Computed Tomography HEAD CT SCAN

- Prepared By: Ahmed Jasem Abass
  MSC Medical Imaging

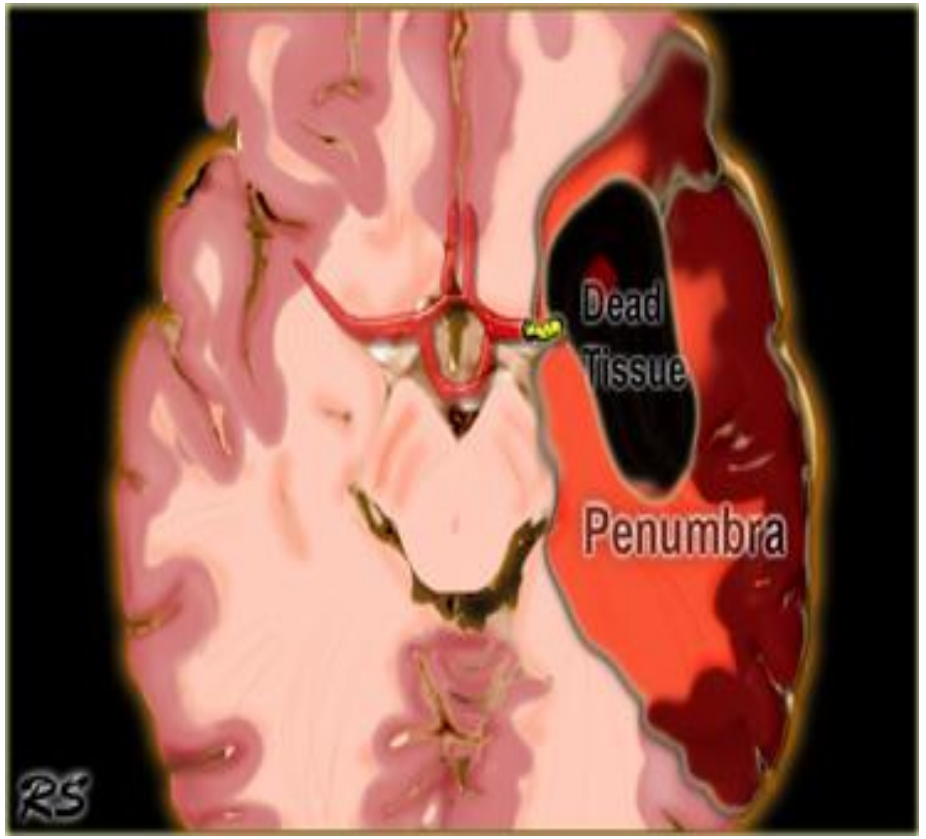




Imaging in Acute Stroke

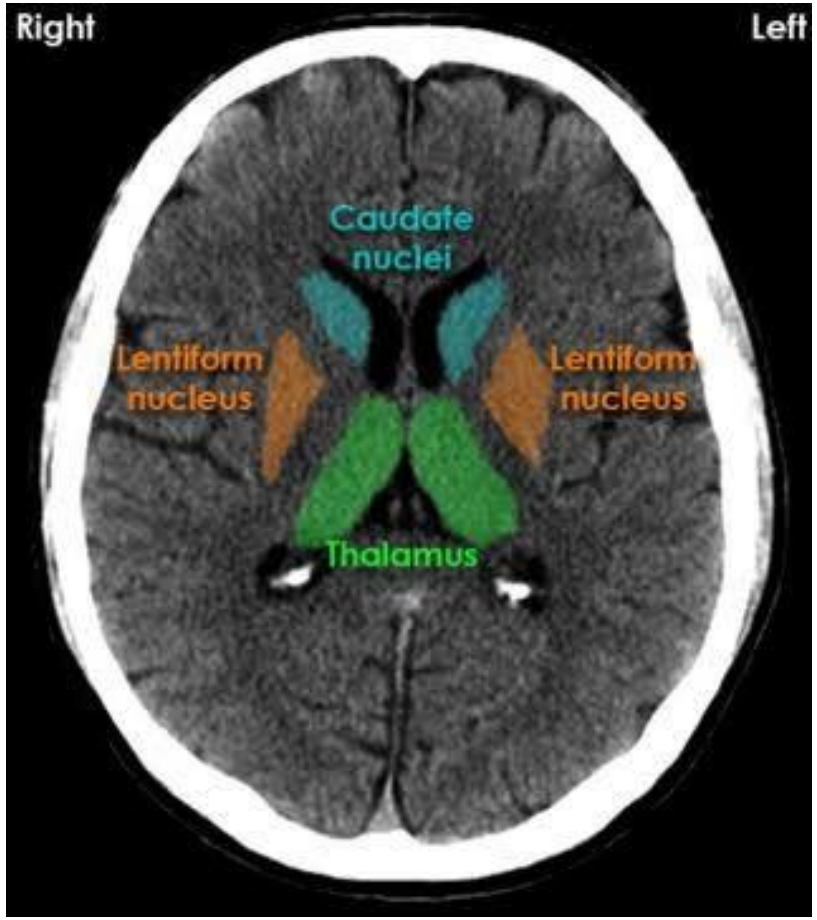
- The goal of imaging in a patient with acute stroke is:

- Exclude hemorrhage.
- Differentiate between irreversibly affected brain tissue and reversibly impaired tissue (dead tissue versus tissue at risk).
- Identify stenosis or occlusion of major extra- and intracranial arteries.



