جَائِزَة ٱلْحُسَيْنُ
بْن عَبْدِ ٱللَّهِ ٱلثَّانِي
لِلْعَمَلِ ٱلتَّطَوُّعِيِّ

النادي الطبي
Medical Club

Radiology

Subject: Neuro Imaging (Brain)

Group no: ٥١

Done by: Hala Yaseen



هَذَا خَلْقُ اللَّهِ فَأَرُونِي مَاذَا خَلَقَ الَّذِينَ مِن دُونِهِ ۚ بَلِ الظَّالِمُونَ فِي ضَلَالٍ مُّبِينٍ

Radiology

تفريغ ال Introduction حول وسائل التصوير التشخيصي (Diagnostic Modalities)

أولاً: مقارنة بين الوسائل (X-ray, CT Scan, Ultrasound, MRI)

• الأشعة السينية (X-ray) والـ CT scan كلاهما يُصدر X-rays، وبالتالي يطلقان radiation

• مقارنة بين الCT Scan والX-ray: إذا كان بالإمكان رؤية bony fracture على الـ X-ray، فبالتأكيد سيُرى بشكل أوضح على الـ CT scan . الـ X-ray يُصدر radiation ويُعطي معلومات عامة. بينما الـ CT scan يوفر more resolution (دقة أعلى)، ما يمنح تفاصيل أوضح.

• الـ Ultrasound والـ MRI لا يعتمدان على radiation

• النيوكلير مديسين (Nuclear Medicine): هي Modality خامسة في التشخيص. تُعتبر الـ Nuclear Medicine في الواقع specialty منفصلة تماماً عن Diagnostic Radiology ولها برنامج residency program منفصل. تُستخدم الـ Nuclear Medicine على سبيل المثال لتصوير PET Scan (Positron Emission Tomography) والذي يعطينا صور وظيفية للجسم تظهر نشاط الأنسجة وليس فقط شكلها.

ثانياً: المصطلحات المستخدمة في التصوير (Terminology)

في الأشعة السينية (X-ray) والراديولوجي العام، يتم التعامل دائماً مع grey scale من الأبيض إلى الأسود

- اذا ظهر الجسم باللون الأسود يُسمى Radiolucent.
- اذا ظهر باللون الأبيض يُسمى Radio-opaque أو Radio-opacity

في الـ CT Scan، يتم الحديث عن tissue density

- الشيء الأبيض يُسمى Hyperdense.
- الشيء الأسود يُسمى Hypodense.

في الـ Ultrasound، يتم الحديث عن tissue echogenicity

- الشيء الأبيض يُسمى Hyperechoic
- الشيء الأسود يُسمى Hypoechoic

في الـ MRI، يعتمد التصوير على magnetic field و signal intensity of the tissue، ويتم التعبير عن signal intensity بالـ grey scale

- الشيء الذي يعطي إشارة عالية يُسمى Hyperintense
- الشيء الأسود يُسمى Hypointense

ثالثاً: آلية عمل جهاز الـ Ultrasound

- جهاز الـ Ultrasound هو جهاز كمبيوتر موصول به probe
- يحتوي الـ probe على crystals تطلق sound waves
- هذه الـ sound waves ترتد على الأنسجة المختلفة.
- الأنسجة المختلفة مثل fluid، air، bone، fat، muscle ترتد عليها الموجات الصوتية بشكل مختلف.
- تعطي الموجات المرتدة قراءات تُسمى echoes أصداء، ولهذا السبب يُطلق على الجهاز أحياناً "جهاز الـ Echo"، مثل جهاز Echocardiogram، وهو ultrasound of the heart

* Depend on echogencity or density of the tissue.

* limitations → operator dependent

رابعاً: جهاز X-Ray وإجراءاته

Supine أي

- مكان الفحص: أغلب فحوصات الـ X-rays تُجرى على الـ table
- الفحوصات الوقوفية: بعض الفحوصات تتطلب أن يكون المريض stand (واقفاً)، وتُجرى على جهاز يسمى stand bucky، من أمثلتها: فحص chest X-ray، أو تقييم حالة effusion، أو عند تقييم الركبة حيث يجب أن يكون المريض على stand weight-bearing position تسمى bearing position

* Abd. X-ray → Erect and supine.

- مكونات الجهاز: يحتوي الـ X-ray tube على X-ray source بينما يحتوي الـ table والـ stand bucky على ما يسمى detector
- الديتكتور: قد يكون digital ويُسمى digital radiography (DR)، أو قد يكون cassette

في حالة الـ cassette، يتم وضعه في مكانه، يتم تصوير المريض، ثم يُؤخذ الـ cassette إلى جهاز يسمى (Computed Radiography) CR لـ "تحميله". أغلب الأجهزة حالياً هي digital، حيث تكون الـ detecto r مُدمجاً وتظهر الصورة مباشرة على الكمبيوتر.

- غرفة التحكم (Control Room): هي غرفة صغيرة يقف فيها فني الأشعة (radiographer) يقوم الفني بعمل positioning للمريض ويصور من هناك.
- العزل والسلامة: يجب أن تكون الغرفة معزولة. تُعزل الجدران والأبواب بالـ lead (الرصاص) لمنع خروج الـ radiation.

خامساً: جهاز CT Scan وإجراءاته

Axial, unipolar, multislides

• مكونات الجهاز: يحتاج الـ CT scan أيضاً إلى X-ray source يكون الـ X-ray source داخل حلقة تُسمى الـ gantry ويكون الـ detector مقابلاً للـ source

• أنواع الأجهزة: تختلف الأجهزة بعدد الـ detectors (مثلاً: 64 شريحة أو 512 شريحة)، وكلما زاد العدد، زادت دقة الـ resolution

• وضعية المريض: ينام المريض غالباً بوضعية supine position

• عملية التصوير: بينما يدخل المريض في الـ gantry، يدور الـ X-ray tube ليأخذ slices شرائح

• نوع الصورة: الـ CT scan هو one-plane imaging modality أو uniplanar imaging modality

تخرج الصور الأولية في مستوى واحد وهو الـ axial plane

يمكن التحكم في سُمك الشرائح الـ slice thickness

• السلامة والمخاطر: يتضمن الـ CT scan استخدام more X-ray beam ، وبالتالي more harm،

لا يُفضل أن يتم تصوير المريض دائماً بالـ CT scan

يجب أن تكون الغرفة معزولة بالـ lead ، وحتى الزجاج المستخدم هو lead glass

• الـ Contrast: يمكن إجراء فحص الـ CT scan باستخدام contrast أو بدونه.

• إدارة الـ Contrast: يتم استخدام automatic injector (حقن آلي) مربوط بـ workstation وذلك لأن التوقيت مهم جداً، فمثلاً لرؤية الشرايين (arteries) يجب أخذ الصور في توقيت معين (ثوان محددة، فترة قصيرة جدًا (عادةً 15–30 ثانية بعد بدء الحقن، حسب مكان الفحص وسرعة التدفق الدموي)) بعد الحقن للحاق بالـ contrast في الـ arterial phase بعد ثوان قليلة، تقريبًا عند 60–90 ثانية، ينتقل الـ contrast إلى ال venous، ويصعب اللحاق بهذا التوقيت بالحقن اليدوي.

سادساً: جهاز MRI وإجراءاته

- مكان العمل: يوجد جهاز الـ MRI داخل غرفة والـ workstation خارجها.

- العزل (الهدف): غرفة الـ MRI تُعزل لمنع دخول موجات الradio frequency (التردد اللاسلكي) إلى الداخل وإفساد الصورة. هذا العزل يُسمى Radiofrequency Isolation فالموجات مثل موجات الراديو والهاتف telephone waves، تؤثر على الـ MRI

- تصميم الجهاز: جهاز الـ MRI له gantry وهو على شكل نفق tunnel-like، يبلغ طول النفق تقريباً 2 meter

- مراقبة المريض: توجد كاميرا في الأعلى لرؤية المريض ومراقبته.

- المشكلة الأكثر شيوعاً في الـ MRI بسبب كونه مغلقاً وtunnel-like هي ال claustrophobia، الخوف من الأماكن المغلقة

- مدة الفحص مقارنة بالCT Scan: صور الـ CT scan تظهر خلال seconds بينما أقل فحص بالـ MRI يحتاج إلى 7 دقائق، وقد تستغرق بعض الفحوصات 45 دقيقة أو ساعة، وبسبب المدة الطويلة في المكان المغلق، قد يعاني بعض المرضى من claustrophobia

→ Axial, coronal, - -

- نوع الصورة (Planar): الـ MRI يسمى multiplanar imaging modality

- على عكس الـ CT scan الذي يُنتج الصور في مستوى واحد (one plane) ثم يتم إعادة بنائها (reconstruction) إلى coronal و sagittal، في الـ MRI، يمكن أخذ الصور مباشرة في أي مستوى مطلوب coronal أو sagittal من البداية

* open MRI system better for pts.

Closed system → min. (1.5) to max. (3T)

open system → max. (0.4)

* intensity → hyperintens
hypointens

X-Ray
CT
Nuclear medicine
→ ionizing radiation = harmful

MRI
US
→ safe in pregnancy

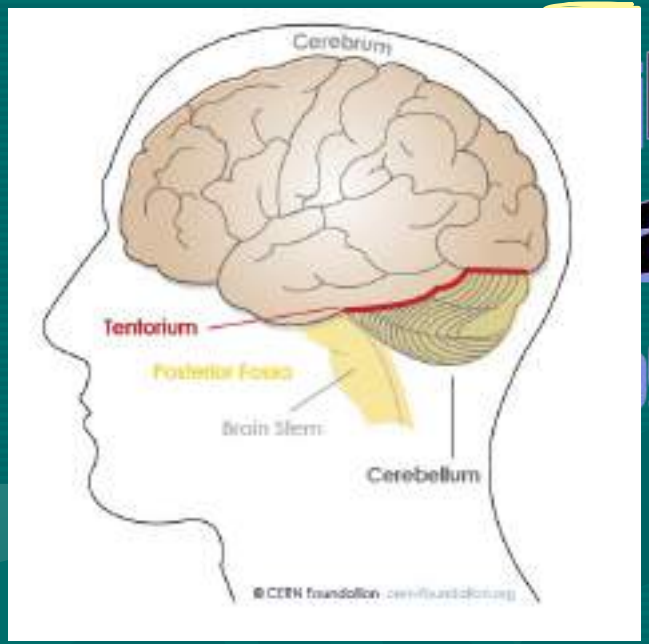
Brain is a vital organ, that Completely enclosed by bone (Skull)

Brain
- supratentorial (cerebrum: lobes)
- infratentorial (brain stem + Cerebellum)

NEURORADIOLGY

white matter: Centrally
gray matter: peripherally
and we have deeply seated gray matter (basal ganglia, thalami)

∴ it's covered by meninges: pia mater (A), arachnoid (B), dura mater (C)



l .Abo oura
ad .Abuain
gest .PHH

Eman Humaidat

4 radiological modalities:

x-ray, ultrasound, CT scan, MRI

(conventional)

*rule of x-ray in brain images? minor (skull fracture, bony lesion..) skull

So, we aren't use the x-ray to look the brain it'self.

But it has limitations regarding complexity of bone in the skull and overlap of bone especially in the base of skull

bone + Air → reflection All

*Role of ultra sound in brain images? in adult → no rule b. protect by Tis.

in neonate → minor rule

Computer connected with prop → sound waves → it goes through the tissue → and reflected back depending on density of tissue.

- bone → Complete reflection of the sound waves back, so we can't see anything beyond bone. hazzy

. we need a window to see s.th under bone (neonate) → open fontaniles.

. we use US to assess vasculority of the brain in the neck (carotid) ✱

neck → brain

* rule of CT scan in brain images? major (hemorrage, stroke, SAH....) bony Assement skull

is it good for bone? yes. in a better way. (best)

CT: more intense x-ray, any thing applied on x-ray, applied on CT scan in a better way.

we can assess soft tissue ( )

CT scan: for acute events. (① faster, ② avilable, ③ no limitations like MRI) (CT: uni planner imaging modalites).

bone → hyperdense

Fluid → hypodense

* MRI: * white matter disease
* bony tumors
* infection ....

MRI → pacemaker

* it has some limitation Ph with any devices.

4 ventricles: 2 lateral ventricles, connected to the 3rd by the foramen of monro.. 3rd & 4th connected by cerebral aqueduct of sylvius

White matter connecting 2 hemispheres: corpus callosum (rostrum, genu, body, splenium)

CT: you take axial, then reconstruction on the computer to get coronal section

MRI: multiplanar: axial, sagittal, coronal.. (T1, T2 or FLAIR)

Conventional angiography is invasive (like heart catheterisation), it's the gold-standard but is invasive.. مشكلتها

blood vessel

*فيها تدخل جراحي

So, Angiography using CT or MRI are good substitutes + are non-invasive

CT Ang.
MRI Ang.

جدول بنستخدم في diagnosis وما فيهم invasive

Ultrasound: hypo- or hyper- echoic (hyper is bright, hypo is dark)

X-ray: radio-opaque or radio-luscent

CT: hypo- or hyper- dense (bone is hyper-dense , white.. While fluid is hypo-dense)

MRI: signal intensity…

T1>> fluid is hypo-intense (black), WM is white, GM is grey

T2>> fluid is hyper-dense (white), WM is grey, GM is white

FLAIR>> same as T2 but fluid is black (Fluid-attenuated inversion recovery)

→ you can easily detect any fracture/ bony lesion

Skull X-ray



CT scan for the skull base of



Overlapping of bones



X-ray for thoracic spine > overlap with lung/ribs



CT scan for thoracic spine

Neuroradiology

- Neuroradiology is a subspeciality of radiology focusing on the diagnosis and characterization of abnormalities of the nervous system, spine, head and neck.
- The imaging modalities include:
  - **Plain radiography**
  - **CT scan**
  - **MRI**
  - **Angiography**: is being replaced in many instances by MRA / because it is invasive
  - **Ultrasound:** is used in limited circumstances.

operator dependence

Neuroradiolgy / investigation

Plain film

The plain skull film may reveal:

- Calcification
- Pituitary fossa enlargement
- Bone lesion or secondary deposit.
- Fractures

■ In macroadenoma >1cm .. may cause bone erosions
■ Bone lesions : as in pts of multiple myeloma→ on lateral skull x-ray we may see bone lesions

Very limited role in imaging the brain
We can use X-ray to rule out fracture but we typically use CT scan since it gives a clearer picture about the injury

ULTRASOUND

- The neonatal brain can be scanned through the open anterior fontanelle for:
  - Hydrocephalous → Delayed closure / wide Ant. fontanelle
  - Interventricular or intracerebral hemorrhage
  - Suspected intracranial pathology.
- Doppler studies are used for the diagnosis of carotid artery stenosis. → to asses vascularity for vertebral and carotid artery.

Neonates have the ant & post fontanelles + the mastoid process is cartilaginous – not ossified

★ craniosynostosis : when the sutures or the fontanelle are prematurely closed in infants before the full formation of the brain

★ Treatment by opening the sutures, to allow the baby's brains an adequate space to grow and develop.

★ Doppler for carotid artery : in elderly a calcifications in the carotid artery occurs which lead to narrowing or stenosis in it

uniplanar

CT and MRI

- CT is especially valuable in acute head injury (recent brain hemorrhage), stroke, and suspected subarachnoid hemorrhage.

In acute emergencies, CT is used rather than MRI bcz of it's availability, cost-effectiveness, rapid results + CT is enough in most acute cases

((CT scan doesn't show ischemic changes in the first 6 hrs))
BUT even in ischemic stroke, CT scan is important to exclude haemorrhage (helps the physician to decide whether it's ok to give anticoagulant..) … we can use MRI later for the characterisation of the infarction

- MRI scan demonstrate the brain using a multiplanar facility in axial, coronal, and saggital planes, with excellent views for the posterior fossa.

Use CT for detection of haemorrhage in acute events, MRI for anything else… tumours, localisation & timing of ischemic strokes, pituitary lesions >> MRI is better

CT and MRI / 2

MRI is superior to CT in:

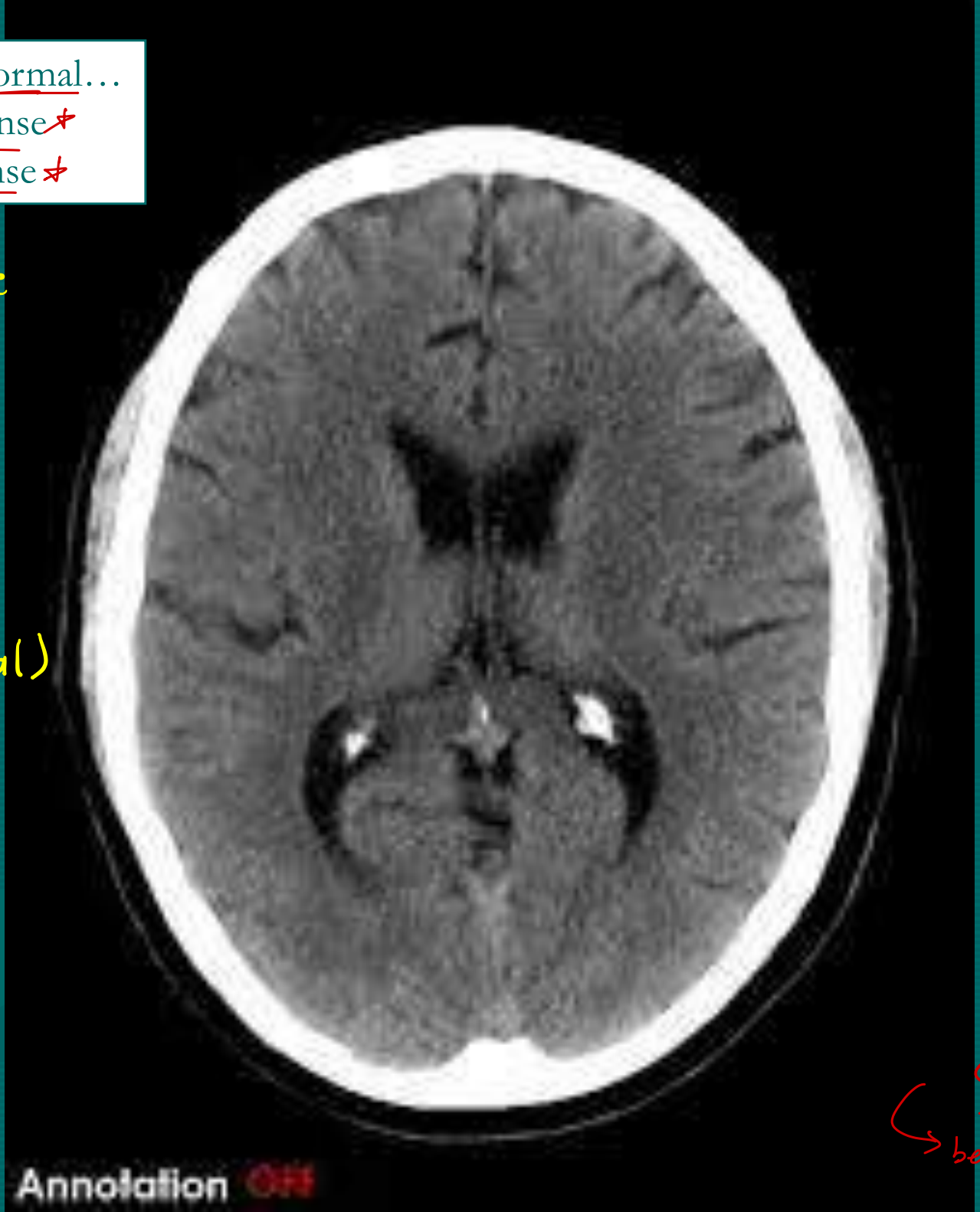
- Lesions of the pituitary fossa.
- Spinal cord abnormalities.
- White matter disease.
- Demyelinating plaques in multiple sclerosis.
- Differentiation of grey and white matter.

MRI indication:
Lesion in pituitary fossa :MRI for pituitary >>sagittal T1 with and without contrast

CT-scan, axial, normal…
Bone is hyper-dense ✱
Fluid is hypo-dense ✱

حلقة
- gantry + table
↓
rotating and
cut patient
into slices.

