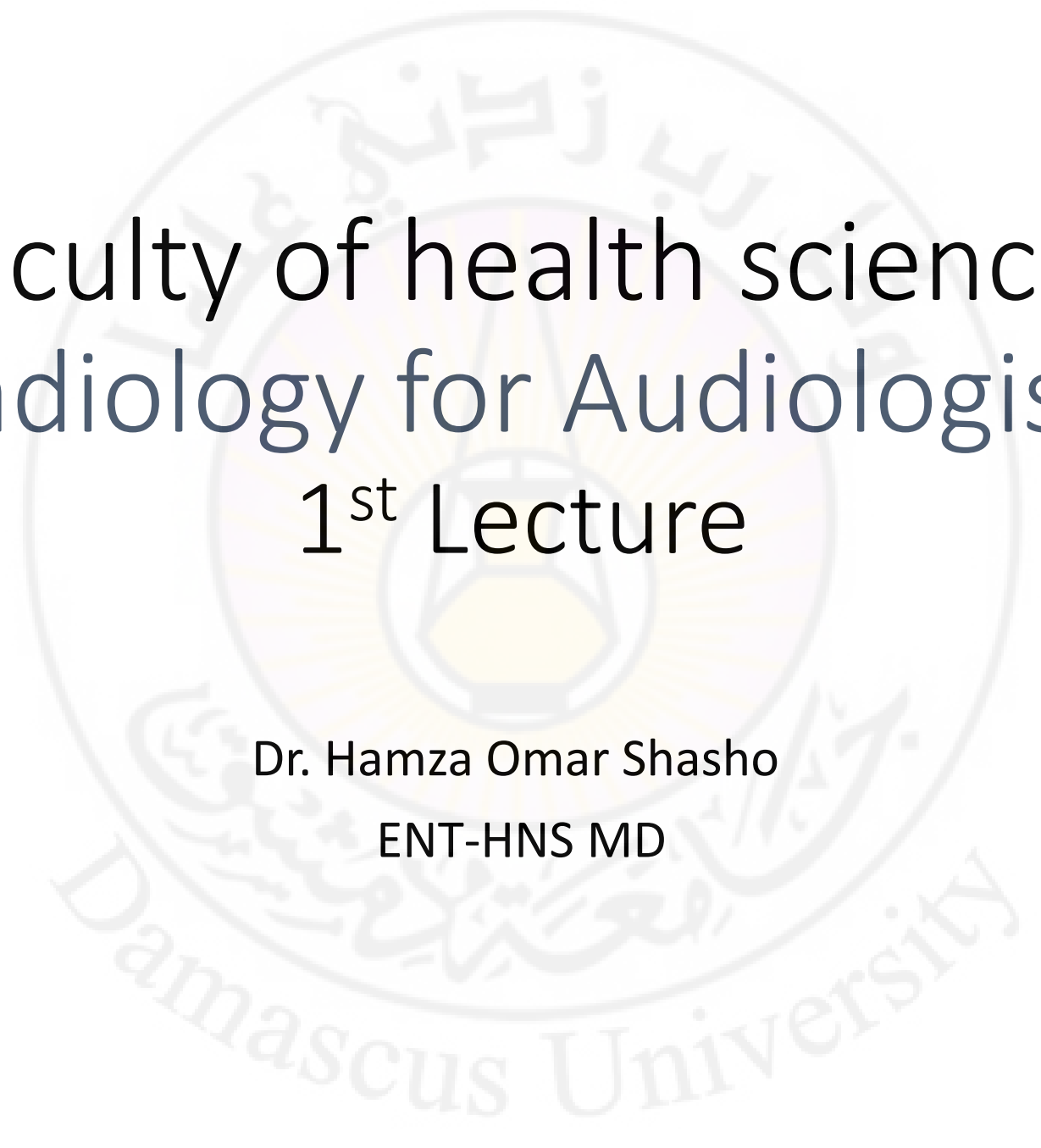




Faculty of health sciences

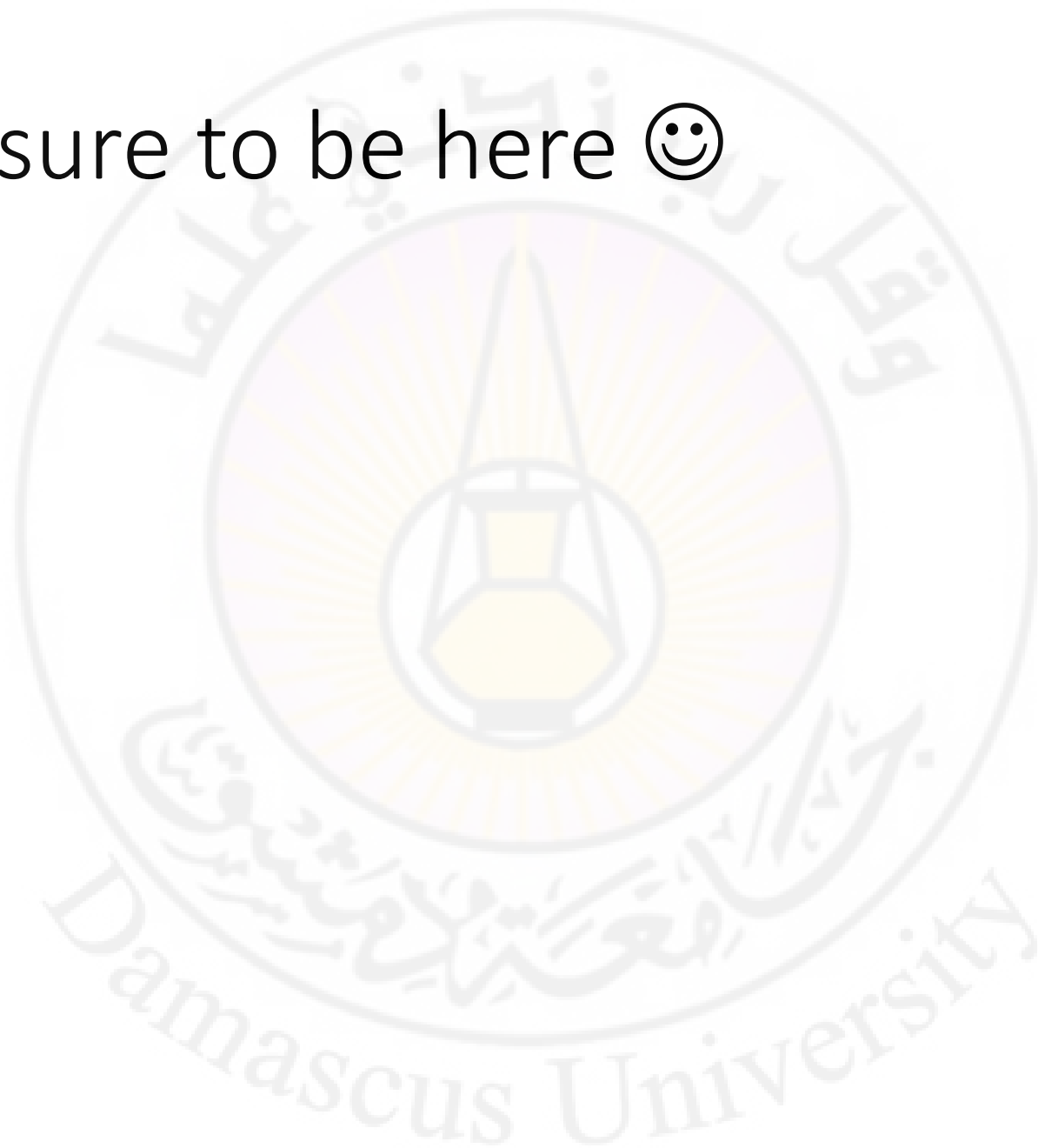
“Radiology for Audiologists”

1st Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

It is a pleasure to be here 😊



You are the first generation !!

Not only in your families .. Rather in your community !!



What is Radiology?

- ✓ Medical specialty that supervises, perform and interprets imaging studies.
- ✓ Reports findings to referring physicians to help in the patients management.

As an audiologist.. Why to study Radiology ?!!



Multidisciplinary approach



To be Case leader



To be a Case leader

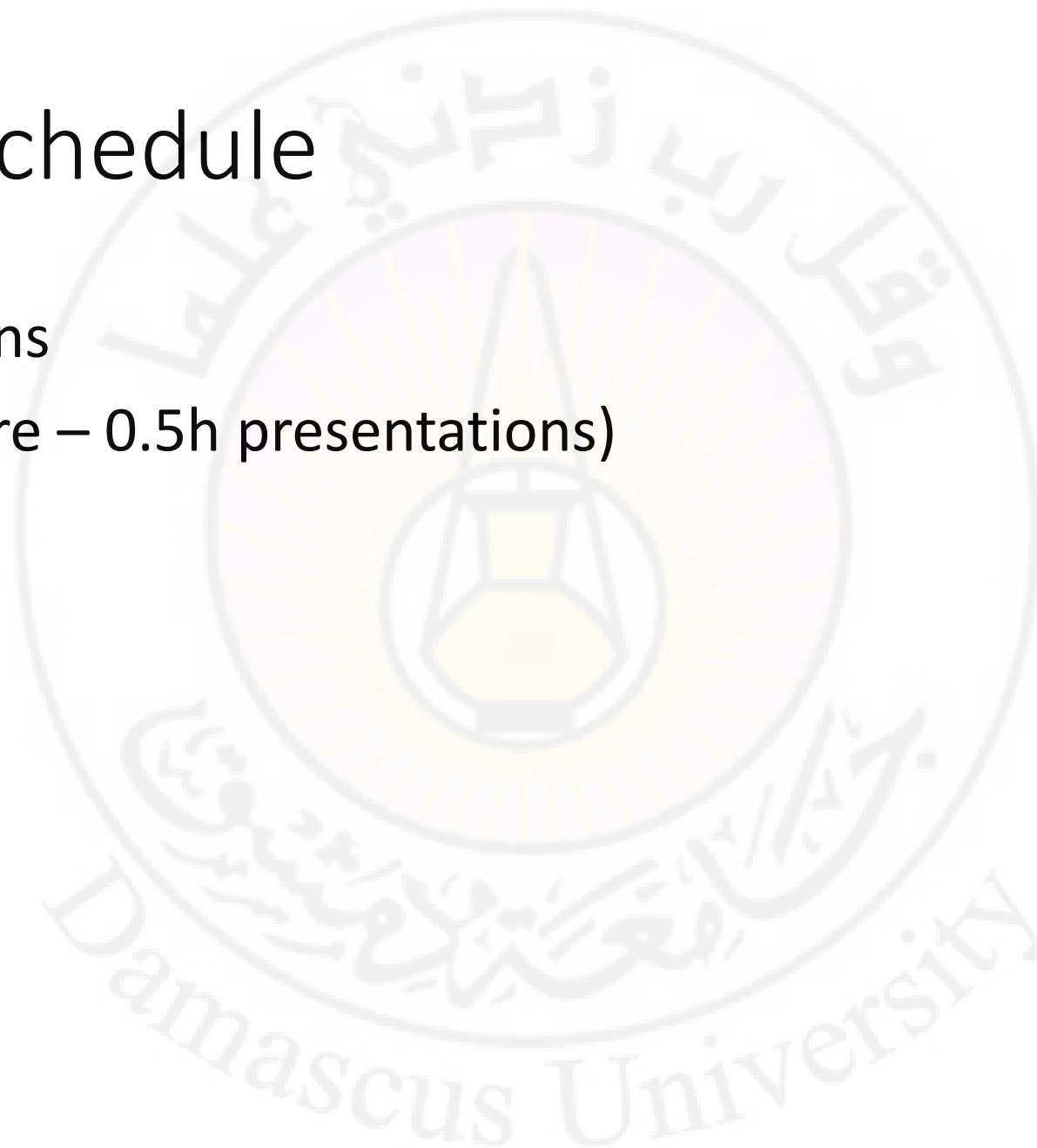


To perform observation on teamwork



Lectures schedule

- 10 – 12 sessions
- 2h (1.5h lecture – 0.5h presentations)



Marks arrangement

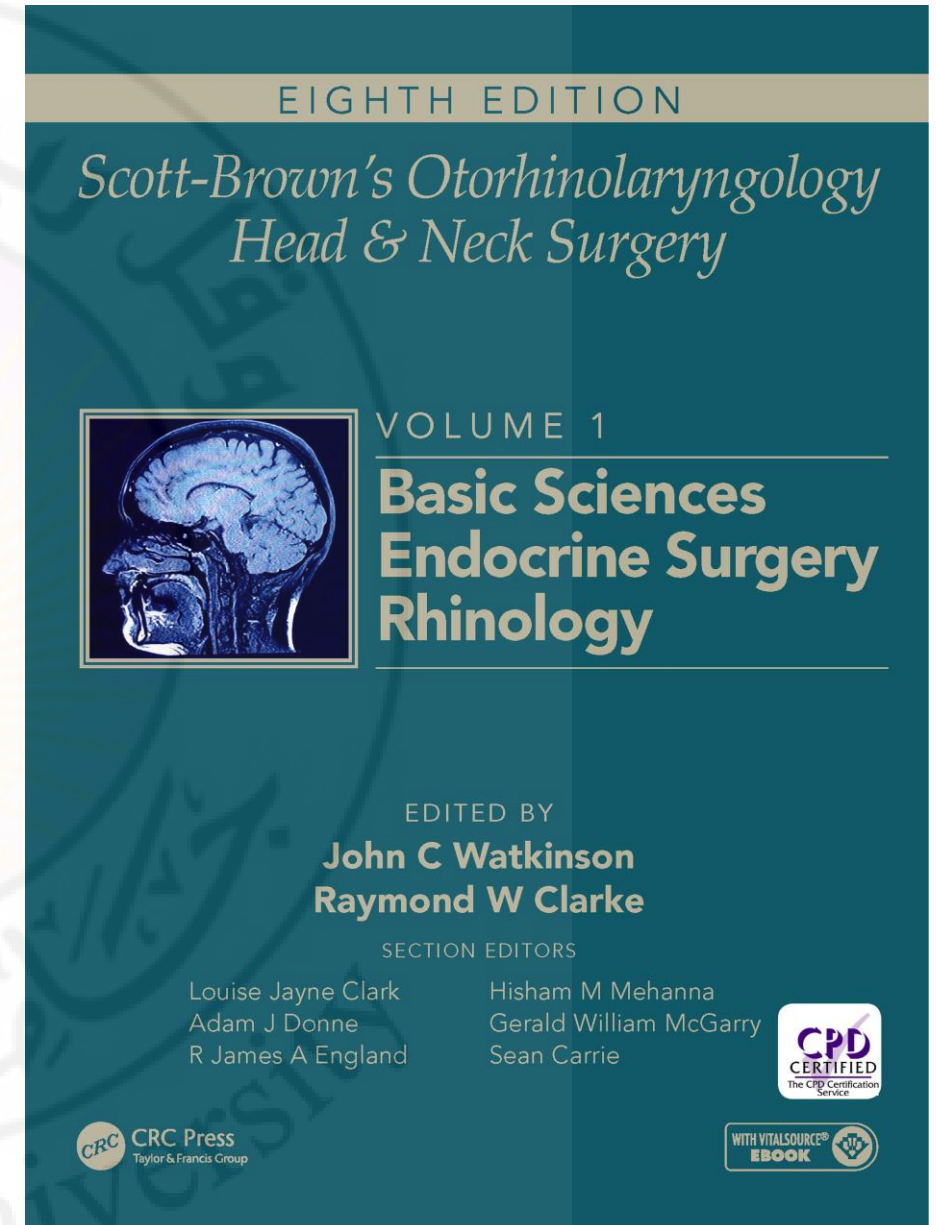
٧. نظري

30 عملي

درجة أعمال: (5) تقديم حالة: (5) امتحان: (10) مذكرات: (5+5)

Your Armamentarium

- Lectures
- Scott-Brown's Otorhinolaryngology
Head and Neck Surgery 8th edition
- Radiopedia.com
- WHATSAPP Group : 0934 306 328

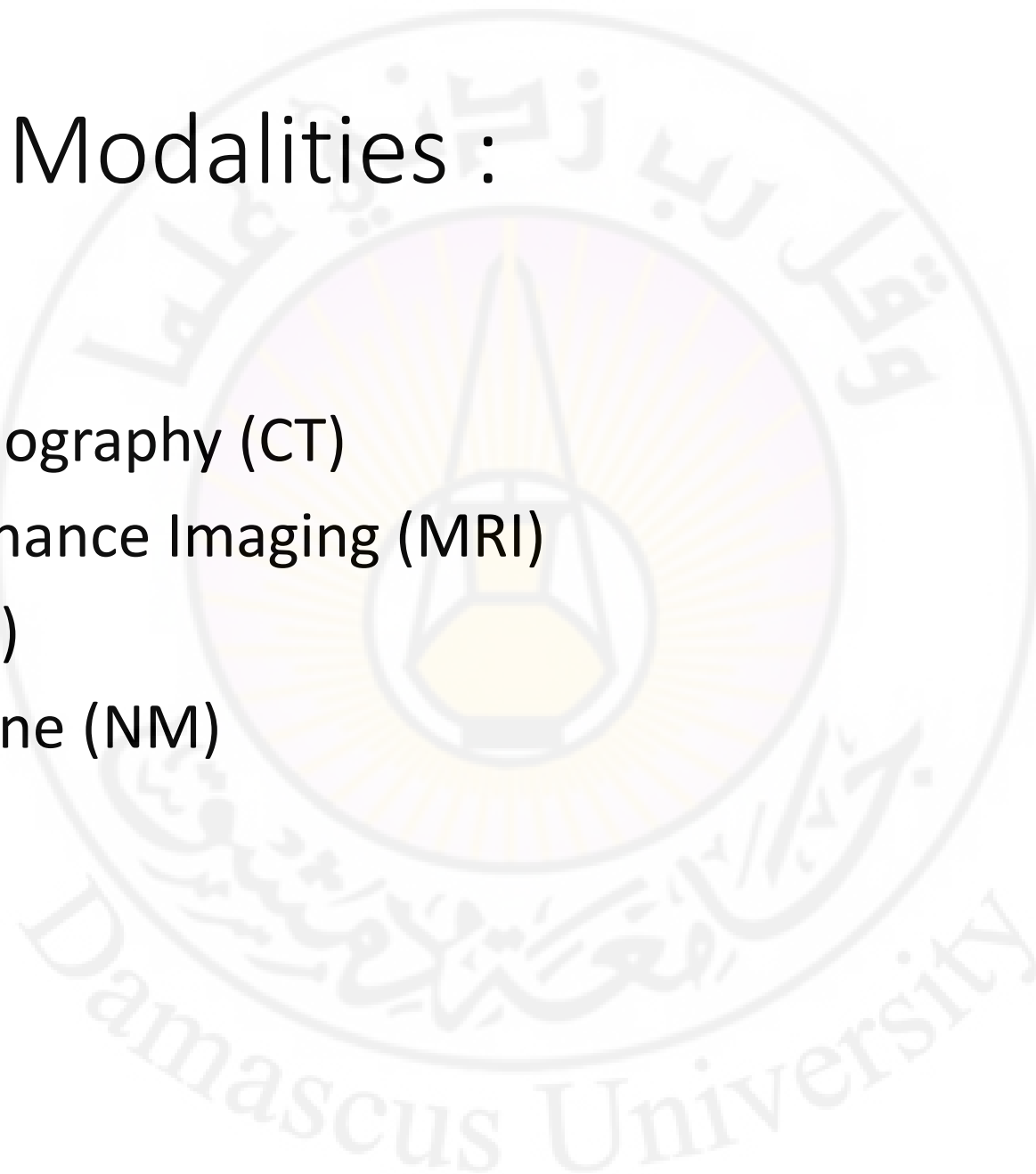


((بسم الله الرحمن الرحيم))



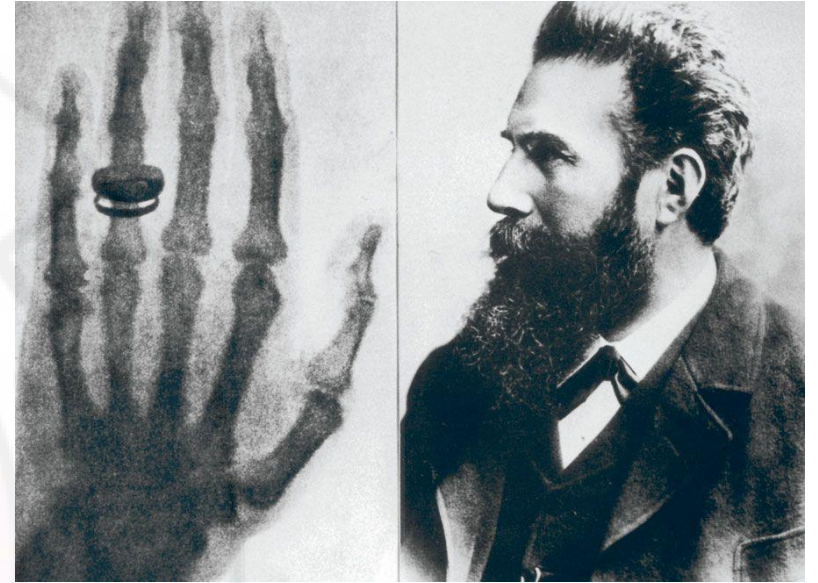
Diagnostic Modalities :

- plain X-Ray
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasound (US)
- Nuclear Medicine (NM)



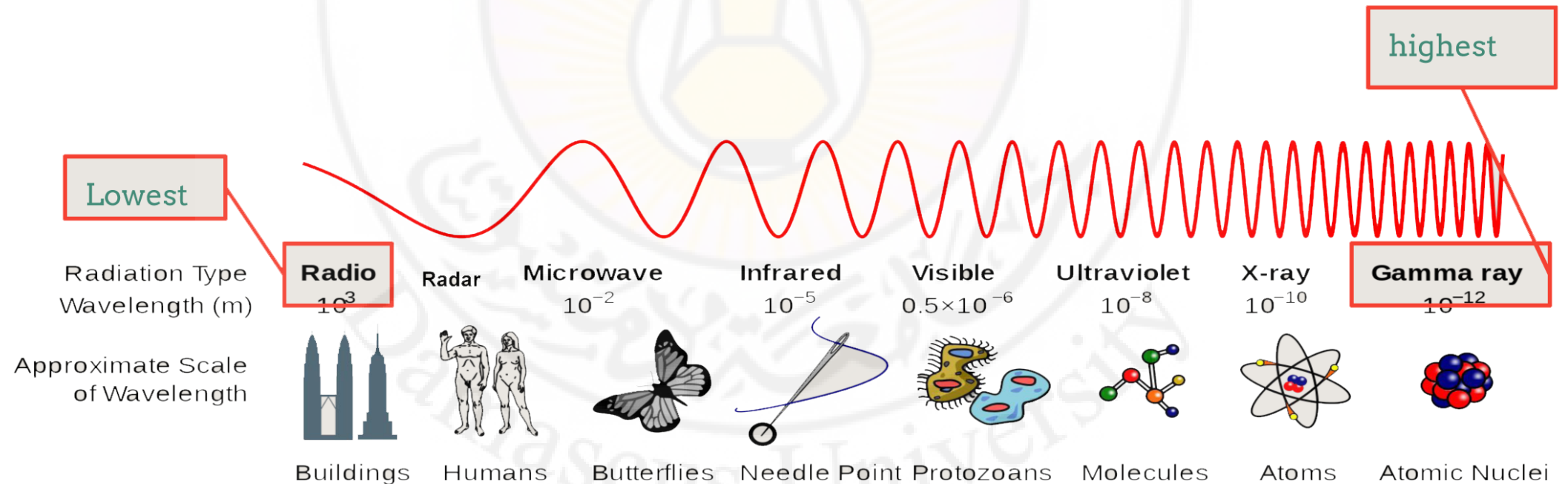
Historical context

- Wilhelm Conrad Rontgen
- German Physicist
- Discovered X-rays in 1895
- Awarded FIRST ever Nobel prize in Physics
- Rontgen didn't seek patent protection for his discovery !



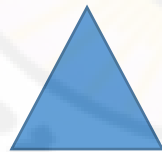
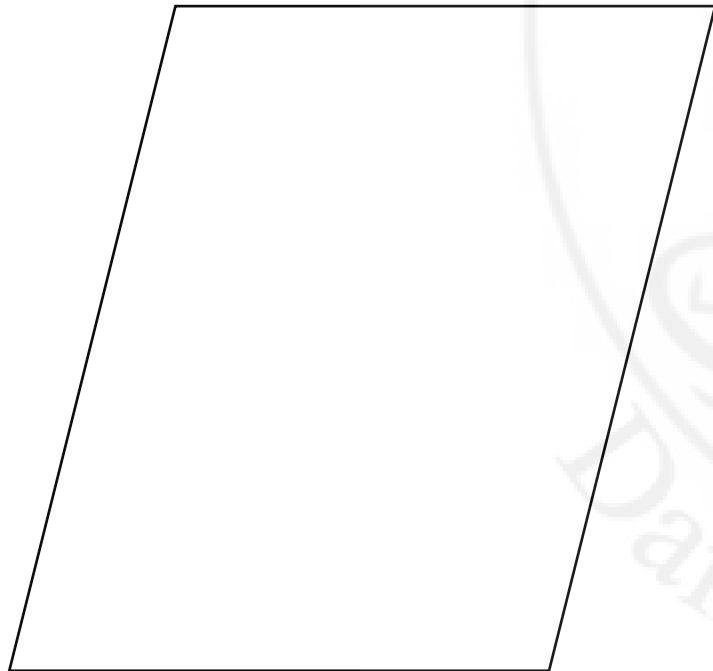
X-rays

Ability of penetration (The higher frequency, the higher penetration ability.)



X-rays in Conventional Radiology

Film is white .. It turns black in areas exposed to radiation Which is determined by how much radiation can penetrate a particular density



X-rays generator



X-rays in Conventional Radiology

Film is white .. It turns black in areas exposed to radiation Which is determined by how much radiation can penetrate a particular density

X-rays generator



X-rays in Conventional Radiology

Film is white .. It turns black in areas exposed to radiation Which is determined by how much radiation can penetrate a particular density

X-rays generator



X-rays in Conventional Radiology

Film is white .. It turns black in areas exposed to radiation Which is determined by how much radiation can penetrate a particular density



X-rays in Conventional Radiology



X-rays in Conventional Radiology

1. Pass all the way through the body:

- Render the film DARK (BLACK shadow), **Radio-LUCENT**.
- Air has a low atomic number → X-rays get through → image is **DARK**.