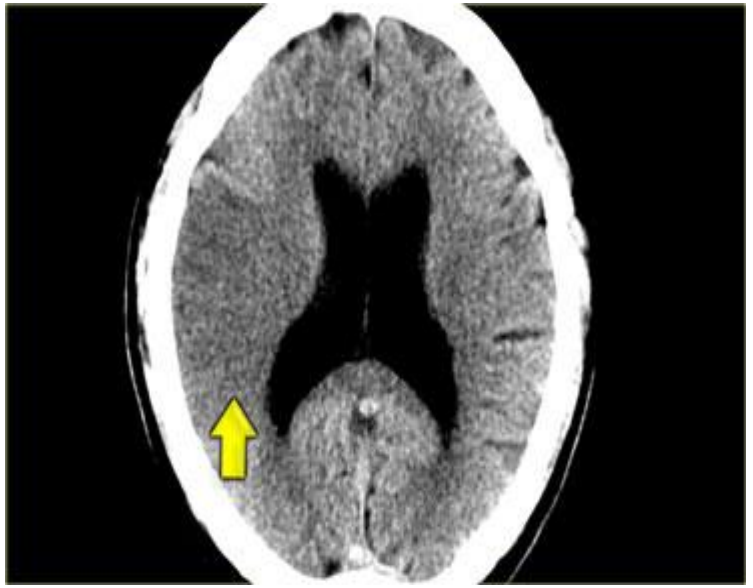
CT Early signs of ischemia

- Hypo attenuating brain tissue.
- Obscuration of the lentiform nucleus.
- Insular Ribbon sign.
- Dense MCA sign.
- Hemorrhagic infarcts.



Hypo attenuating brain tissue

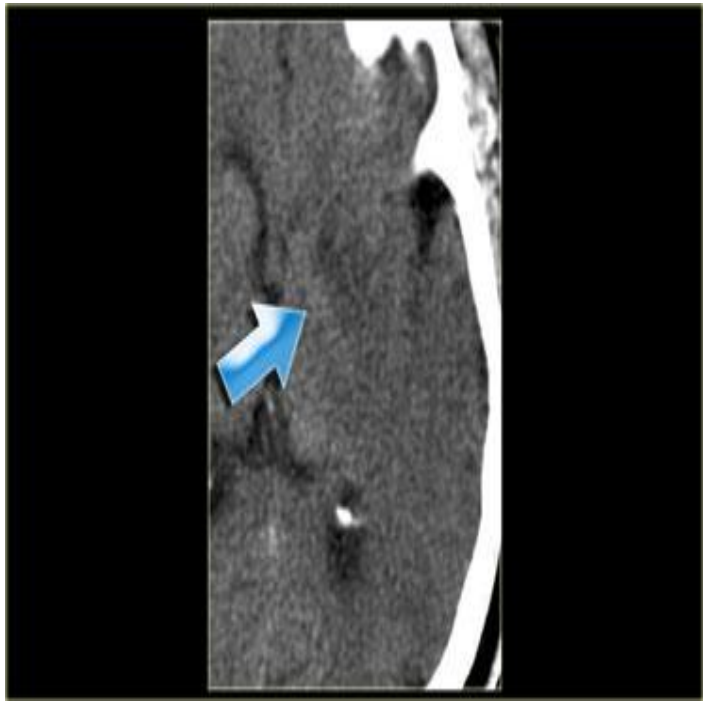
- The reason we see ischemia on CT is that in ischemia cytotoxic edema develops as a result of failure of the ion-pumps.
- These fail due to an inadequate supply of ATP.
- An increase of brain water content by 1% will result in a CT attenuation decrease of 2.5 HU.
- On this patient with hypoattenuating brain tissue in the right hemisphere.
- The diagnosis is infarction, because of the location (vascular territory of the middle cerebral artery (MCA) and because of the involvement of gray and white matter, which is also very typical for infarction.



What Is ATP? Energy used by all Cells Adenosine Triphosphate Organic molecule containing high-energy Phosphate bonds

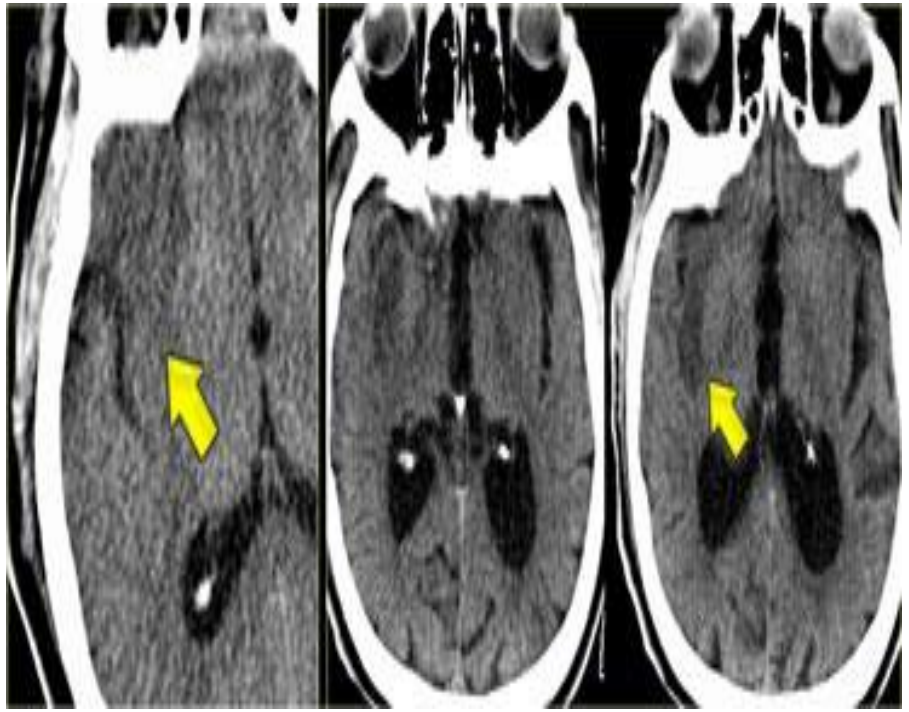
Obscuration of the lentiform nucleus

- Obscuration of the lentiform nucleus, also called blurred basal ganglia, is an important sign of infarction.
- It is seen in middle cerebral artery infarction and is one of the earliest and most frequently seen signs (2).
- The basal ganglia are almost always involved in MCA-infarction.