CT scan:
uniplanar (axial)
فقط واحنا
على الأكسيون
Sagittal بنعمل
or
Coronal

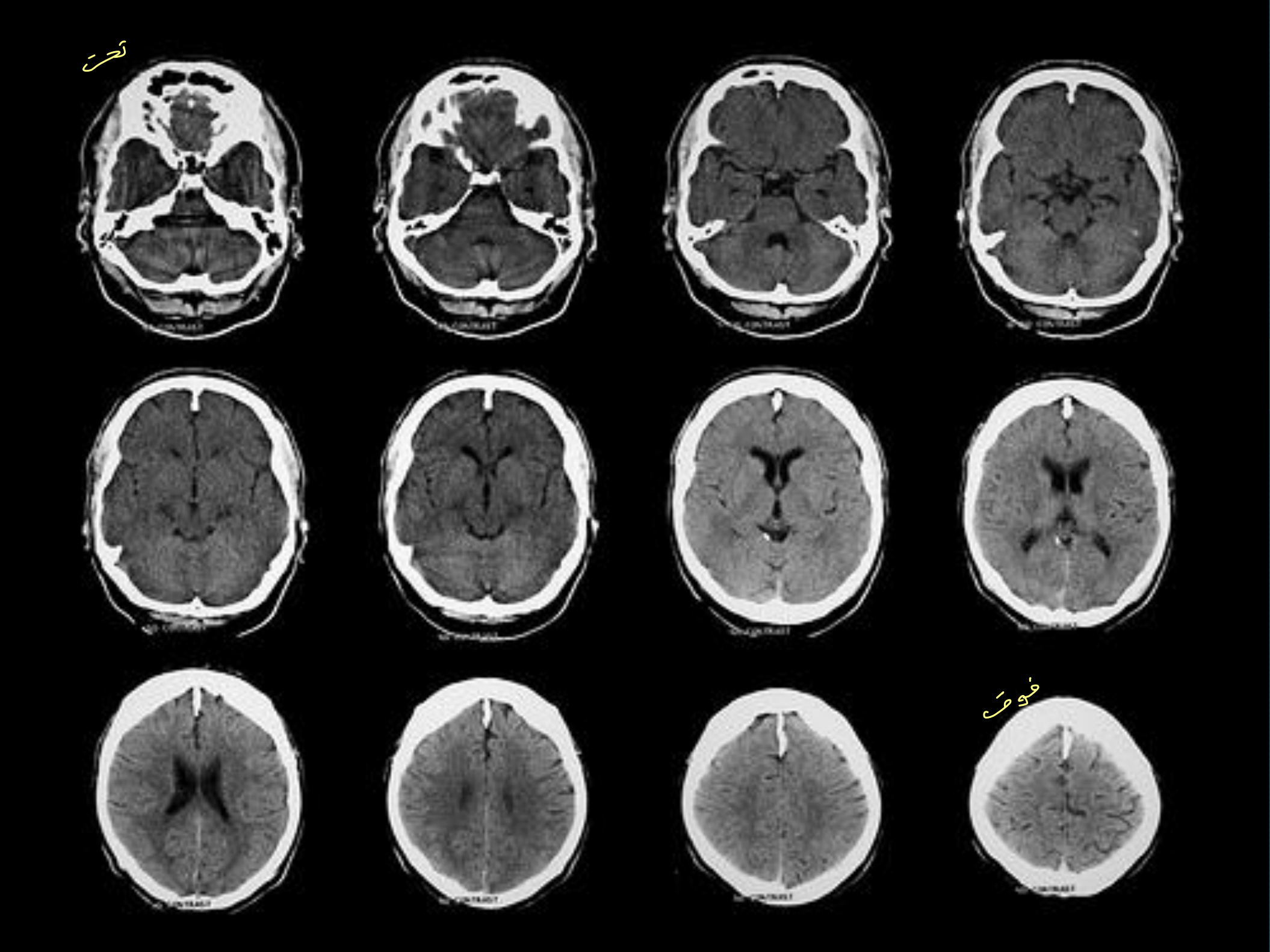


. bone:
white
"hyper dense"

. fluid:
"hypo dense"

. gray - white matter
Junctions
is not clear

better appearance on MRI than CT


تحت
فوق

Normal MRI, axial

Very imp. slide.



T1...	T2... عكس عكس	FLAIR...
WM is white ✓	WM is grey	WM is grey
GM is grey ✓	GM is white	GM is white
Fluid is hypo-intense (black) ✓	Fluid is hyper-intense (white)	Fluid is hypo-intense (black)

T2 → suppress fluid signals

* . sequences of MRI : appearance تغيير of tissue

Arteriography

* modality of choice to any blood vessels pathology
* Gold standard

imaging of blood vessels

- Cerebral angiogram is useful in evaluation of aneurysm and arterio-venous malformations.

  - Arteriography … if I suspect brain aneurysm or AVM

By Contrast we catch it in the arterial, we give in IV to catch in arterial

- CTA and MRA demonstrate cerebral arterial and venous circulation and has replaced conventional angiography in many situations. (non invasive)

  - MRA can be used without contrast

* diagnostic * Therapeutic

Conventional angiography

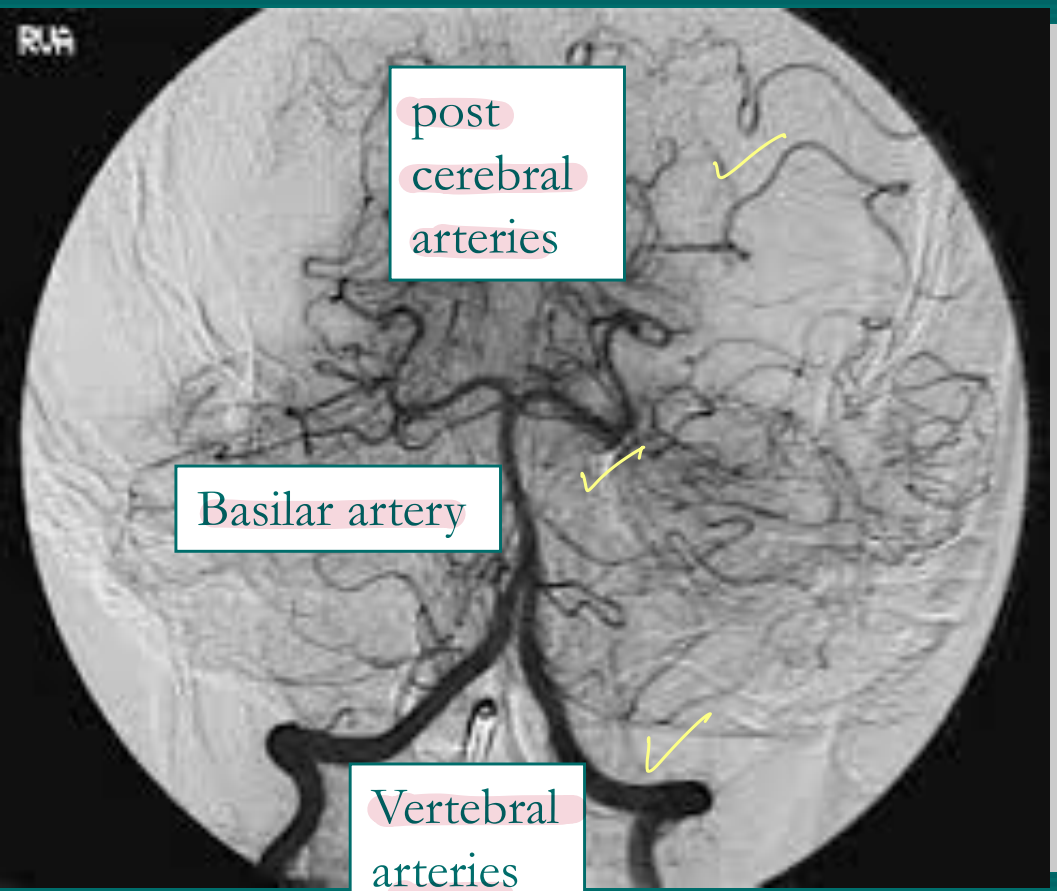
OR Radial

Right Femoral (A) بخدوا Cerebral لـ 2 بدي

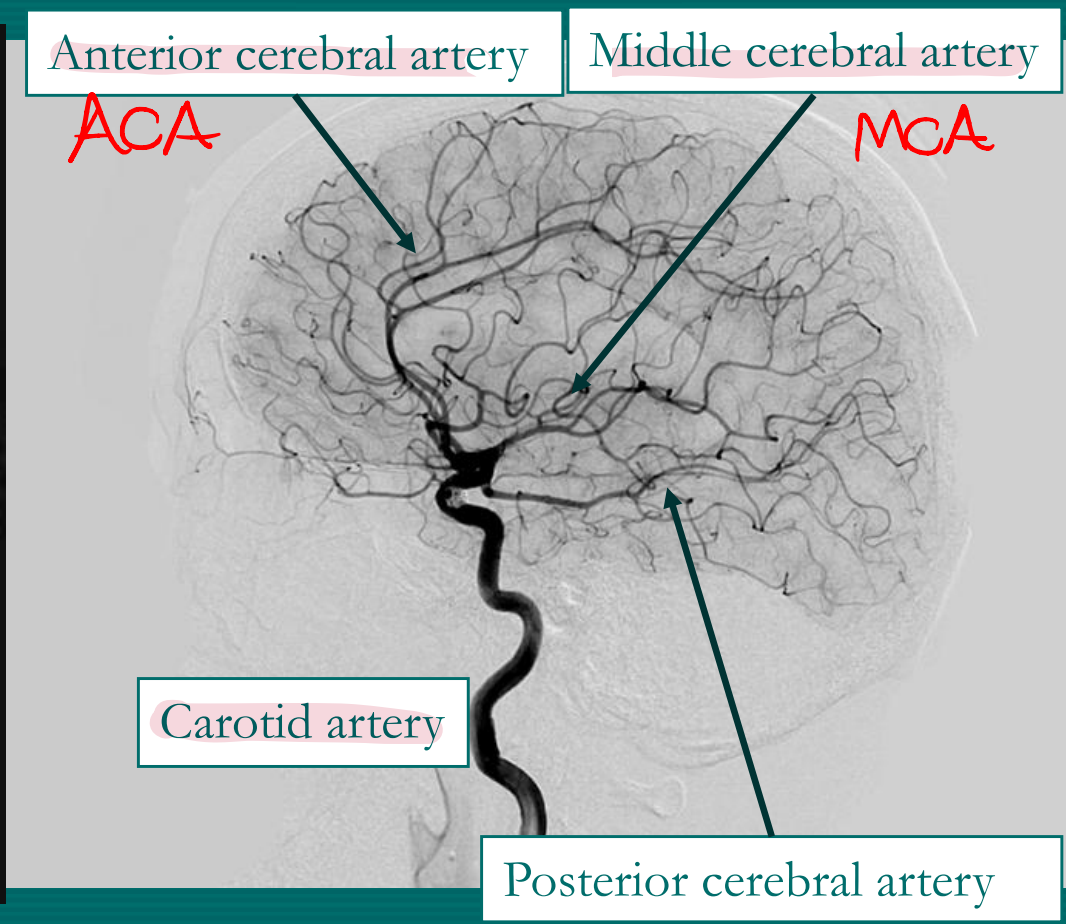
(invasive) (gold standard for any blood vessels pathology)

CA → gold standard

The posterior circulation – coronal plane



Sagittal plane



* ACA + MCA → Ant. circulation
* basilar + vertebral → post. circulation

Circle of willis can only be seen on transverse plane

Brain infarction: injury of the brain resulting from complete occlusion of the A. the area of brain affected, depending on the A. that affected.

* cut of blood supply → shifting of fluid from extracellular to intracellular region → more fluid (edema) in intracytoplasmic
  cell body → grey m.
  Fluid → hypodence in grey m.

* edema → hypodense (CT scan) at the gray matter + loss of gray-white matter function.
  ↳ these changes to appear on CT scan, need at least 6 hours.

بساعات

* diffuse MRI / DWI MRI → best sequence to detect Acute brain infarction
  ↳ detect Acute brain infarction within minutes of their onset

هون مثلاً دقيقة

* Hemorrhagic transformation → أحياناً بيجي الدم بعد ما يصير infarction ويصير Hemorrhage

BRAIN infarction

- Ischemic infarction of the brain result from interruption of the blood supply to a portion of the brain.
- The main sign of infarction is an area of decreased attenuation (hypodense) within the cerebral substance with effacement of the adjacent sulci.

- **Hemorrhage** may develop within the infarct, (about 10-15%), and is seen as an area of hyperdensity.

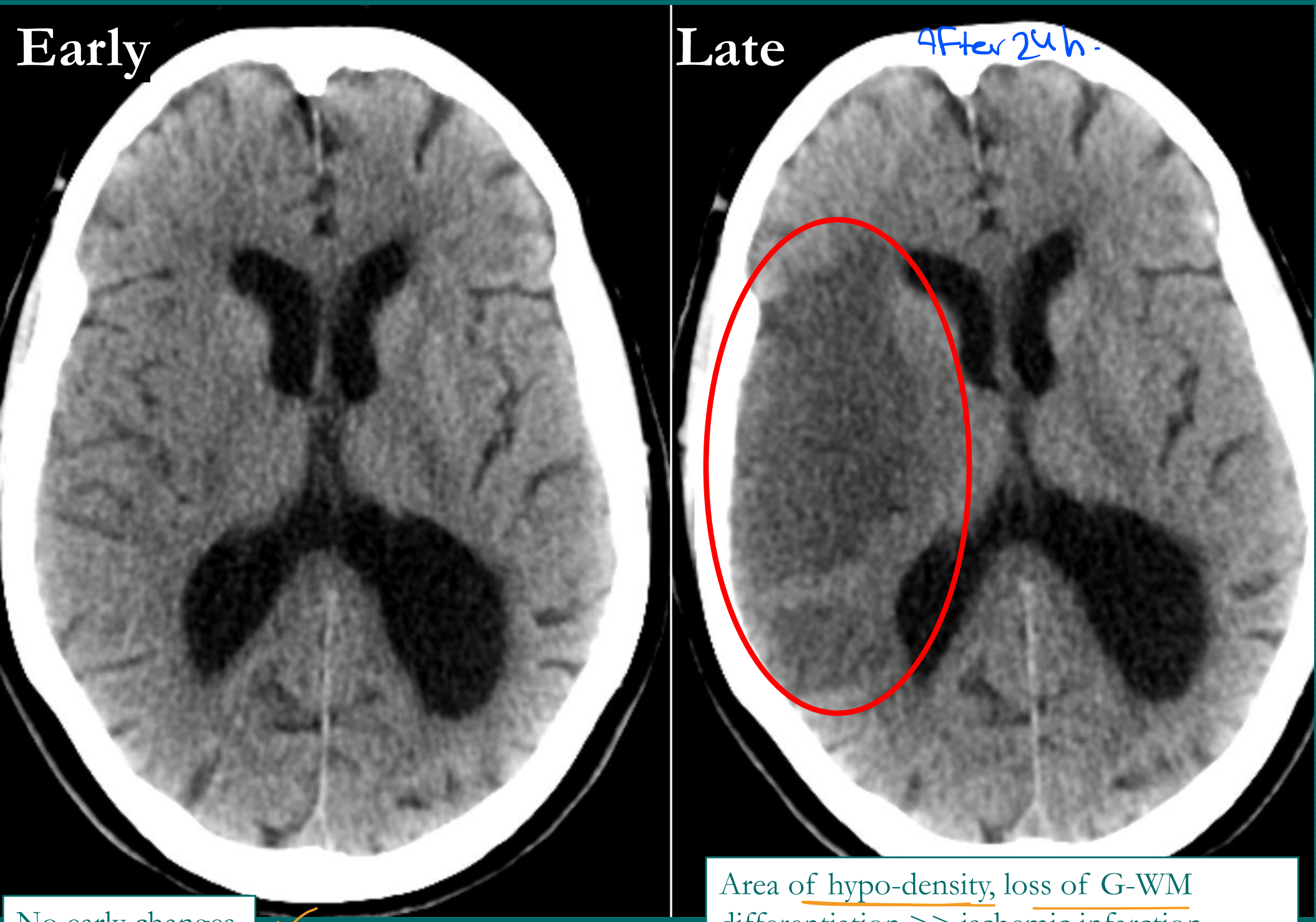
Haemorrhagic transformation>> stop the anticoagulant

Brain oedema involving the grey matter >> enlargement of GM >> loss of grey-white differentiation

↳ blurring of grey-white → Cytotoxic edema

↳ edema Caused by Stroke

Usually, the brain responds to triggers by oedema..
Ischemic infarction >> oedema >> hypo-density on CT (but these changes are late, appear after 6hrs..)
So, ischemia is hypo-dense while haemorrhage is hyper-dense

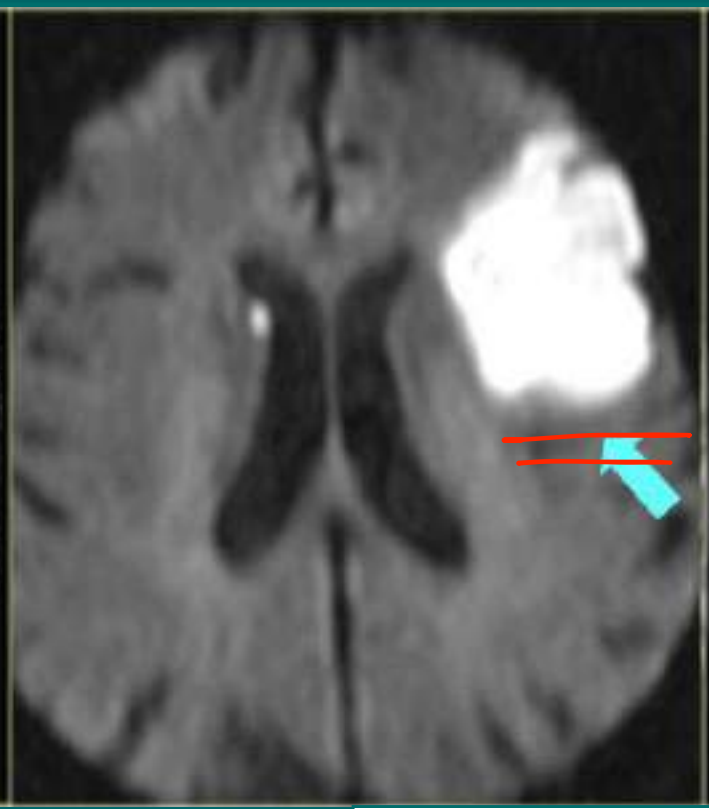


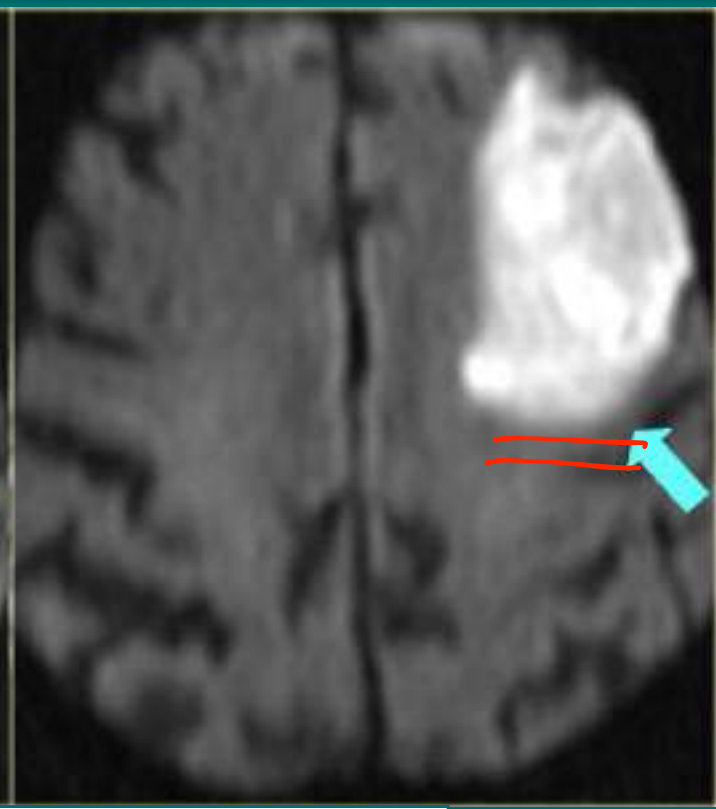
No early changes

Area of hypo-density, loss of G-WM differentiation >> ischemic infarction

CT vs Diffusion





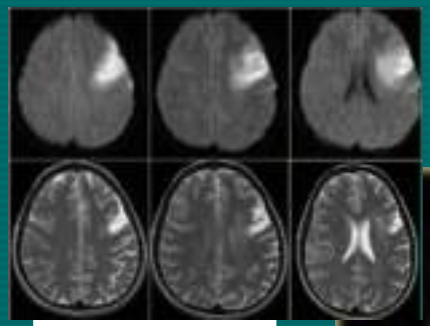


No early changes on CT

*Diffusion is the most sensitive MRI sequence for detection of early ischemic changes (within minutes)
>> shows areas of hyper-intensity → Fluid

Important note

*most common way to detect acute ischemic stroke in brain.



Diffusion

Very clear ischemic changes within mins

T2

Minimal early changes

* patient 80 years old, diabetic and hypertensive, left side weakness of ≥ hours and acute dysarthrea, what do you want to do?