2. Be deflected, scattered or absorbed:

- Render the film LIGHT (WHITE shadow), **Radio-OPAQUE**.
- Bone has a high atomic number → X-Rays are blocked → image is **white**.

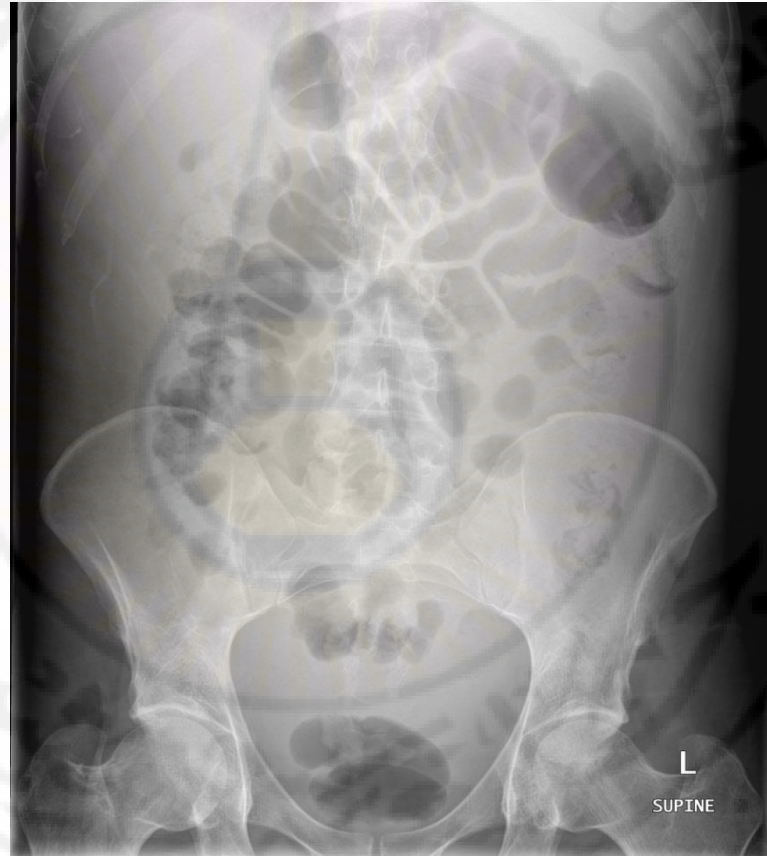
X-rays in Conventional Radiology

5 basic densities:

1. Air (all rays Pass through)
2. Fat
3. Fluid/Soft tissue
4. Bone
5. Metal (Attenuated)



X-rays in Conventional Radiology



Air

Fat

Soft tissue

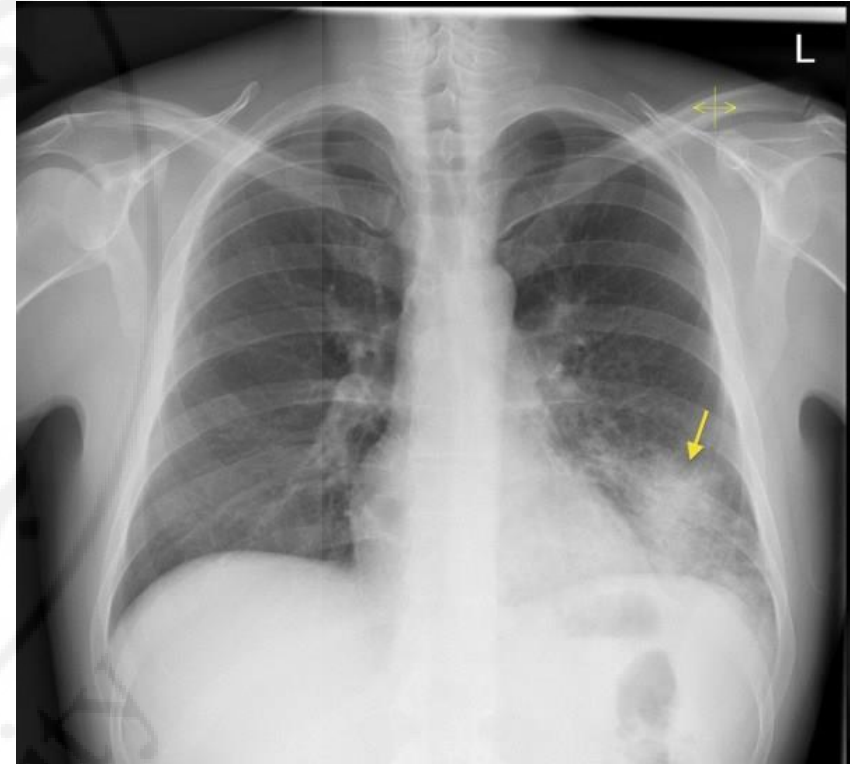
Bone

X-rays in Conventional Radiology

Lateral Directions in conventional radiology are inverted!

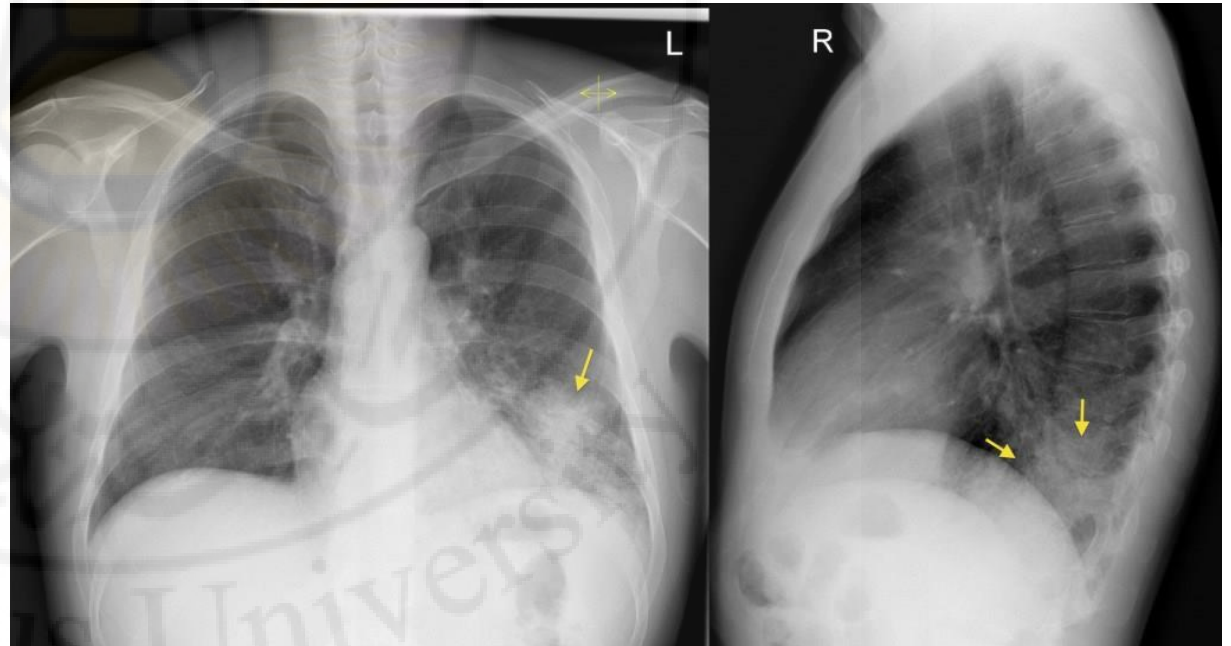
How to distinguish right from left ??

1. By use of labels ,film notches and words (if present)
 2. By hints provided by anatomical structures (**unreliable**)
 3. in head and neck)
 4. Digital images are **supposed** to be properly directed
 5. By use of laterality of pathology (used with **caution**)
- This apply to CT and MRI as well.
 - Improperly directed films might lead to a medical disasters.



X-rays in Conventional Radiology

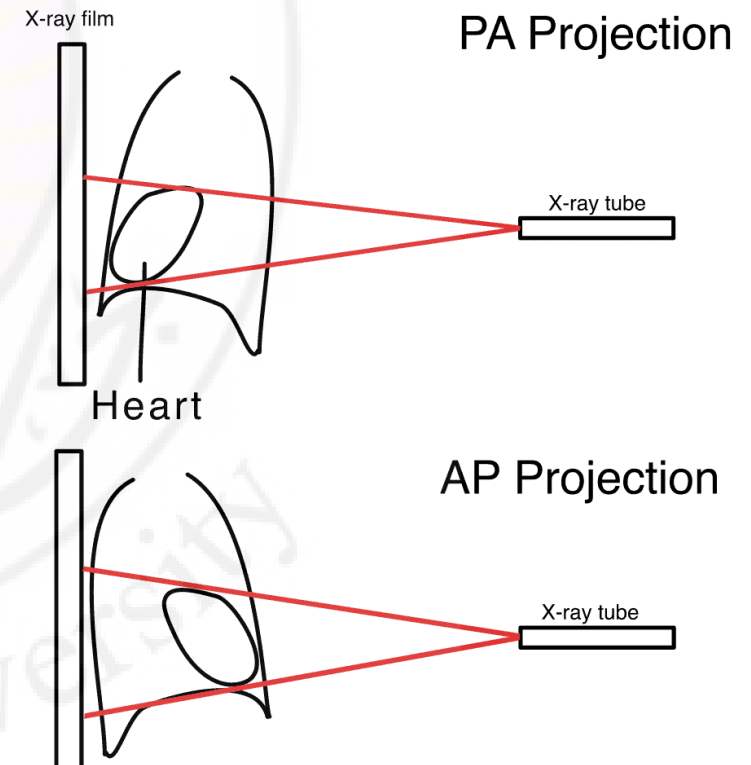
At least 2 views (orthogonal to each other) are often needed to facilitate study of superimposed structures and thus increasing sensitivity of X-rays images.



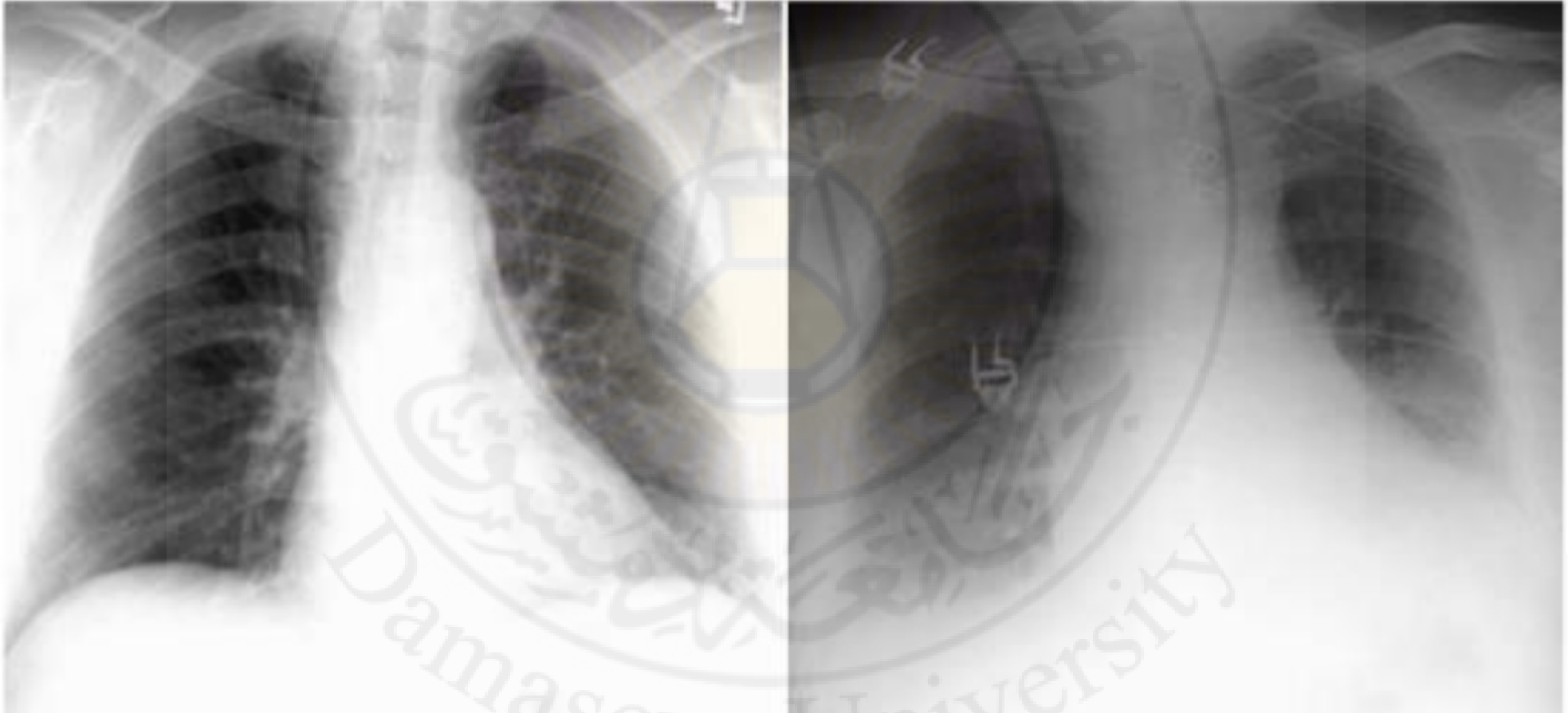
X-rays in Conventional Radiology

AP(anterior-posterior) VS PA(posterior-anterior):

1. Refers to how the x-ray is first entering the patients.
2. Can have effect on organ's size and definement.

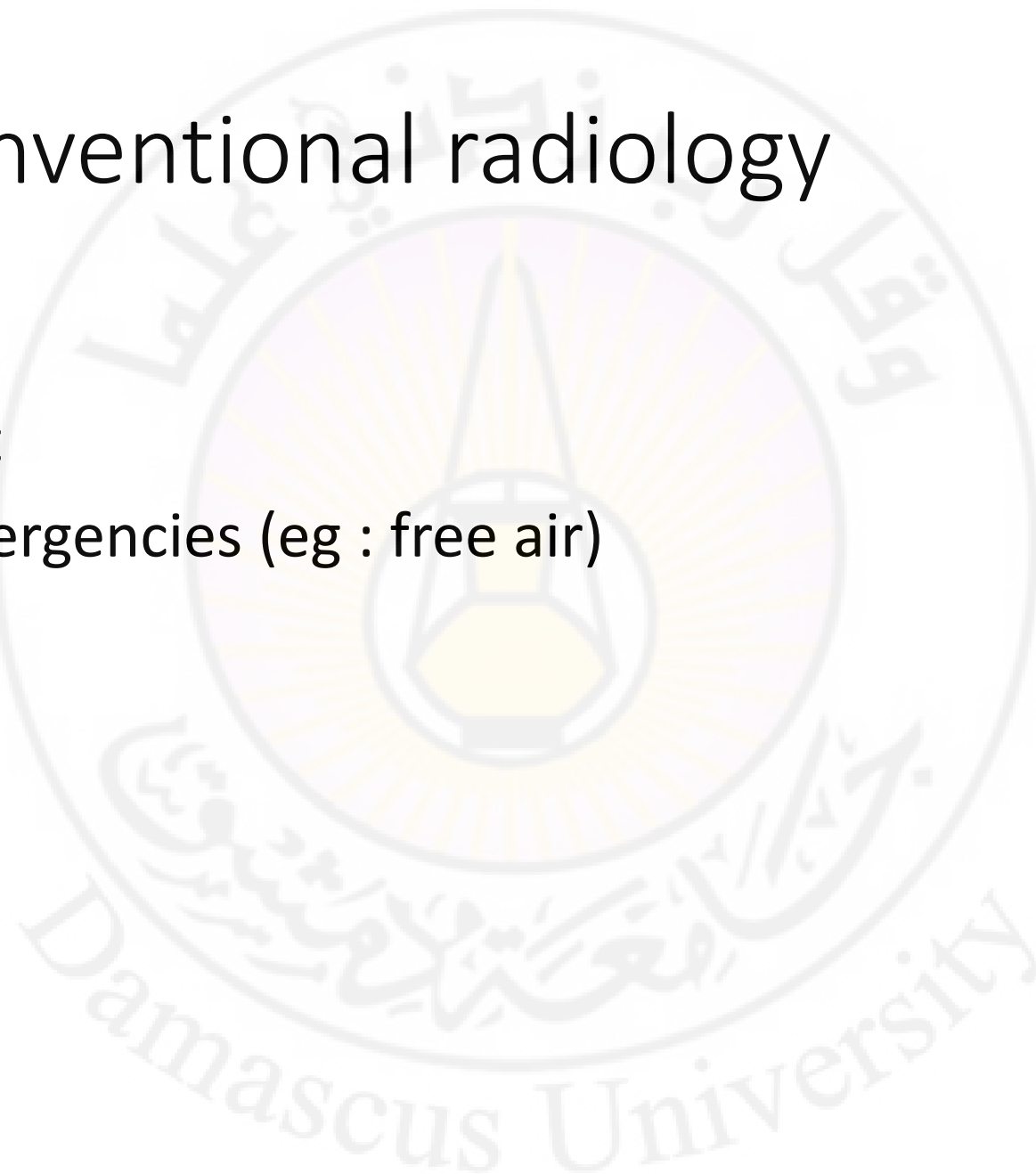


PA vs AP view



Uses of conventional radiology

- Fractures
- Line placement
- Abdominal emergencies (eg : free air)
- Chest imaging



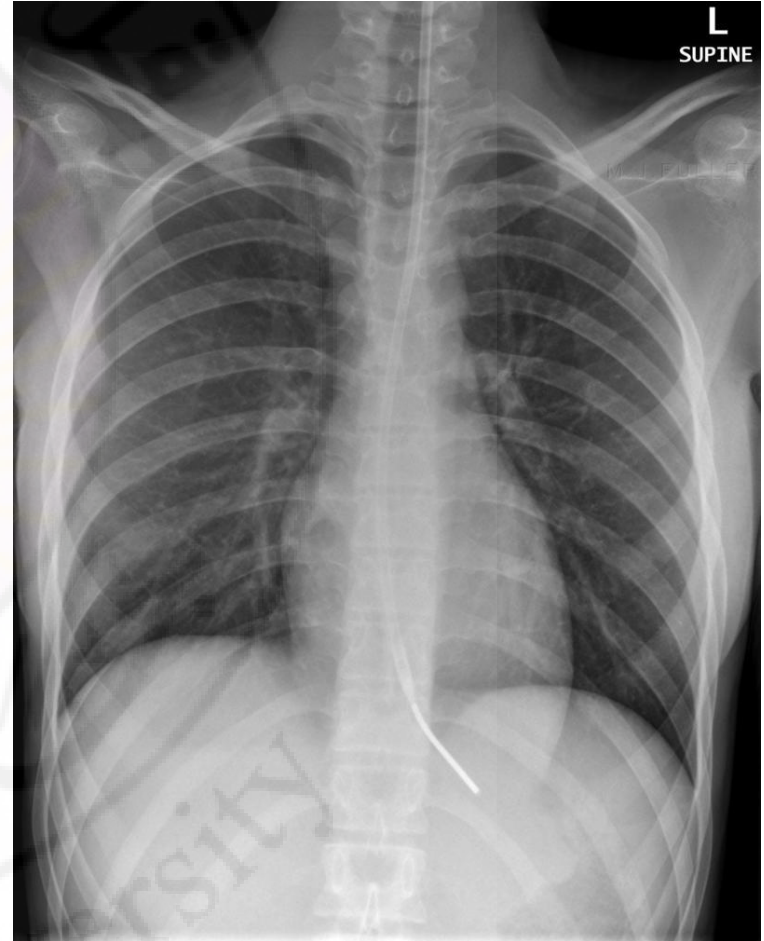
Uses of conventional radiology

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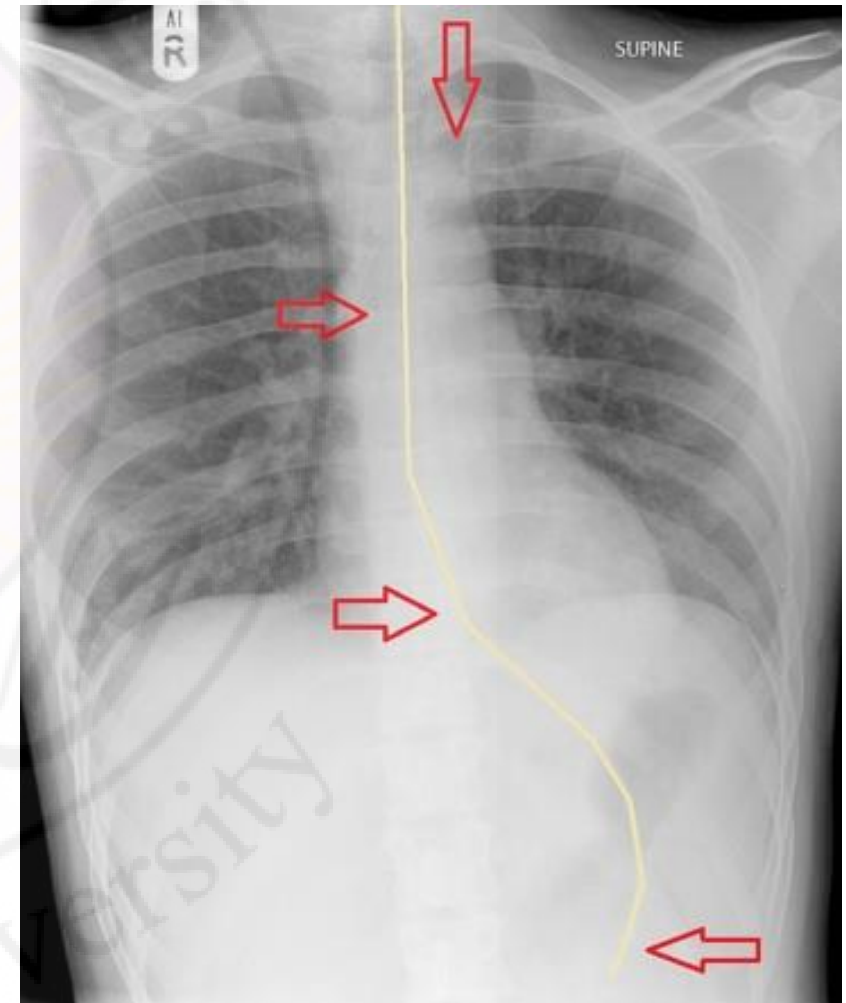
Uses of conventional radiology

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Uses of conventional radiology

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Uses of conventional radiology

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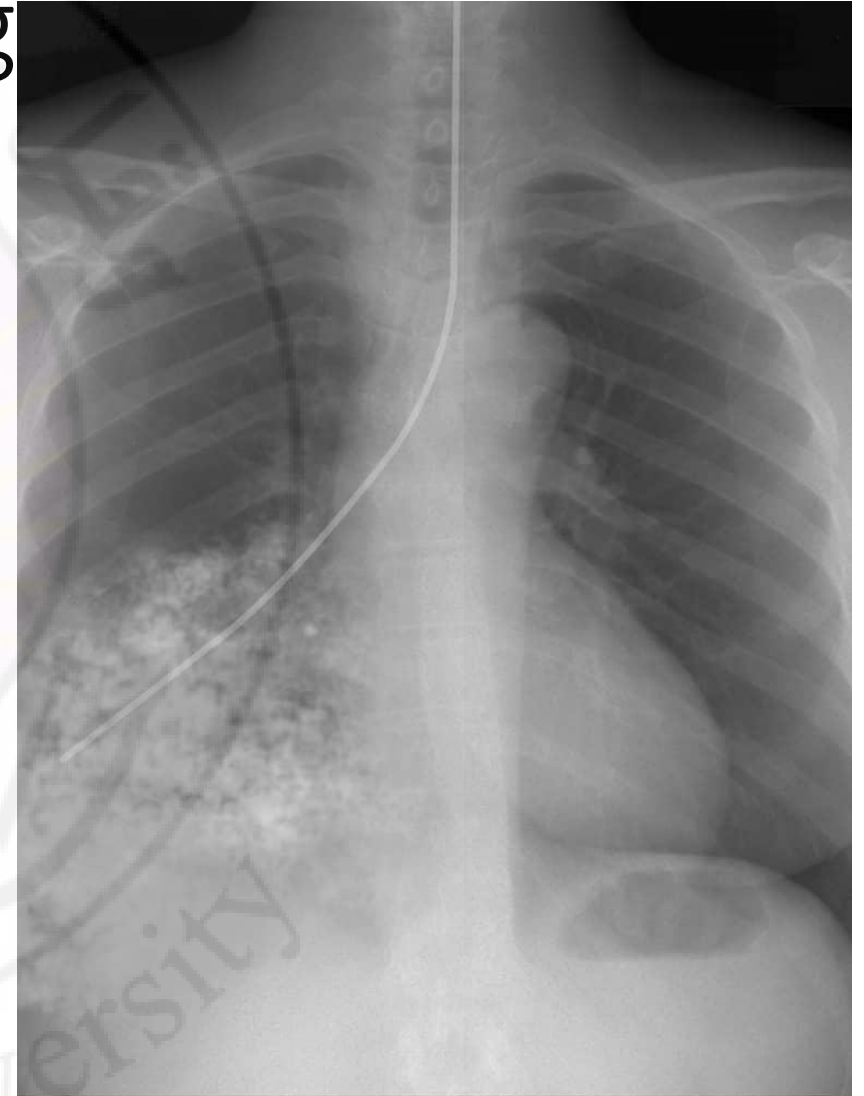


Figure 3. Chest Radiograph Representing Nasogastric Feeding Tube in Lower Lobe of Right Lung with Infiltrate

Uses of conventional radiology

- Fractures
- Line placement
- Abdominal emergencies (eg : free air)
- Chest imaging