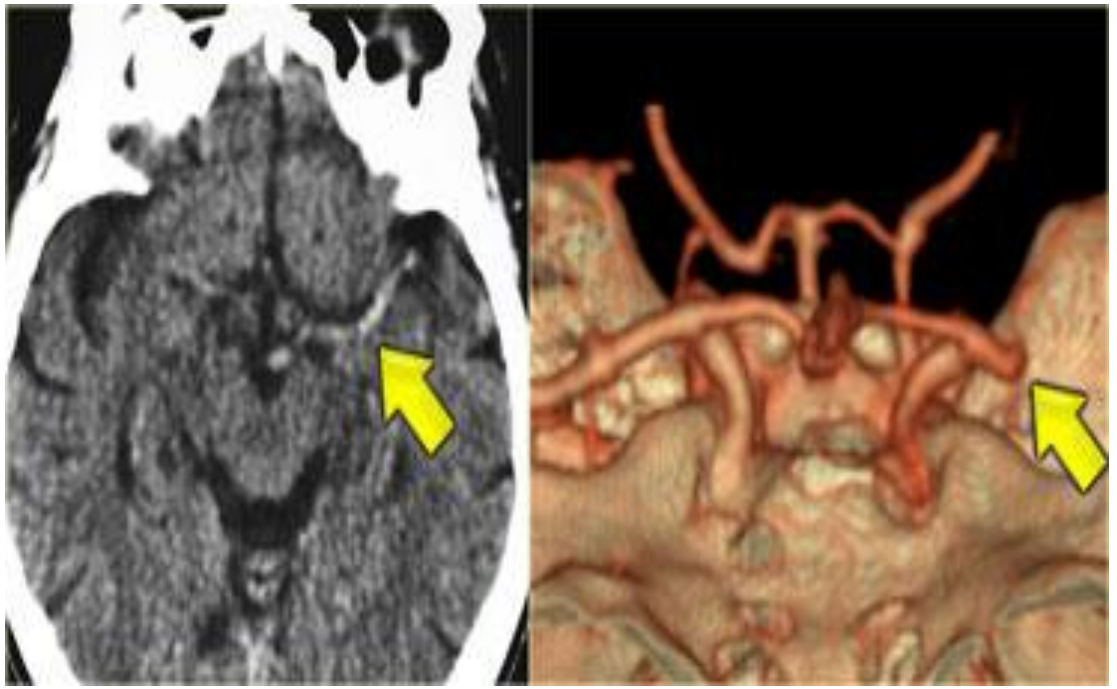
Insular Ribbon sign

- This refers to hypodensity and swelling of the insular cortex.
- It is a very indicative and subtle early CT-sign of infarction in the territory of the middle cerebral artery.
- This region is very sensitive to ischemia because it is the furthest removed from collateral flow.
- It has to be differentiated from herpes encephalitis.



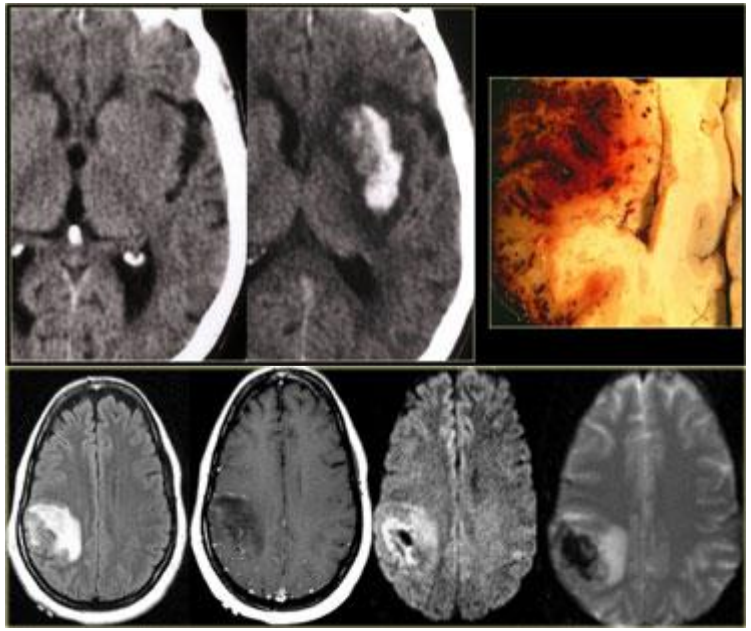
Dense MCA sign

- This is a result of thrombus or embolus in the MCA.
- On the left a patient with a dense MCA sign.
- On CT-angiography occlusion of the MCA is visible.



Hemorrhagic infarcts

- 15% of MCA infarcts are initially hemorrhagic.
- Hemorrhage is most easily detected with CT, but it can also be visualized with gradient echo MR-sequences.



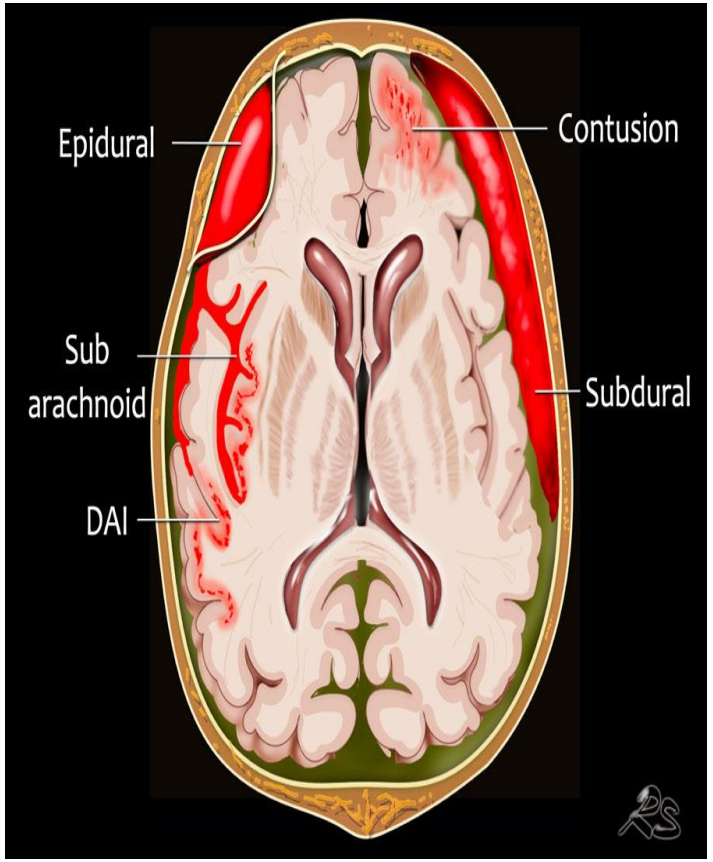
Traumatic Intracranial Hemorrhage

- Any type of bleeding inside the skull or brain is a medical emergency.
- The most common causes of hemorrhage are trauma, haemorrhagic stroke and subarachnoid haemorrhage due to a ruptured aneurysm.
- Complications are increased intracerebral pressure as a result of the hemorrhage itself, surrounding edema or hydrocephalus due to obstruction of CSF.