- stroke is clinical diagnosis, not imaging diagnosis.

So, we don't need images to diagnos, you need images for treatment.

- CT scan without contrast to exclude hemorrhage (10% From stroke) => To start treatment tPA, - -

infarction ال بين ما و حتى

* برضه بنعمل CT, عشان نتأكد بلاش يكون ضغط دم وطار trauma

→ Hemorrhagic over ischemic stroke.

Small arteries (like perforators/thalamo-striate arteries) >> small infarcts

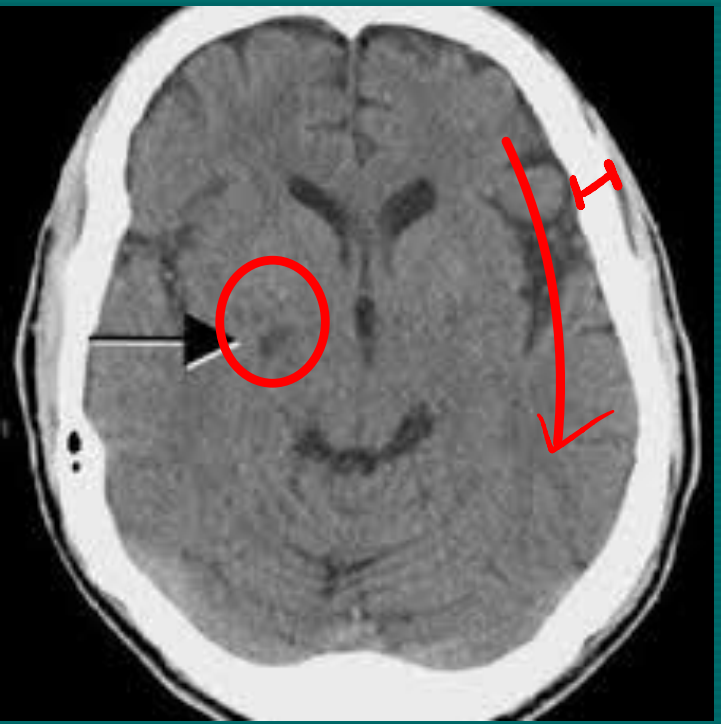
(deep cerebral A)

Lacunar infarction (less than 1cm)

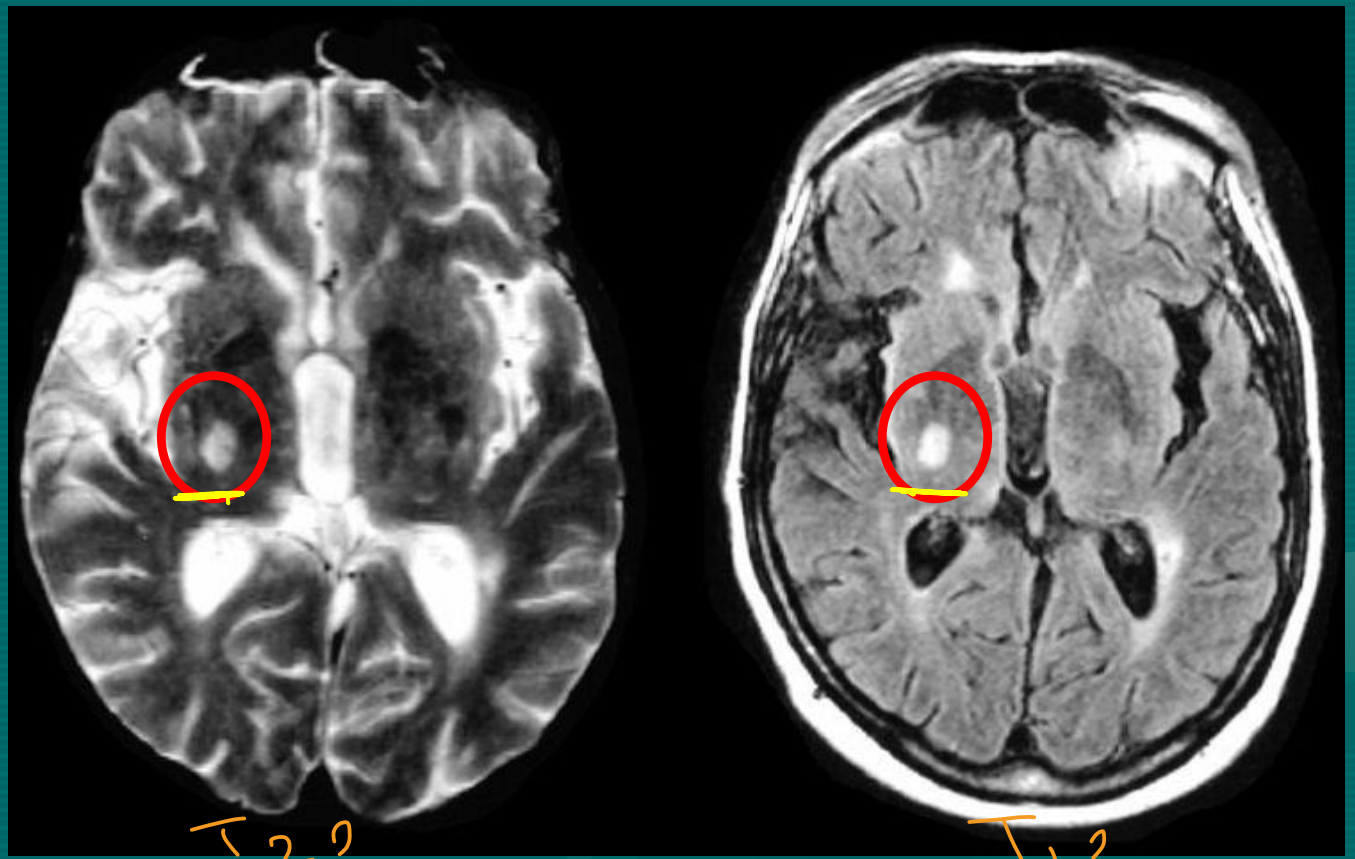
- Lacunar infarcts are small, deep cerebral infarcts, occur as a result of occlusion of small distal intracerebral arteries.
- Lacunar infarcts are usually less than 1cm in diameter and appear in the region of the internal capsule, basal ganglia, thalamus and brainstem.
- Lacunar infarcts are commonly seen in patients with small vessel disease.

Small vessel dzs: HTN/DM/small vessel vasculitis

عند مدول مرضى بحوض الـ Small vess



CT scan.. Late ischemic changes



MRI diffusion ??

CT and MRI in brain infarction

Why CT is the modality of choice for the initial evaluation of stroke ?

- CT is superior to MRI in detecting recent brain hemorrhage, and the role of CT is to exclude the presence of intracerebral hemorrhage, because the treatment of an infarct will differ depending on whether hemorrhage is present or not.
- MRI is superior and more sensitive than CT in the evaluation of any kind of edema and for the detection of acute infarction.

intra cerebral H: Hemorrhage within the brain.

most common causes: Trauma, hyper tension, AVM, aneurysm

Ar-ve

it happens in deep Cerebral tissue

depending where the Hemorrhage is ?

*So it's small ← easy ruptured

penph.. but could be central ← H

* مثلاً AVM بال Right Frontal = فص

يعني وينما تكون بصير الـ Hemorrhage .

Brain hemorrhage ⇒ CT

- Intracerabral hemorrhage:

  Is bleeding in the brain caused by rupture of a blood vessel.

  Usually takes the shape of the structure affected

- May occur in any part of the brain, but the frequent sites are: basal ganglia, thalamus and cerebellum.
- A third of intracerebral bleeds result in intraventricular hemorrhage.
- **Most common causes are:**
  - Chronic hypertension
  - Rupture aneurysm or arterio-venous malformation ↳ At periphary

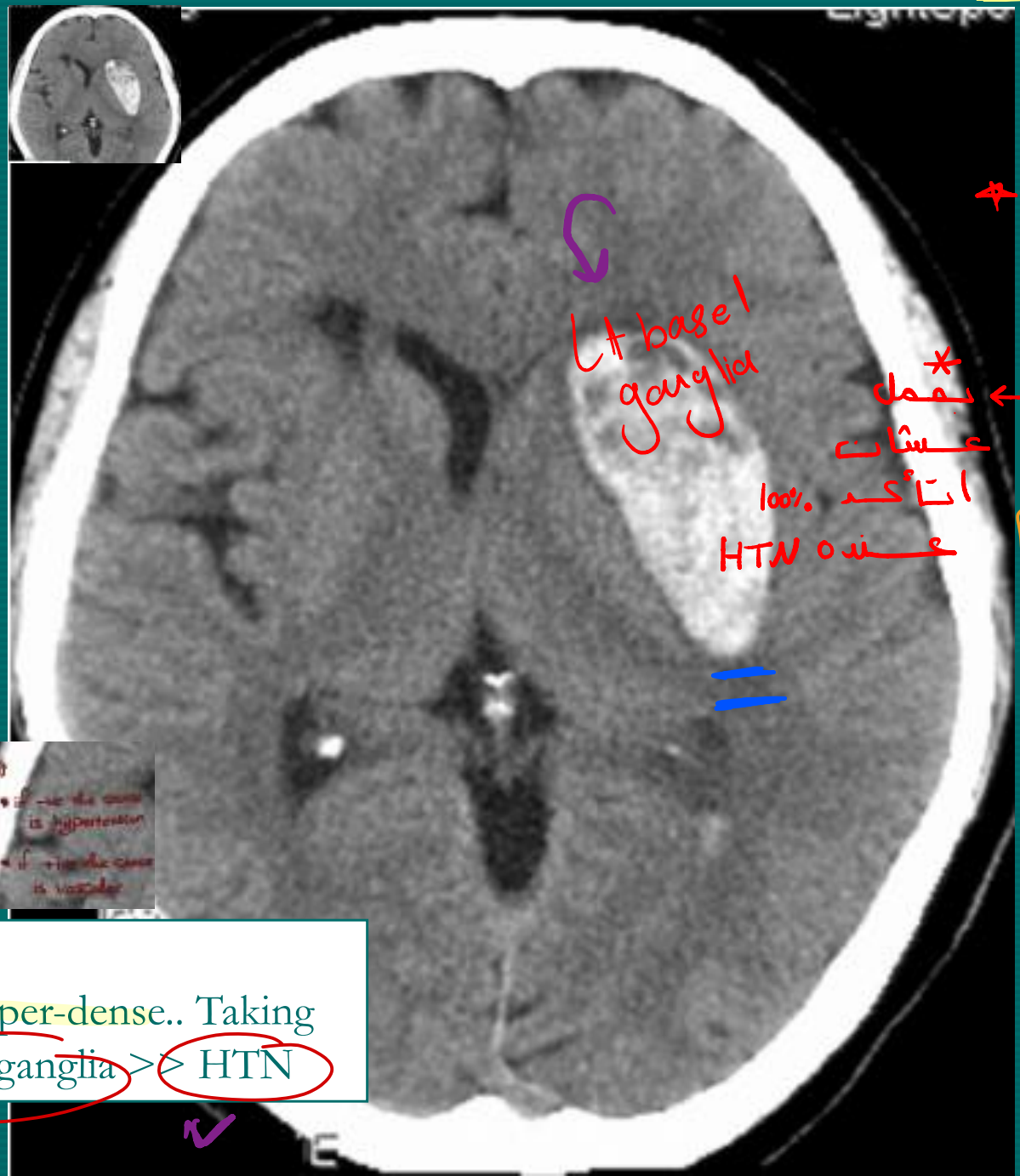
Usually affects basal ganglia, brainstem, cerebellum.. (thalamus)
Usually taking the shape of these structures

You need to determine the cause for the management
HTN >> treated medically
Aneurysm/AVM >> treated surgically

On CT scan >> haemorrhage is hyper-dense acutely, (hypo-dense later?) → yes

7 Zoy here 20y HTN ?

• Intracerebral hemorrhage (HTN patient)



MRA/CTA

ما تخلف, دائما

angiography اعمل

hemo إذا في

to excluded other causes.

non-invasive

Angiography CT, MRA

CT scan
Haemorrhage is hyper-dense.. Taking the shape of basal ganglia >> HTN

other Causes:

. Trauma (excluded from history)

. Angiograph

AVM

aneurysm

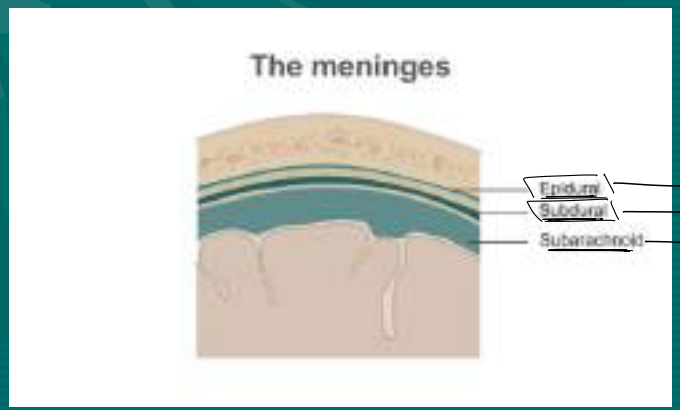
if it negative so, the Cause is hyper tension.

In emergency → non contrast brain CT

Abd CT ← اعطيني الـ CT بدون contrast

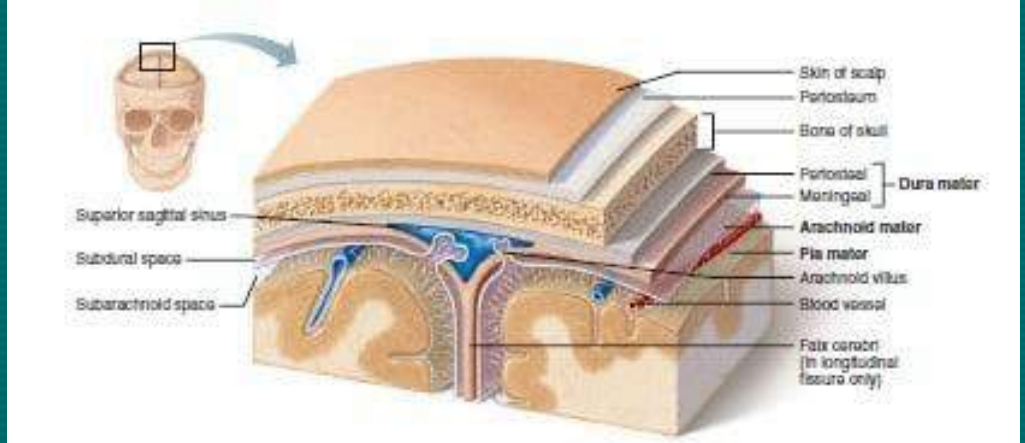
Intracranial Hematomas Head injury

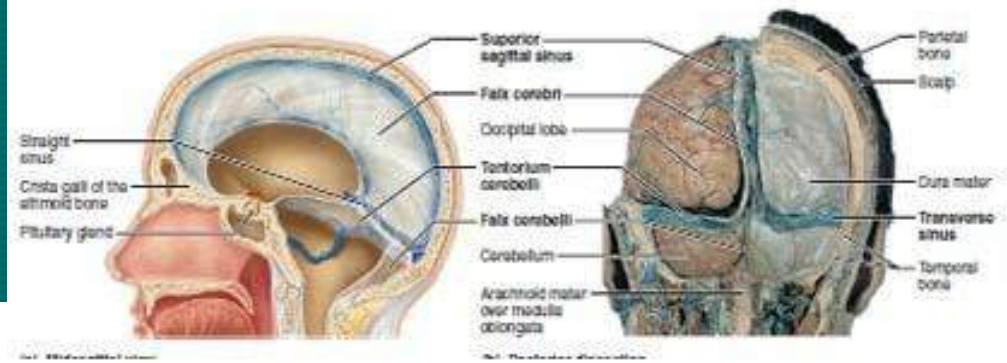
- Intra parenchymal hematoma
- Epidural hematoma → Collection of blood outside the blood vessels.
- Subdural hematoma
- Subarachnoid hemorrhage

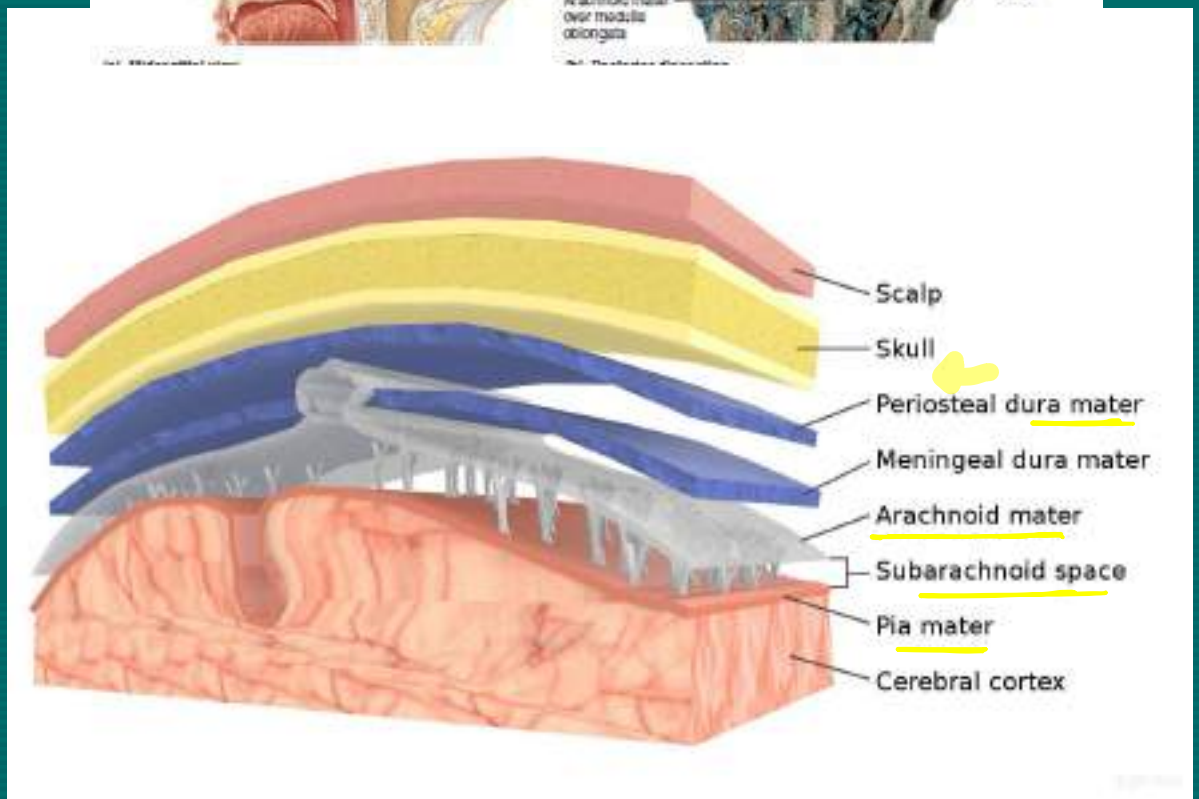


Epidural H.: H. btw skull and dura matter.