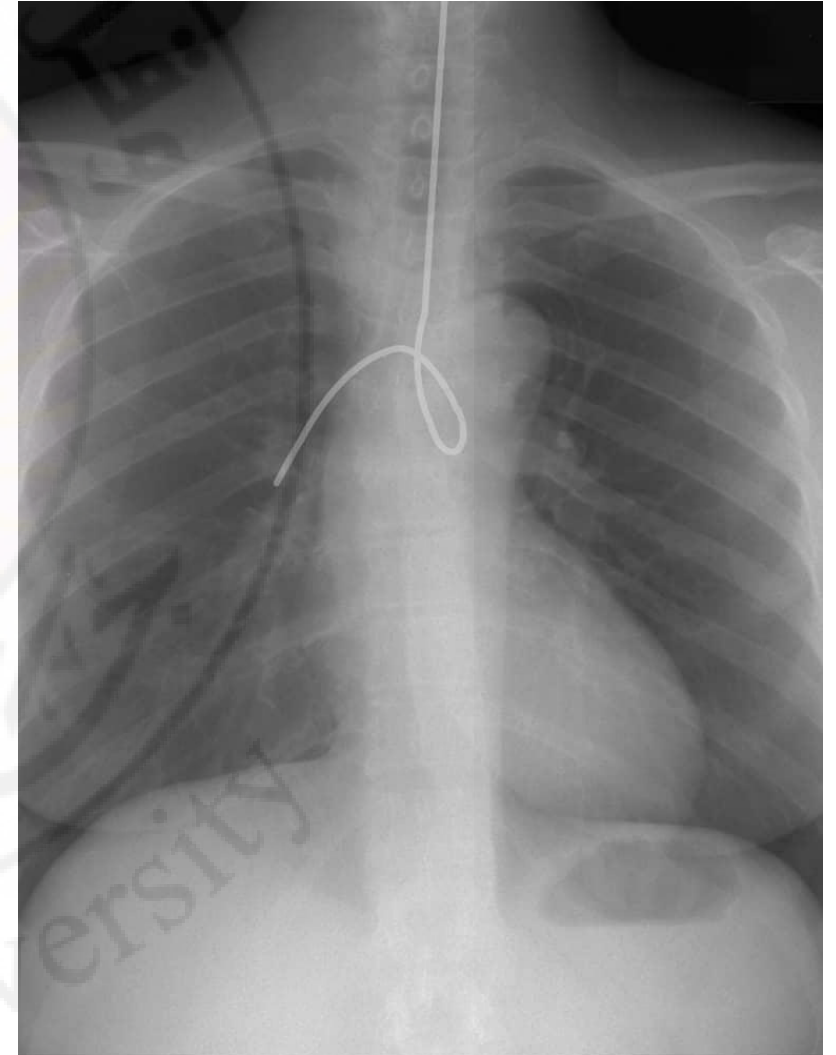
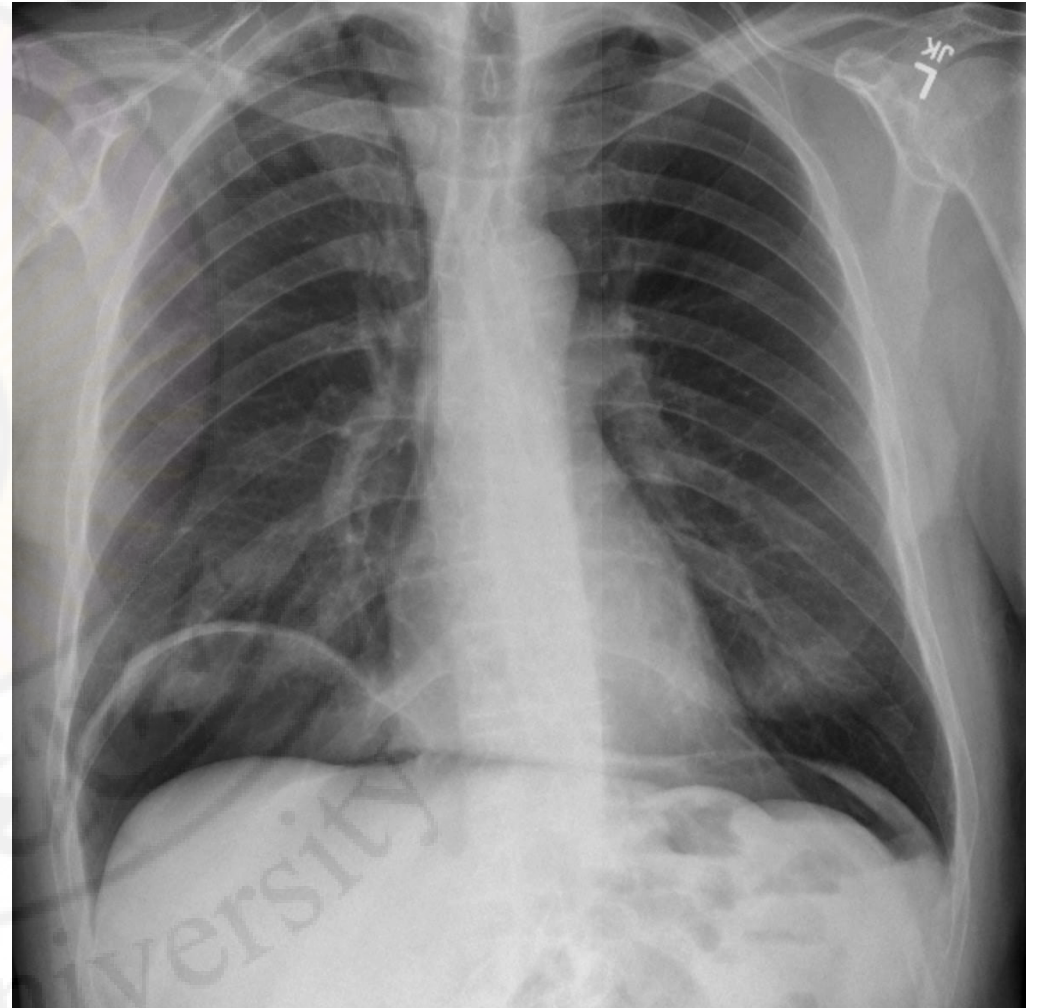


Figure 2. Chest Radiograph Representing
Nasogastric Feeding Tube Coiled in
Tracheobronchial Tree

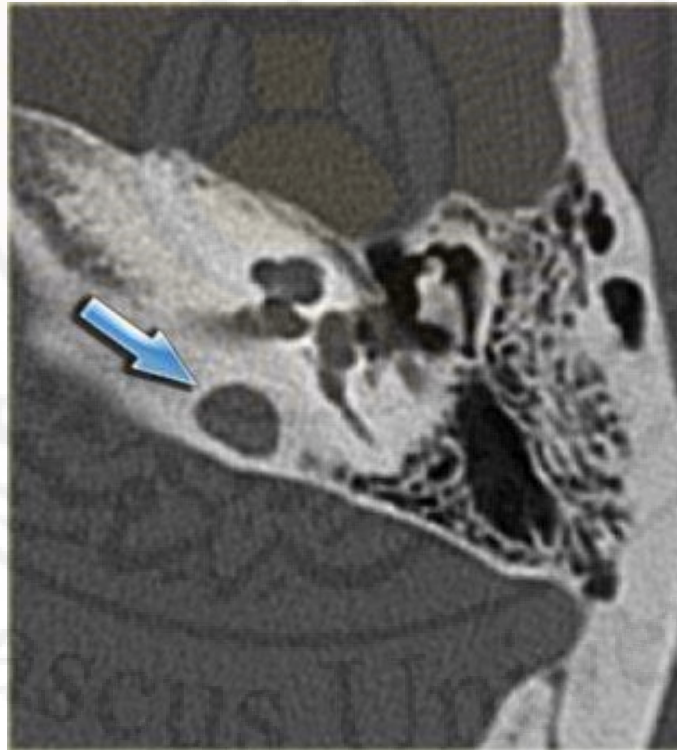
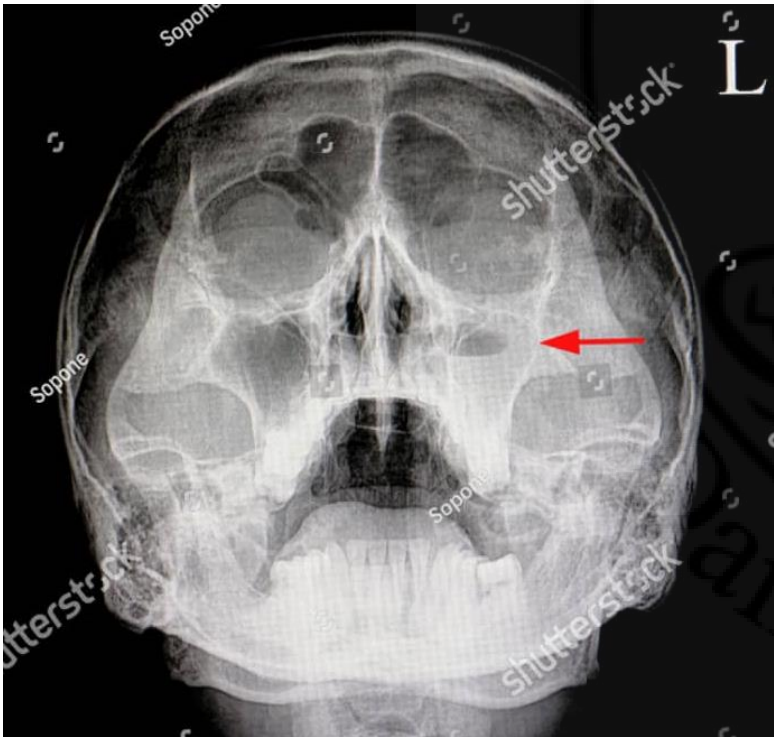
Uses of conventional radiology

- Fractures
- Line placement
- Abdominal emergencies (eg : free air)
- Chest imaging



Uses of conventional radiology in Head & Neck

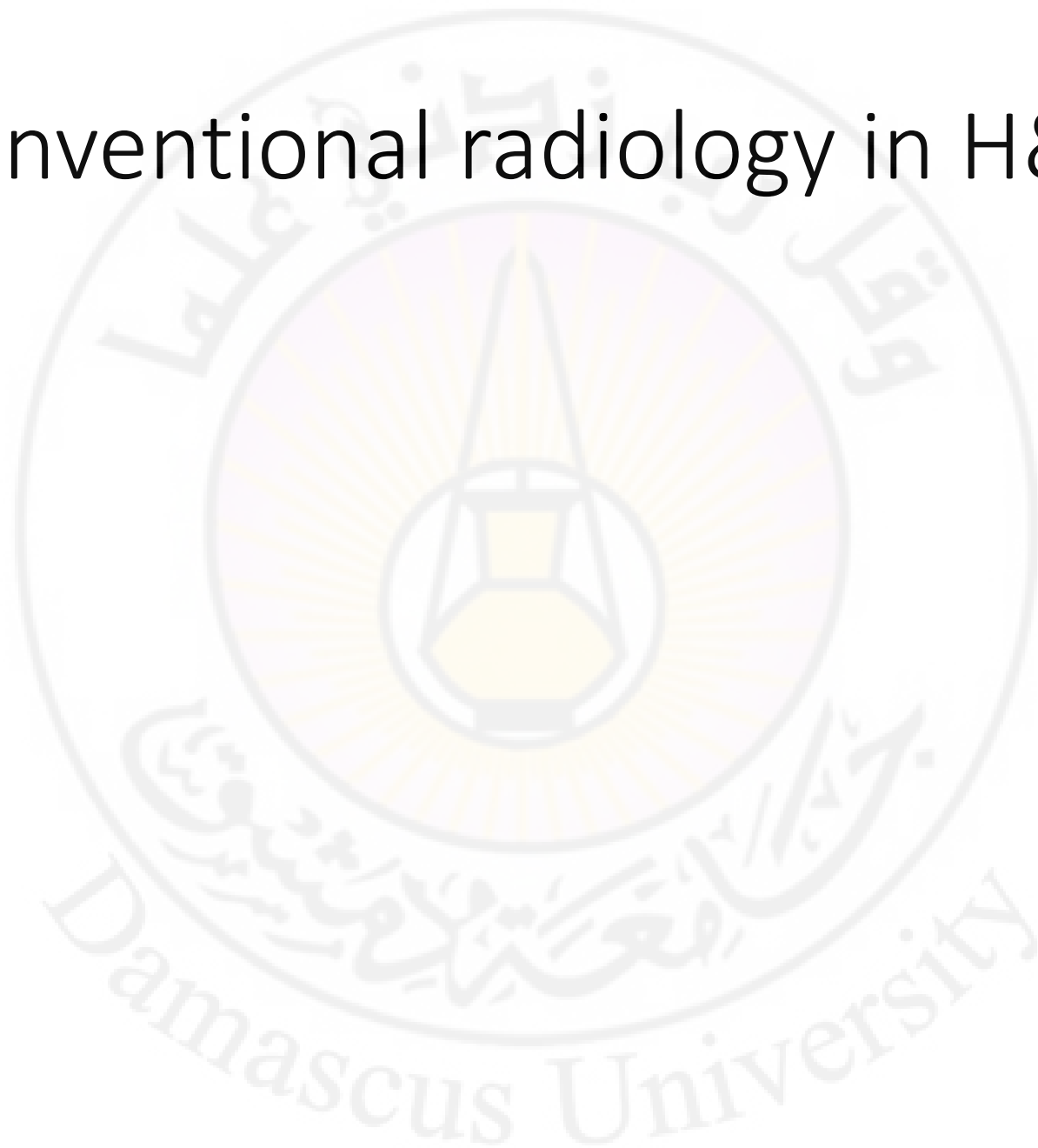
- Have been greatly replaced by CT scan, especially in domains of Rhinology and Otology.



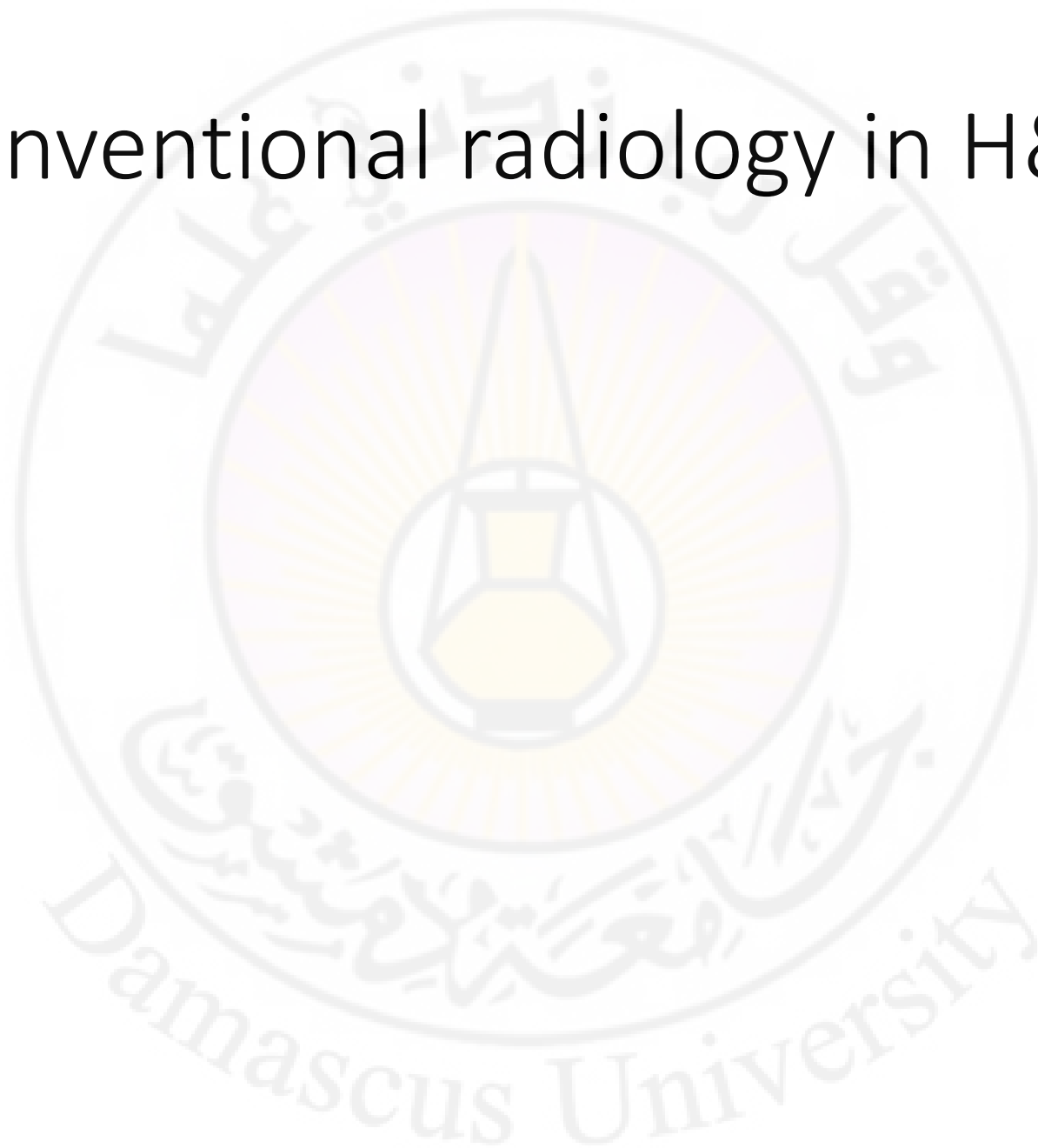
Uses of conventional radiology in H&N

- Some remaining indications of conventional radiology in H&N:
 1. Documentation of nose fractures for medico legal aspects.
 2. Adenoids
 3. Foreign body aspiration and ingestion
 4. Check placement of Cochlear implant

Uses of conventional radiology in H&N



Uses of conventional radiology in H&N



X-rays in Conventional Radiology

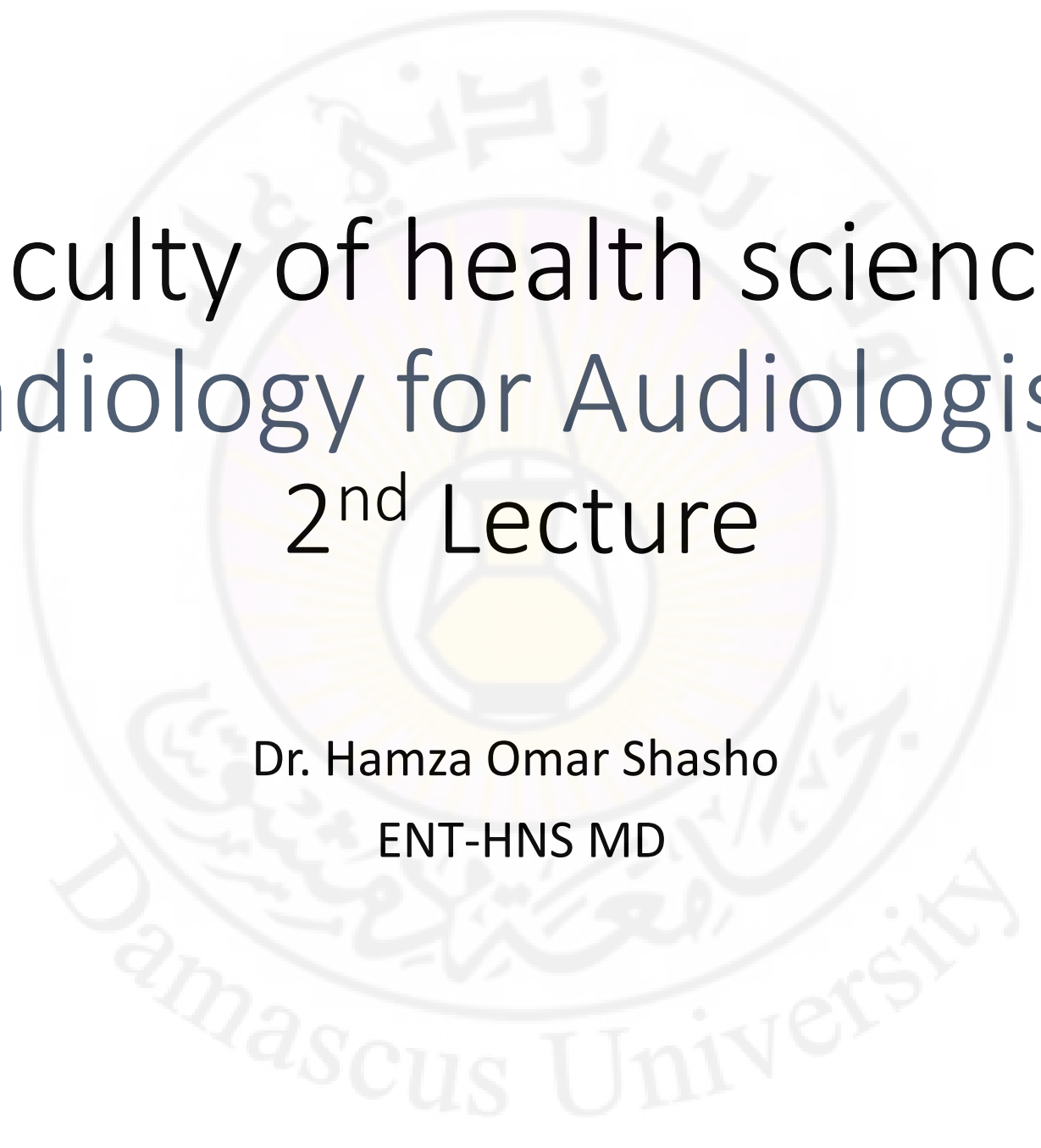
Advantages

- ✓ Widely available.
- ✓ Inexpensive
- ✓ Doesn't require advanced technologist knowledge.
- ✓ Can be performed quickly.
- ✓ Can be portable.

Disadvantages

- × Ionizing Radiation.
- × Relatively insensitive (superimposed structures).
- × Requires patient cooperation.

تم بحمدہ تعالیٰ
بالتوفیق جمیعاً



Faculty of health sciences

“Radiology for Audiologists”

2nd Lecture

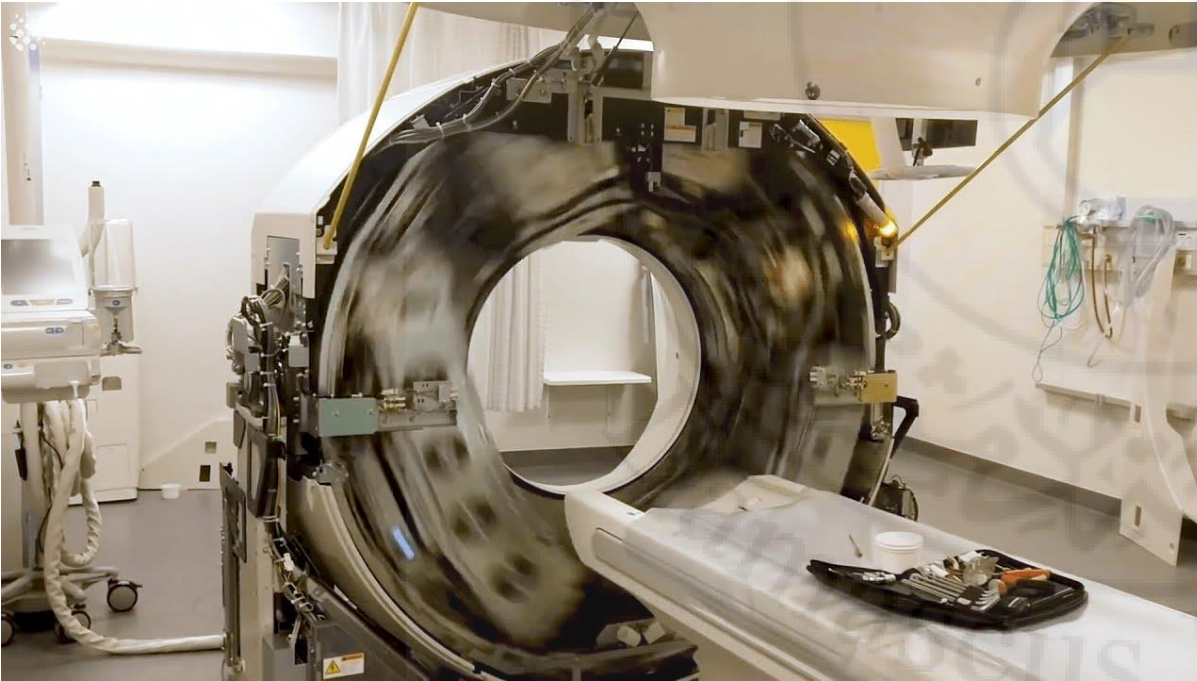
Dr. Hamza Omar Shasho

ENT-HNS MD

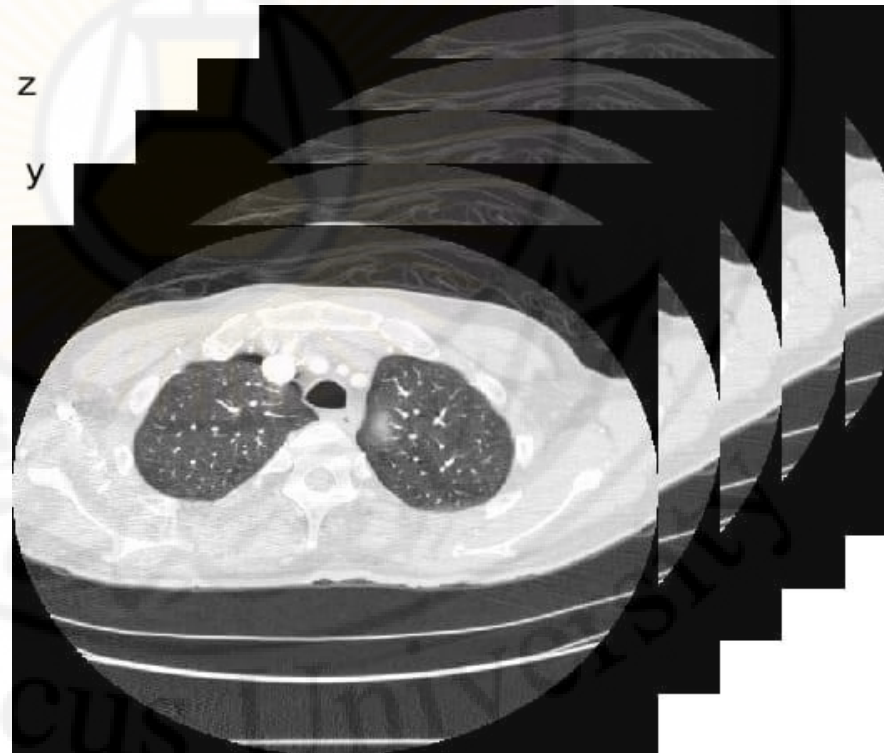
CT SCAN / CAT SCAN / Computed Axial Tomography



Rotating an X-Ray tube with the **X-Ray** detector, and the patient will go through these rays.



cross-sectional images (like slices) is received from the body. Each slice is an image itself.