Localization of hemorrhage

- Subarachnoid hemorrhage is acute bleeding under the arachnoid. Most commonly seen in rupture of an aneurysm or as a result of trauma.
- Subdural hematoma is a bleeding between the inner layer of the dura mater and the arachnoid mater of the meninges. It usually results from traumatic tearing of the bridging veins that cross the subdural space in patients with anticoagulantia therapy.
- Epidural hematoma is bleeding in the virtual space between the dura mater and the skull. Seen in fracture of the temporal bone with rupture of the middle meningeal artery.
- Intra-axial hemorrhage - intracerebral
- Cerebral hemorrhagic contusion small post-traumatic hemorrhages located near the skull in the area of the coupe and contre-coup, most commonly frontobasal and anterior in the temporal lobes. Sometimes in combination with a subdural hematoma or subarachnoid hemorrhage.
- Diffuse axonal injury (DAI). Diffuse injury at the level of the gray-white matter junction seen in high velocity injuries. CT has low sensitivity. Better seen on MRI.

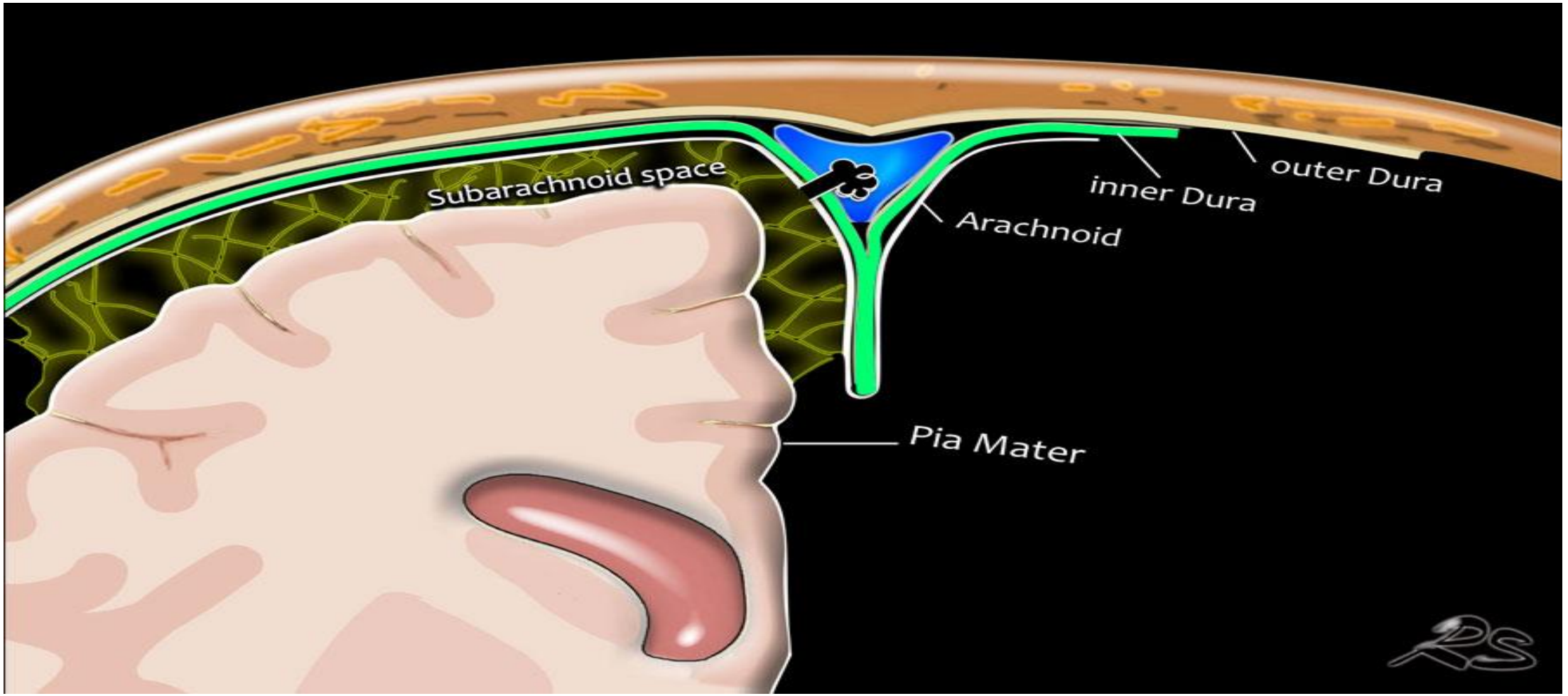


Localization of hemorrhage

Anatomy of the meninges

- Meninges are the three membranes that envelop the brain and spinal cord: the dura mater, the arachnoid mater, and the pia mater.
- Cerebrospinal fluid is located in the subarachnoid space between the arachnoid mater and the pia mater.
- Dura mater is the outermost meningeal layer that covers the brain and spinal cord.
- It consists of two layers: the inner meningeal layer and the outer periosteal layer.
- Arachnoid is a layer with delicate fibres which extend down through the subarachnoid space and attach to the pia mater.
- Arachnoid granulations - also called Pacchionian granulations - are small protrusions of the arachnoid mater through the outer membrane of the dura mater into the dural venous sinuses of the brain, and allow cerebrospinal fluid to exit the subarachnoid space and enter the blood stream.
- Pia mater is the innermost layer covering the brain.
- The pia mater allows blood vessels to pass through and nourish the brain.
- The arachnoid and pia mater together are sometimes called the leptomeninges.