- dura matter is attached to the sutures
  so epidural space is limited btw the sutures.
- resulted from trauma associated with Fractures, blood arterial in origin
  ↳ high blood flow in limited space → bulging (بين الجمجمة و dura) → bi convex dense hyper densety


Skin of scalp
Periosteum
Bone of skull
Periosteal
Meningeal
Dura mater
Arachnoid mater
Pia mater
Arachnoid villus
Blood vessel
Falx cerebri (in longitudinal fissure only)
Superior sagittal sinus
Subdural space
Subarachnoid space


Superior sagittal sinus
Falx cerebri
Occipital lobe
Tentorium cerebelli
Falx cerebelli
Cerebellum
Arachnoid mater over medulla oblongata
Straight sinus
Crista galli of the ethmoid bone
Pituitary gland
Parietal bone
Scalp
Dura mater
Transverse sinus
Temporal bone


Scalp
Skull
Periosteal dura mater
Meningeal dura mater
Arachnoid mater
Subarachnoid space
Pia mater
Cerebral cortex

Epidural Hematoma

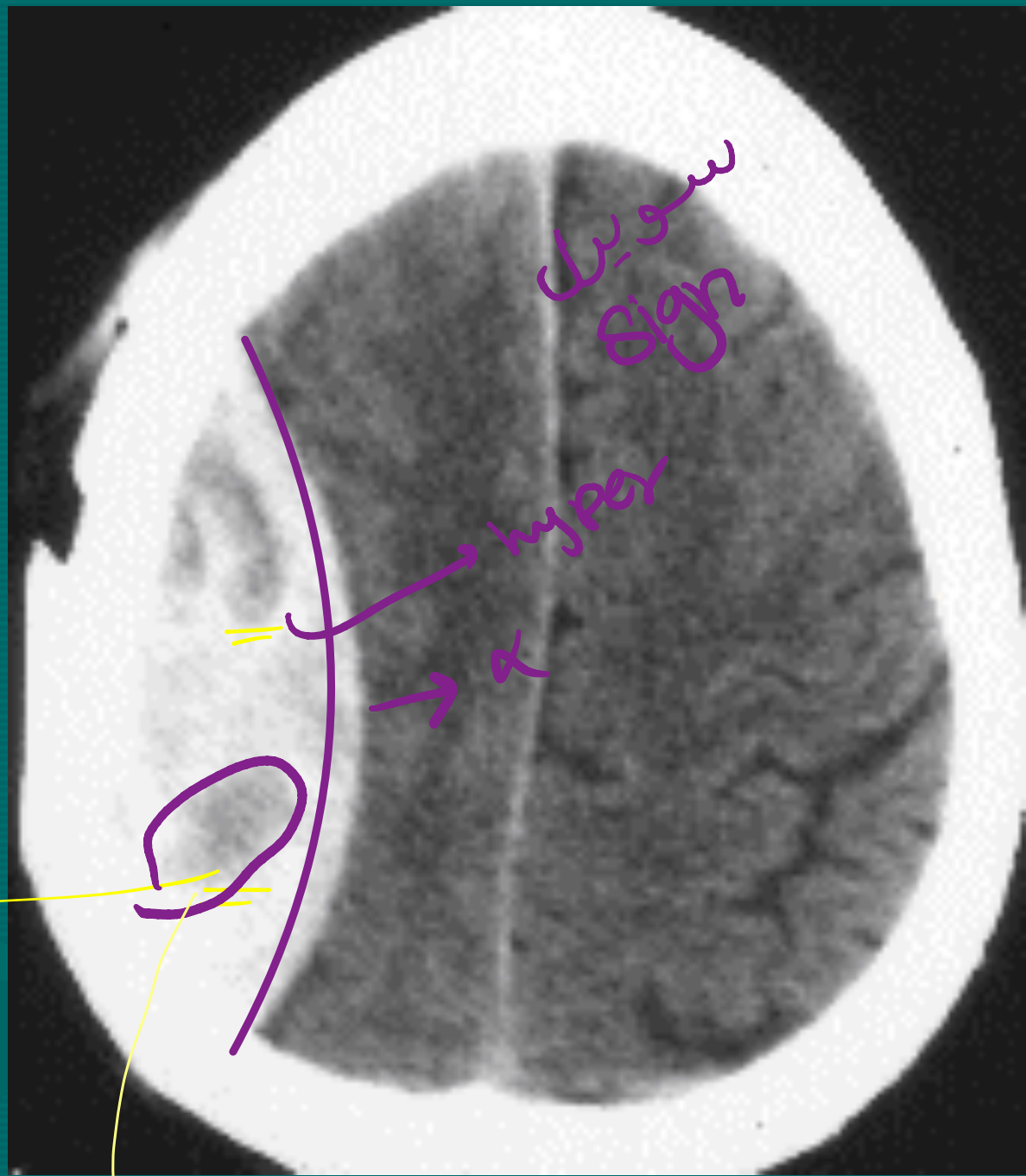
- Collection of blood between the inner table of the skull and the dura
- Most often occurs as a result of an arterial injury, usually middle meningeal artery or one of its branches, and therefore are usually temporo-parietal in location.
- The typical CT appearances of epidural hematoma is biconvex or lenticular, high density lesion.



Dura is attached to sutures >> epidural haematoma is limited in that space >> appears biconvex
It's usually caused by fractures/trauma
Blood is arterial ✓
Most commonly temporo-parietal ✓

* high Flow blood and Limited space } → swirl

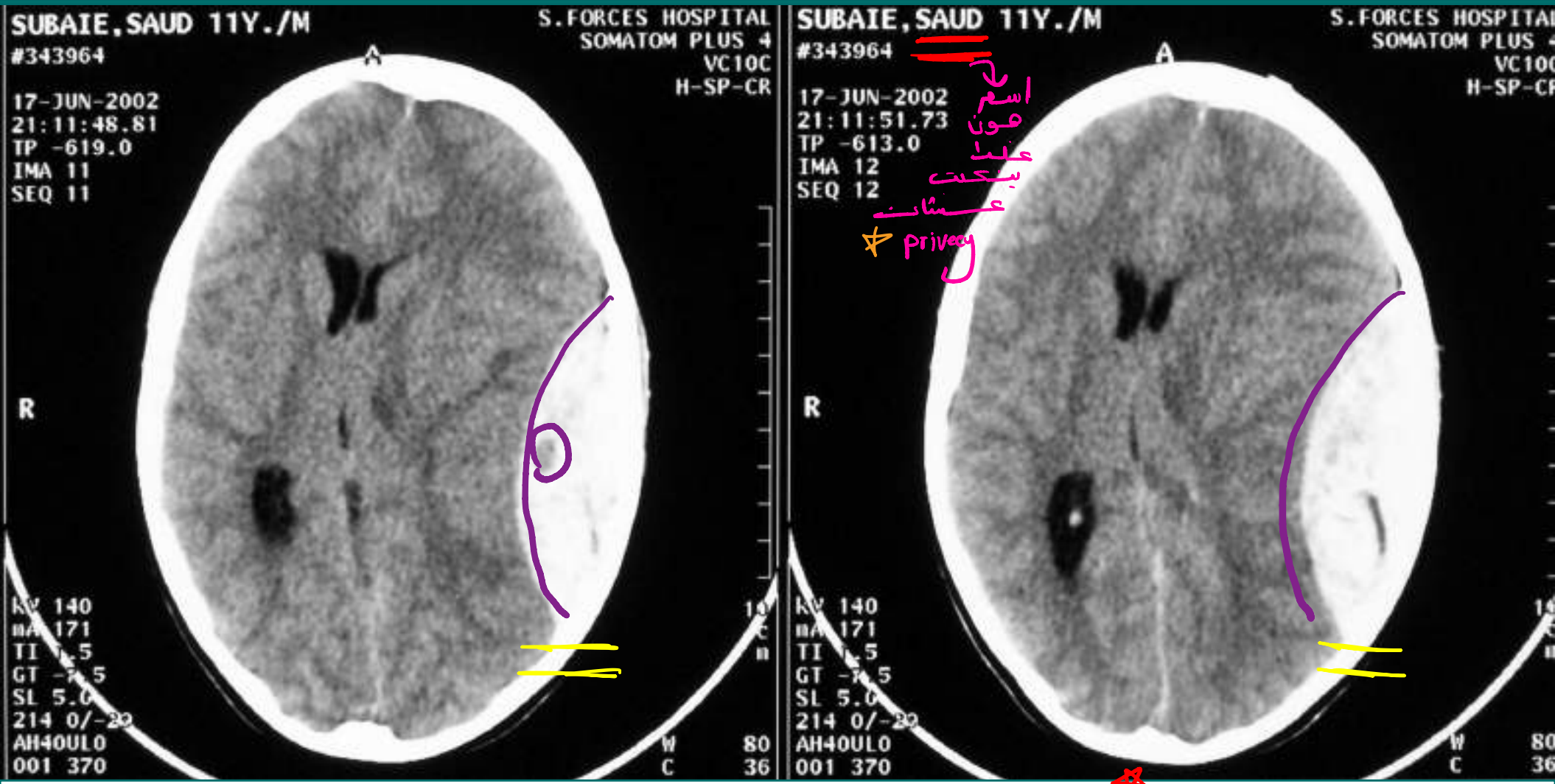
Haemorrhage is typically homogenous
Sometimes it's not >> SWIRL SIGN
Since the space is limited, and blood is arterial in origin (there's a high blood flow) >> blood swirls within this space
These swirls appear as hypo-dense areas within the hyper-dense are of haemorrhage



- it doesn't cross the sutures.

hypo - densety
- swirL - دوامة
sign

Epidural haemorrhage – arterial blood – high blood flow – actively bleeding lesions >> this may eventually cause herniation



This is brain CT scan, ventricular level, young male pt.. Well defined biconcave hyperdense area in the parieto-occipital lobe of the left side causing shifting of the midline to the right side and compression of the left-side structures. It is epidural haematoma

Subdural hematoma: • btw dura matter and arachnoid.
• not limited by the sutures ✱

mostly associated with * trauma, not- associated with fractures

. blood venous in origin.
↳ low blood Flow within wide space → Crescent shape.

* Spontanous subdural hematoma → in alcholic and elderly patient → veins بكونوا ✱ Fragile → دماغ بصير brain ✱ Atrophy → بصير ضغط على ✱ مايي veins → easly ✱ ruptured.

subdural:
- acute: hyperdensety "Cells + fluid"
- Chronic: lysis of cells so it just Fluid - hypo densety-

✱ صح تظهر اعراض ← بصير حدث عليهم

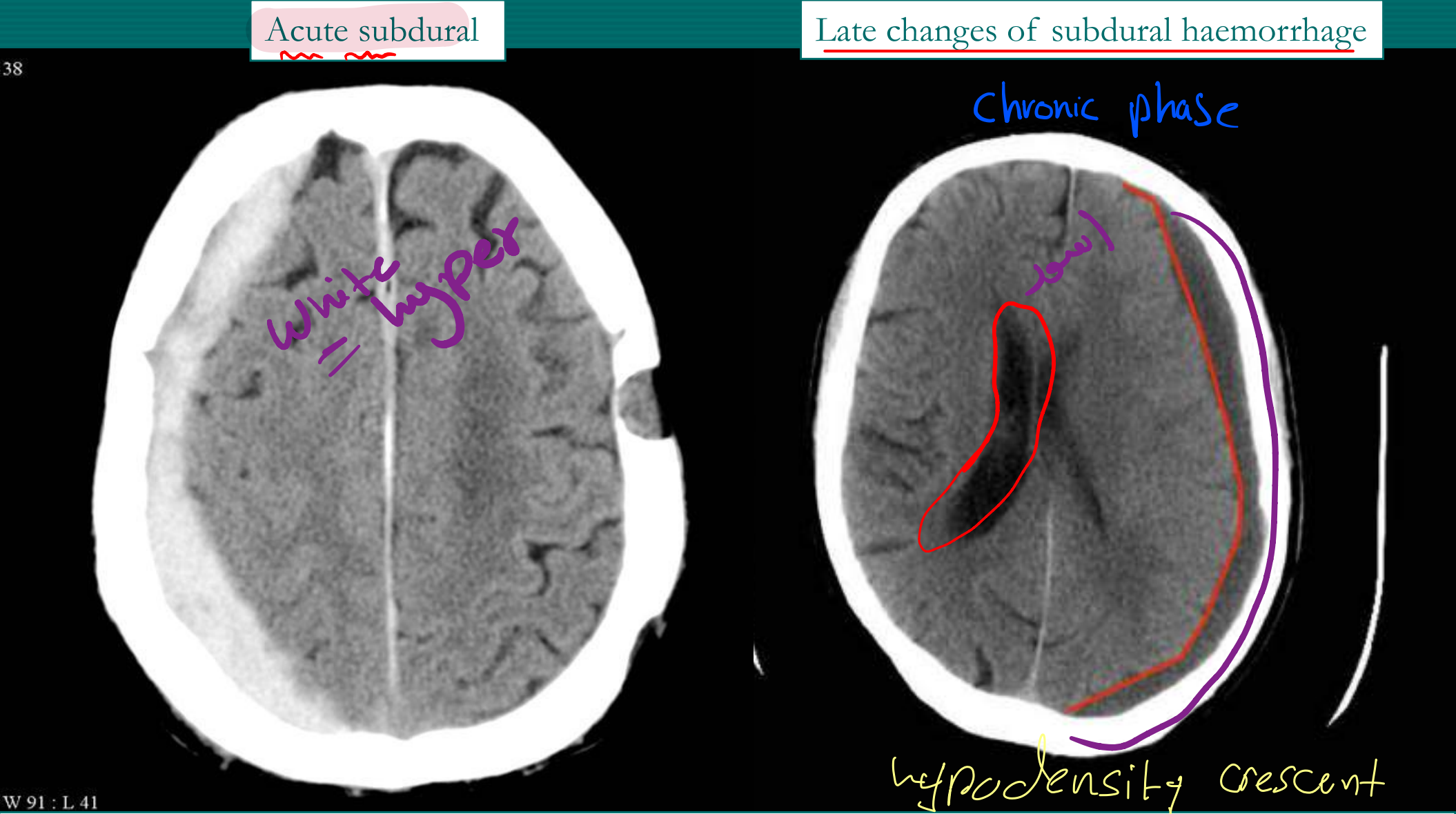
Subdural Hematoma

- Collection of blood between the dura and arachnoid
- Result from venous injury, usually tear of the bridging cerebral veins within the subdural space.
- The characteristic appearance of acute subdural hemaotma on CT is hyperdense crescent-shaped collection with concavo-convex configuration.

Occur in extremity of ages very old or very young
Very old: have brain atrophy and stretched veins may be spontaneous or due to minor trauma
In young, maybe a major trauma
Usually not related to fractures
Blood is venous
Not limited by the sutures >> crescent shape

in acute: hyperdense crescent shape
in chronic : hypodense due to liquefaction; all cells becomes in fluid status (bcz it's venous blood)
as patient is lying on bed so cells and fluid accumulate posteriorly >> the hematoma appears more hypo-dense anteriorly but more hyper-dense posteriorly





Epidural vs subdural haematoma…

Epidural must be immediately referred to tertiary centre with neurosurgery unit.. Bcz the blood is arterial (high flow) it may rapidly deteriorate.. Pt must be continuously monitored there, since at any moment a surgery may be required..

While subdural haematoma is venous, should be referred but we're not as much in a hurry.. Since it may progress rapidly but may also stop with proper medications and monitoring

أولًا: مين أخطر بالطوارئ؟

✅ **Epidural hematoma (EDH)**

هو الأكثر إلحاحًا ويتدهور بسرعة جدًا.

❌ **Subdural hematoma (SDH)**

أخطر من المتوسط الحجم، بس عادة أبطأ

ليش الـ EDH أخطر فوق؟

- **Arterial blood** (middle meningeal artery)
- النزيف سريع
- التمزق ممكن

شو اللي يصير فسيولوجيًا؟

1. **Trauma** → loss of consciousness
2. **Temporary recovery**
   - يكون صاحي → **lucid interval**
   - الدماغ يتدهور → **herniation / death**
   - الدم لسه قليل
   - التمدد بطيء
   - أن تأخير = خطر كبير
3. **Rapid arterial expansion**
   - ↑ intracranial pressure
   - brain herniation

الطوارئ: شو نعمل عمليًا؟

🟥 **Epidural Hematoma (أولوية القصوى)**

- **Immediate neurosurgical referral** 🚨
- **Urgent CT non-contrast**
- يلي:
  - **GCS**
  - **Pupils** (anisocoria)
  - Signs of ↑ ICP
- اللي:
  - **Emergency surgical evacuation**

🟧 **Subdural Hematoma**

- **venous** blood اللي
- التدهور أبطأ
- يعتمد على:
  - الحجم
  - midline shift
  - GCS

Management:

- **Small + stable** → observation + repeat CT
- **Large / ↓ GCS / shift** → neurosurgery

small epidural hematoma وشو عاملة اذا effect

• أغلب بيث عمره ٦ سنة واقع ، صوبة ، طلع عنده واقريب

• لحوله وعليه في الدراسة، إذا ما فيه وضع يحتاج surgery ← حتى الـ neurosurgery

• most of epidural hematoma is spontaneous resolved

Usually NO

Epidural hematoma (EDH) **rarely resolves spontaneously** and is considered a **neurosurgical emergency**.

• لو كانت الحالة subdural وأنا مرتاح slowly

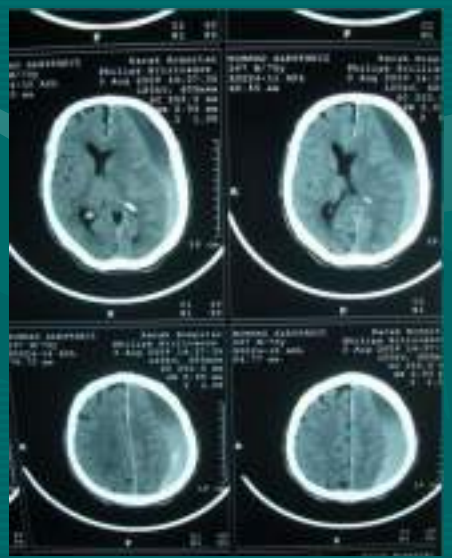
Why EDH usually does NOT resolve on its own

- EDH is most often **arterial bleeding** (middle meningeal artery)
- Bleeding is **under high pressure**
- The clot **expands rapidly**
- High risk of:
  - ↑ ICP
  - brain herniation
  - sudden death

Also subdural - late

- mid - line shifting

acute on Chronic SDH





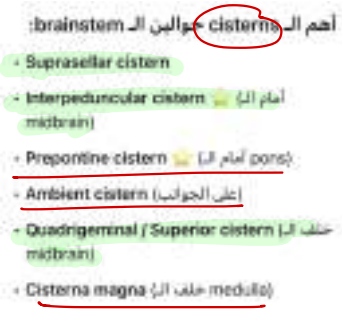






SAH: btw Pia matter and arachnoid.

SA space: between gyri (Sulci) ✓
موجود
+ basal cistern ✓
+ Brain stem



نعم ؛ CSF spaces هو SA spaces الـ طب.

SA spaces هو CSF spaces الـ طب. & ؛

CSF spaces هي Ventricles مثل

SA spaces بعض من CSF spaces .

فال SA space معبّة CSF فبكون hypo dense أغمق من hyper density الـ SAS هو SAH .

on CT-scan.

* Causes:
  * traumatic
    overall trauma is the most common cause.
  * non traumatic: Aneurysm

* Clinical Features: worst headache ✓ meningeal signs (neck stiffness, vomiting...) أسوء وجع راس بحياته

* images: Emergency (CT without Contrast)

Subarachnoid Hemorrhage

- Hemorrhage into the CSF spaces, and frequently present in the acutely injured patient.
- SAH appear as hyperdensities filling the CSF spaces (basal cisterns, cerebral sulci, sylvian fissures and interhemispheric fissure).
- Subarachnoid hemorrhages are most often the consequence of penetrating injury, rupture aneurysm and systemic hypertension.

predisposing / عامل مساعد
aneurysm يساهم بتمزق الأوعية أو
لكنه نادراً يكون السبب الوحيد

most common non-traumatic cause

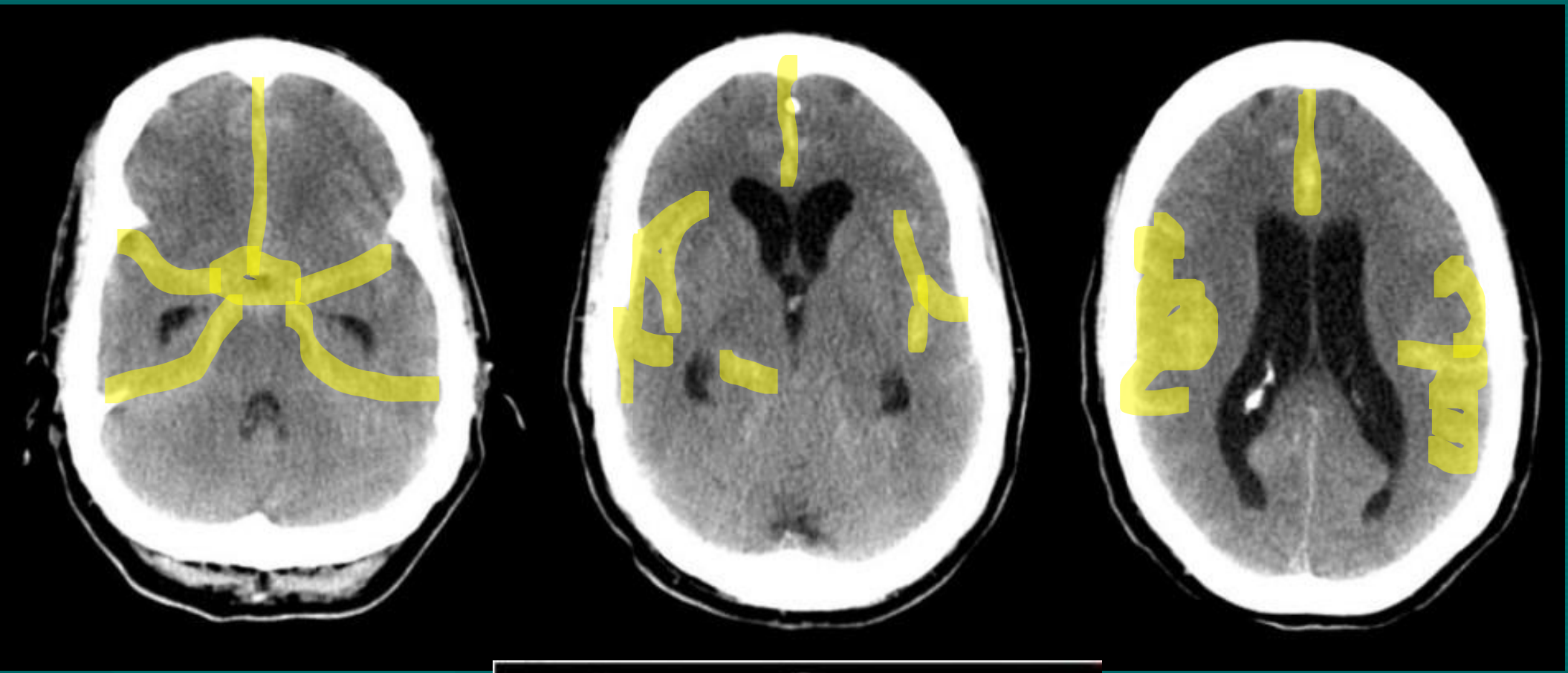
Most common cause is traumatic (penetrating injury)
But most common non-traumatic is rupture aneurysm

Best seen using MRI T2 star sequence (hypo-intense).
But it's quite expensive and not always available..