To show coronal (frontal) or Sagittal images, data are manipulated (reconstructed) by a computer → requires thin slices (Multislice CT scan)

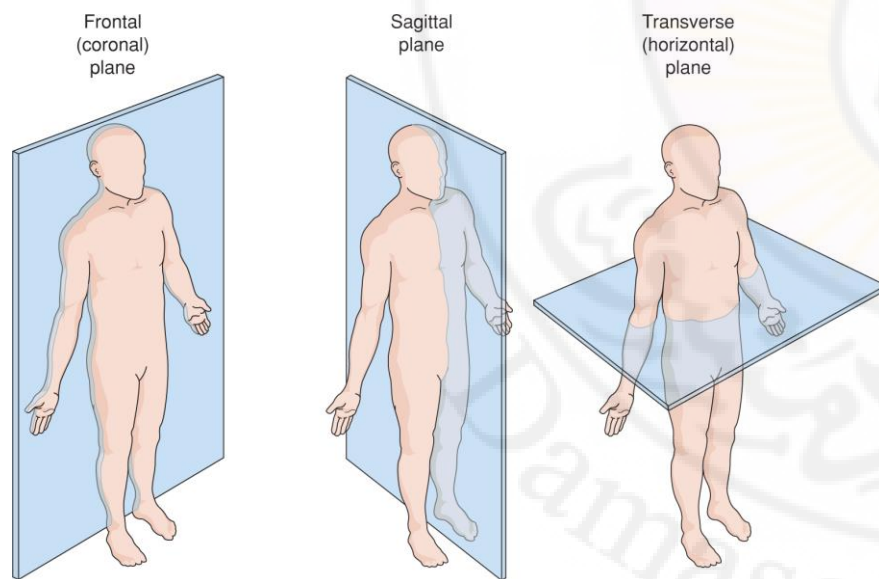
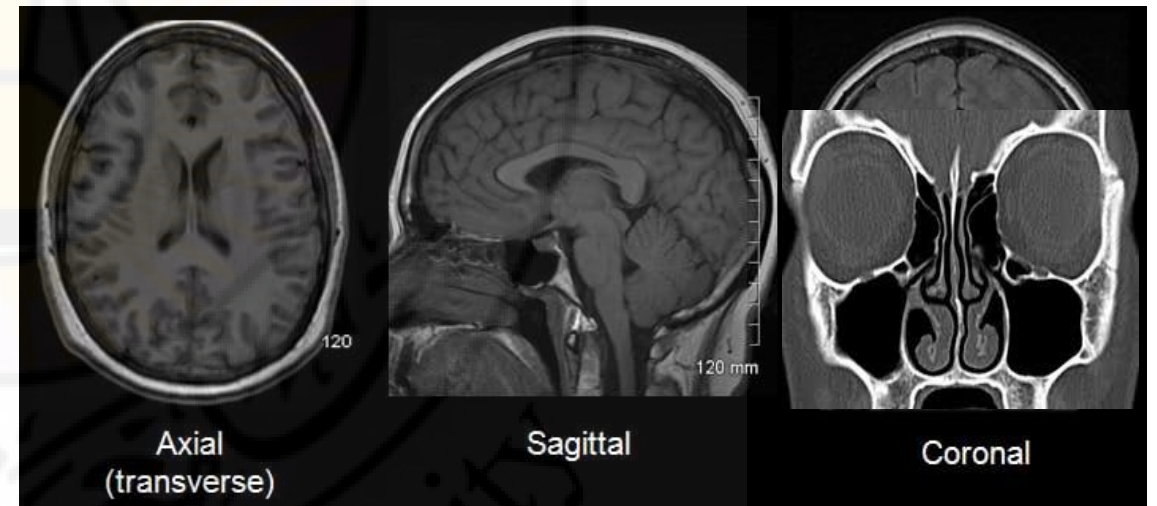
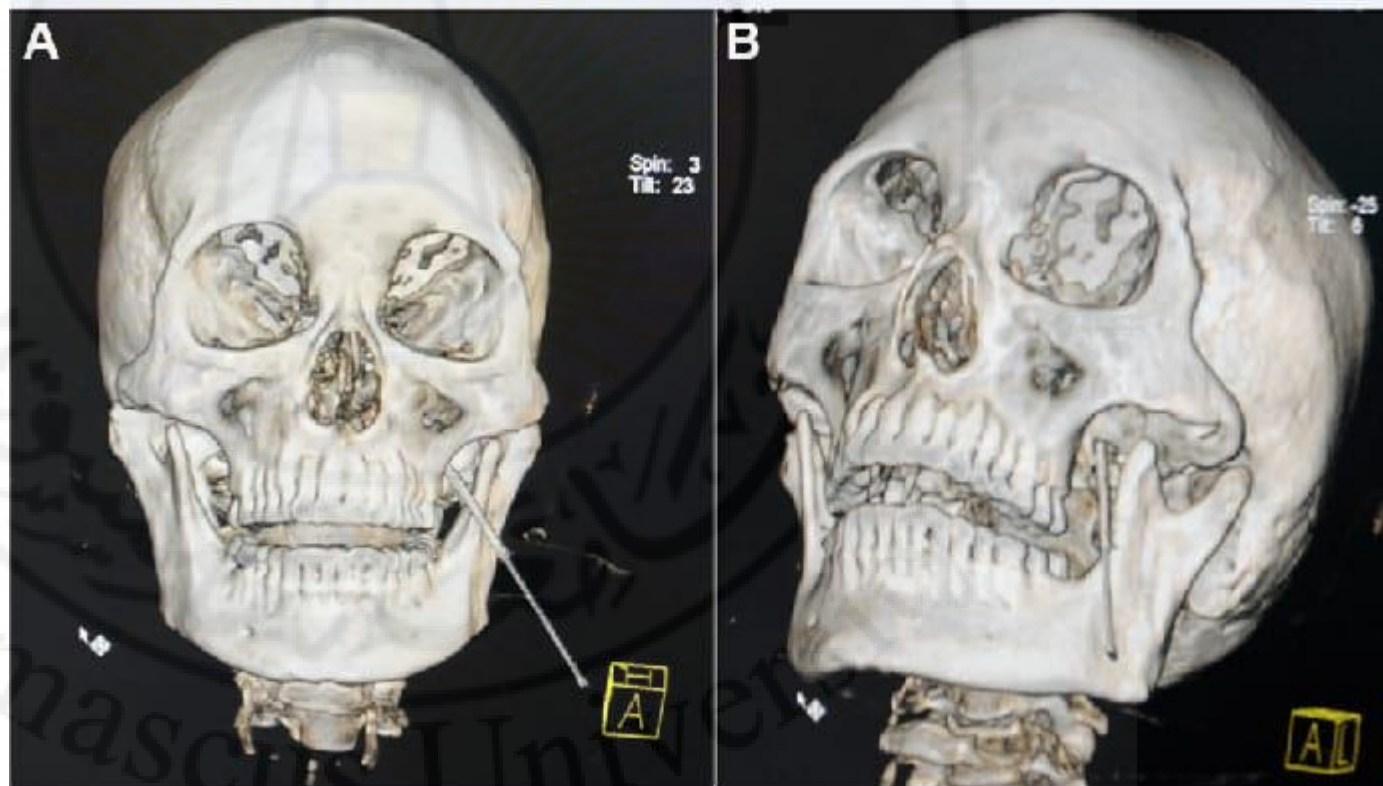


FIGURE 2-12 Planes of division.



3D image can be generated



3D image can be generated



CT has very small differences in X-Ray absorption values compared with conventional radiography

So, gradations of density within soft tissues can be recognized, e.g. brain substance from cerebrospinal fluid, or tumor from surrounding normal tissues.

It has the capability to measure the density by analyzing the chemical component of tissue “Hounsfield Unit (HU)”.



Figure 1. Selection of site

Components Densities: image key: shades (densities)

Air:
-1000

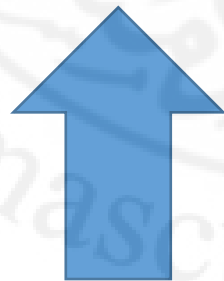
Fat:
-150

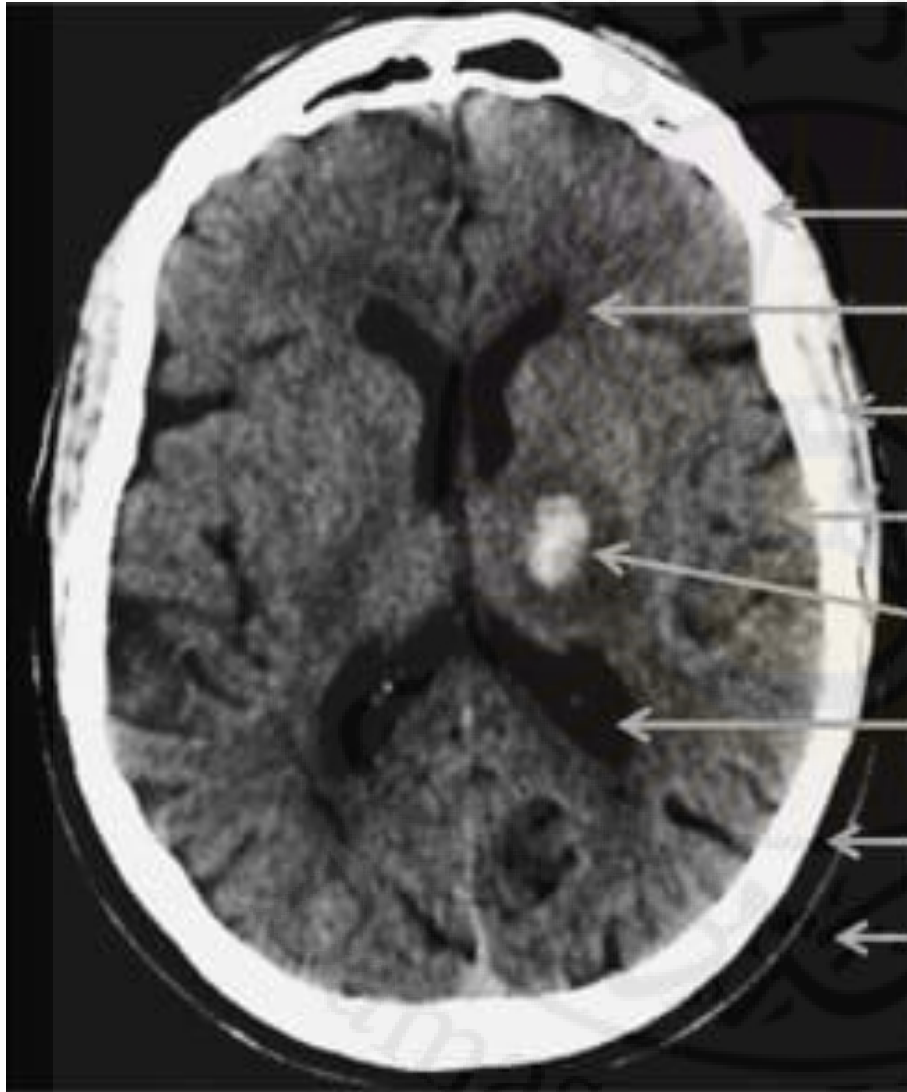
Water:
0

Soft Tissue:
20-80

Blood:
45-75

Bone/Ca:
>100->1000





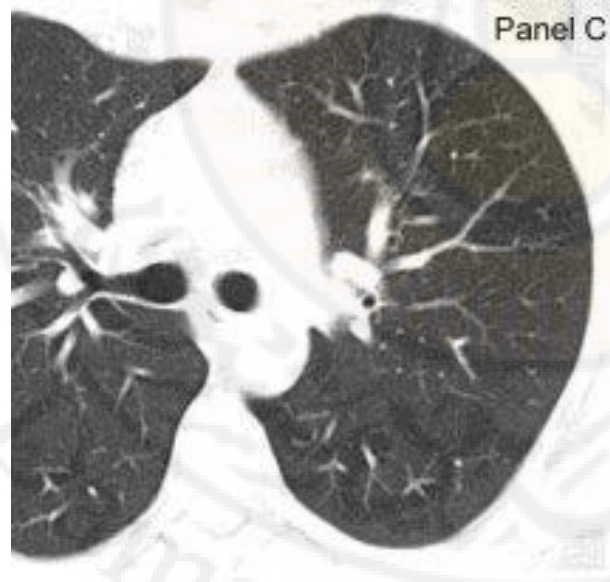
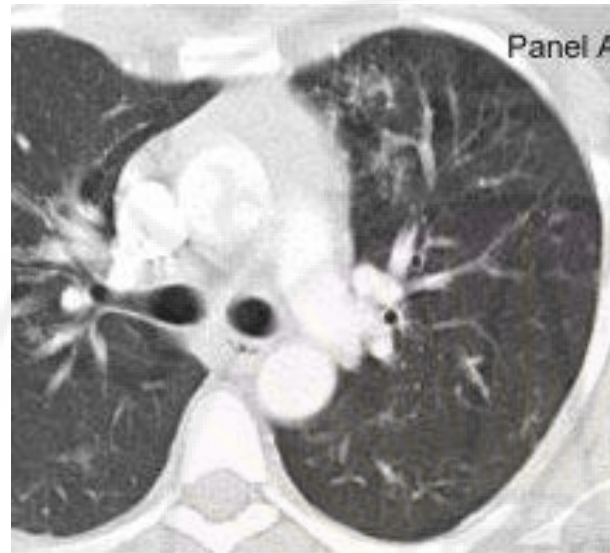
CT Number Ranges in Hounsfield Units (HU)	
Bone	+1000
White matter	+20 to 30
Muscle	+20 to 40
Gray matter	+30 to 40
Hemorrhage	+65 to +95
CSF (water)	0
Fat	-30 to -70
Air	-1000

CAT Scan windows

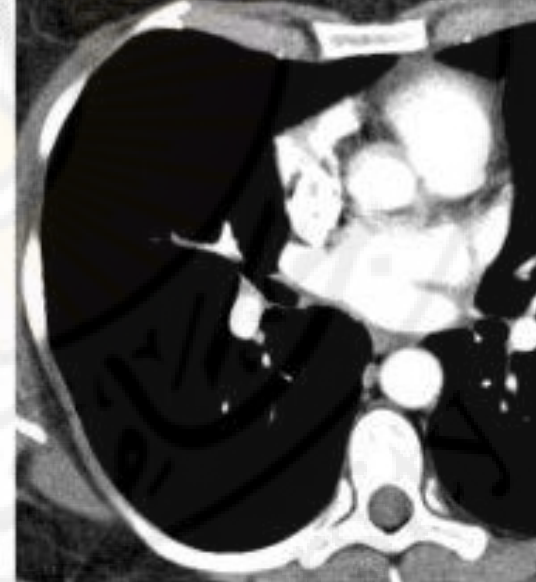
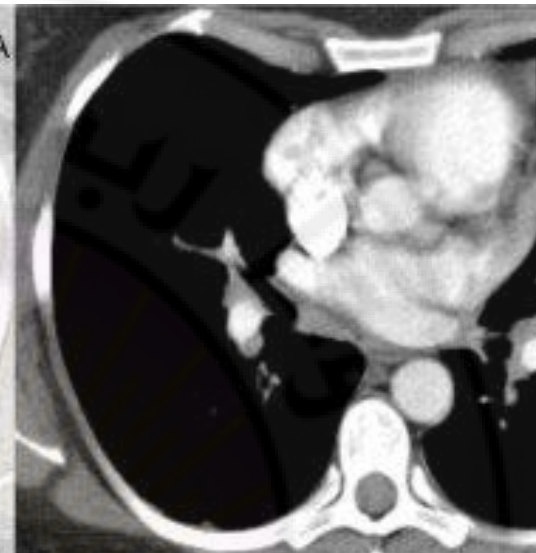
Different windows are to used to better visualize different organs.



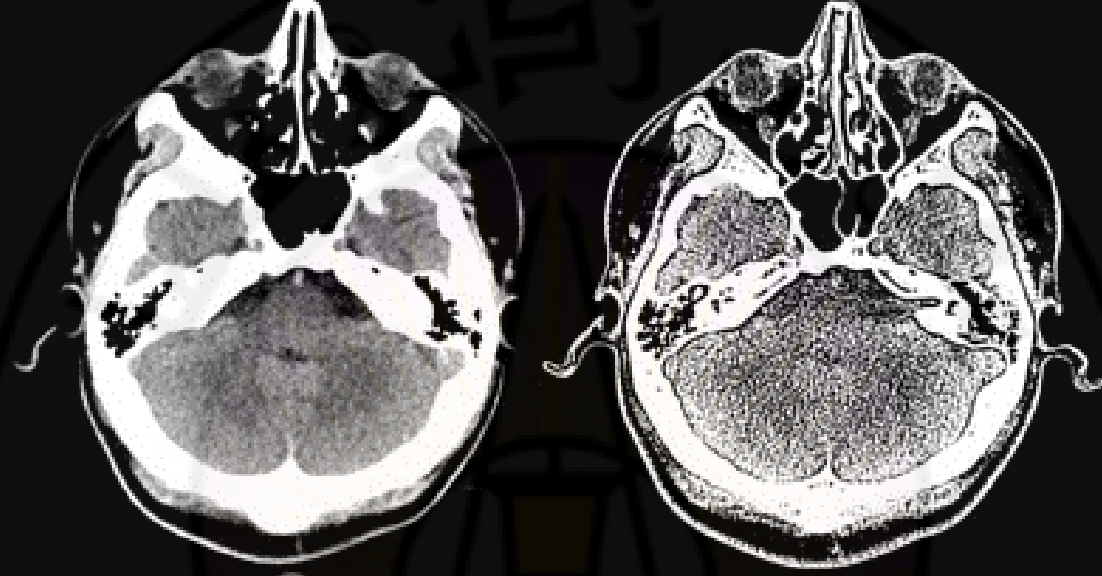
Lung window



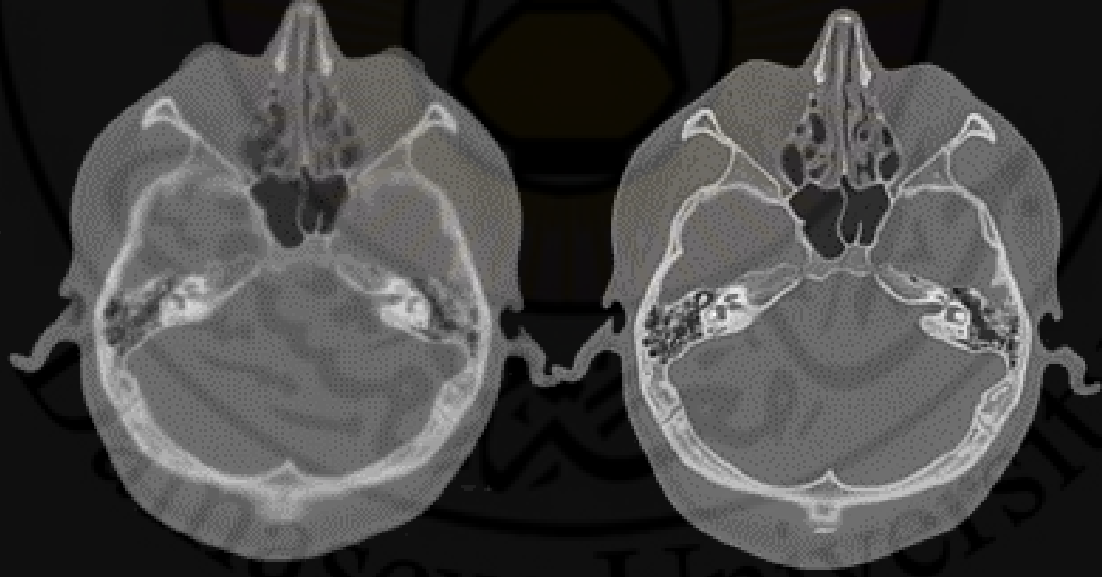
Mediastinal window



Brain Window



Bone Window



Uses of CT:

1. Neuroimaging:

- Acute head trauma, acute intracranial hemorrhage.
- We can use CT on patient that presents with headache to diagnose brain tumor.
- Low sensitivity for:
 - a. Early ischemic stroke.
 - b. Intracranial metastatic disease.
 - c. White matter degenerative disease.

2. Head and neck imaging:

Soft tissue of neck, paranasal sinuses, temporal bone, and orbital wall imaging.

Uses of CT:



hemorrhage

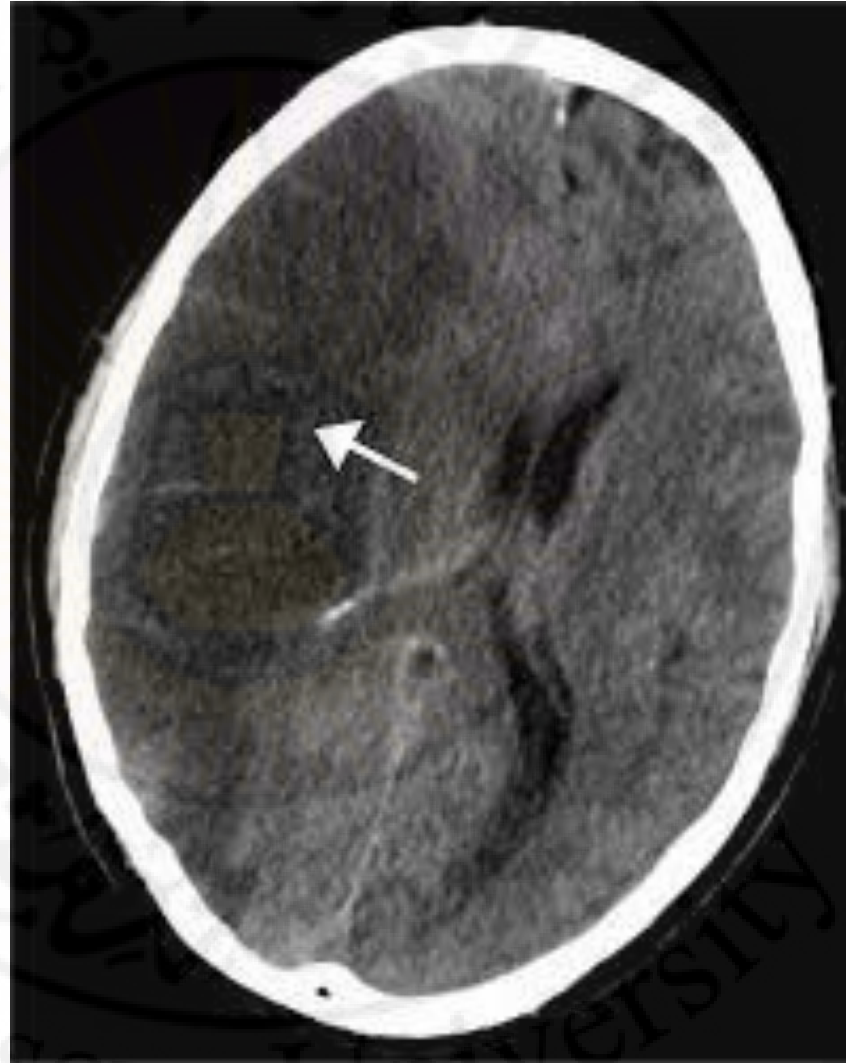
Uses of CT:

tumour



An example of a head CT scan showing a brain tumour (circled), in this case a rare tumour known as central neurocytoma

Uses of CT:



Stroke

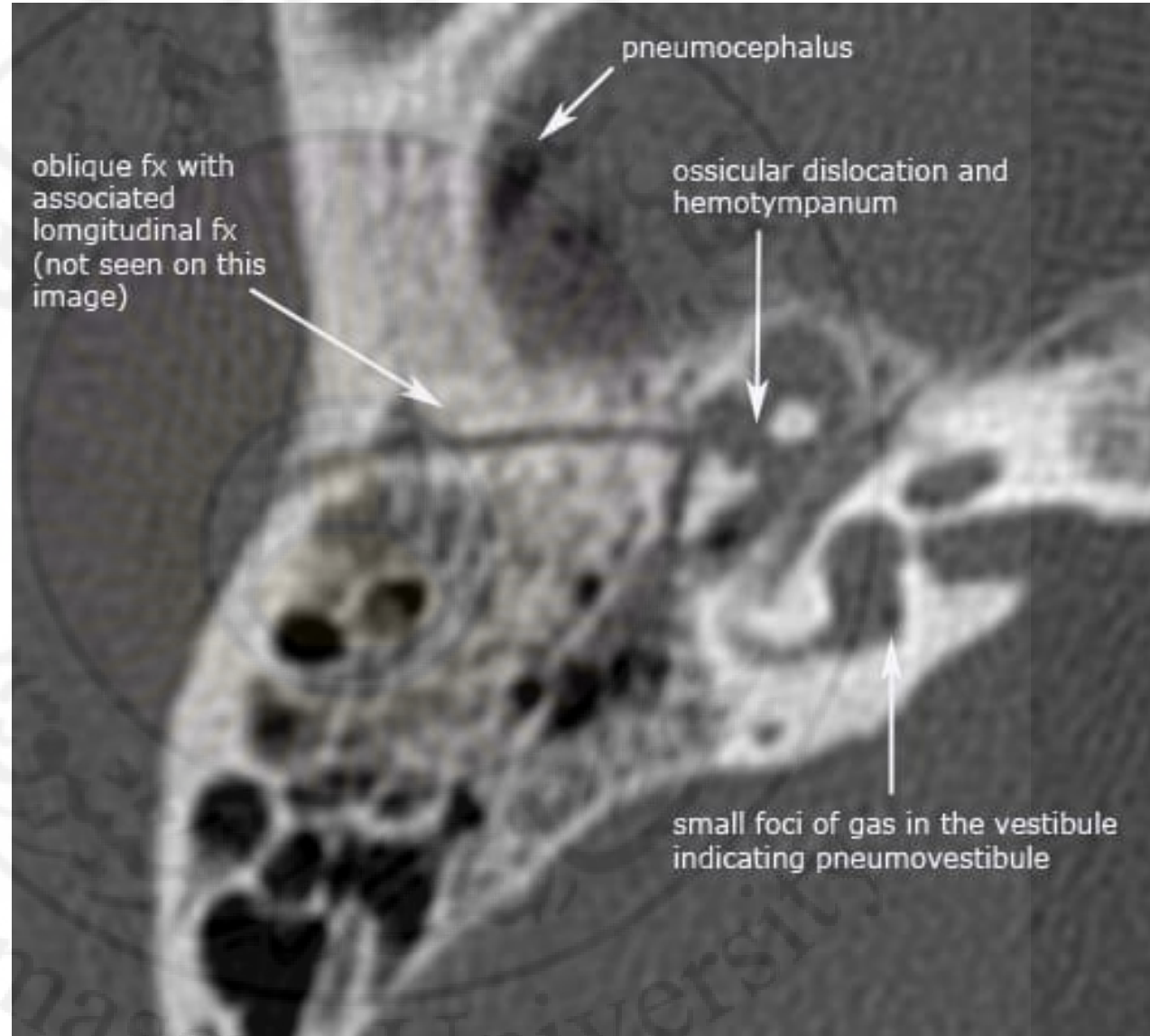
Uses of CT:

Colon Ca Mets



CECT

Uses of CT:



Trauma

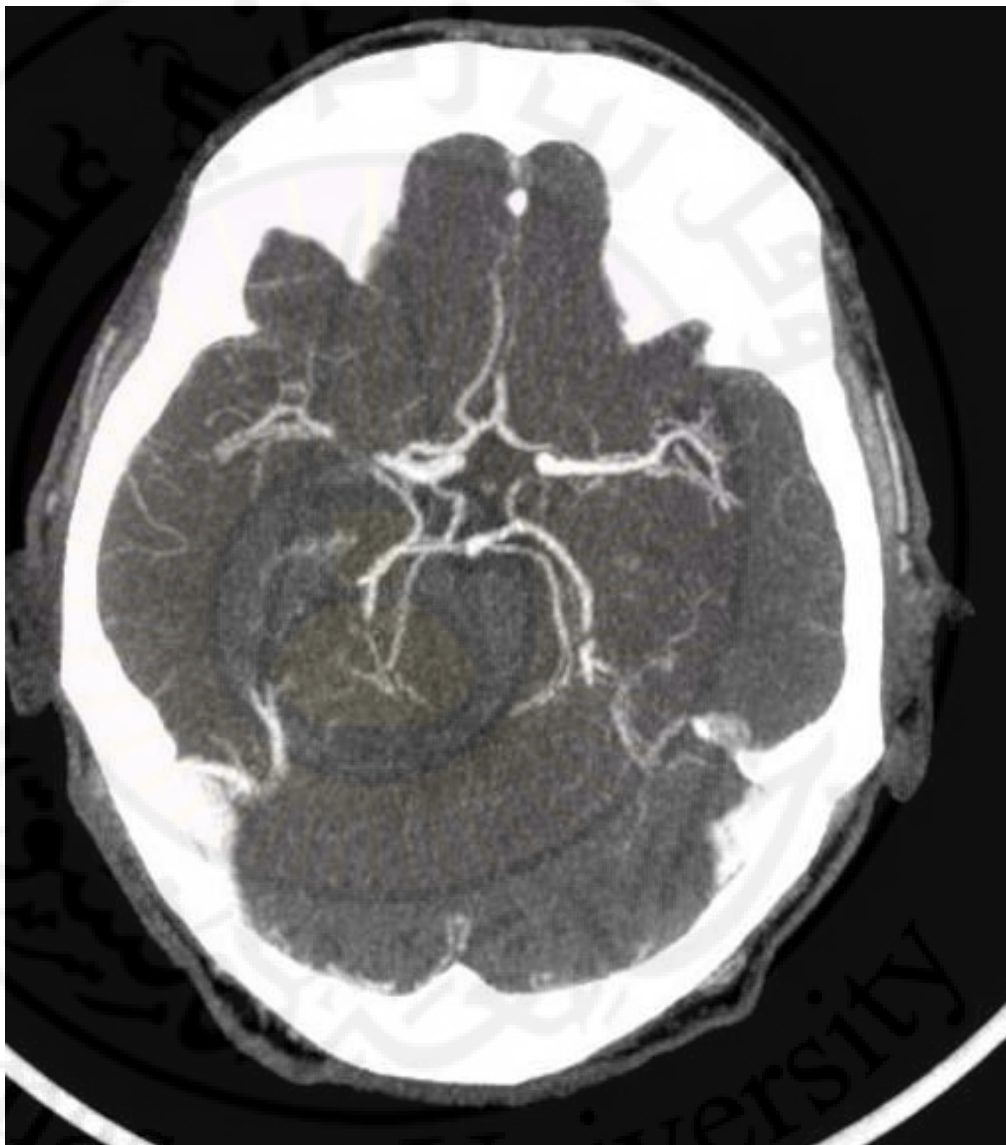
CONTRAST MEDIUM

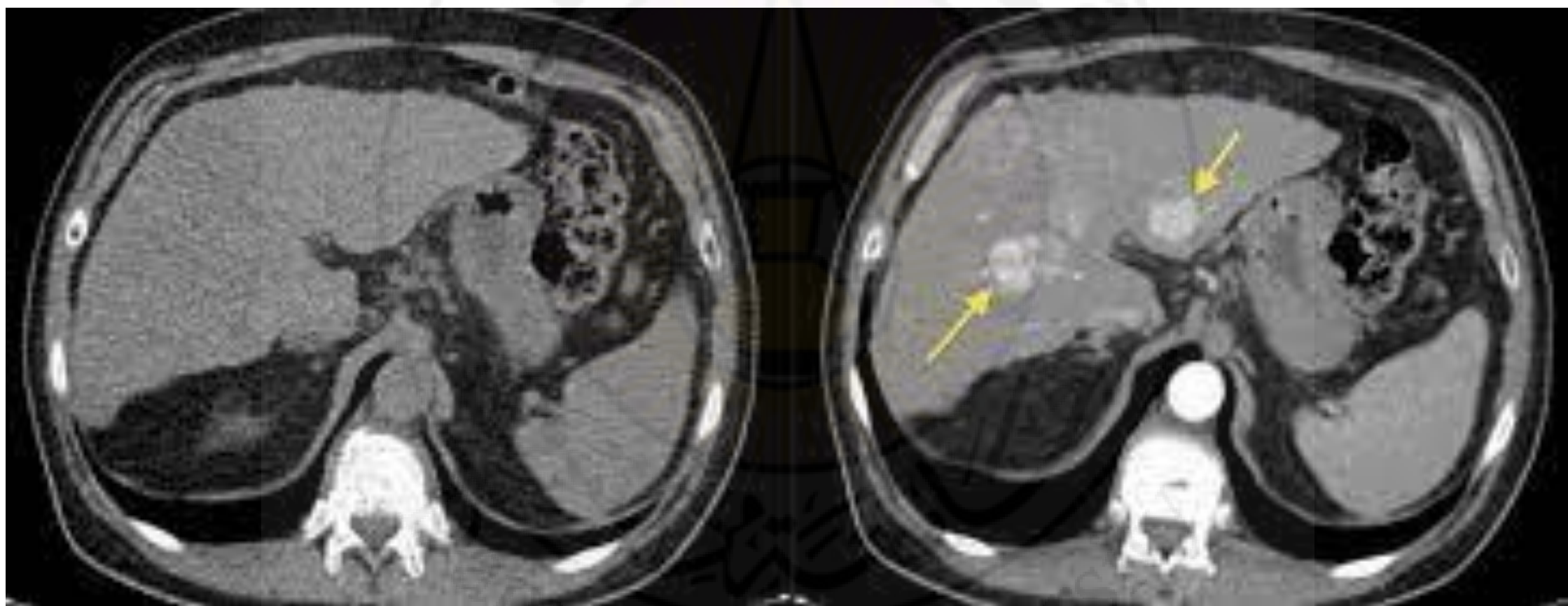
- Intravenous Iodine – based (omnipaque)
- Oral route
- Intrathecal
- Others

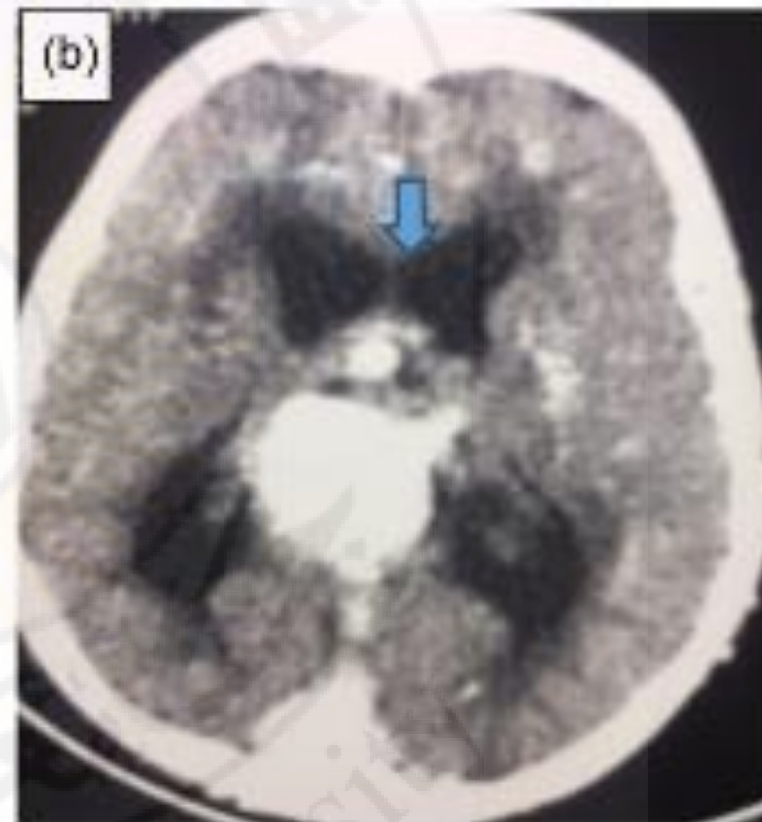
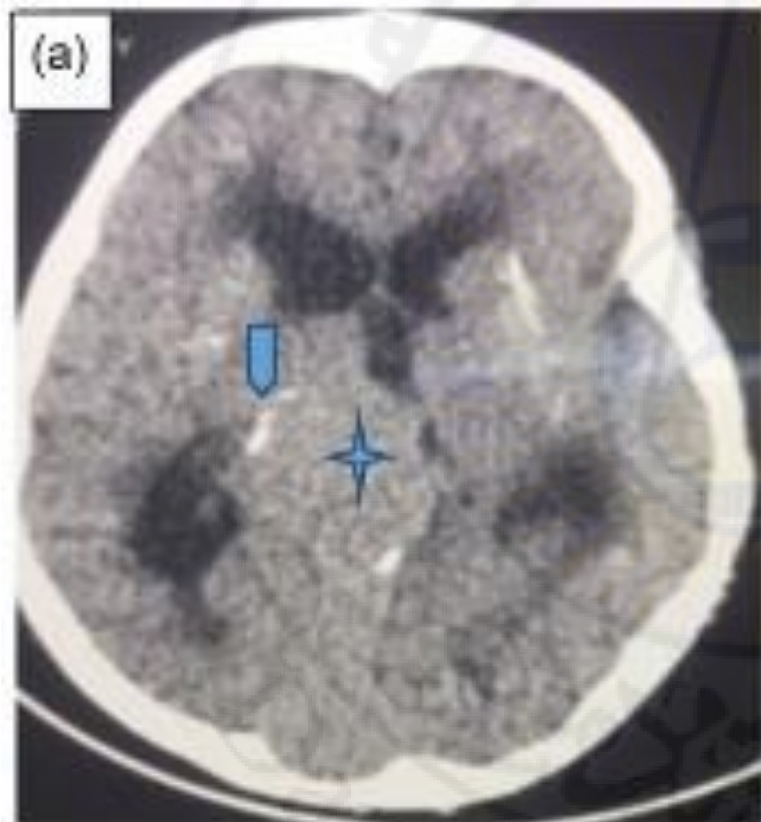


How CONTRAST MEDIUM works ?









Radiation Risks

There is a major risk behind CT scan:

- One brain CT scan radiation = 200 X-Ray radiation.
- don't request a CT scan unless needed
- and we can't use it for a pregnant women unless absolutely necessary.



Advantages

- ✓ Can give: Cross sectional, Sagittal and Coronal Images.
- ✓ More sensitive.

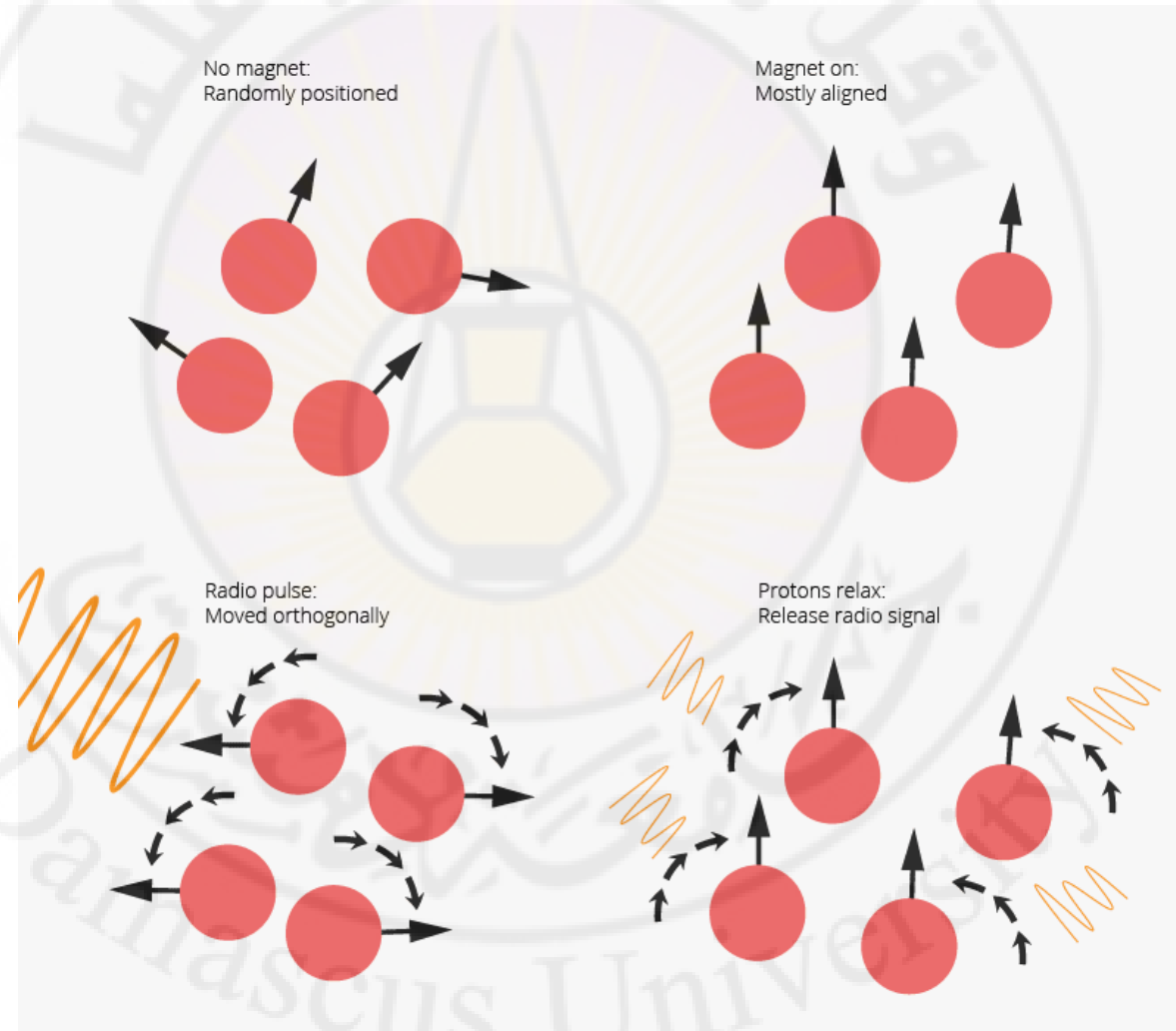
Disadvantages

- × High Radiation.
- × Expensive.

MAGNETIC RESONANCE IMAGING

- Hydrogen atoms act like little magnets
- They align with a strong external magnetic field
- Delivery of a radiofrequency pulse disperses these atoms
- Realignment with the magnetic field creates signal which can be captured
- Different tissue realign differently

MAGNETIC RESONANCE IMAGING



Major advantage of MRI

Much more Details



Preparation/ Precautions

Avoid Any Metallic Object

Wear Comfortable & Loose Cloth

Inform Known Allergy

4-6 Hrs. Fasting for Contrast

Claustrophobia : Sedative Requires Fasting

Any Implants: Must Inform the Doctor Before Scan

Special Precautions for Children

CONTRAST MEDIUM

GADOLINIUM



We use the term “Signal” to describe the brightness on MRI Imaging .

Ex: bright area → high signal area

Dark area → low signal area

In conventional radiology and CT we use the term “density”

MRI imaging sequences

T1

T2

T1+C

Flair

Fat saturation

STIR

DWI

ADC



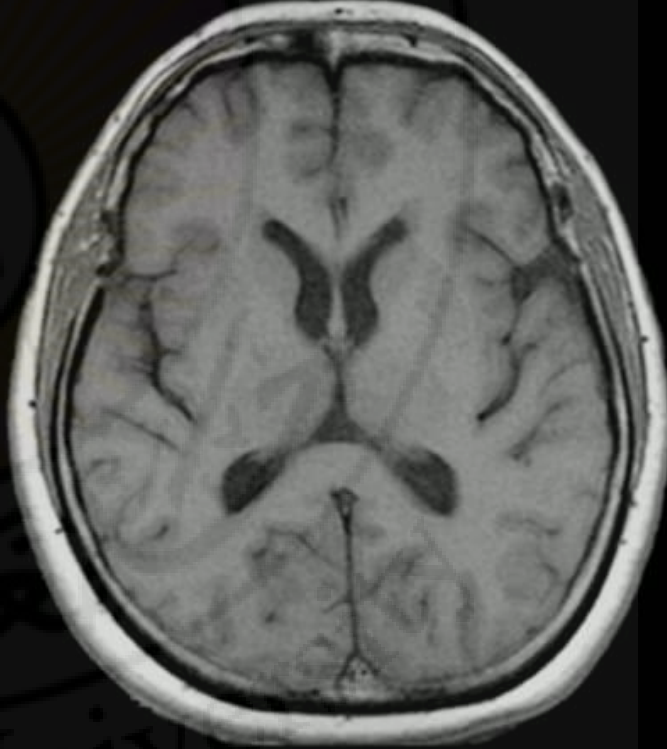
MRI imaging sequences

RADBUZZ

T1 Sequence

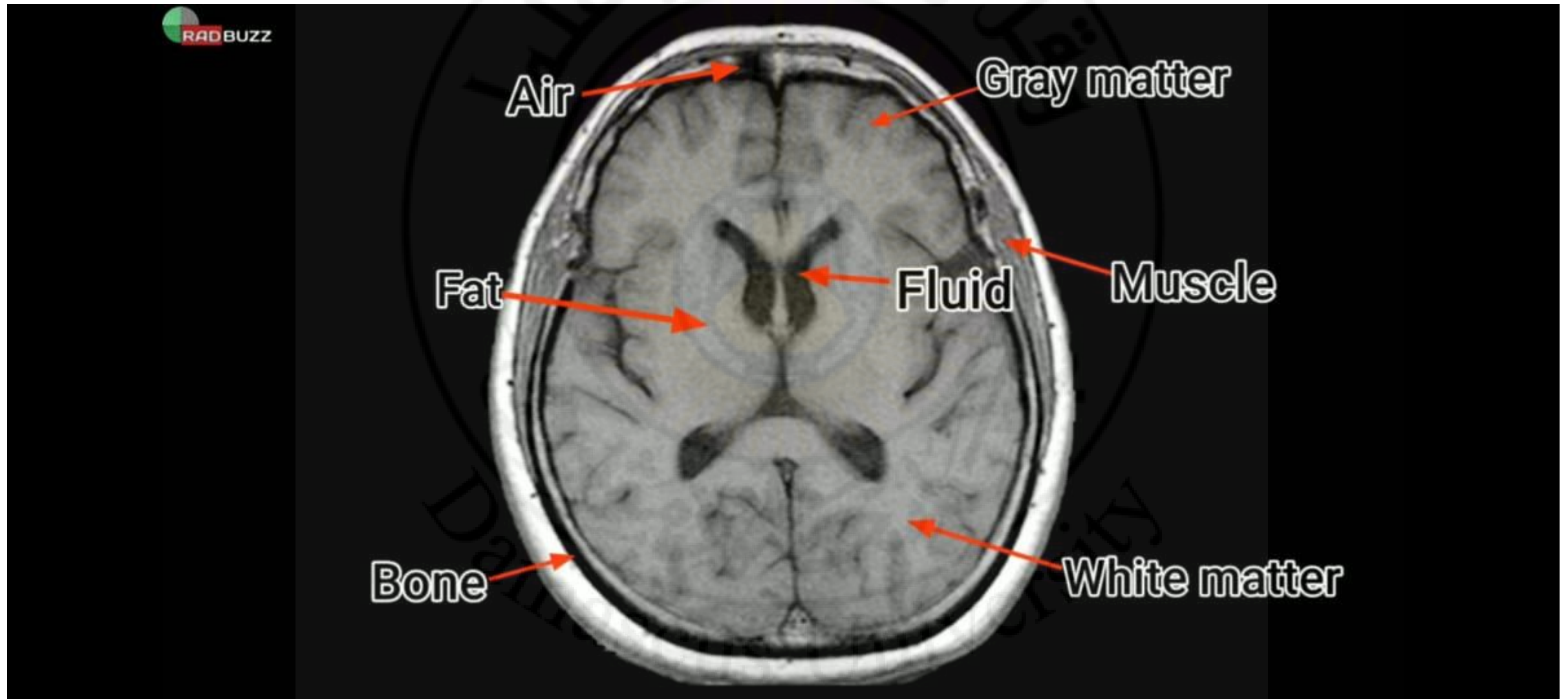
Recognition:-

• White matter	- Whiter
• Gray matter	- Gray
• Fluid	- Dark
• Fat	- Bright
• Air	- Dark
• Bone	- Dark
• Muscles	- Gray
• Moving blood	- Dark



An axial T1-weighted MRI scan of the brain. The image shows a cross-section of the brain with the following characteristics: White matter is bright (whiter), gray matter is gray, fluid (ventricles) is dark, fat (scalp) is bright, air (sinuses) is dark, bone (skull) is dark, muscles (neck) are gray, and moving blood (ventricles) is dark.

MRI imaging sequences



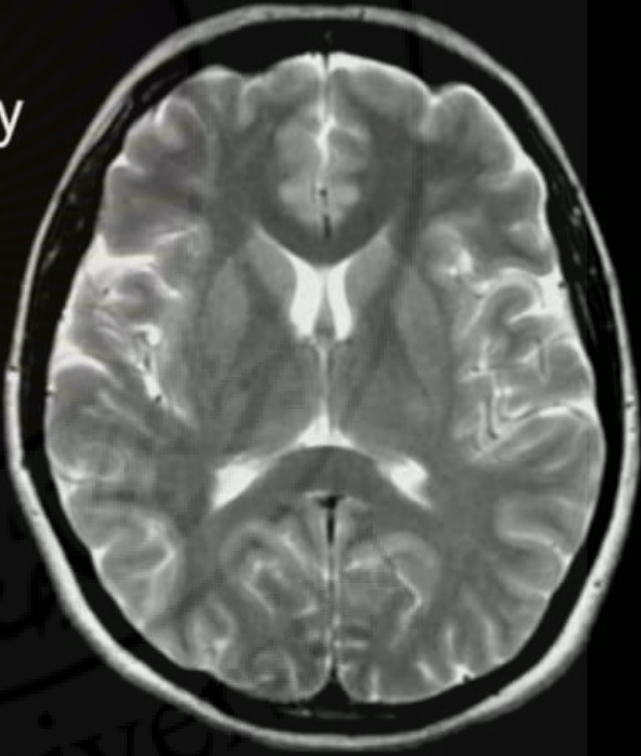
MRI imaging sequences

RADBUZZ

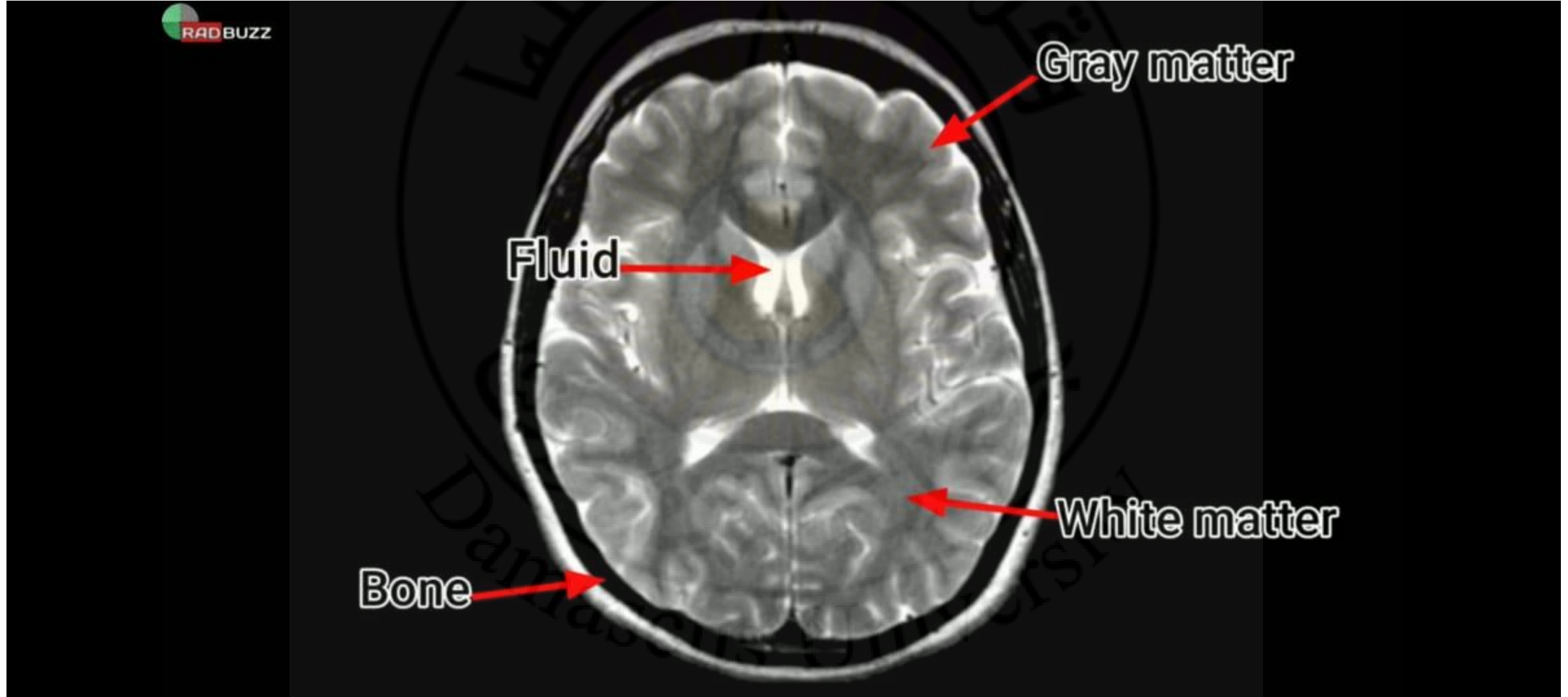
T2 Sequence

Recognition:-

• White matter	- Dark than gray
• Gray matter	- Gray
• Fluid	- Bright
• Fat	- Bright
• Air	- Dark
• Bone	- Dark
• Muscles	- Gray
• Moving blood	- Dark