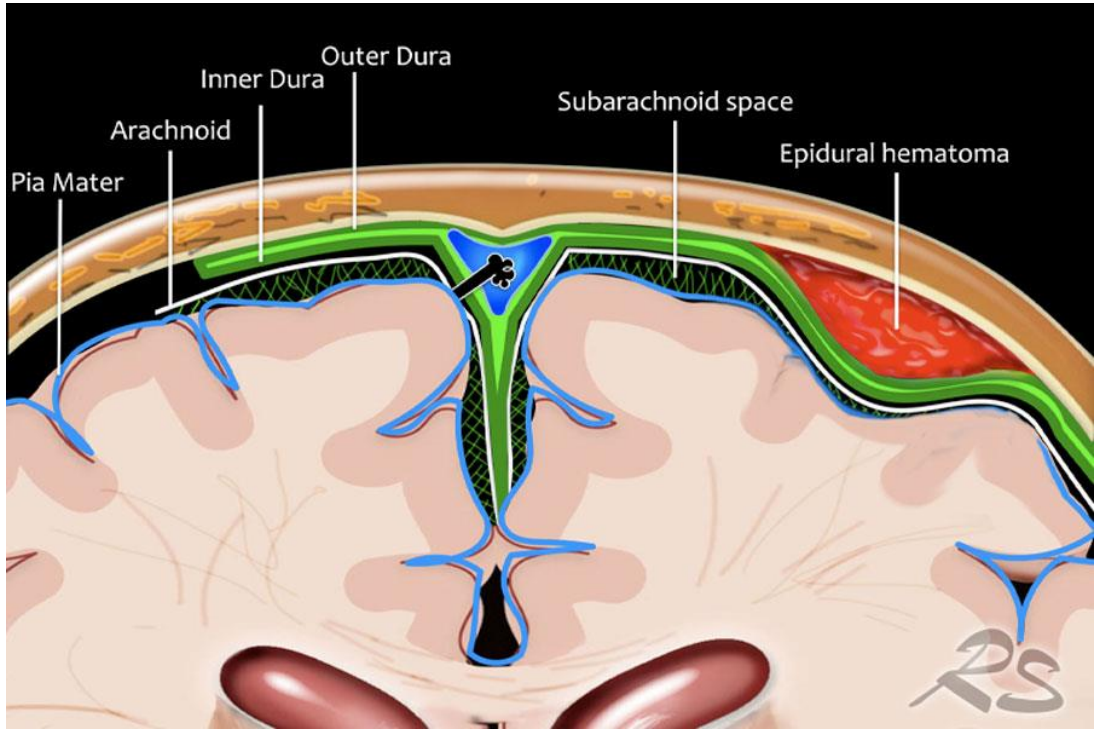
Anatomy of the meninges



Traumatic hemorrhage

- Epidural hematoma
- An epidural hematoma is a bleeding that occurs between the dura and the skull.
- It is mostly seen in children who have a head injury with fracture of the temporal bone resulting in tearing of the middle meningeal artery.

- In theory an epidural hematoma can cross the midline because it is located between the dura and the skull.
- However since the dura is tightly adherent to the adjacent skull near suture lines, an epidural hematoma usually does not cross suture lines.

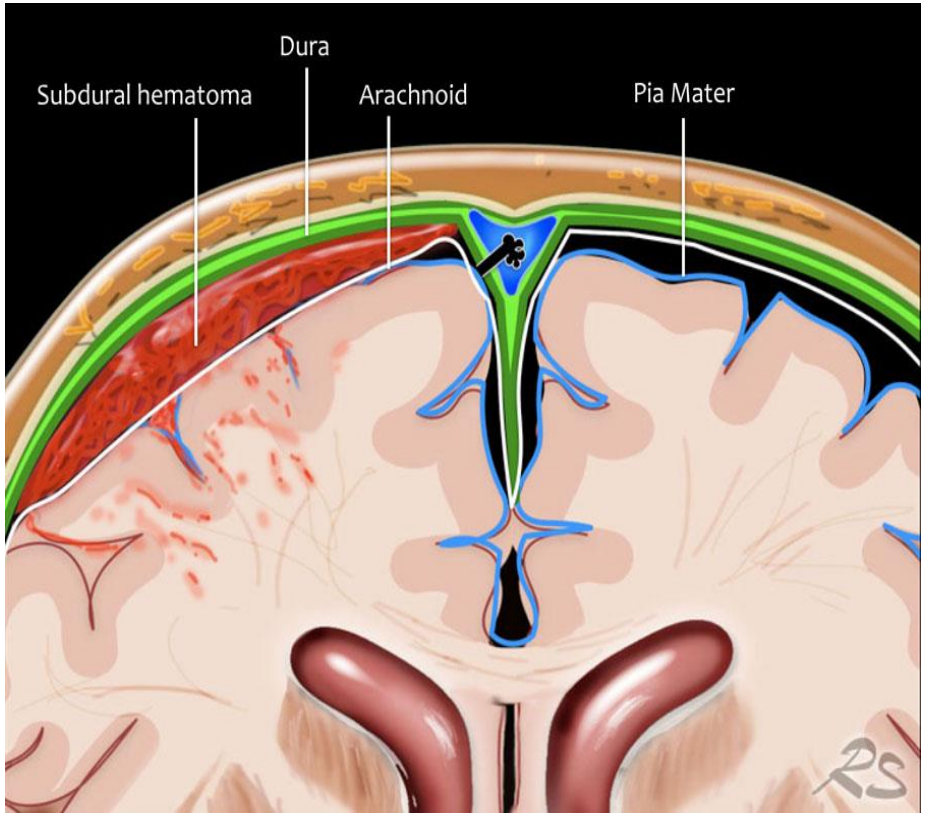


Subdural hematoma

- A subdural hematoma is a collection of blood between the inner layer of the dura and the arachnoid.
- It cannot cross the midline, but can be located near dural folds like the falx or the tentorium.