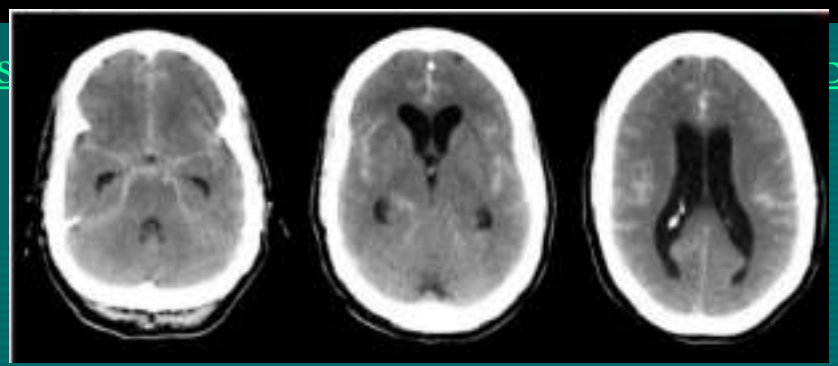
Signs of SAH: vomiting ,meningeal(sings like neck stiffness) sever sudden headache Thunderclap headache

On CT, CSF spaces normally appear hypo-dense.. In SAH, you find areas of hyper-density

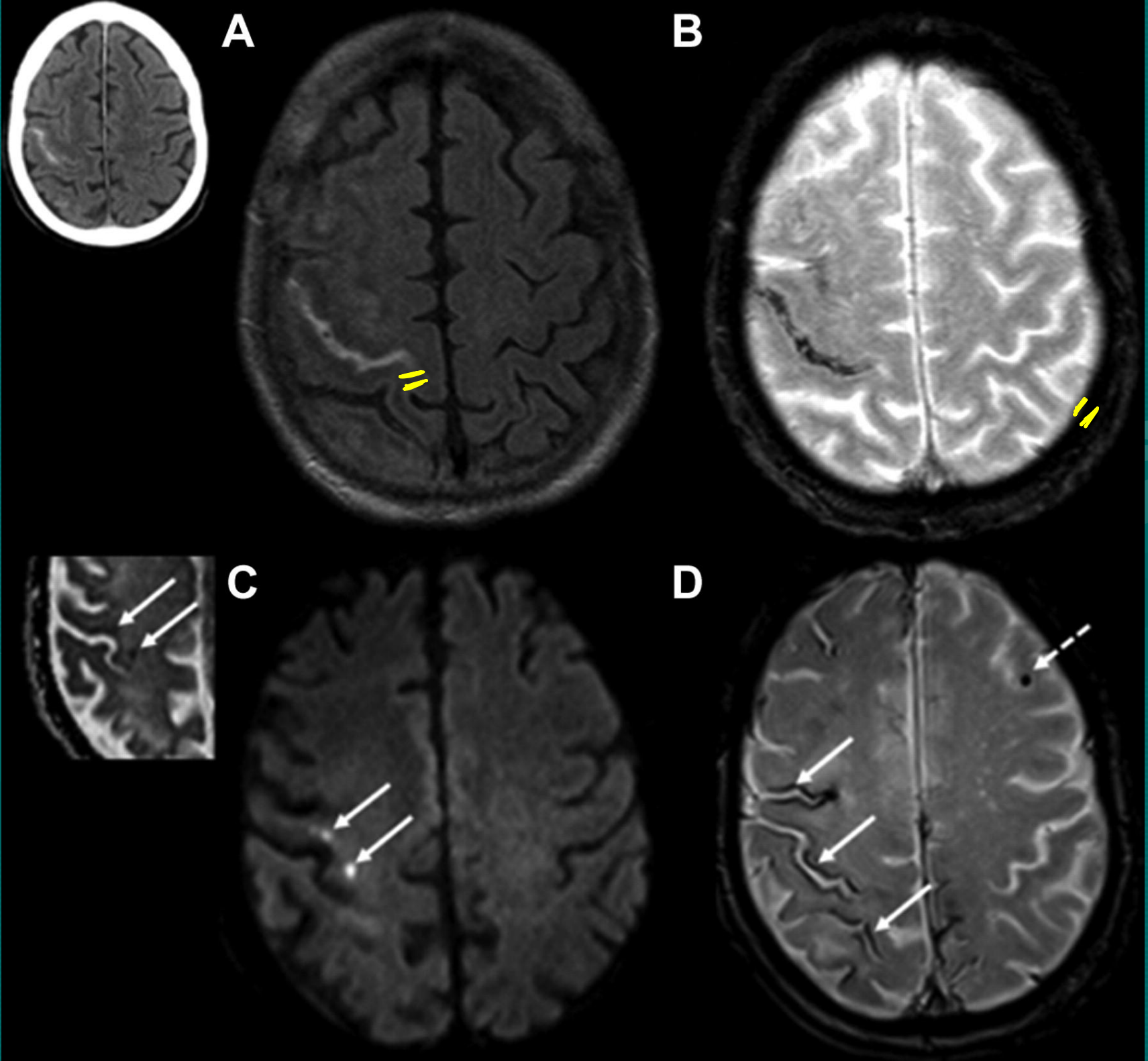
Muti-axial CT, multiple areas of hyper-density filling the sulci



http://casemed.case.edu/clerks



parachnoidHemorrhage3.htm



Gradual echo sequence to SAH in MRI

gradiant Echo sequance

MRI

T_2

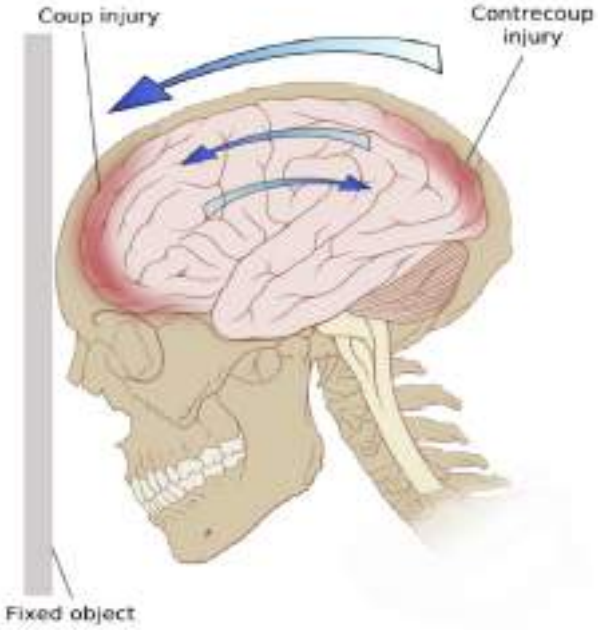
- most Common sequence to detect SAH

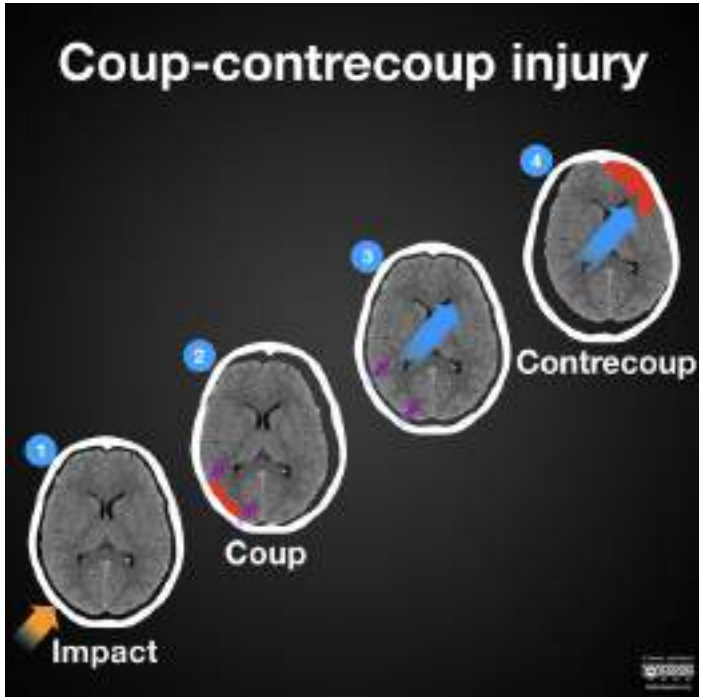
Cerebral Contusion (كدمة)

- Bruising or crushing of brain tissue.
- Two types of cerebral contusion:
  - * nonhemorrhatic (necrotic)
  - * Hemorrhagic
- The hemorrhagic areas may not be evident in the very acute stage or in the first 24 hours.

Usually due to acceleration-deceleration like car accidents >> shearing of axons >> brain respons to triggers by oedema >> multifocal areas of hypo-density on CT >> within these areas there may be haemorrhage (haemorrhagic contusions) >> areas of hyper-density within hypo-density

. if ICH secondary to trauma.
. multiple Contusion
. Hx of trauma عنده يكن ← شرط ← trauma
في البداية بتكون عبارة عن area of edema ← hypodense on CT
rupture of Artery ← اذا صار
Hemorrhagic Contusion ← بتصير

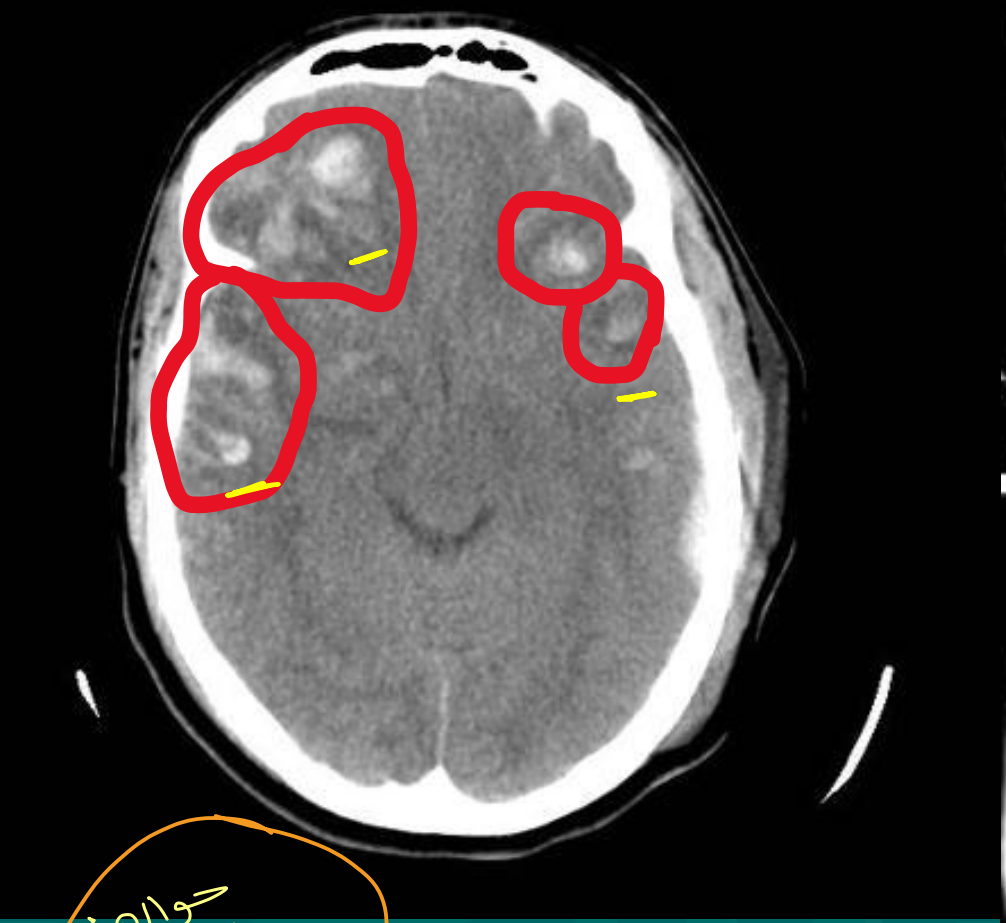

Coup injury
Contrecoup injury
Fixed object


Coup-contrecoup injury
1
2
3
4
Contrecoup
Coup
Impact

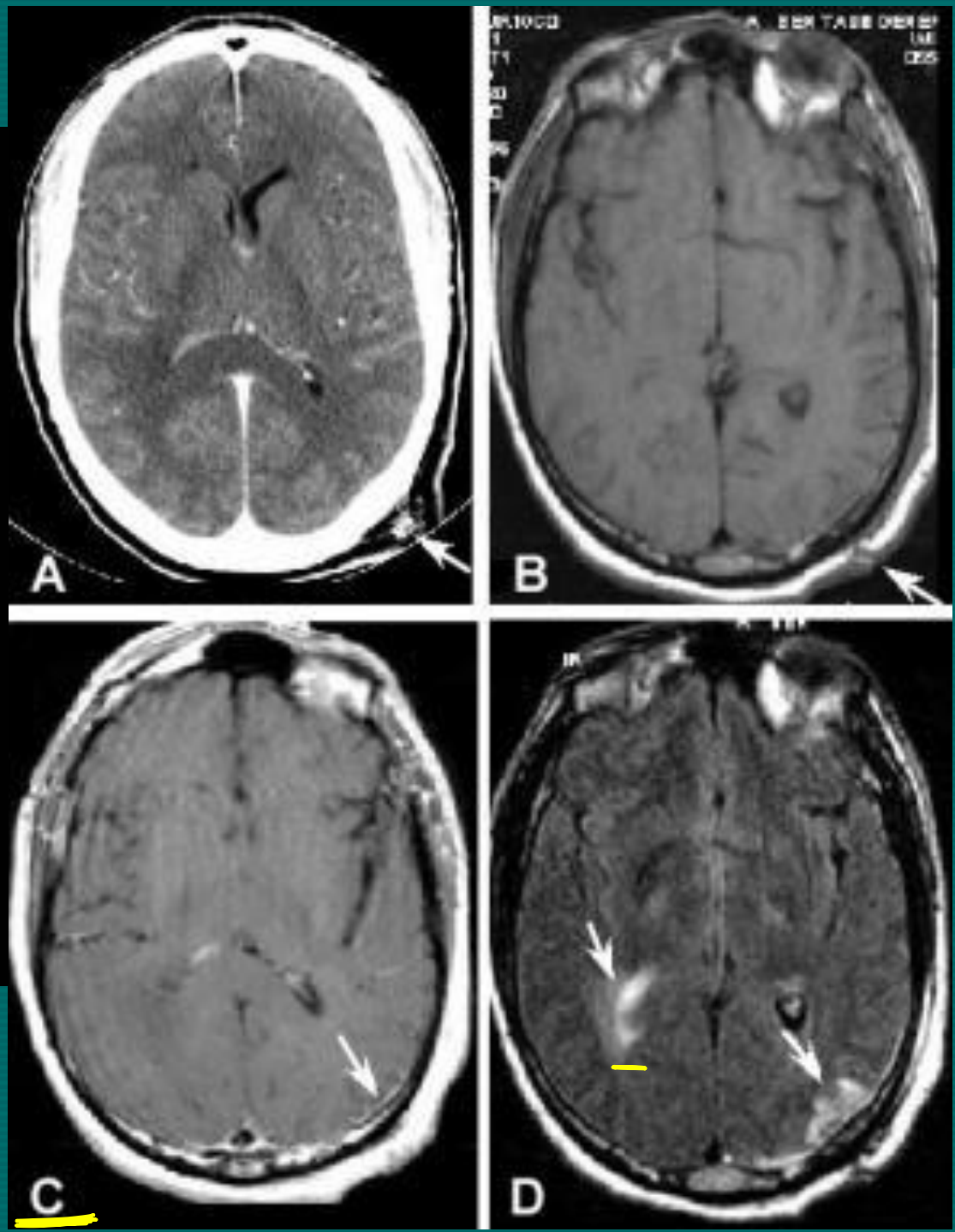

42
:52

History of trauma

Hyper- within hypo-density



حواليها بكون فيه edema



The most common WM dz

Multiple sclerosis (MS)

- **MS is a white matter disease**, affects areas of the brain and spinal cord, destroying the fatty layer (the myelin sheath) which wraps around nerve fibers, resulting in areas of demyelination.
- Most common in young people and about two thirds of patients are female.
- The demyelinating lesions (plaques) present with a characteristic relapsing and remitting course.

CT may not show lesions.. we should also do MRI for spinal cord.
-Hyper-intensty lesions in the deep white matter/ subcortical white matter mostly periventricular and perpendicular to the lateral ventricles
-Flair is the best sequence.. used with contrast to detect active lesions
this is important in follow up during treatment

MS → MRI

∴ most white matter involve: periventricular white matter
∴ hyper intensity on T2 and FLAIR, usually peri ventricular with lateral ventricles

Multiple sclerosis / 2

with Contrast

- **MRI is the investigation of choice.**
- The demyelinating plaques appear as focal discrete areas of abnormal high signal intensity on T2-weighted images.
- The common location of plaques are in the periventricular region, corpus callosum, and to a lesser extent in the brain stem, cerebellum, optic nerves and in the spinal cord.
- Contrast enhancement of the plaques indicate active disease.

active lesion → active inflammation → تباخ Contrast



T2

T2 - FLAIR

* well defined
* hyperintense
* oval-shaped

* CSF flare

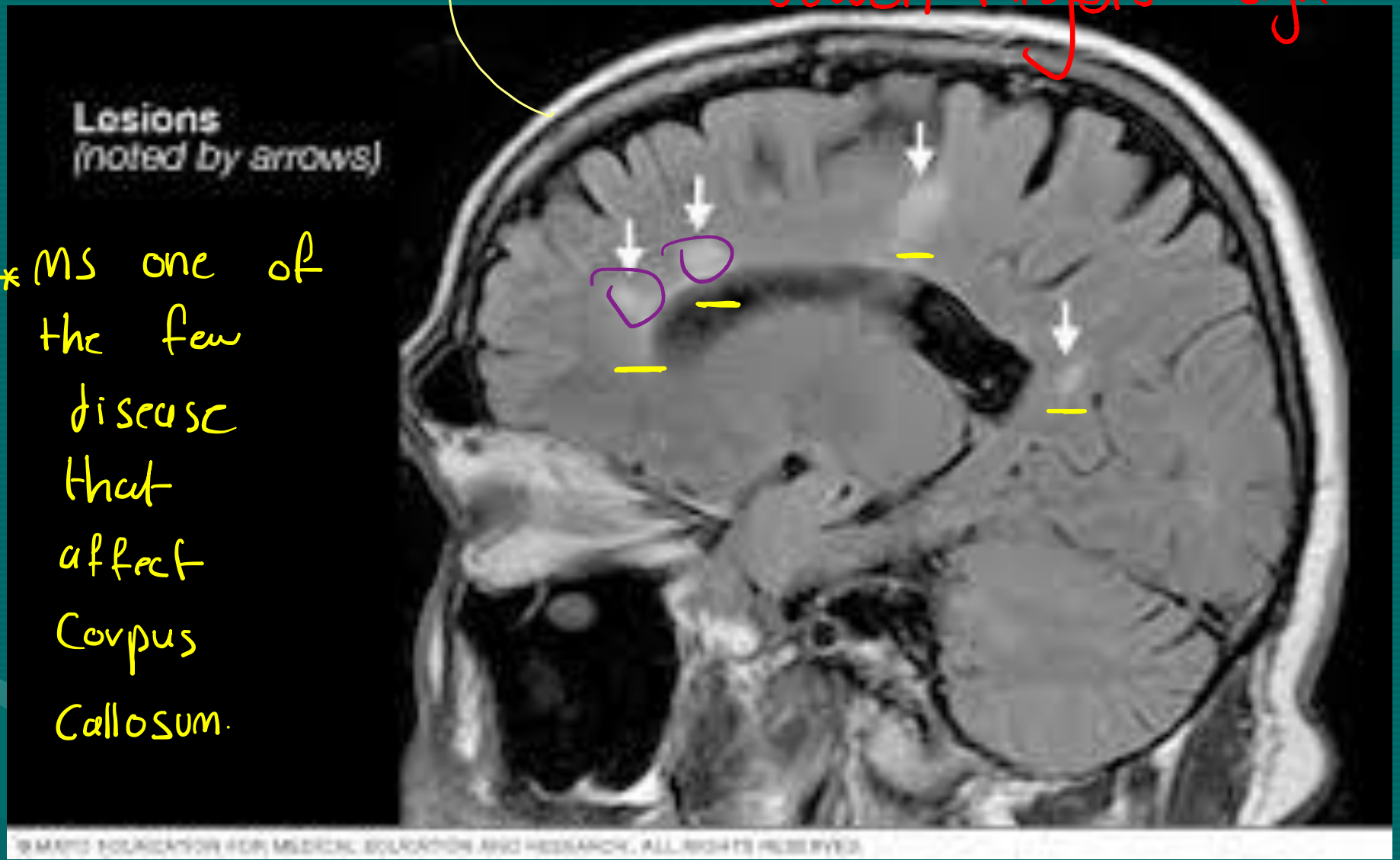
suppression to the fluid by flair is better

On T2, both CSF and the lesions are hyper-intense >> we may miss the lesion

That's why FLAIR is the sequence of choice for MS, as it supresses the CSF so we can see the lesions more clearly

perpendicular to the Lat. ventricles

dowen fingers sign



* MS one of the few disease that affect Corpus Callosum.