MRI imaging sequences



MRI imaging sequences



FLAIR Sequence

Recognition:-

- | | |
|----------------|------------------|
| • White matter | - Dark than gray |
| • Gray matter | - Gray |
| • Fluid | - Dark |
| • Fat | - Bright |
| • Air | - Dark |
| • Bone | - Dark |
| • Muscles | - Gray |
| • Moving blood | - Dark |



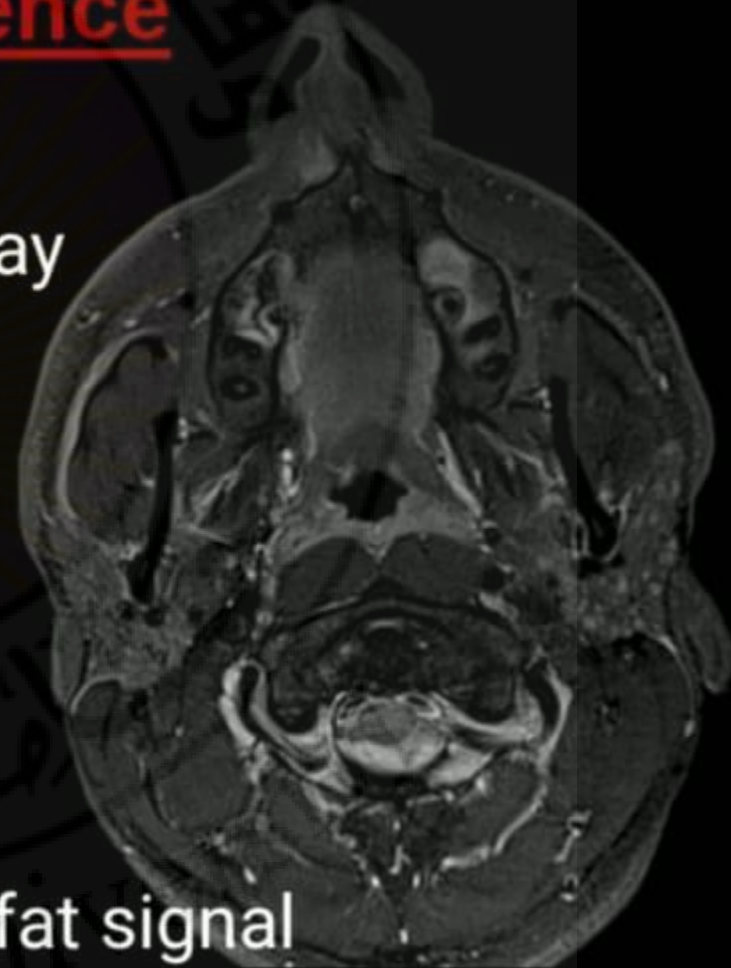
MRI imaging sequences



STIR Sequence

Recognition:-

- White matter - Dark than gray
- Gray matter - Gray
- Fluid - Very bright
- Fat - Dark
- Air - Dark
- Bone - Dark
- Moving blood - Dark
- Muscles - Darker than fat signal

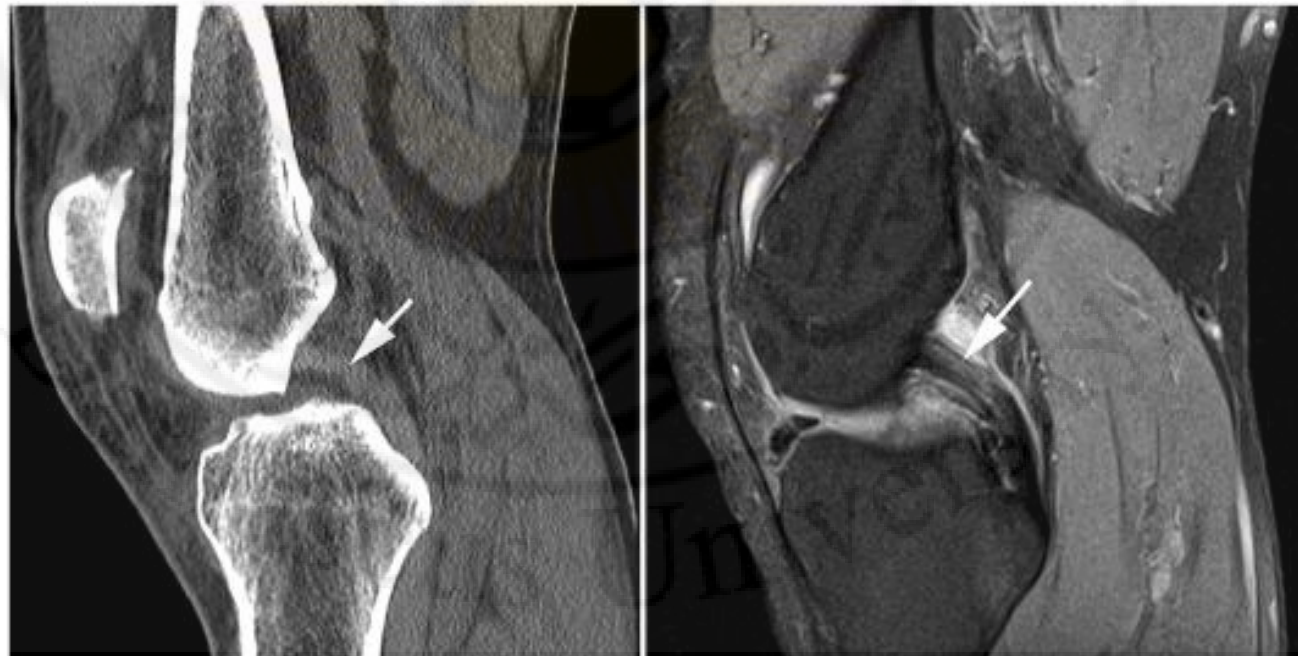


MRI imaging sequences

SIGNAL	Fluid	Fat	Bone cortex	Moving fluids (blood stream)	Air
T1	low	bright ^{er}	Dark signal	Dark signal	Dark signal
T2	high	bright	Dark signal	Dark signal	Dark signal
T1+C					
FLAIR	T2 WITH FLUID SIGNAL SUBTRACTED				
FAT SUPPRESSION SEQUENCES	FAT SIGNAL SUBTRACTED				

Differentiating MRI from CT images

	CT	MRI
BONE CORTEX	WHITE DENSITY	BLACK SIGNAL
FAT	LOW DENSITY	BRIGHT (EXCEPT IN FAT SATURATIONS SEQUENCES)
DETAILS	LESS DETAILS	MORE DETAILS
CSF	LOW DENSITY	WHITE SIGNAL ON T2



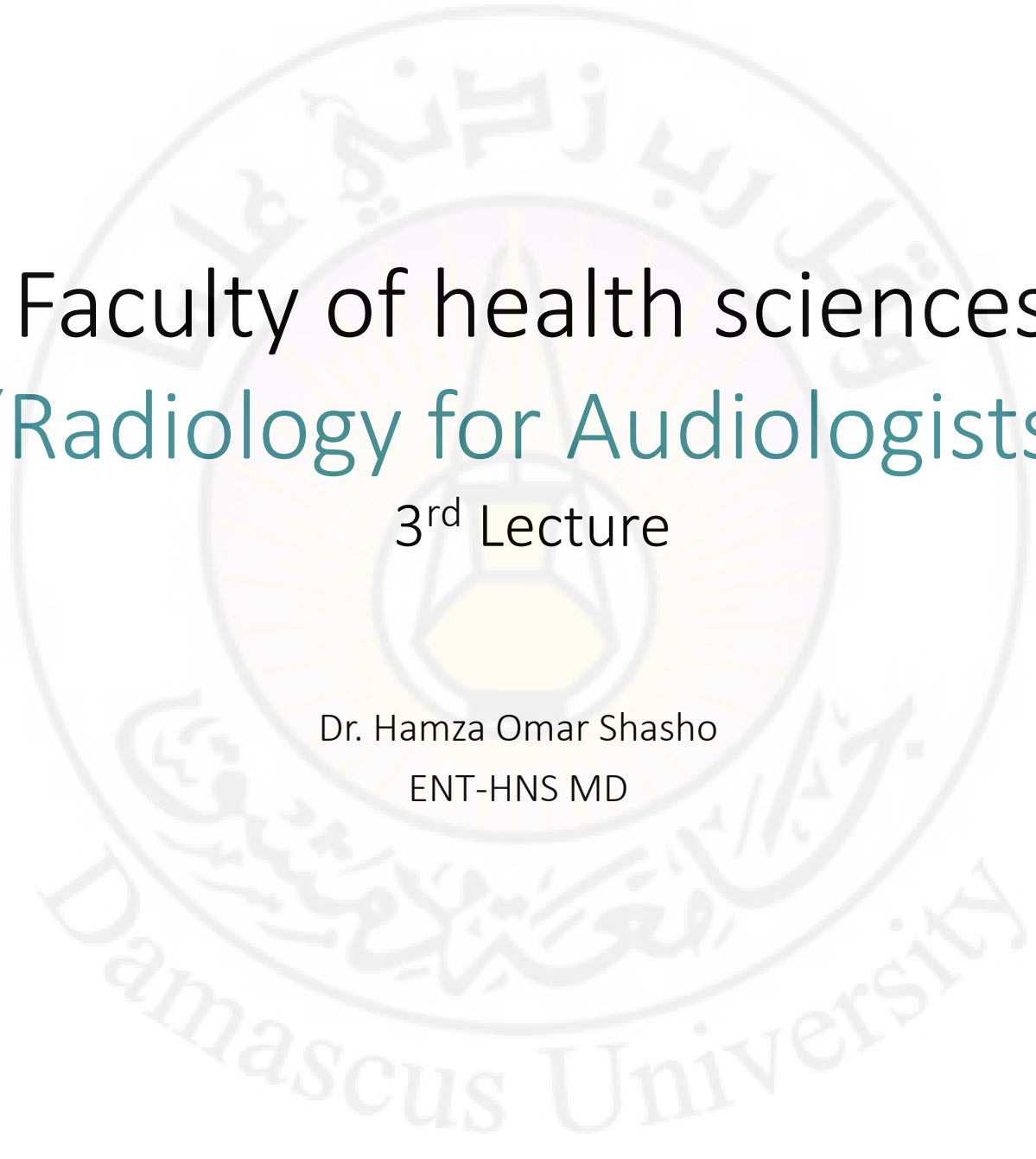
MAGNETIC RESONANCE IMAGING

Advantages

- ✓ The best soft tissue imaging and pathology (tumors and infections).
- ✓ **No ionization.**
- ✓ Can be done on pregnant women.
- ✓ **Images can be obtained in any plane** (unlike CT which is taken in axial position).

Disadvantages

- × **Expensive.**
- × **Time consuming.** so we can't use it on emergency patient
- × **May evoke phobias Claustrophobia** (phobia of narrow places).
- × No metals allowed.
- × Motion. (patient movement)

The background of the slide features a large, faint watermark of the Damascus University seal. The seal is circular, with the university's name in Arabic at the top and in English at the bottom. In the center is a shield with a sunburst and a sword.

Faculty of health sciences

“Radiology for Audiologists”

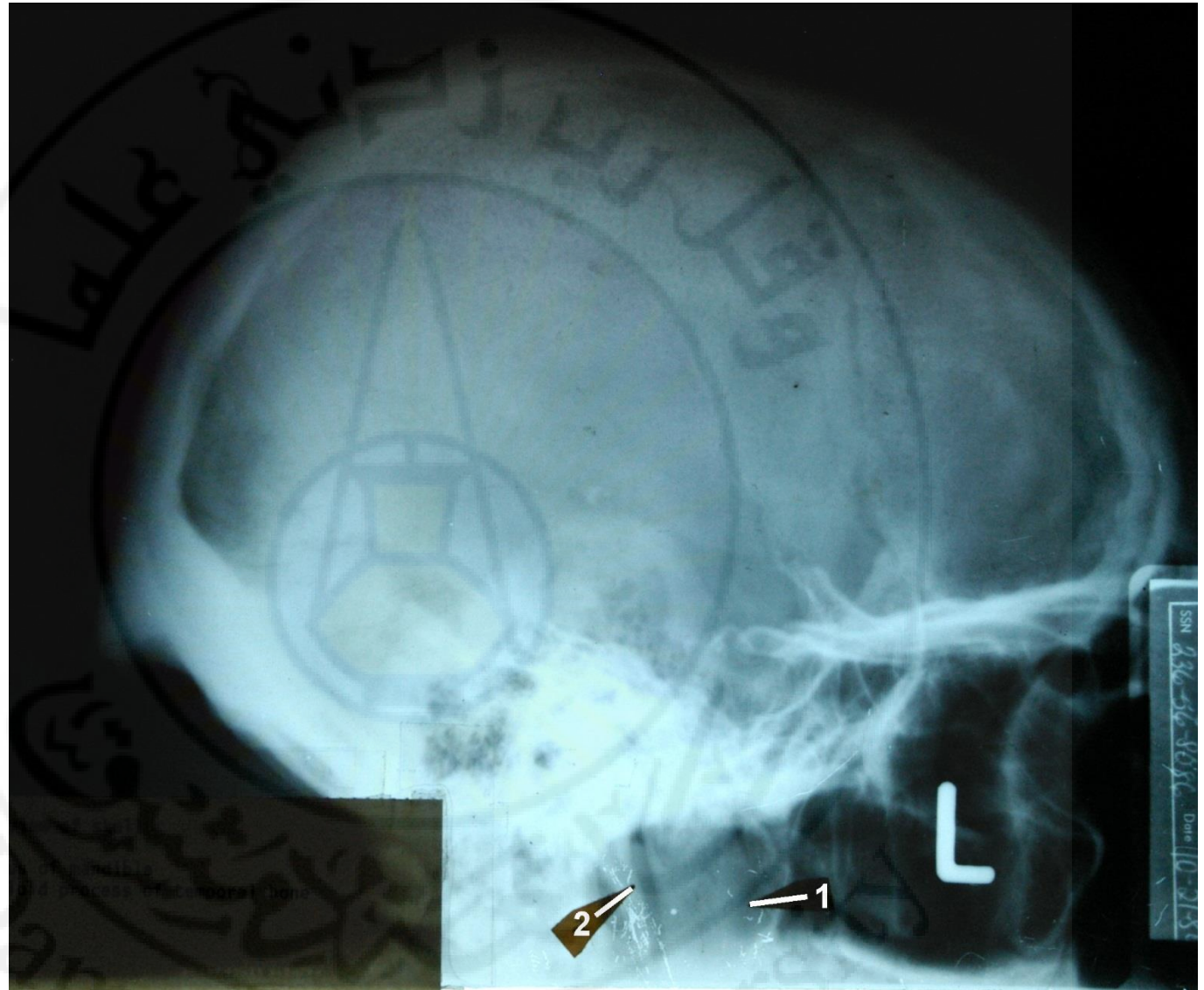
3rd Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

**6 Lateral
view of skull**

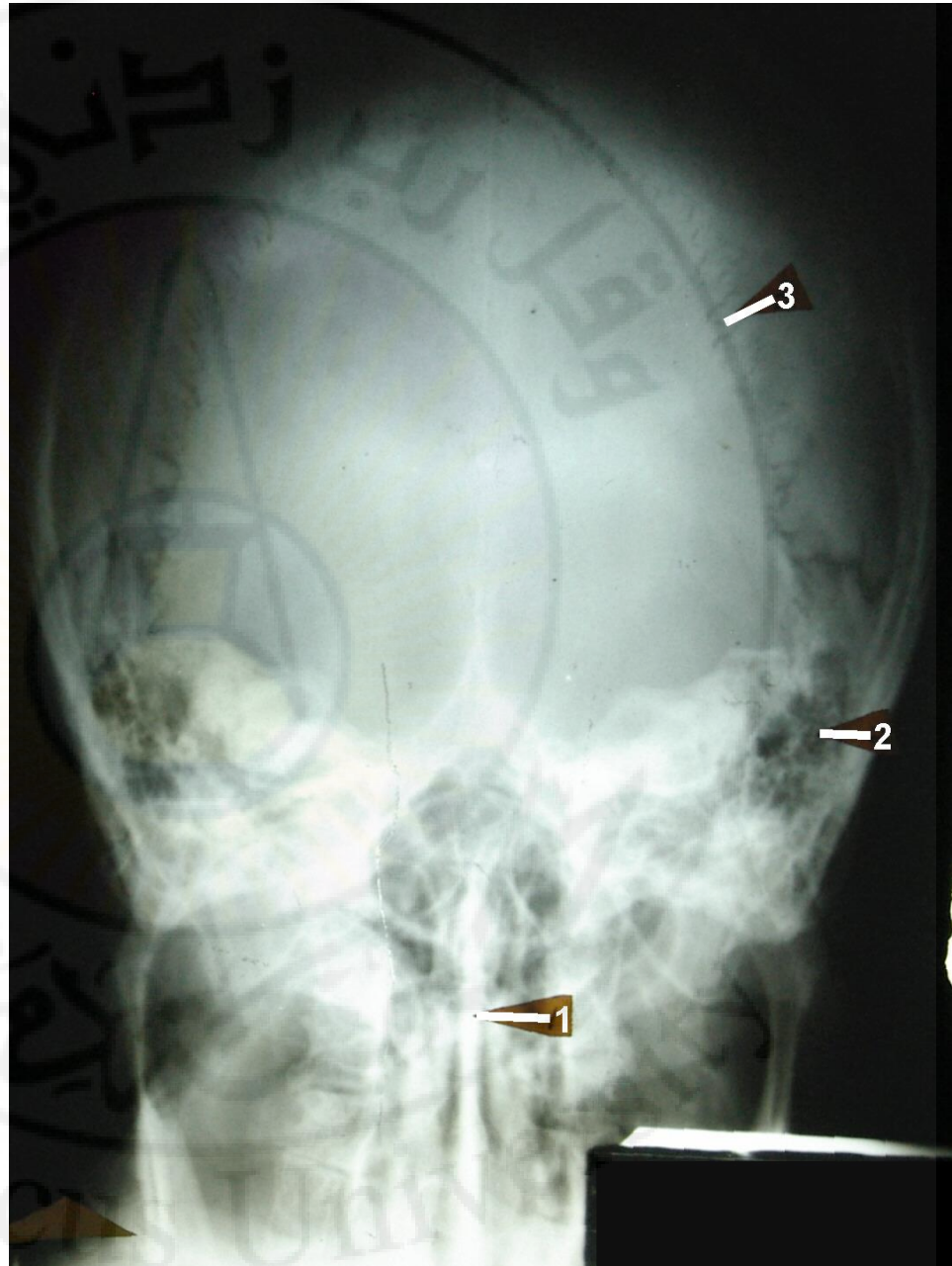
- 1. Ramus of
mandible**
- 2. Styloid
process of
temporal
bone**



PA VIEW OF SKULL

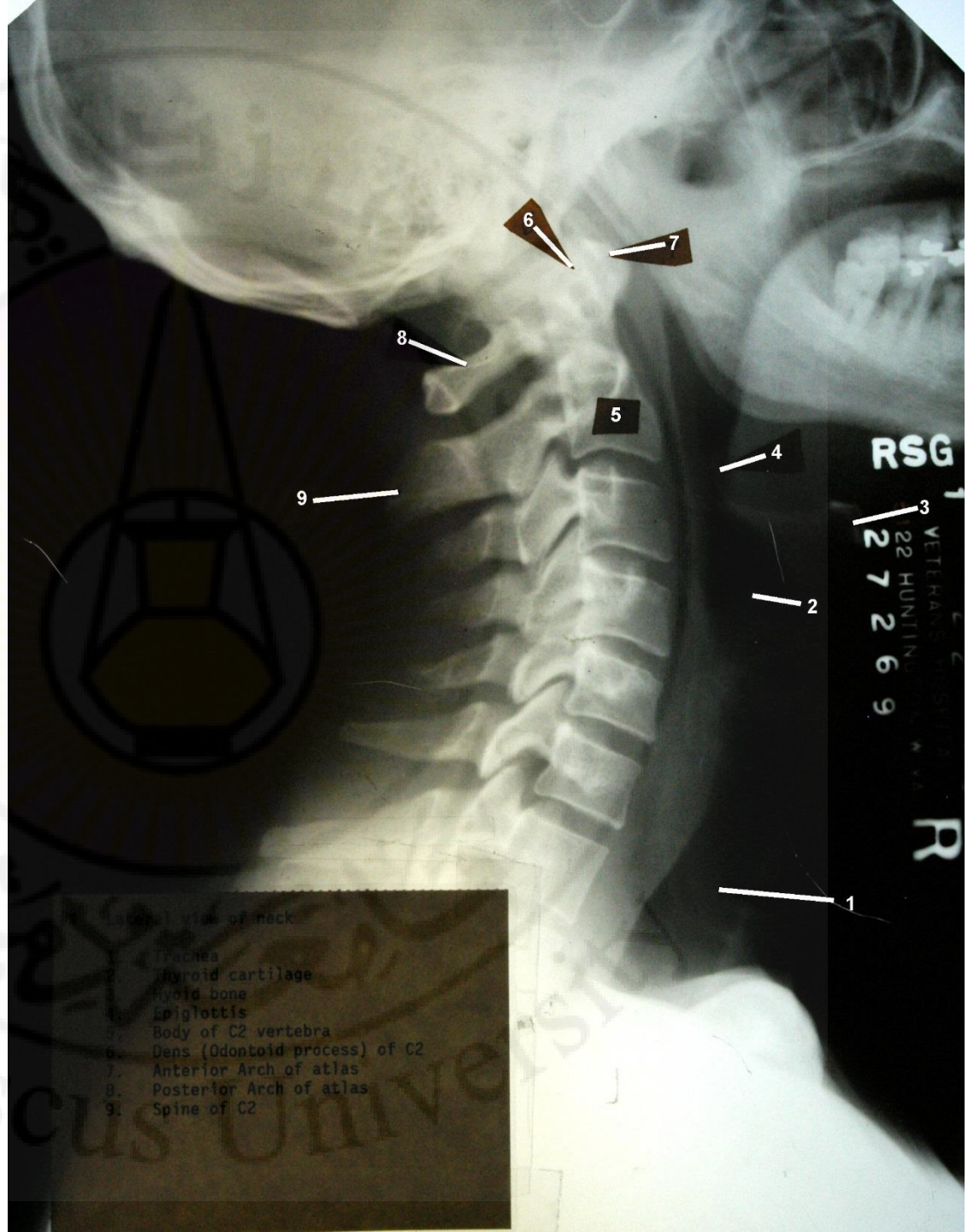
Posteroanterior view of
skull

- 1) Nasal septum
- 2) Mastoid air cells



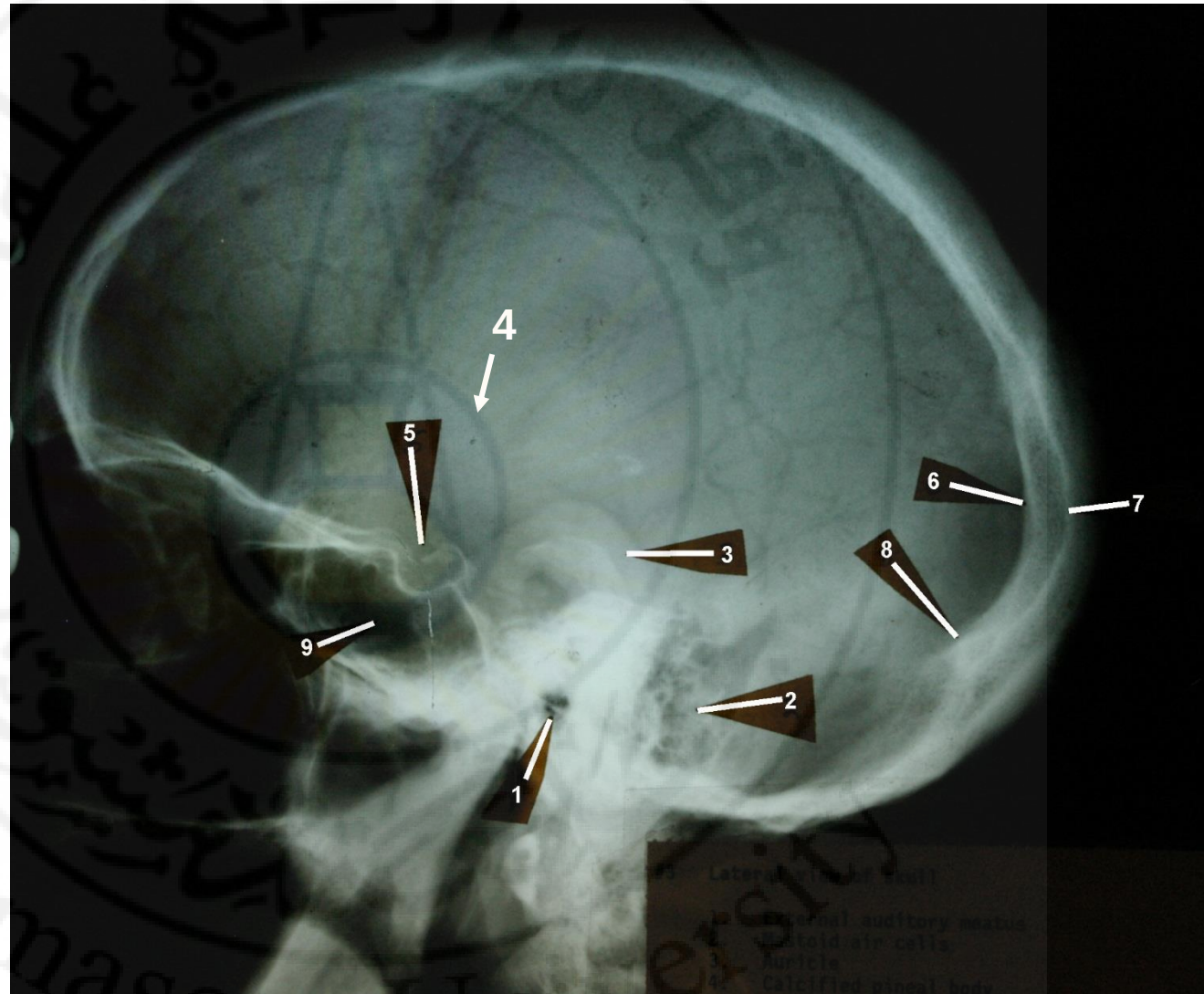
Lateral View of Neck

1. Trachea
2. Thyroid cartilage
3. Hyoid bone
4. Epiglottis
5. Body of C2
6. Dens of C2
7. Anterior arch of atlas
8. Posterior arch of atlas
9. Spines of C2