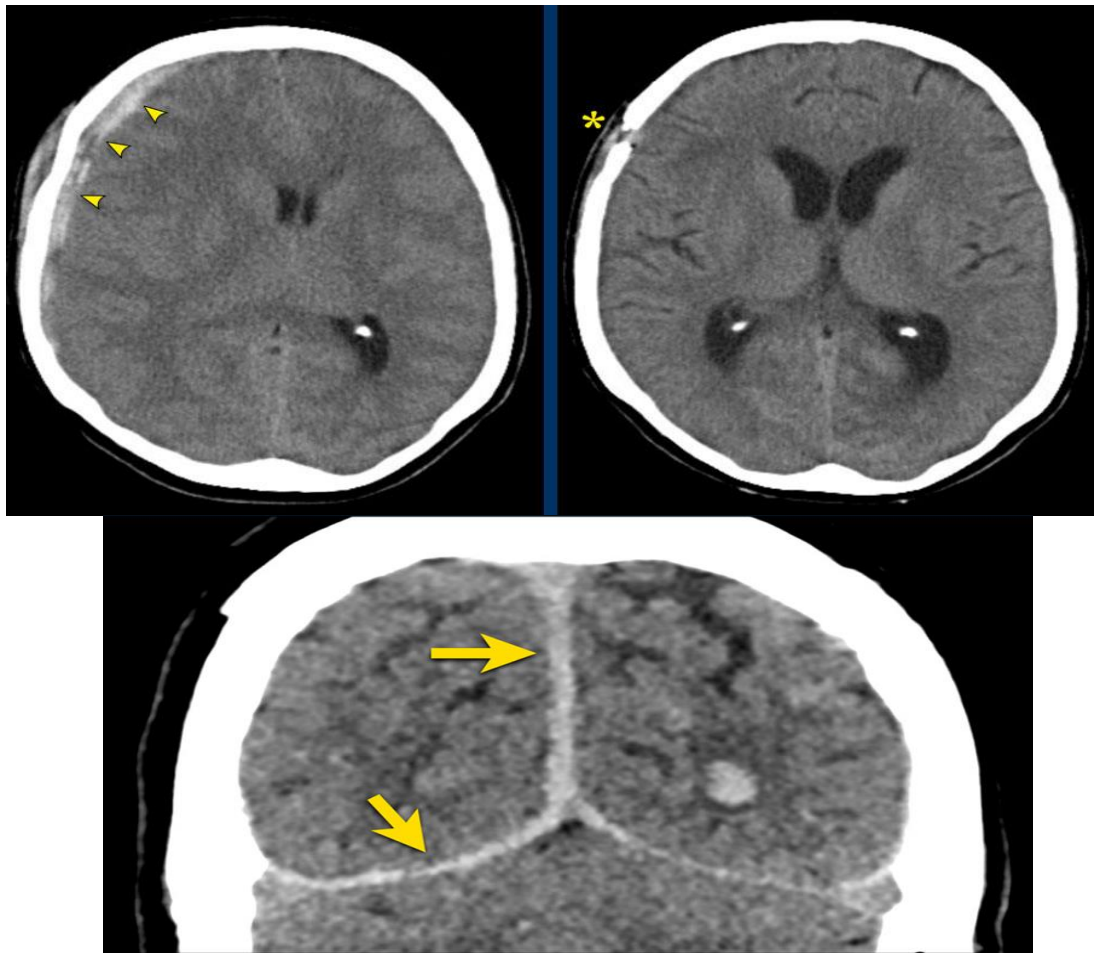
- It usually results from rupture of the cortical bridging veins.
- It usually occurs in head trauma and especially in patients who are treated with antcoagulantia.

- It is most common in elderly and alcoholics with atrophy.
- In brain atrophy the venous subdural structures are less well “packed” against the skull, which give them more space to move and possibility to torn.



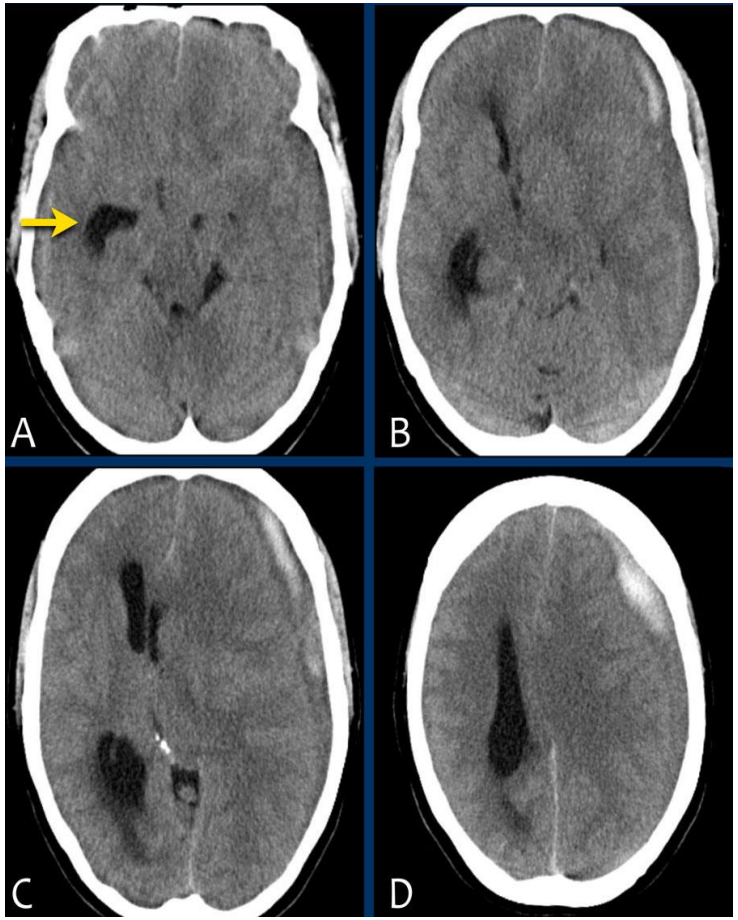
Subdural hematoma

- This patient has an acute subdural hematoma.
- There is midline shift (left image).
- The patient was operated and the hematoma was evacuated (right image).
- A subdural hematoma can spread along the falx and tentorium as seen in this case.