Brain Tumors

Metastasis can be intra- or extra- axial

Primary brain tumors can be classified as:

- **Intra-axial tumors:** (depending on age group → adult: supratentorial; children: infratentorial)
  arising in brain parenchyma. from glial cells (gliomas) most common
- **Extra-axial tumors:**
  arise from cells outside the brain, such as the meninges and cranial nerves, bone, pituitary gland ... (blood vessels, nerve roots)

Child with infra → SDD diagnosis

Most common primary brain tumours in adults : Supratentorial tumours
Most common primary brain tumours in children : infratentorial tumours
Tumours can be seen without contrast but we always use it to intensify the picture(low grade tumours there is no enhancement but grade 4 there is enhancement)

grade 1-4
grade 1 : least aggressive , good prognosis , grade 4: more aggresive , bad prognosis.

Brain tumors / 2

* Radiology: MRI with Contrast
  grade 1:
* CT (not modility of choice):
  hypo densety with loss of GW Junction. (infarction)

MRI: very soft apearance (no enhancement - no edema ... الخ) no mid-line shifting.

* CT → not for tumors

GLIOMAS:

More than 50% of primary intracranial tumors are gliomas, and constitute a heterogenous group of tumors including:

- Astrocytomas.
- Ependymomas.
- Oligodendrogliomas.

AEO

High grade glioma: Contrast .. edema ...
بتعجب على الدينا

* high grade → Glioblastoma multiforms (grade 4)

* low grade glioma → very smooth and benign

Astrocytomas



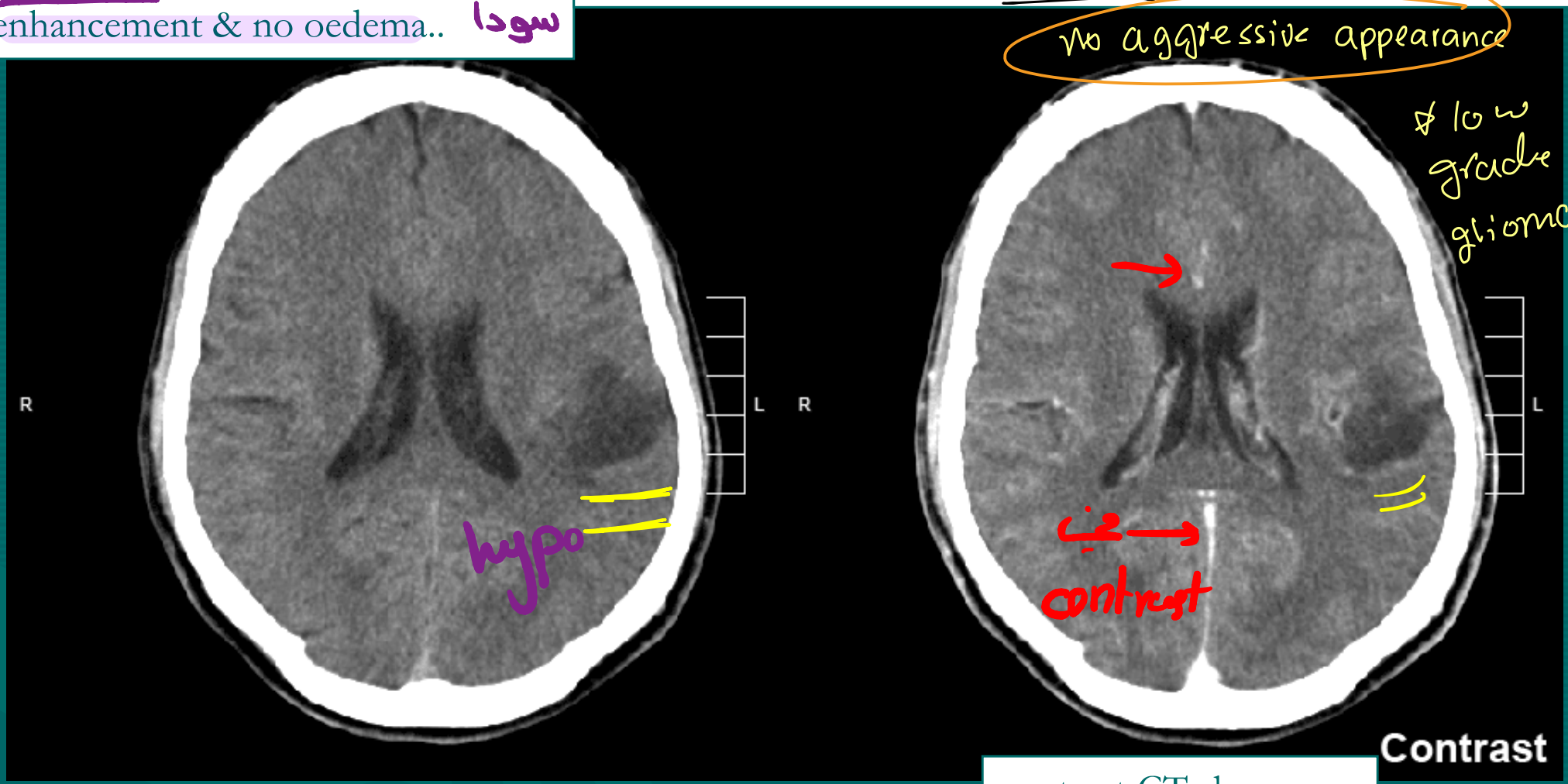
- Arise from astrocytes
- Graded into four grades depending on the severity and prognosis (grade I favourable prognosis and grade IV worst prognosis)
- The low grade astrocytomas are most commonly in young adults.
- The high grade astrocytomas (grade 1V) are called glioblastoma multiforme.

MRI is the best for brain tumours but we can use CT scan. Low grade gliomas on CT appear as areas of hypodensity.. With no contrast enhancement & no oedema..

Areas of hypodensity could be infarction or tumour – diagnosis depends on history

Acute onset of weakness/paraesthesia >> probably infarction

History of headache for a long time>> tumour



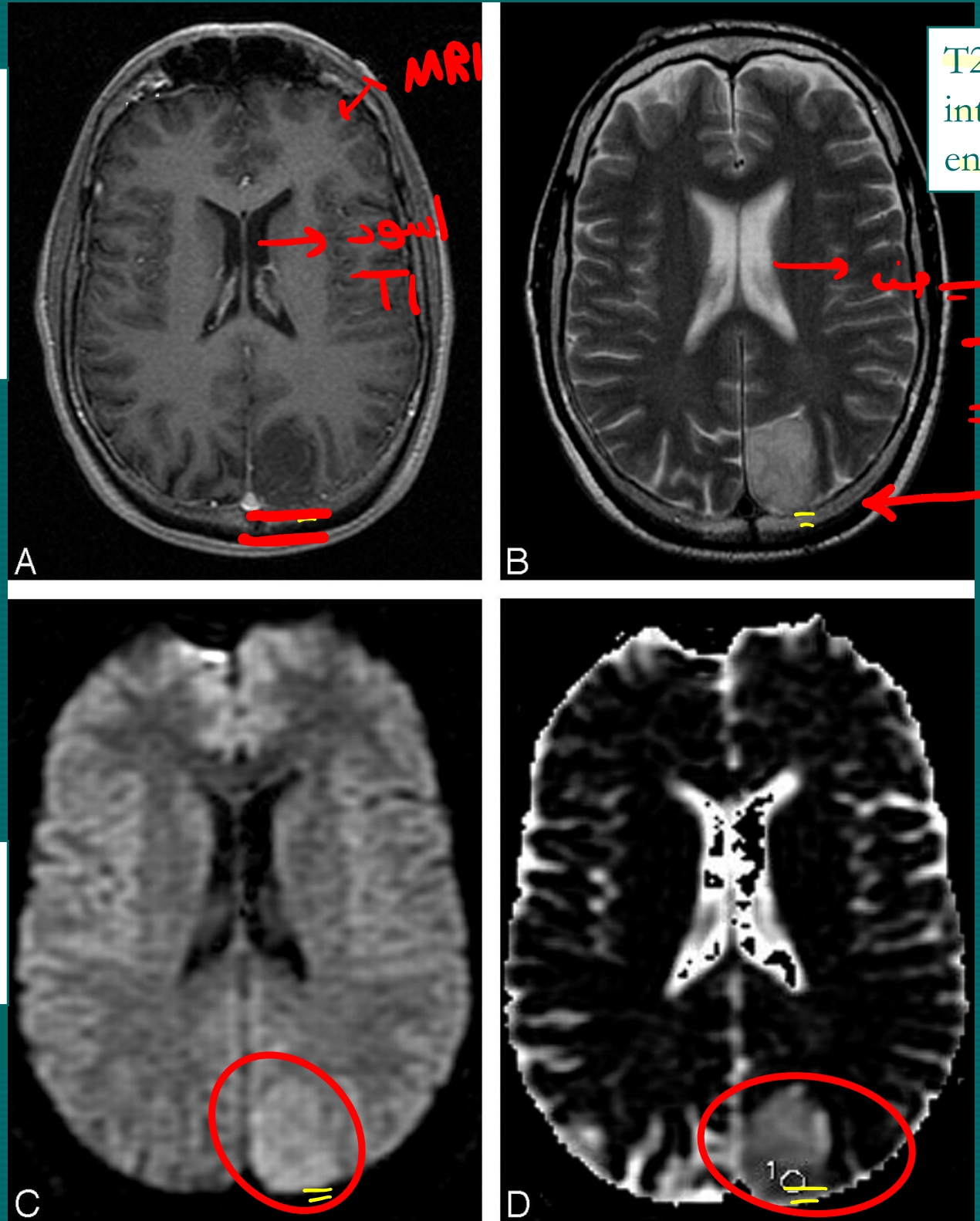
-the superior sagittal sinus with contrast is enhanced so there is no thrombosis if its not enhanced it will give empty delta sign

-NEXT STEP is MRI

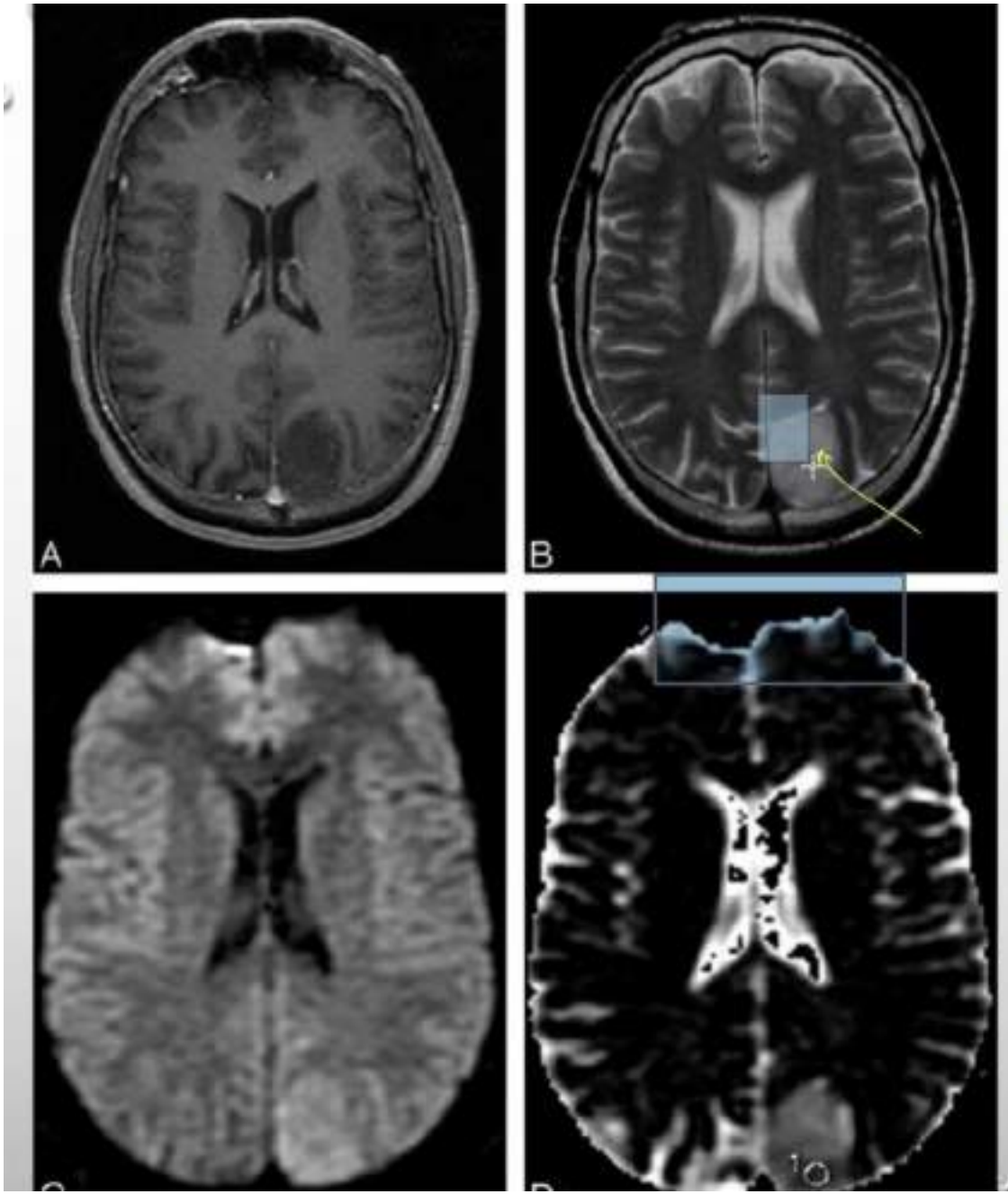
contrast CT shows low grade tumor- no shift, no enhancement, not haemorrhage, lesion is well defined

T1.. Hypo-intense.. No contrast enhancement.. Well-defined, no oedema >> low-grade glioma

T2>> hyper-intense, no enhancement



FLAIR>> hyper-intense, no enhancement



low grade glioma

= V. Smooth nice benign, appearance

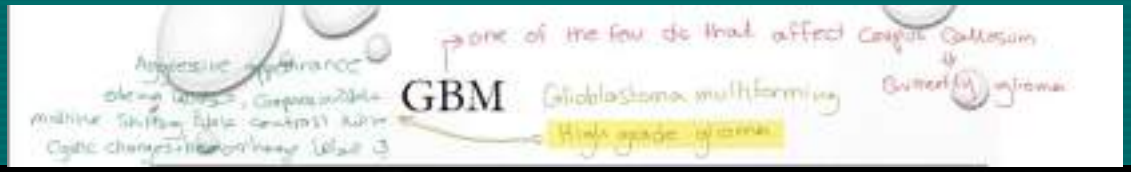
no mass effect

no surrounding edema

Contrast مش ملتزة

ما في جواها أي hemorrhage / Cystic changes

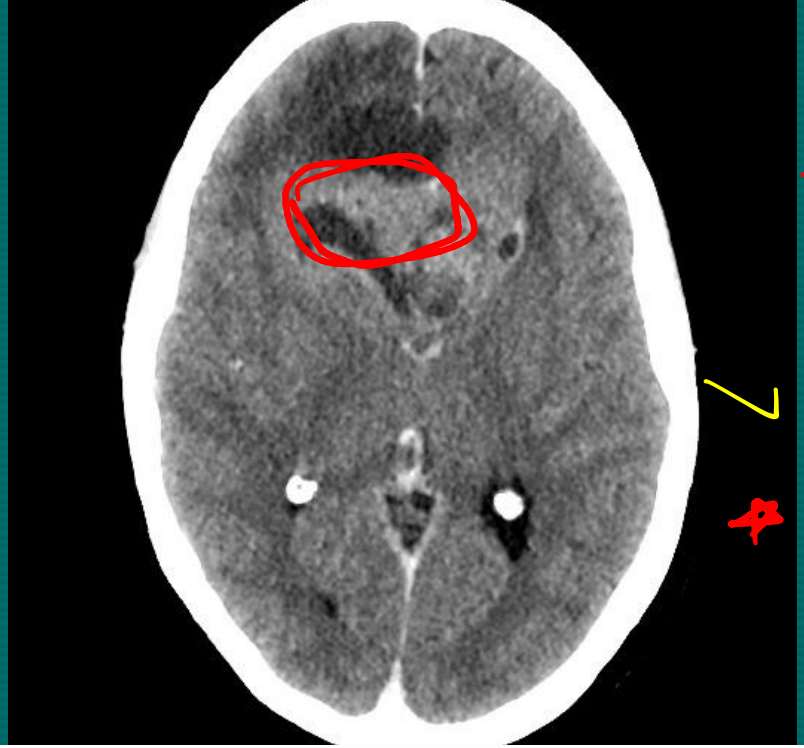
"Glioblastoma multiforming" ,high grade glioma , grade 4



A B C

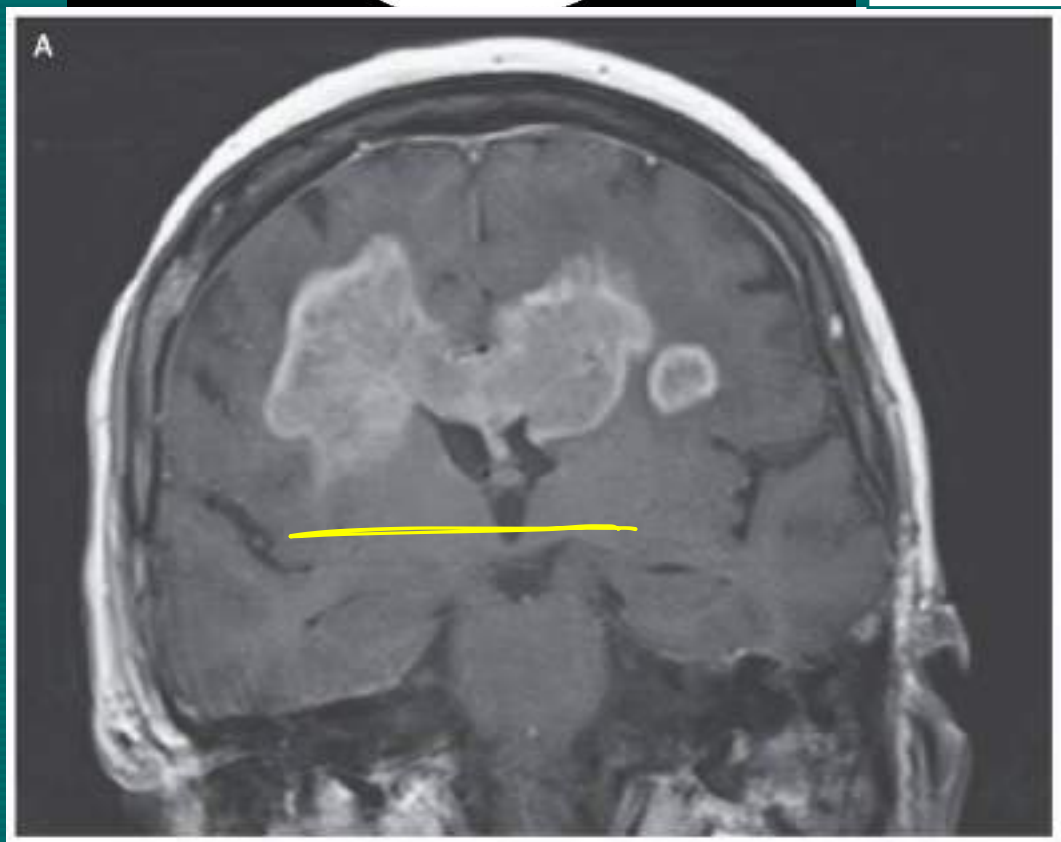
High-grade glioma>> Contrast-enhancement, with oedema, may have cystic or necrotic changes + pts are usually elderly

