereby causing an accumulation of venous blood below the dura but above the arachnoid mater.

Deceleration injury is an impact injury to a body within or upon a rapidly moving object caused by the forces exerted when the object is brought to a sudden halt.

It occurs more frequently in elderly patients due to reduced brain volume and "stretched" bridging veins.

Sudden fall or sudden rotation of the head may break these bridging veins.

This type of hemorrhage cross suture lines since bleeding is below the dura, which is tightly attached to the calvarium, thus giving crescent-shaped appearance on head CT.

This type of hemorrhage is the diagnosis of unexplained fluctuating levels of consciousness.

SUB-ARACHNOID HEMORRHAGE

There are many blood vessels in the sub-arachnoid space which are approaching to the CNS. One very important circle of blood vessels which are present in sub-arachnoid space is **circle of Willis**. This circle of blood vessels is present at the base of the brain in sub-arachnoid space. Usually in circle of Willis, some people develop aneurysms. Aneurysms are abnormal irreversible dilatations of vessel walls. Sometimes some people have small berry aneurysms that are abnormal dilatations of blood vessels participating in circle of Willis. These aneurysms may spontaneously rupture and produce severe hemorrhage in sub-arachnoid space.

CAUSES OF SUB-ARACHNOID HEMORRHAGE:

1. Berry aneurysm (about 80%)
2. Arteriovenous malformations

Sudden, very severe headache may indicate sub-arachnoid hemorrhage.

Presence of RBCs on lumbar puncture indicate sub-arachnoid hemorrhage.

INTRA CEREBRAL HEMORRHAGE

Patients with chronic hypertension develop micro-aneurysms and sometimes they rupture causing intra-cerebral hemorrhage. Special feature of intra-cerebral hemorrhage is it will lead to neurological deficit.

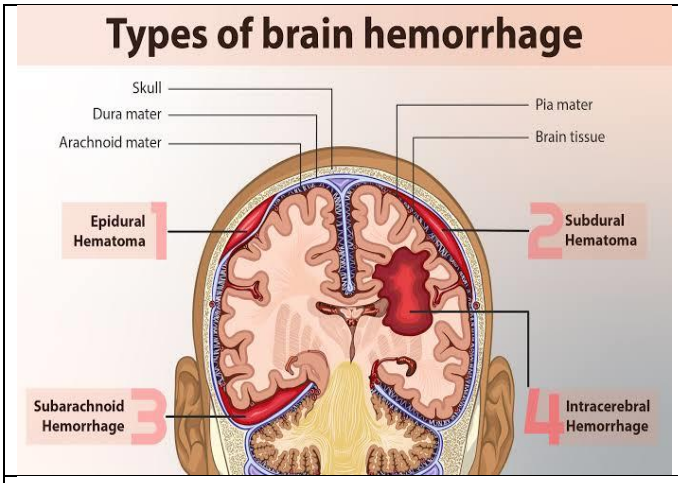
SUMMARY

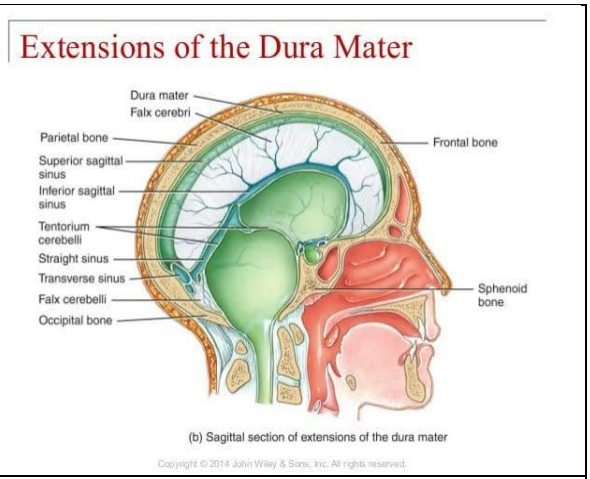
If hemorrhage is between skull and dura mater → Epidural hemorrhage