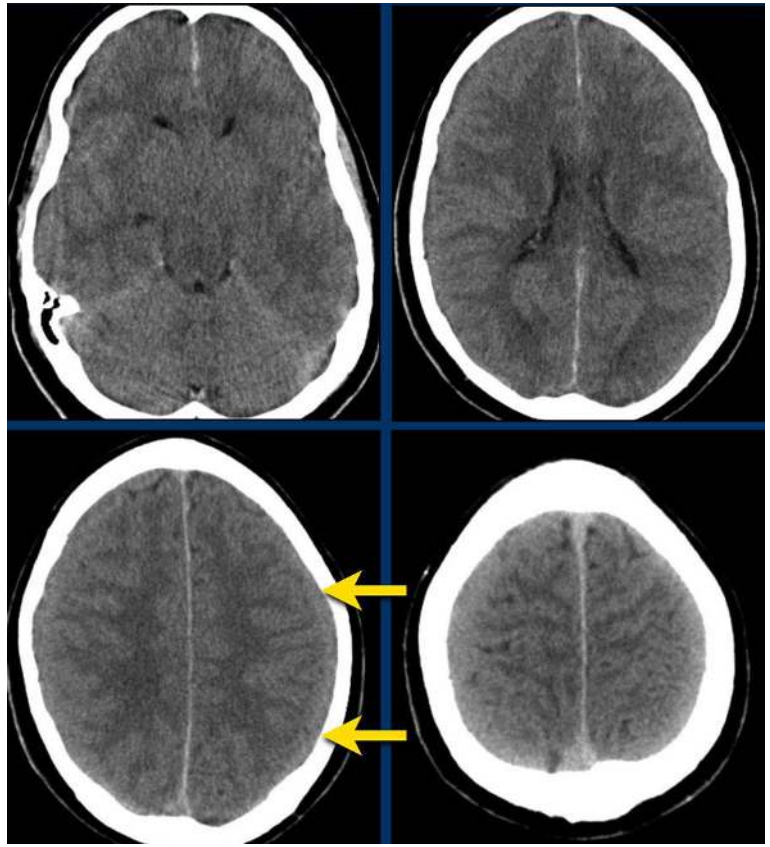
The images show a subdural hematoma.

- Notice that the hematoma has both hyperdense and isodense areas.
- This can be seen in hyperacute bleeding, but can also be seen in rebleeding.
- There is displacement of midline structures with obstruction of CSF flow resulting in dilatation of the temporal horn of the right lateral ventricle (arrow).
- An acute subdural hematoma is hyperdens (clotted blood), a subacute hematoma is isodens and a chronic subdural hematoma appears hypodens to brain parenchyma (isodens to CSF).
- Sign of active bleeding
- In the acute setting, a subdural hematoma can appear heterogenous, because of the mixed components of the hemorrhage: fresh in flow of non clotted blood (hypodens) and clotted blood (hyperdens).



Isodense subdural hematoma

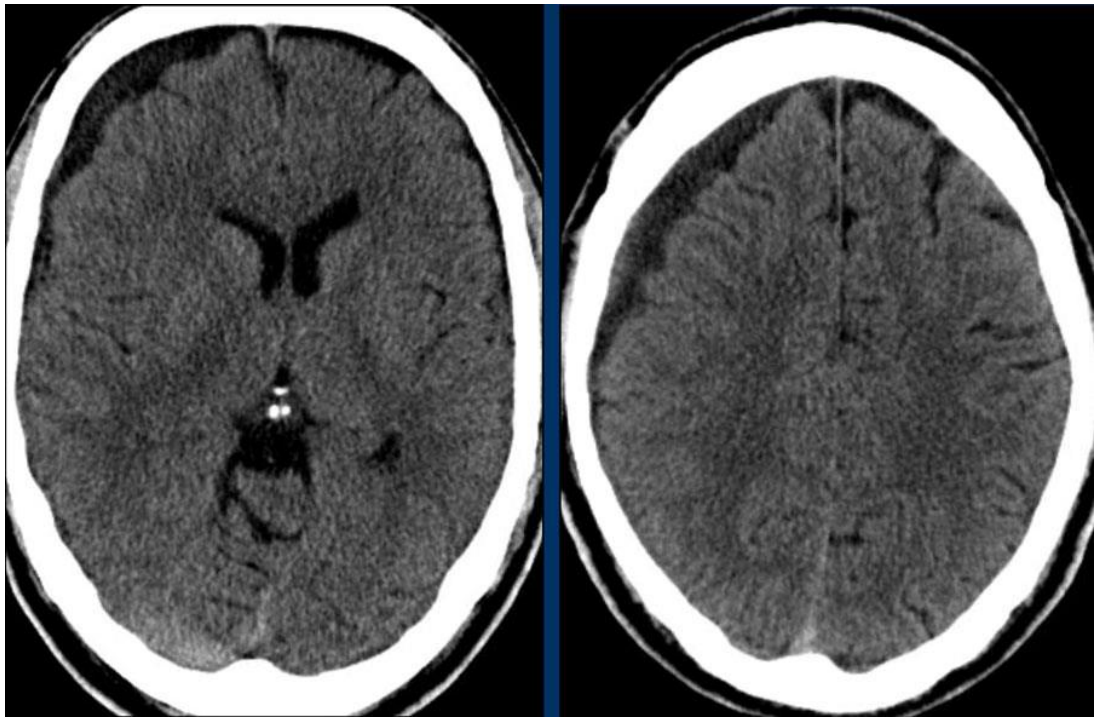
- As a subdural hematoma ages, the density of the hematoma will decrease and may be the same as the density of the brain, which make it difficult to detect the hematoma.
- Here a case of an isodense subdural hematoma which is very hard to detect (arrows).
- Notice that on a higher level there is a bilateral subdural hematoma.
- In rare cases an acute subdural hematoma may be isodense to the brain.
- This is seen in patients with severe anemia, disseminated intravascular coagulation, or if the hematoma is diluted with cerebrospinal fluid (ref).