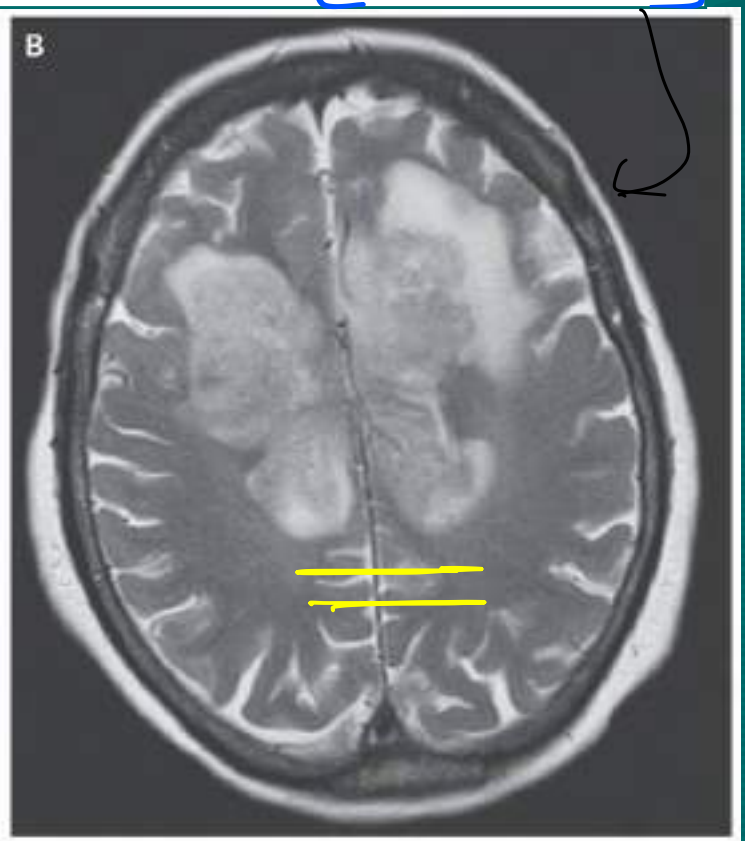
* mass effect
* shifting to the left



High-grade glioma affecting corpus callosum

Few lesions affect the corpus callosum..
When you see a lesion there, it could be lymphoma, GBM, MS
MS: hyper-intense lesions, multiple
GBM: heterogenous enhancement, diffuse enlargement, >> butterfly glioma





Cerebellar tumors (infratentorial)

intra-axial

In adults:

- The most common cerebellar lesion is a metastasis. Even if solitary metastatic lesion
- The second most common tumor is a hemangioblastoma.

In children:

مهم جدًا

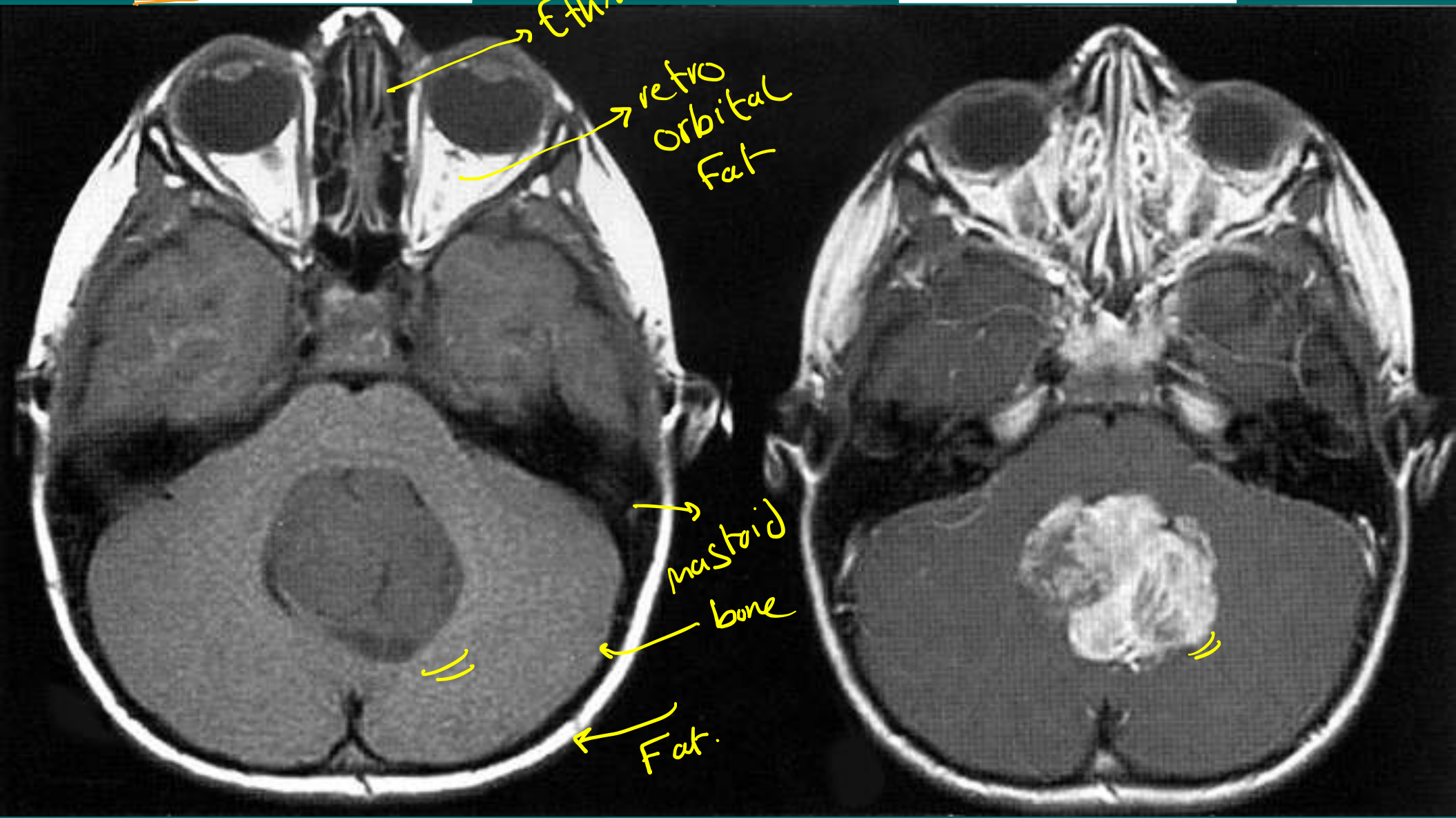
- Medulloblastoma: is the most common malignant brain tumor of childhood.
- Astrocytoma.
- Ependymoma.
- Brain stem glioma.
- Atypical teratoid rhabdoid tumour (ATRT)

MRI → عرفنا من bone

Mass occupying the 4th ventricle

T1- pre-contrast

T1- post-contrast



If this pt is young >> medulloblastoma
If pt is adult >> metastasis

↘ it is in infratentorial region.

✱ Choice → Brain MRI without contrast

What are the common extra-axial tumors ?

- Meningiomas (most common)
- Neuromas
- Metastasis
- Pituitary tumors

Extra-axial tumours could arise from meninges, BVs, skull, pituitary, nerve sheath neuromas (most commonly schwannomas) or metastasis

most Common extra axial tumor (MRI with Contrast)

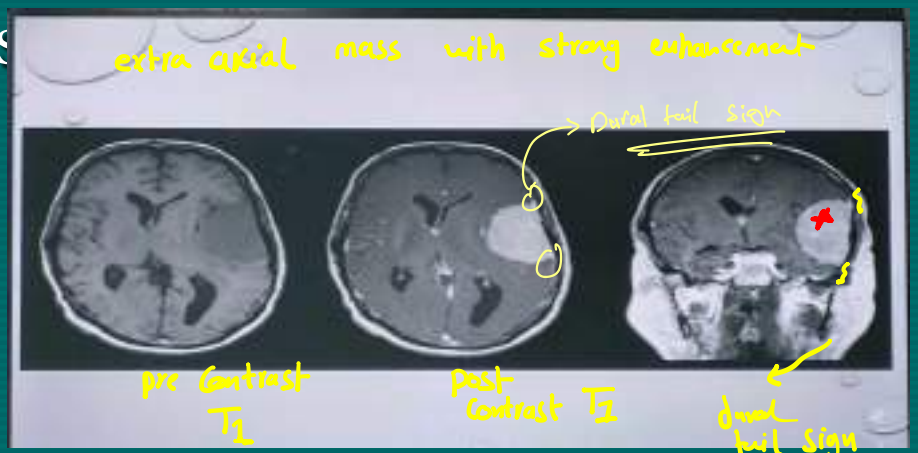
Meningiomas

well-defined extra axial mass with strong enhancement (vivid enhancement)

with dural tail Sign that indicates this mass arising From meninges.

Along Convexity

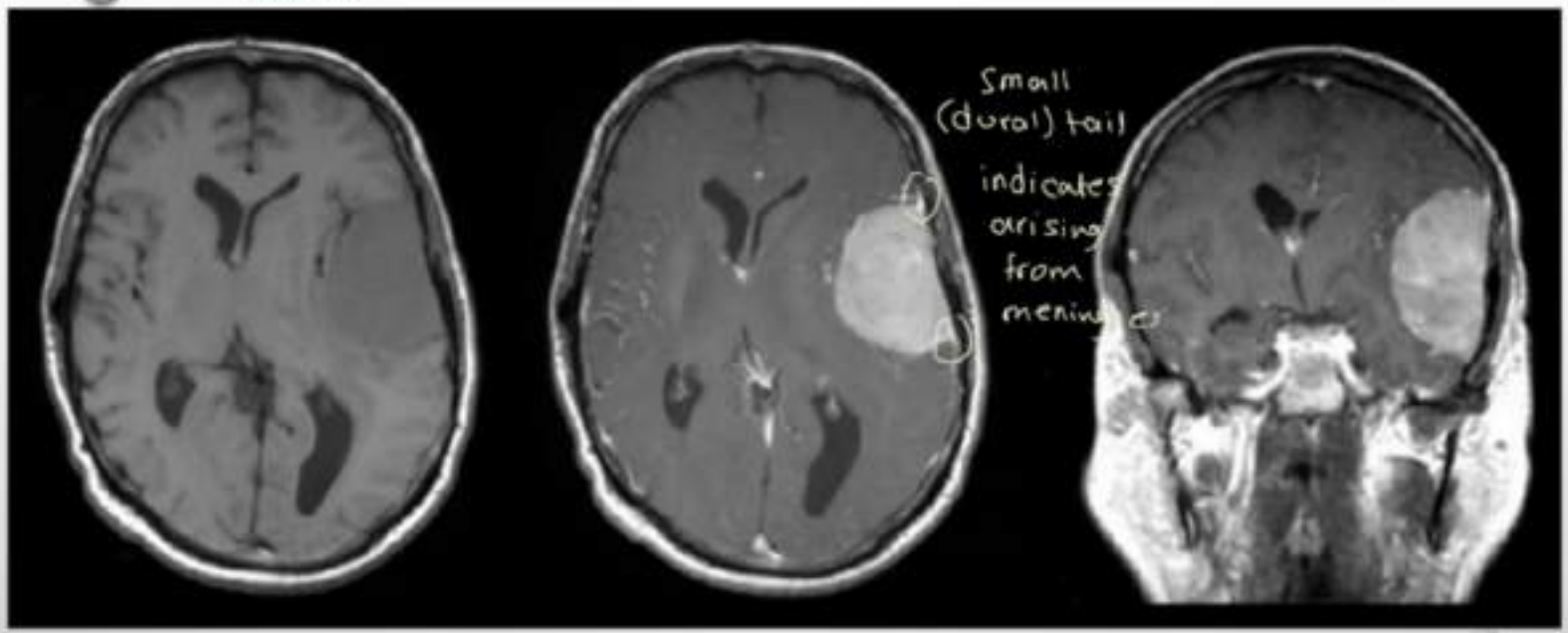
- Represent 15-20% of primary brain tumors.
- They are benign, well circumscribed lesions, arising from any part of the meningeal covering of the brain, most commonly in the parasagital region and sphenoid wing.
- Small punctate calcifications can be seen in 25% of tumors.
- CT or MRI show well defined lesions enhancing strongly and diffusely after intravenous contras



Extra-axial, well-defined, homogenously enhancing on MRI, sometimes with oedema
May see calcifications within the lesion (25%)
Typically affecting middle aged women
MRI is better than CT scan

T1 w/out Contrast

T1 w/ Contrast



well defined, strongly enhancing, extra axial mass

Right frontal lobe convexity tumour (meningioma) with massive oedema causing compressing effect (we don't usually see as much oedema - this is atypical meningioma)





neuroma → from sheath of nerve root

- most common nerve affected by schwanoma: vestibulocochlear nerve 8.

nuclei in pons → internal auditory meatus → تمر من خلال Subarachnoid space

* Cerebellopontine angle CPA

* well defined extraaxial with strong enhancement. arising from axon of 8 cranial nerve in CPA.

meningioma ممكن يعطي شبيه لـ schwanoma (بتشبها) + appearance والتشتت نفس

كيف نفرق

schwanoma هاد ← Follow the tract of the nerve

* ice cream cone shape يعطي شكل ، extension يكون في IUM

- meninges هاد شي meningioma بس not extent to IUM

extend ما بتعمل ← طالما ماخذ

Pituitary tumors: most common (Adenoma)

* micro: less than 1 cm
  - usually function: فانكشن بيجي لـ hormonal imbalance
* macro: more than 1 cm
  - non function: انكشن بيجي due to local mass effect
    * most structure compressed is optic chiasm
      * bitemporal hemianopia.

Radiology: MRI with Contrast.

micro: small lesion within pituitary → hypo enhancing not intense?

macro: strong enhancement & appearance.

Pituitary tumors

- The plain films show pituitary fossa enlargement or erosion.
- Adenomas smaller than 1cm are microadenomas, and larger adenomas are macroadenomas.
- MRI is superior to CT in detecting adenomas.

Micro- are usually functional, usually prolactinoma >> on imaging: well-defined area within the gland, less enhancing than the rest of the gland

Macro- involve the whole gland, extending beyond the suprasellar area, compressing the optic chiasm >> bitemporal hemianopia , usually non-functioning.. On imaging: large, homogenously enhancing pituitary, on coronal section you see 'figure of 8'

Acoustic neuroma:

- Arise in or near the internal auditory canal and may cause widening and erosion of the canal.
- MRI is more sensitive than CT in its detection.

Neuromas arise from nerve sheath, they follow the tract of the nerve

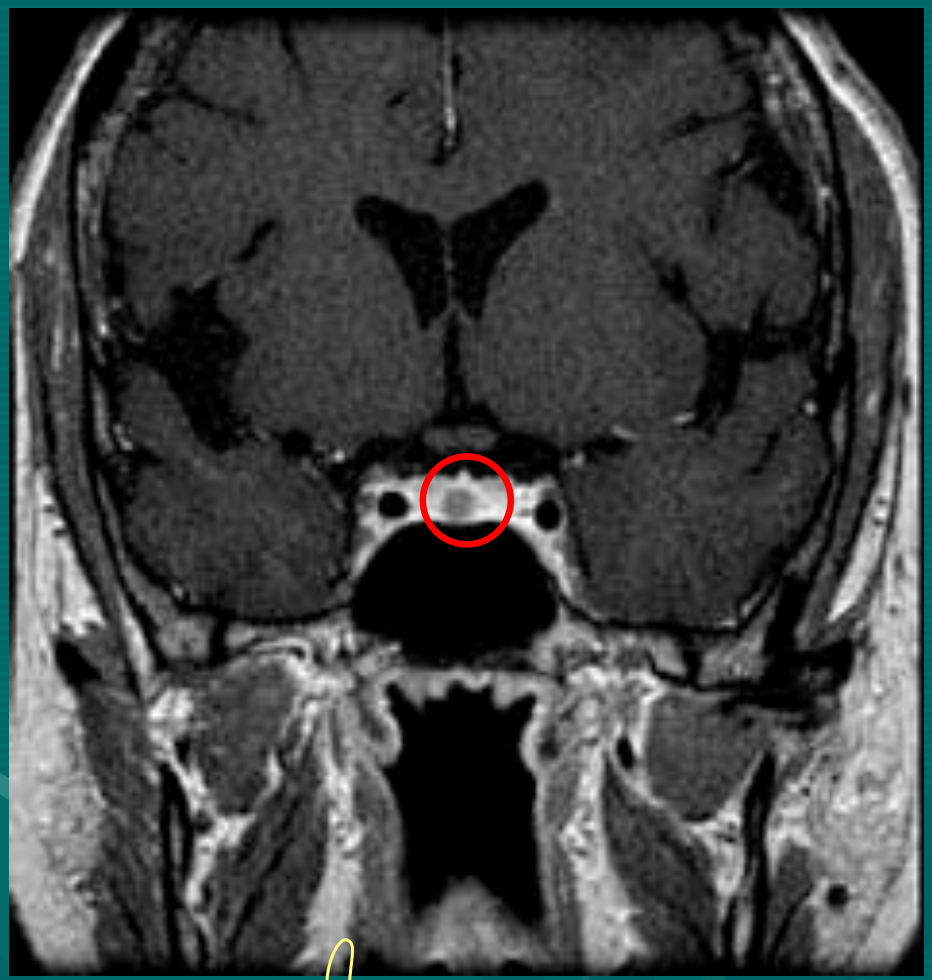
Usually affects vestibulocochlear nerve >> called schwannoma, the nerve leaves the pons to inter the internal acoustic meatus through the cerebellopontine angle (CP angle) >> so, part of the tumour will be seen interring the internal acoustic meatus>> ice-cream cone shape

Well-defined, homogenously enhancing, may see cystic changes

To differentiate meningioma & schwannoma, meningioma doesn't extend to the internal acoustic meatus >> no ice-cream cone shape

MRI T1>> Small, well-defined area within the pituitary, less enhancing than the rest of the gland >> micro-adenoma of the pituitary gland