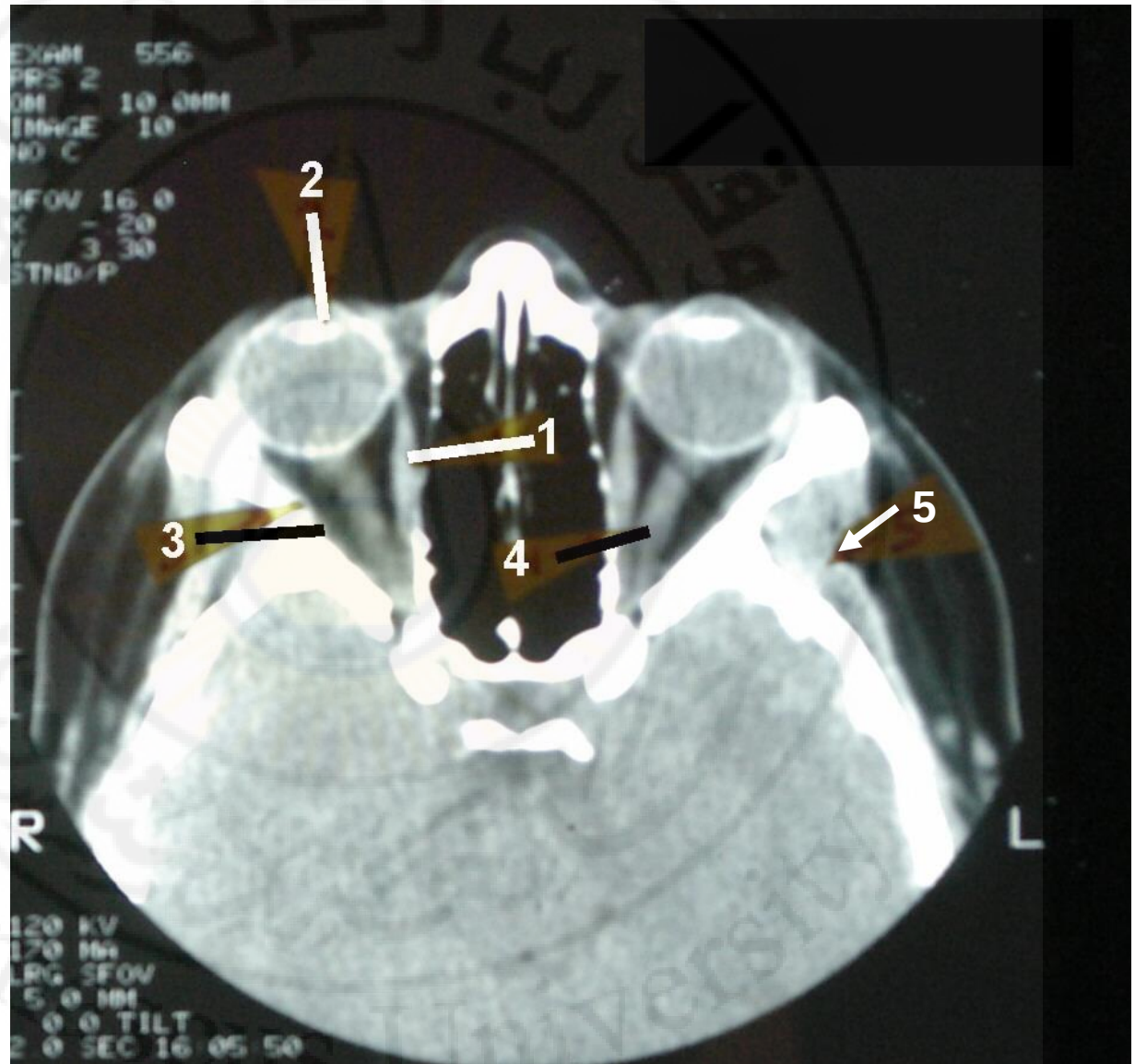
Lateral View of Skull

1. External auditory meatus
2. Mastoid air cells
3. Auricle
4. Calcified pineal body
5. Sella turcica
6. Inner table of skull bone
7. Outer table of skull bone
8. Internal occipital protuberance
9. Sphenoid air sinus



CT HORIZONTAL SECTION OF ORBIT

- 1- Medial Rectus
- 2- Lens
- 3- Lateral Rectus
- 4- Optic Nerve
- 5- Temporalis muscle



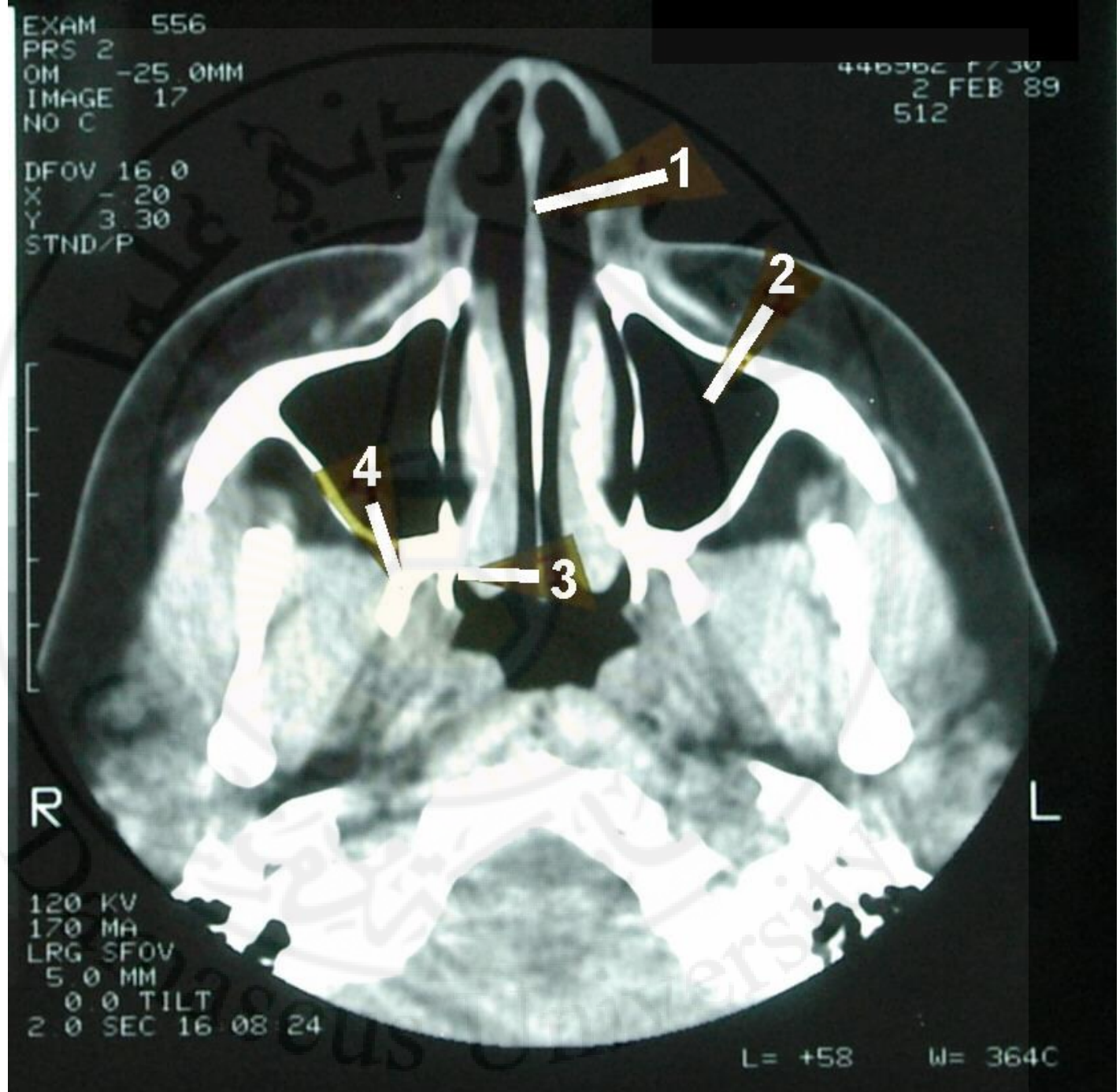
**CT
Horizontal
Pterygoid
Plate
Part 1**

- 6- Lateral
Pterygoid
Muscle**
- 7- Neck of
Mandible**
- 8- Coronoid
Process of
Mandible**



**CT
Horizontal
Pterygoid
Plate
Part 2**

- 1- Nasal
Septum**
- 2- Maxillary
Sinus**
- 3- Medial
Pterygoid
Plate**
- 4- Lateral
Pterygoid
Plate**



**CT
Horizontal
Pterygoid
Plate
Part 3**

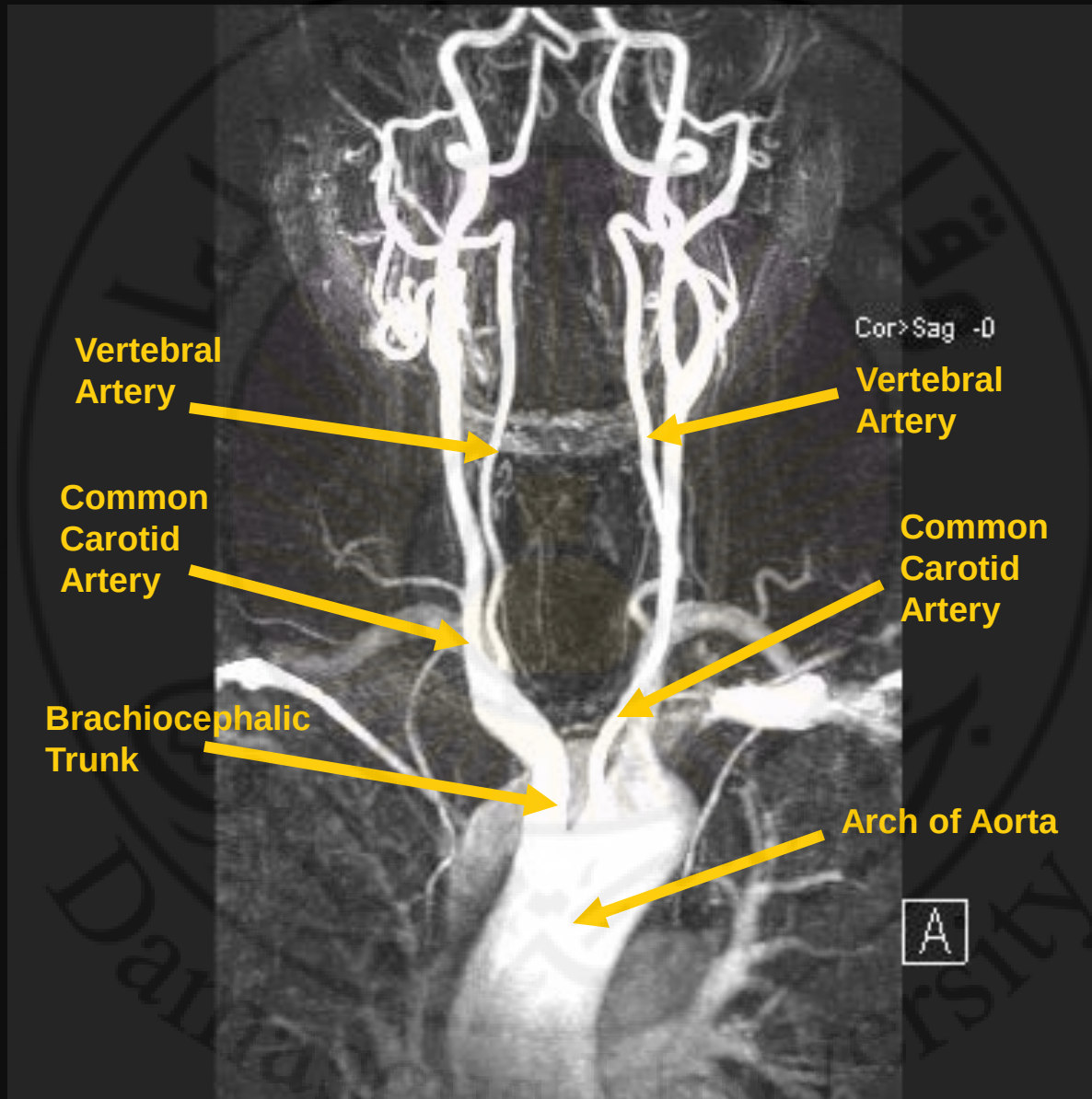
**5- Ramus
of Mandible**



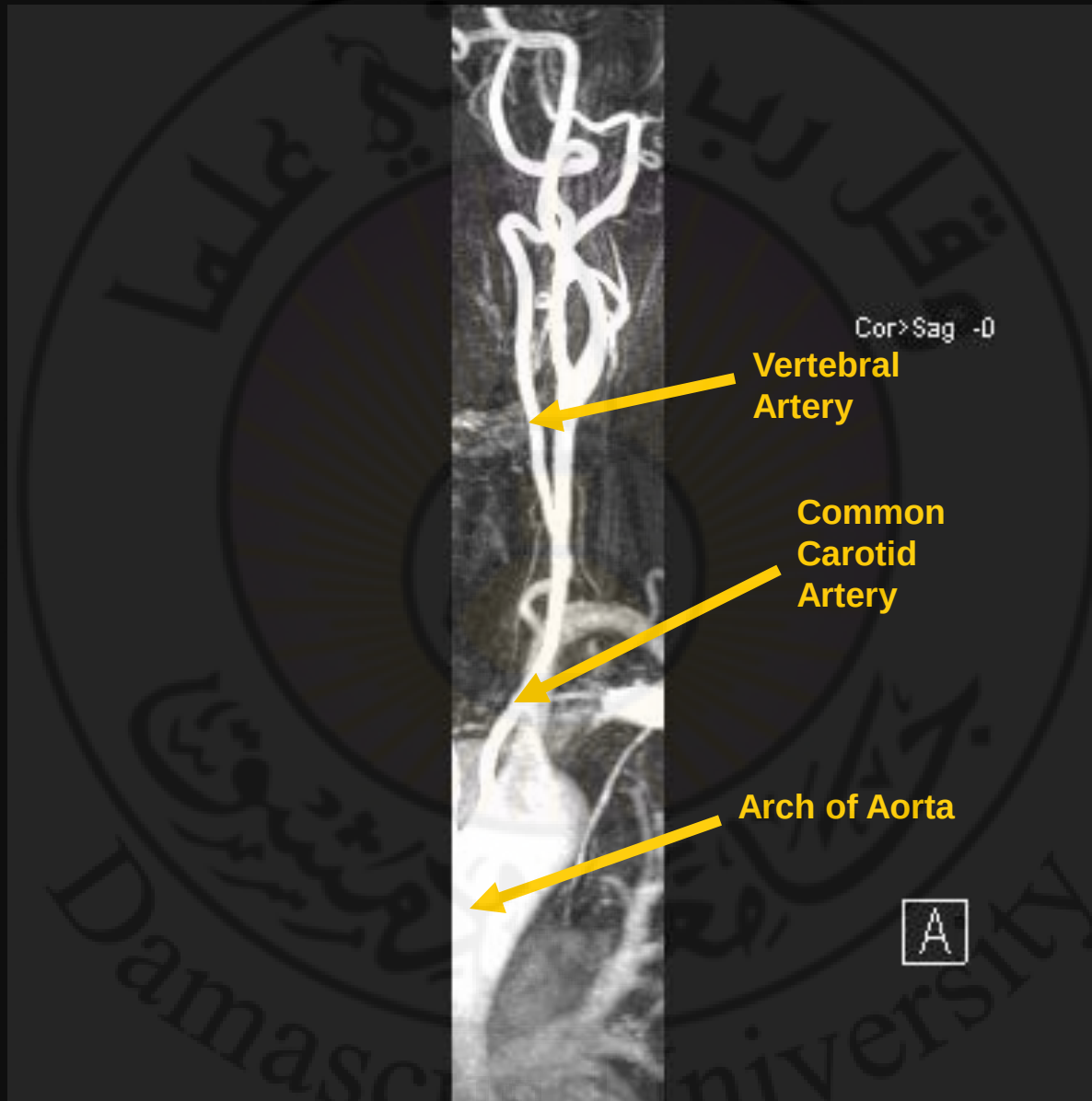
CT Horizontal Pterygoid Plate (three preceding slides)

- 1- Nasal Septum**
- 2- Maxillary Sinus**
- 3- Medial Pterygoid Plate**
- 4- Lateral Pterygoid Plate**
- 5- Ramus of Mandible**
- 6- Lateral Pterygoid Muscle**
- 7- Neck of Mandible**
- 8- Coronoid Process of Mandible**