chronic subdural hematoma

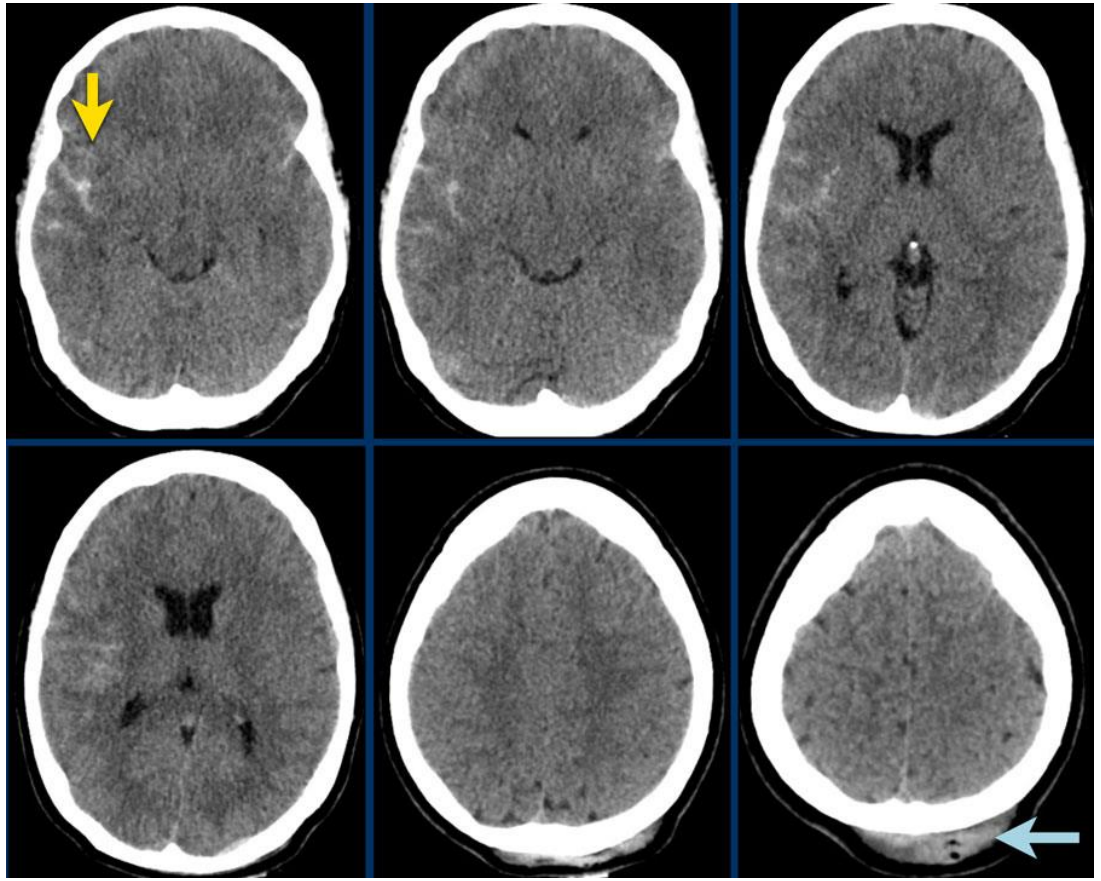
- When a chronic subdural hematoma (> 21 days) becomes hypodens to parenchyma and isodens to CSF, it may mimick a hygroma.

- A hygroma is the result of a traumatic torn in the arachnoid layer which causes CSF to leak to the subdural space,.



Subarachnoid hemorrhage

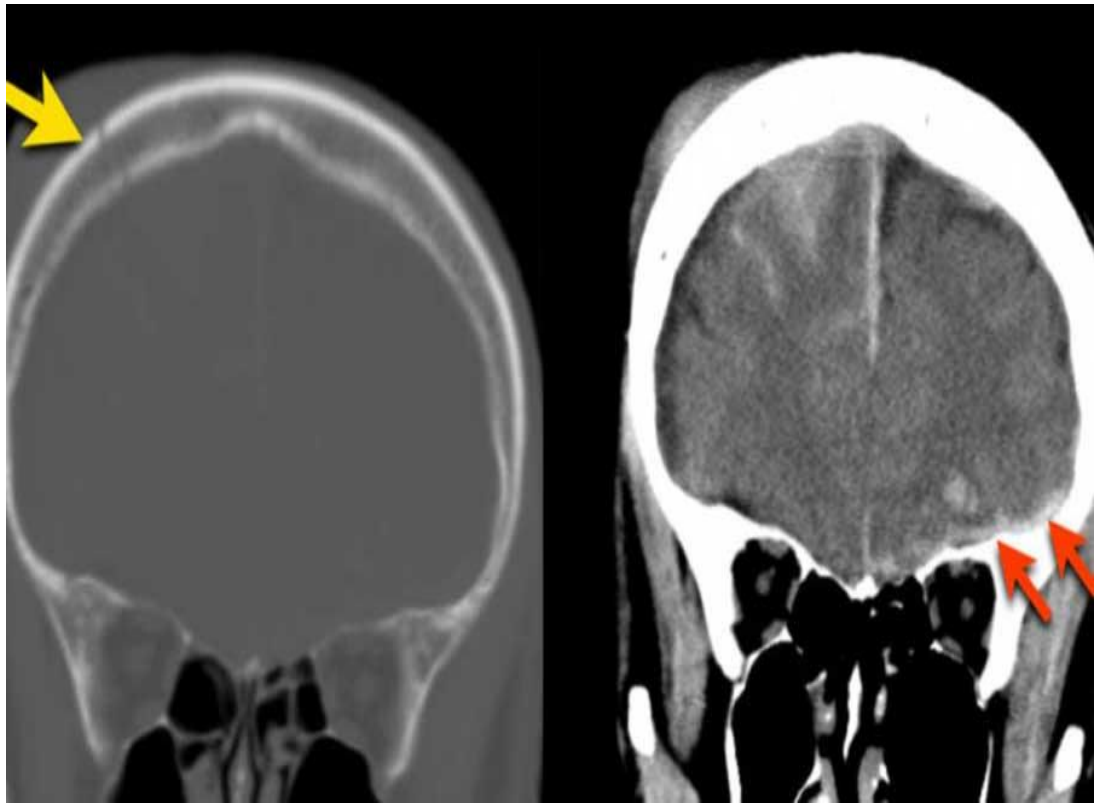
- The images show hyperdense blood in the subarachnoid space of the Sylvian fissure (yellow arrow).
- Notice the subgaleal hemorrhage in the right occipital region (blue arrow).
- This is a coupe contrecoupe type of injury.



coupe contrecoupe type of injury

- This is another coupe contrecoupe type of injury with contusional hemorrhages and a subdural hematoma in the left frontal lobe near the skull base (red arrow).

- There is a subarachnoid hemorrhage on the right with a fracture of the parietal bone (yellow arrow).




Thank You!
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