If hemorrhage is between dura and arachnoid mater → Subdural hemorrhage

If hemorrhage is between arachnoid and pia mater → Subarachnoid hemorrhage

If hemorrhage is within pia and within brain substance → Intracerebral hemorrhage


Types of brain hemorrhage
Skull
Dura mater
Arachnoid mater
Pia mater
Brain tissue
Epidural Hematoma
1
2
Subdural Hematoma
Subarachnoid Hemorrhage
3
4
Intracerebral Hemorrhage


Extensions of the Dura Mater
Dura mater
Falx cerebri
Parietal bone
Frontal bone
Superior sagittal sinus
Inferior sagittal sinus
Tentorium cerebelli
Straight sinus
Transverse sinus
Falx cerebelli
Occipital bone
Sphenoid bone
(b) Sagittal section of extensions of the dura mater
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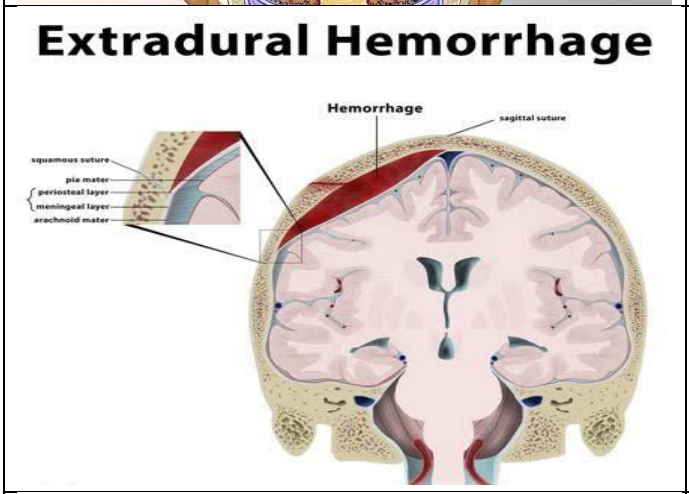
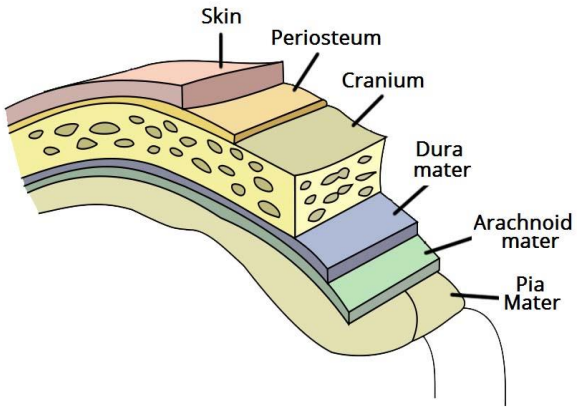
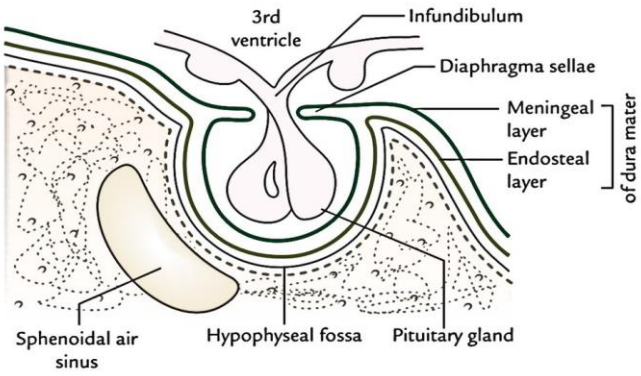

Extradural Hemorrhage
Hemorrhage
sagittal suture
squamous suture
pia mater
periosteal layer
meningeal layer
arachnoid mater

MENINGES


Skin
Periosteum
Cranium
Dura mater
Arachnoid mater
Pia Mater


3rd ventricle
Infundibulum
Diaphragma sellae
Meningeal layer
Endosteal layer
of dura mater
Sphenoidal air sinus
Hypophyseal fossa
Pituitary gland