Dynamic Study

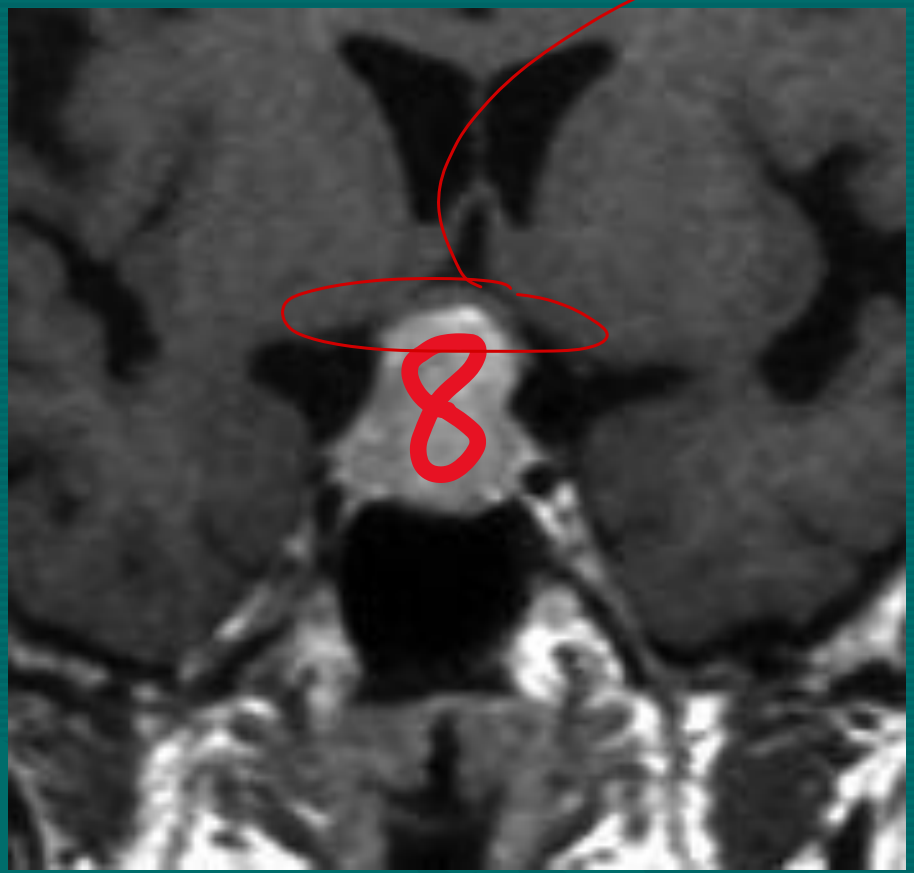


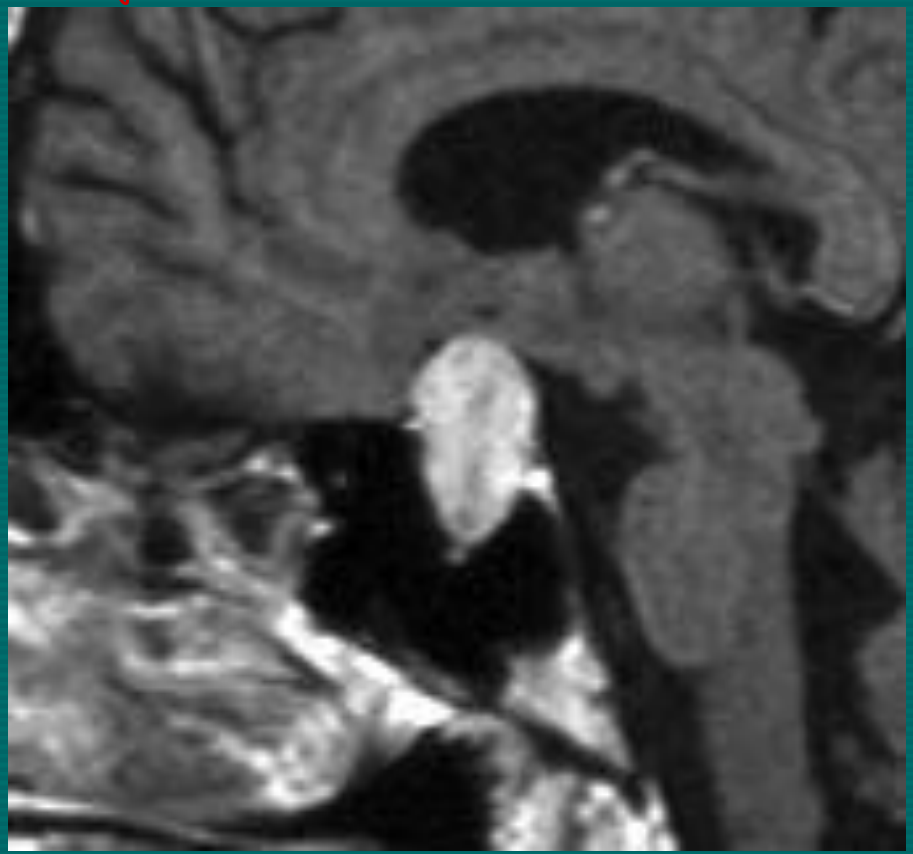


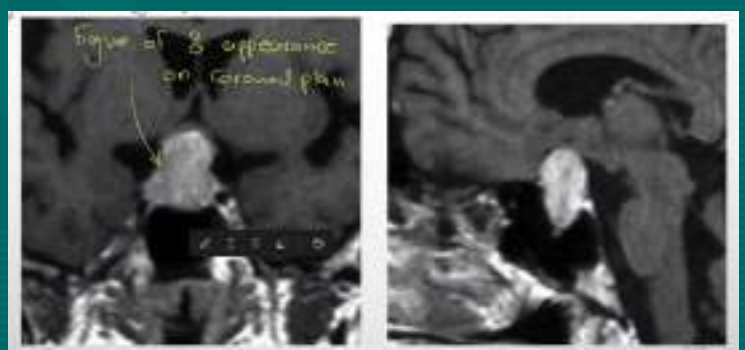
- well defined

Contrast خافتة بين أقل من ال whole gland.

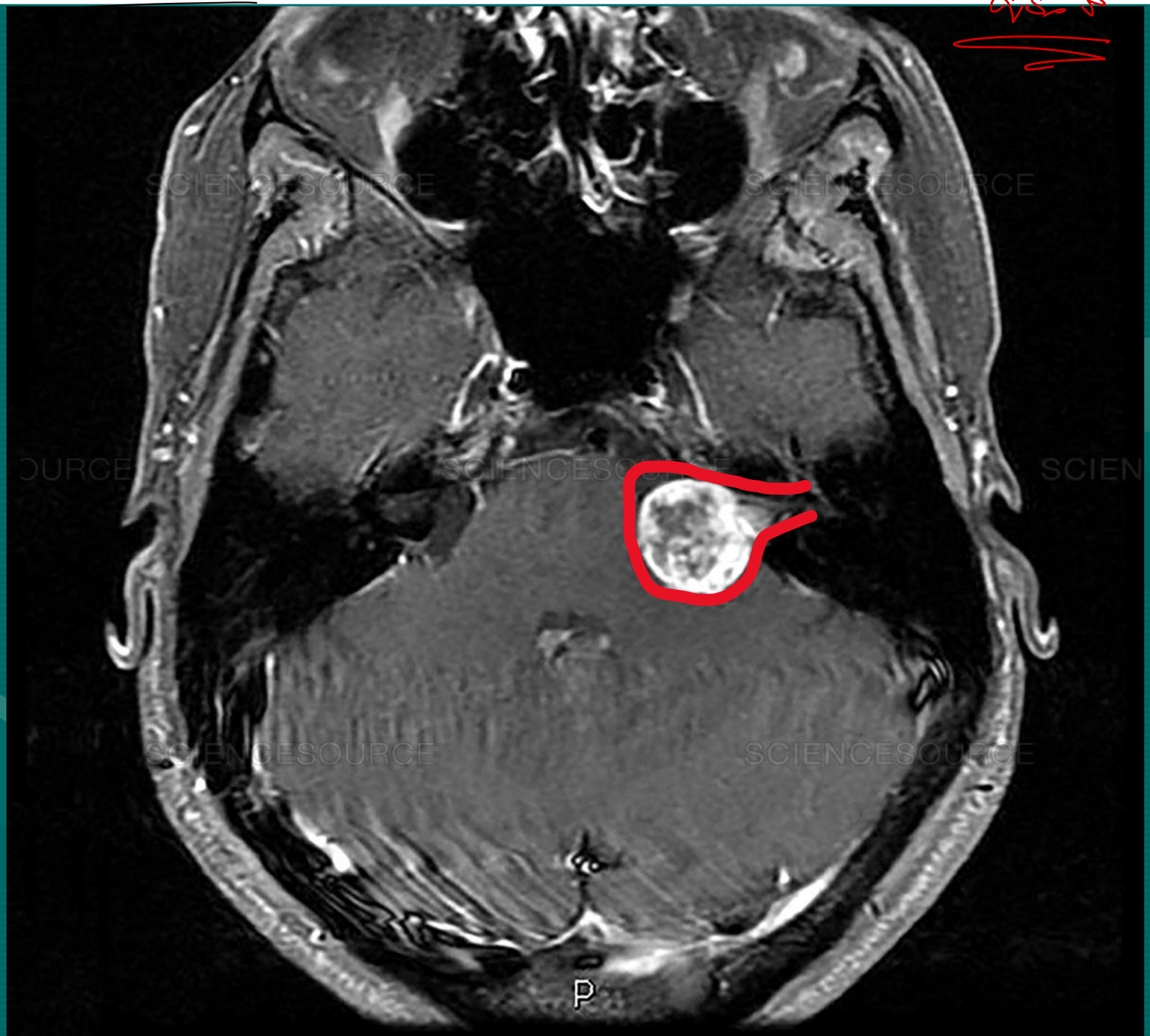
MRI T1 >> large, homogenously enhancing pituitary, 'figure of 8' on coronal section, involving the whole gland, extending beyond the suprasellar area, compressing the optic chiasm



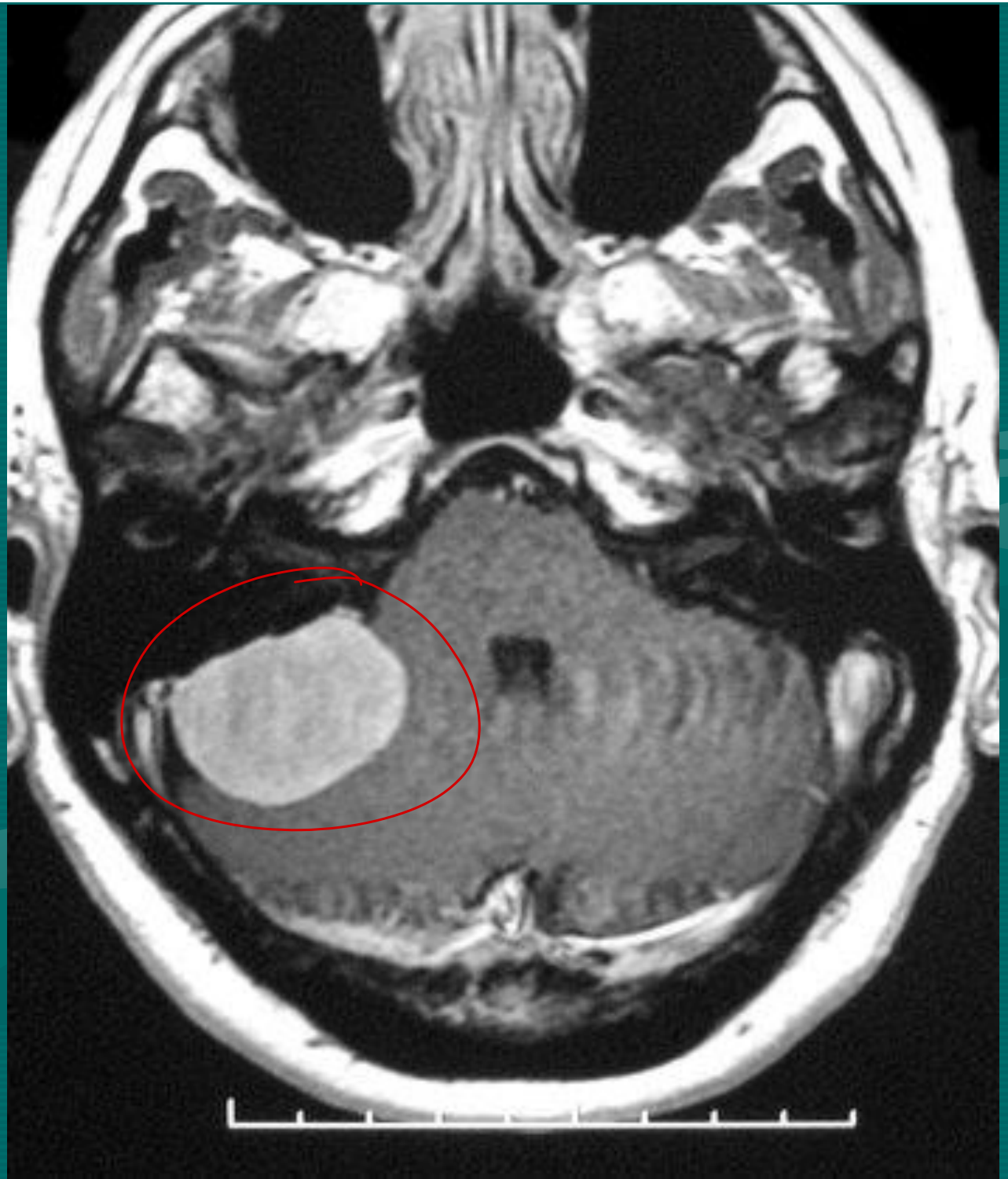




MRI FLAIR with contrast >> Well-defined, homogenously enhancing, ice-cream cone shape on CP angle >> schwannoma | follow the track of the nerve



Well-defined, homogenously enhancing, no ice-cream cone shape on CP angle >> meningioma



Doesn't follow the tract of vestibular-cochlear nerve

Most commonly intra-axial but could be extra-axial

Brain metastasis

- MRI with contrast (modality of choice)

- The majority are multiple (80%)
- They can occur anywhere in the brain, but the gray-white matter junction is the commonest site.
- Metastatic lesions are usually associated with a considerable amount of surrounding edema.
- Brain metastasis are commonly from bronchial, breast and gastro-intestinal tumors.

1 2 3

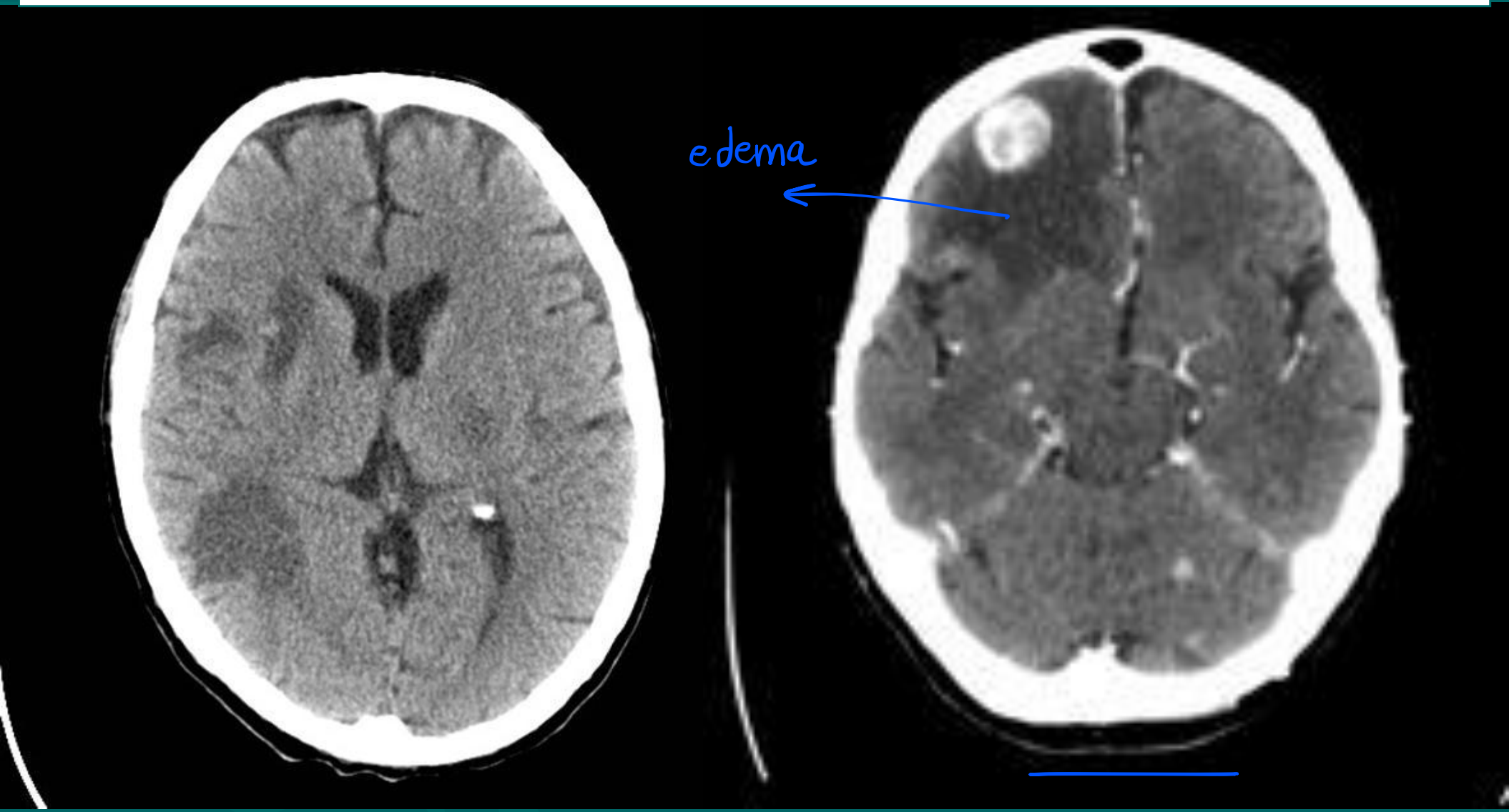
+ melanoma 4
(melanoma produces haemorrhagic mets)

Radiologically>> multiple, well-defined, ring-enhancing lesions, usually at grey-white matter junction, oedema out-proportional to the size of the lesion

CT w/out contrast >> we may see the oedema but not the lesion itself

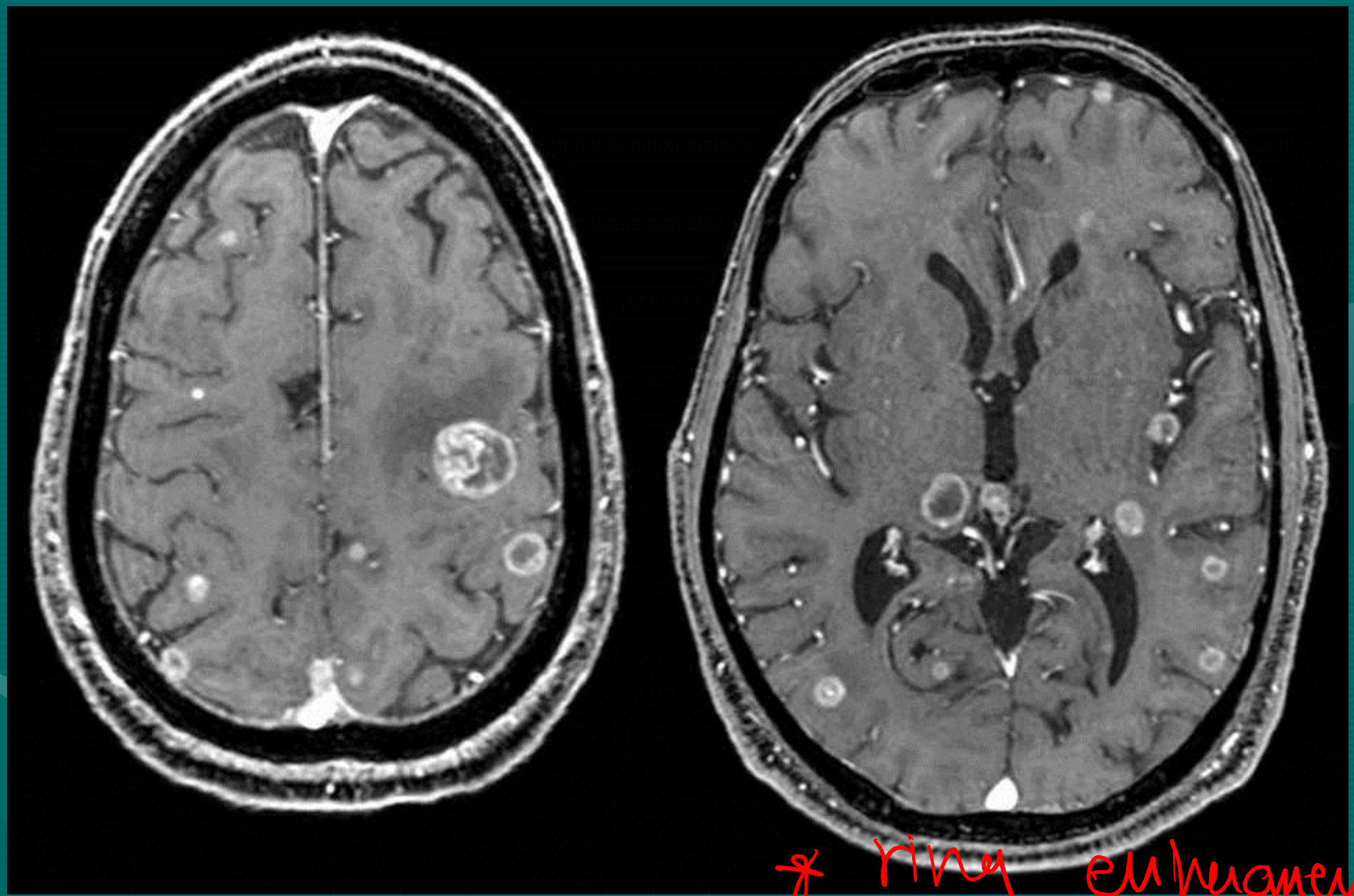
With contrast >> ring-enhancing….

#At grey, white matter junction.



MRI T1 >> Multiple lesions, ring-enhancing

periphral



* ring enhancement

**** Notes after the first lecture :

- When writing a report for brain tumor It's imp to know :
- If it is supra or infra "in posterior fossa"
- Age
- Cystic or solid
- Calcifications : in some tumors it is rare to find calcifications and in others it is common >>>> as in the(craniopharyngioma)In childs 90% Calcifications while in (medulloblastoma)it is impossible to find calcifications → Knowing these things about the mass helps us to determine the type of it .

**** In the barium follow through >>> the abdominal films which are taken in the first hour the pt should be in prone position because by the compression that the table makes on the pt's abdomen , the ileum would be visualized clearly .. after the first hour the films taken in supine position.