MRA - Magnetic Resonance Angiography - Blood Supply to Head



MRA - Magnetic Resonance Angiography - Blood Supply to Head - Left side only



Anterior
view

MRA - Magnetic Resonance Angiography - Blood Supply to Head - Left side only



Rotate
to
Right

MRA - Magnetic Resonance Angiography - Blood Supply to Head - Left side only



Rotate
to
Right

MRA - Magnetic Resonance Angiography - Blood Supply to Head - Left side only



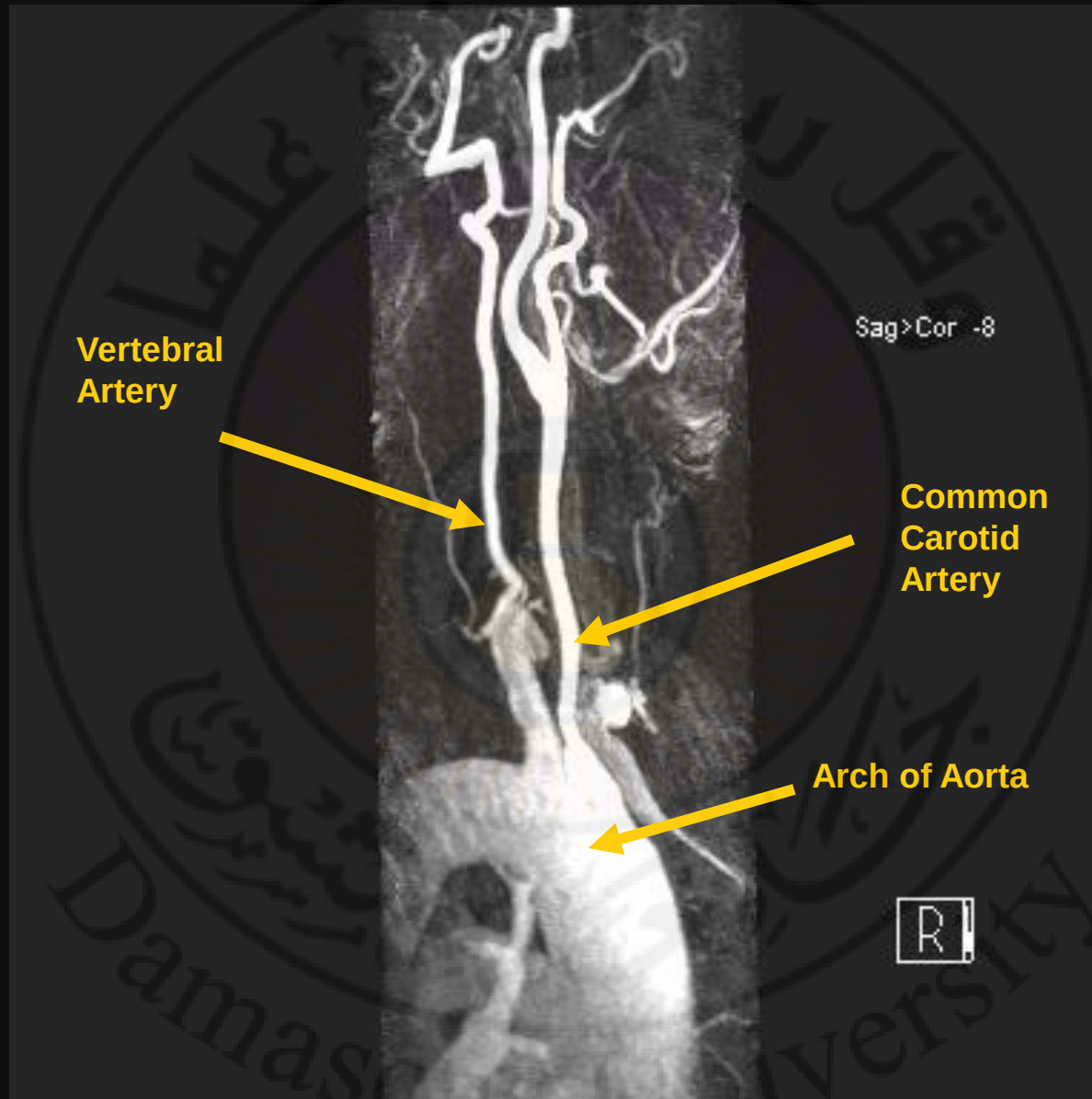
Rotate
to
Right

MRA - Magnetic Resonance Angiography - Blood Supply to Head - Left side only



Rotate
to
Right

MRA - Magnetic Resonance Angiography - Blood Supply to Head - Left side only



Rotate
to
Right

Left side only
High
Mag

Occipital Artery

Maxillary Artery

Facial Artery

Internal
Carotid
Artery

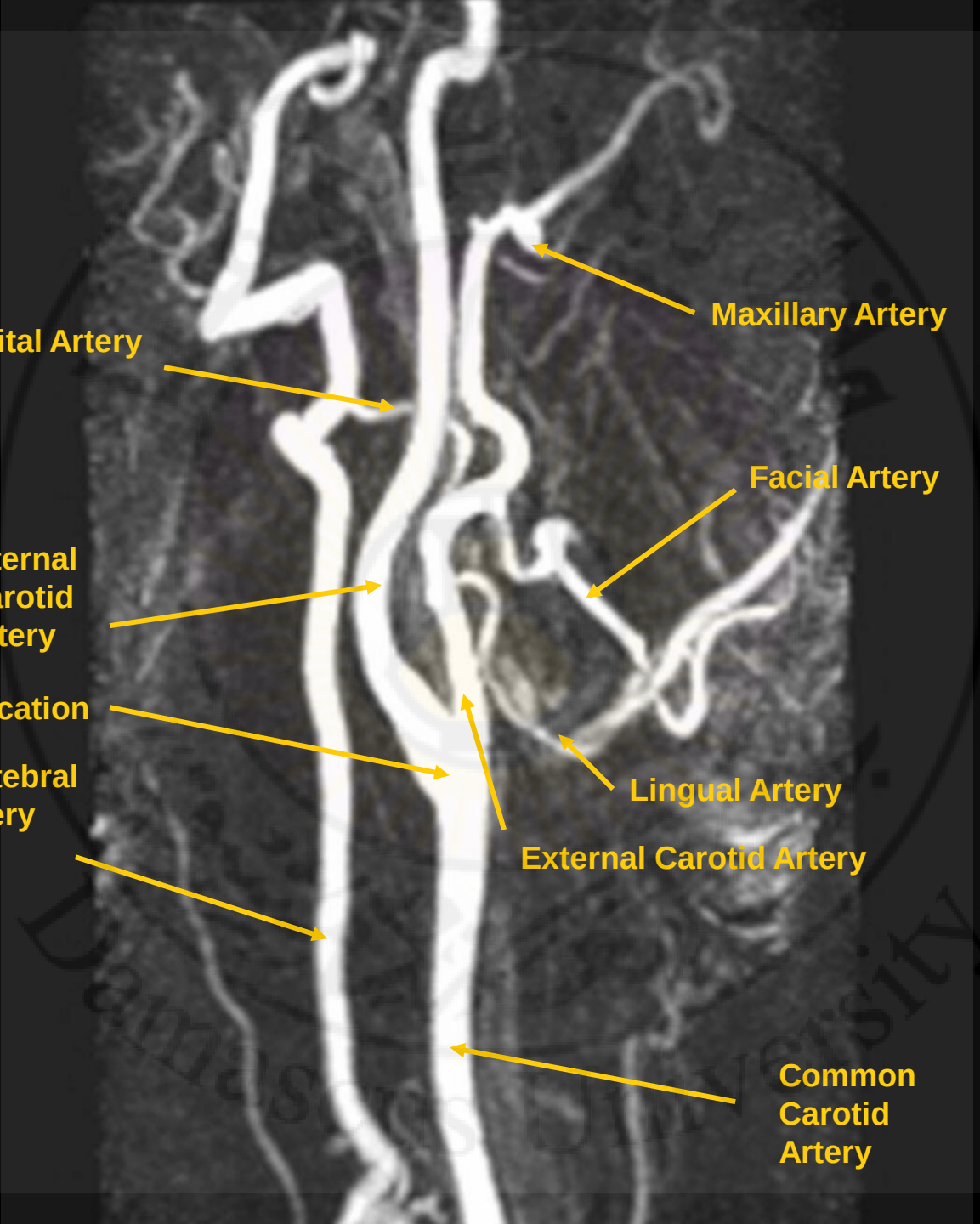
Bifurcation

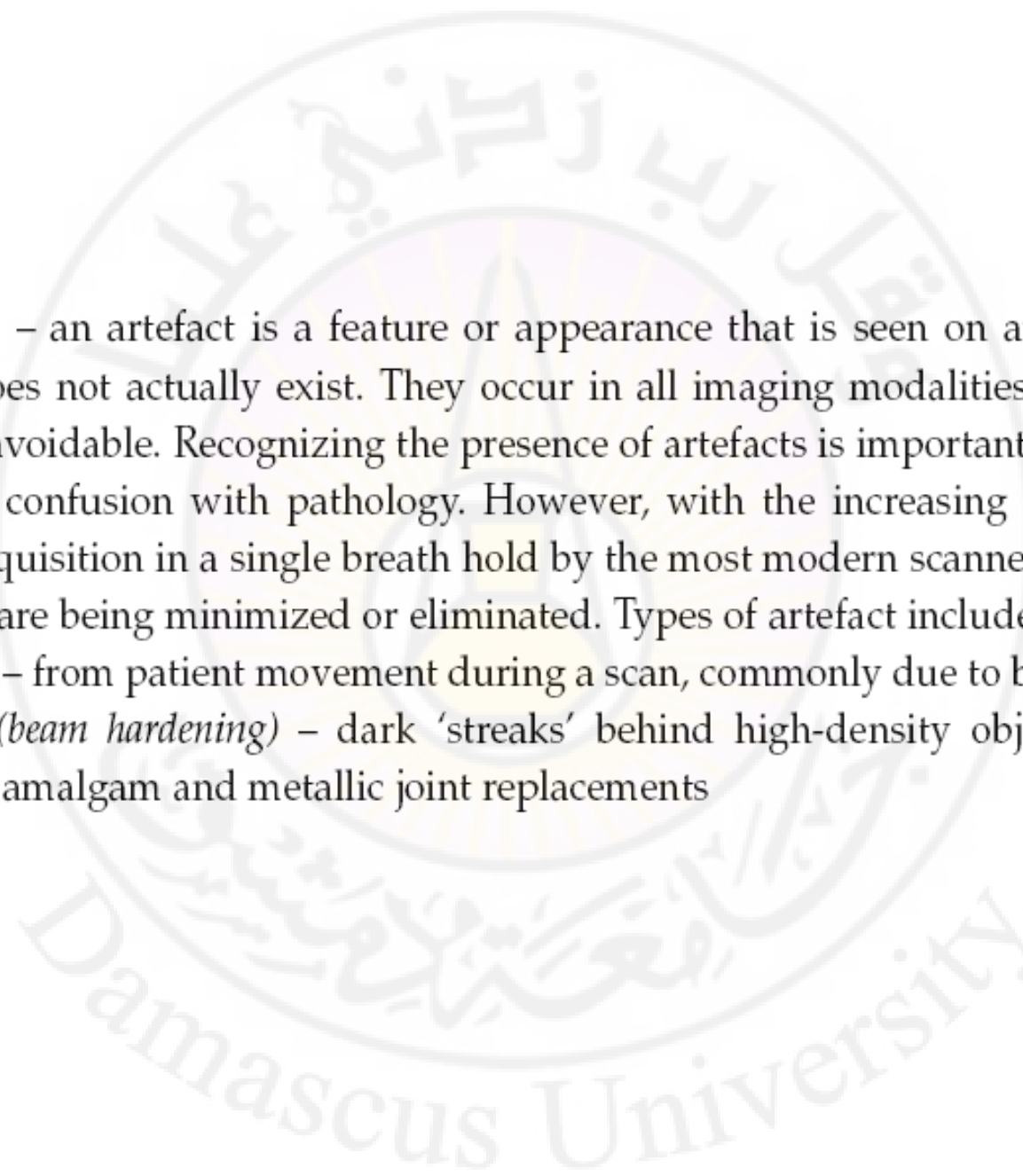
Vertebral
Artery

Lingual Artery

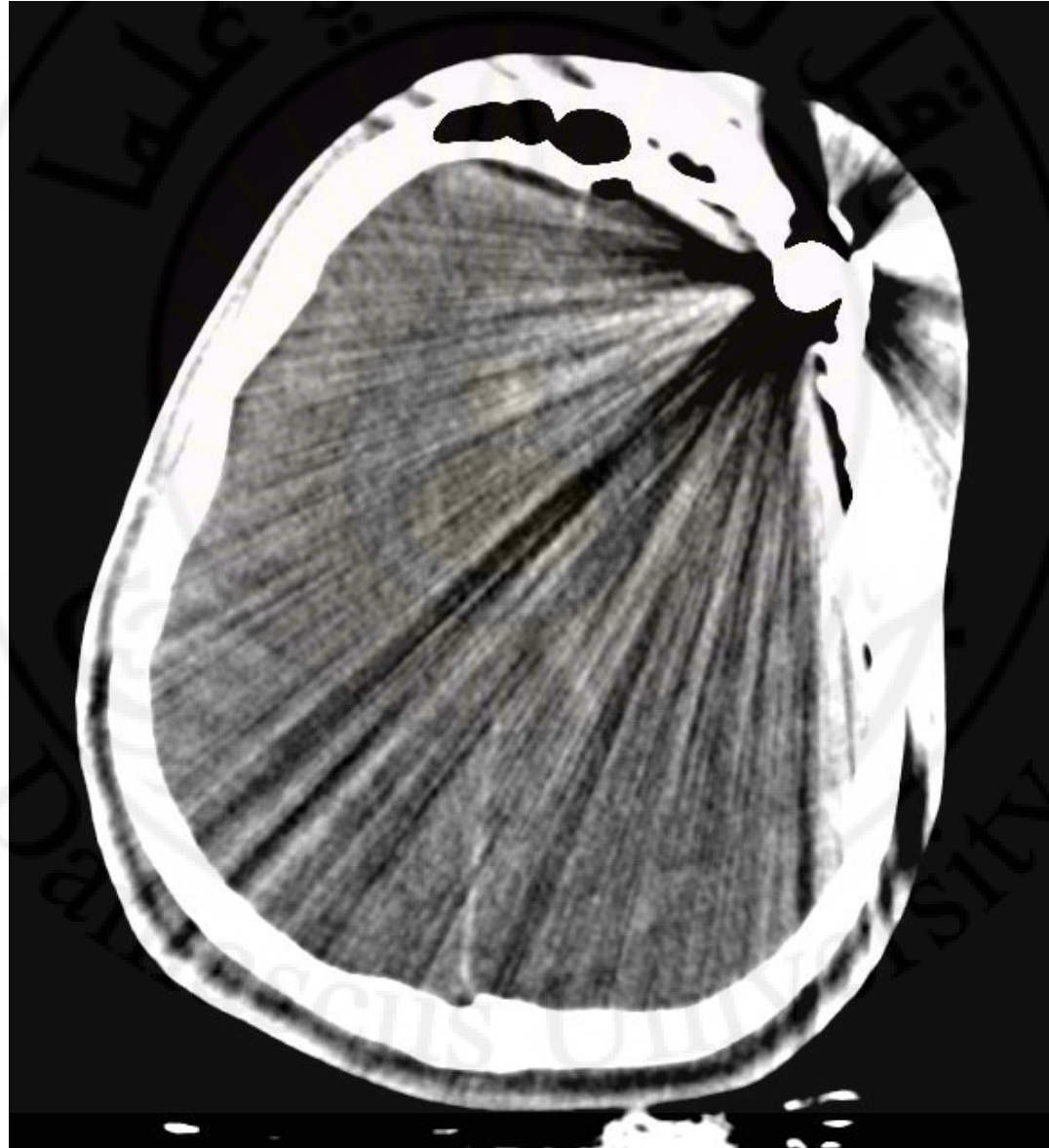
External Carotid Artery

Common
Carotid
Artery

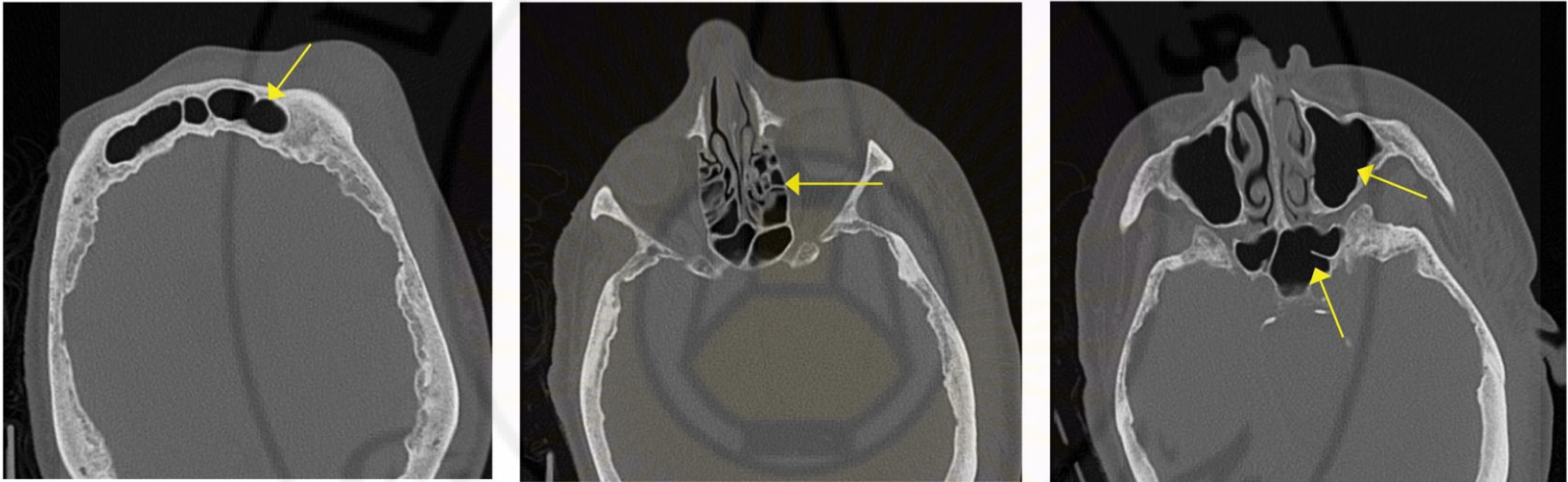


- 
- A large, faint watermark of the Damascus University seal is centered in the background. The seal is circular, featuring a five-pointed star in the center, surrounded by Arabic calligraphy. The words "Damascus University" are written in English around the bottom half of the seal.
- **Artefacts** – an artefact is a feature or appearance that is seen on an image, which does not actually exist. They occur in all imaging modalities and are often unavoidable. Recognizing the presence of artefacts is important in order to avoid confusion with pathology. However, with the increasing speed of image acquisition in a single breath hold by the most modern scanners, many artefacts are being minimized or eliminated. Types of artefact include:
 1. *motion* – from patient movement during a scan, commonly due to breathing
 2. *streak (beam hardening)* – dark ‘streaks’ behind high-density objects, e.g. dental amalgam and metallic joint replacements

Beam Hardening Artifact from
Metal Alloy in a Lodged Bullet



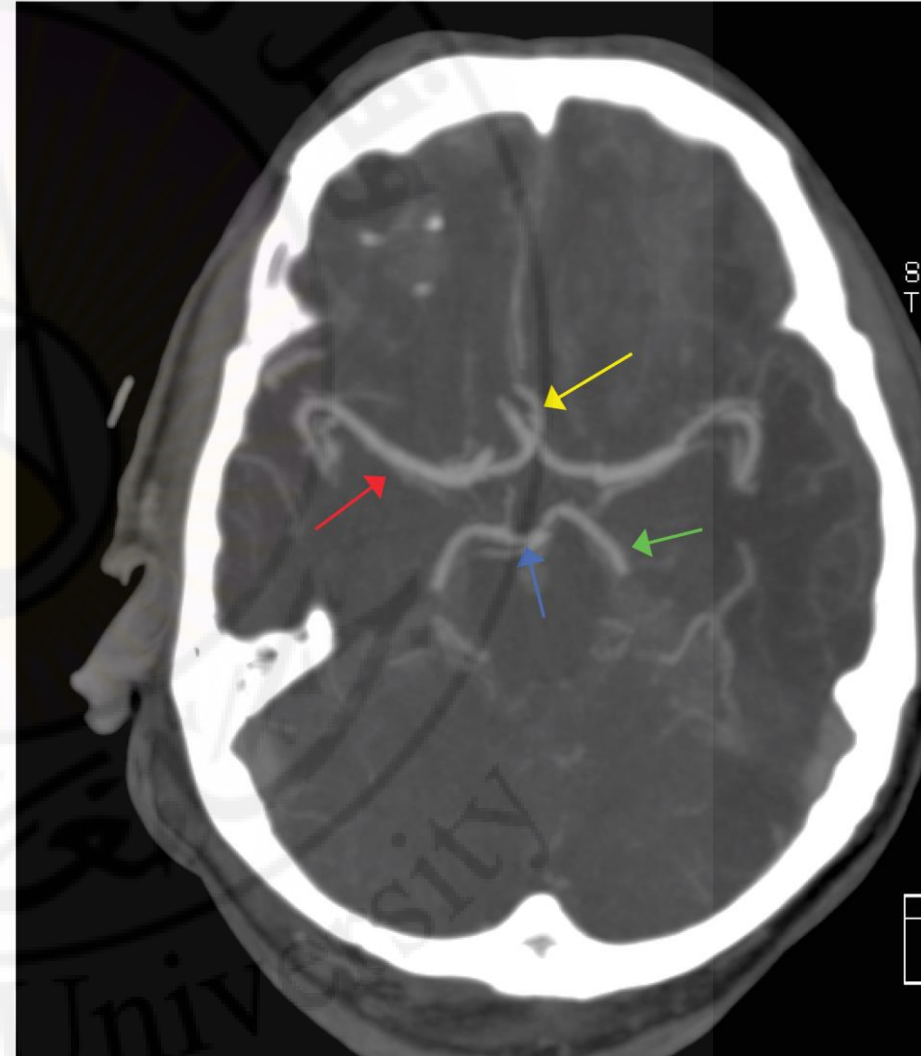
Sinuses in the Axial Plane



- Left to right: frontal sinus, ethmoid sinus, maxillary sinus and sphenoid sinus

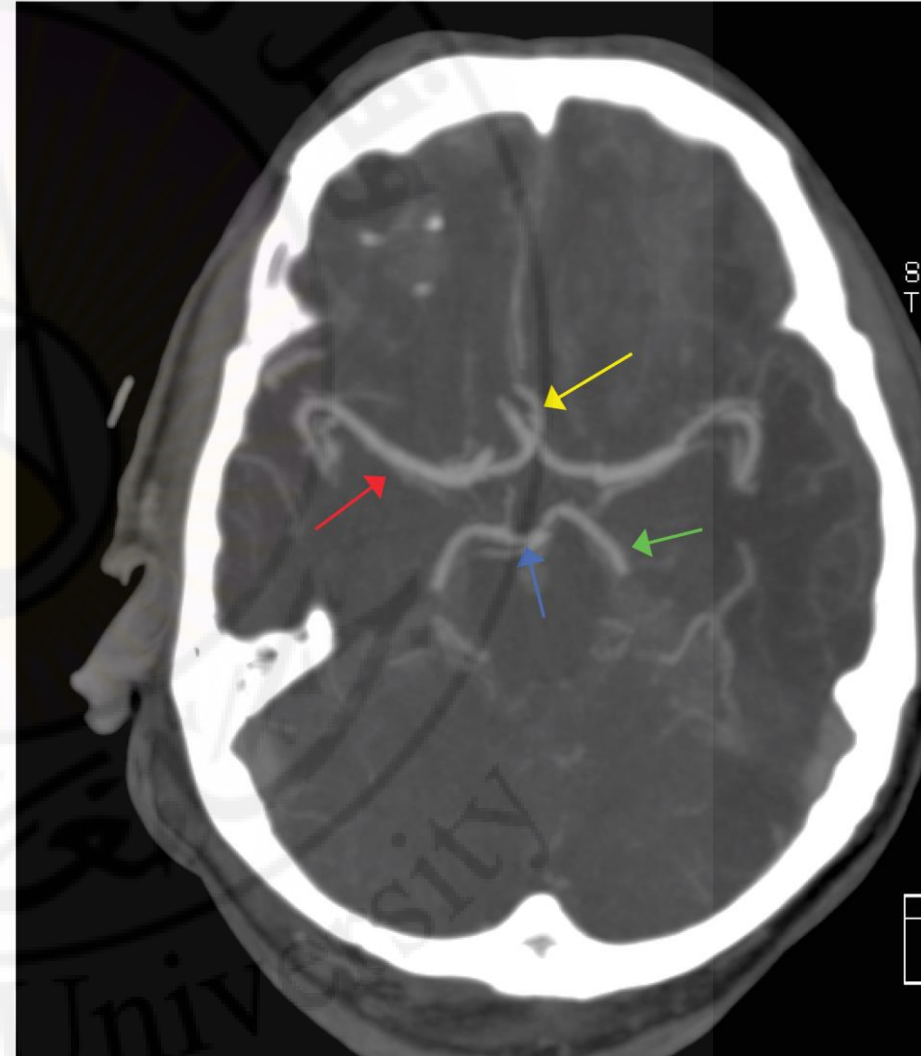
CT Angiographic Anatomy

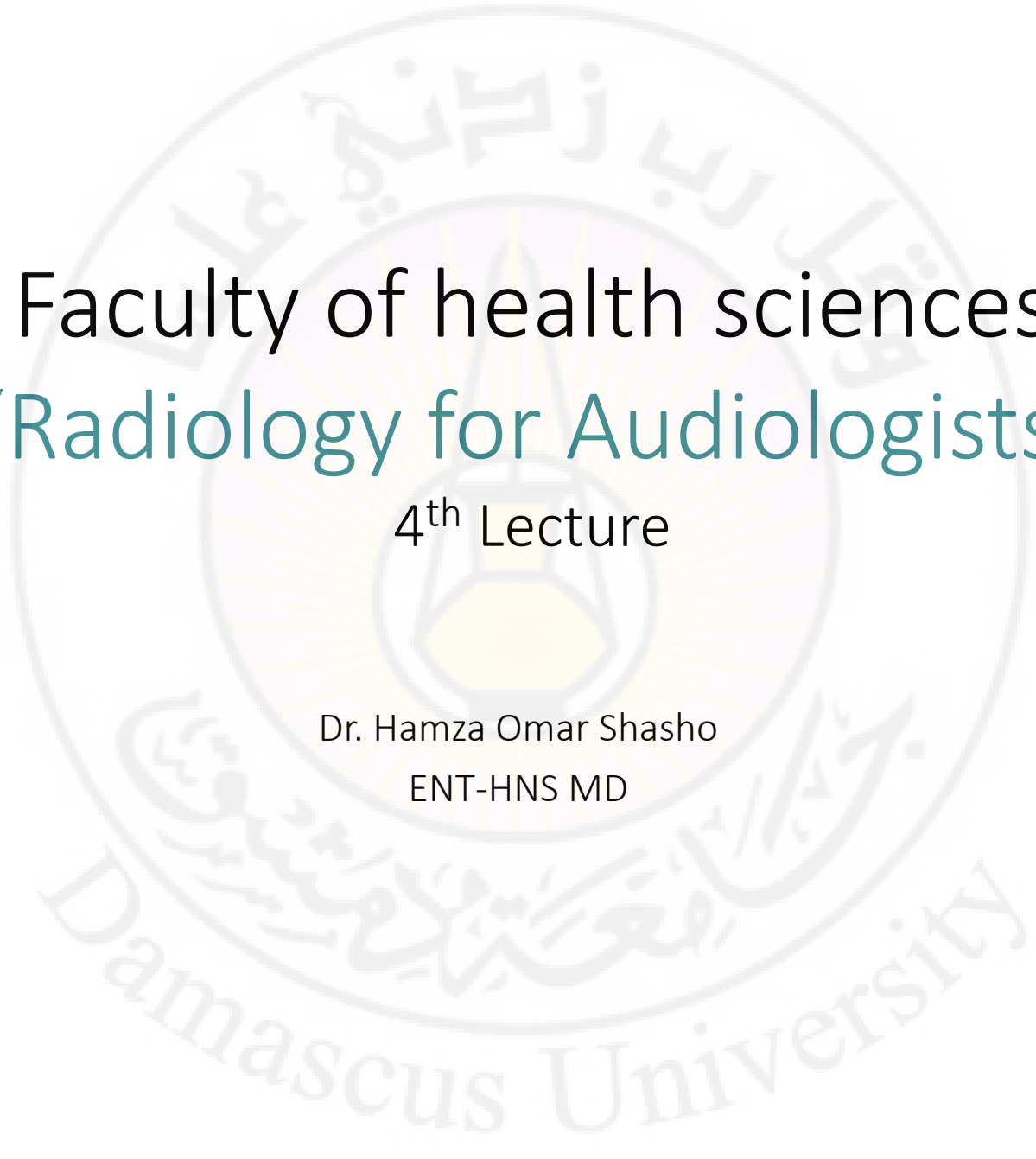
- Red – MCA or middle cerebral artery
- Yellow – ACA
- Green – PCA
- Blue – Basilar artery



CT Angiographic Anatomy

- Red – MCA or middle cerebral artery
- Yellow – ACA
- Green – PCA
- Blue – Basilar artery





Faculty of health sciences

“Radiology for Audiologists”

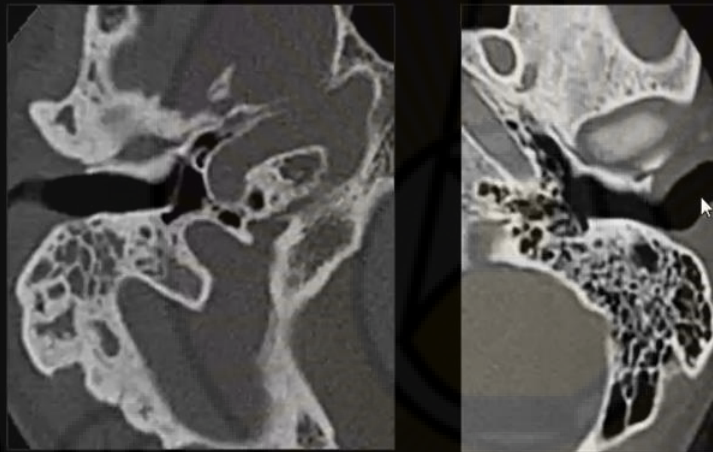
4th Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

External ear

- ♦ Cartilaginous and bony parts
- ♦ Ends by the tympanic membrane which is attached to the tympanic annulus



Tympanic membrane is very thin but might be seen

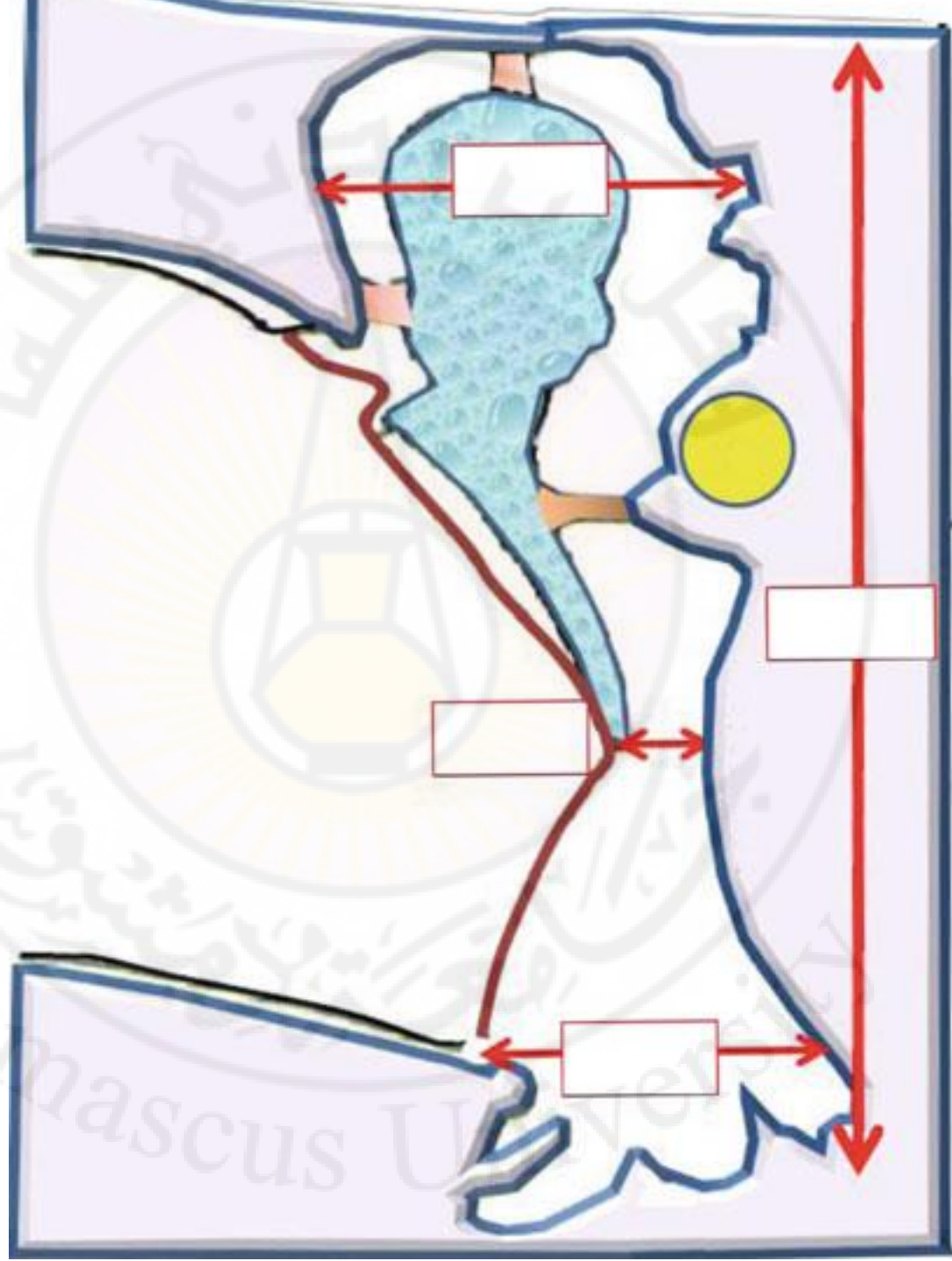
Middle ear

- ◆ Medial to the drum
- ◆ Contents
 - ◆ Ossicles (Incus, malleus, stapes)
 - ◆ Muscles and nerves

Connections

- ◆ To the nasopharynx via Eustachian tube
- ◆ To the mastoid antrum via aditus ad antrum
- ◆ To the vestibule via oval window
- ◆ To the cochlea via the round window

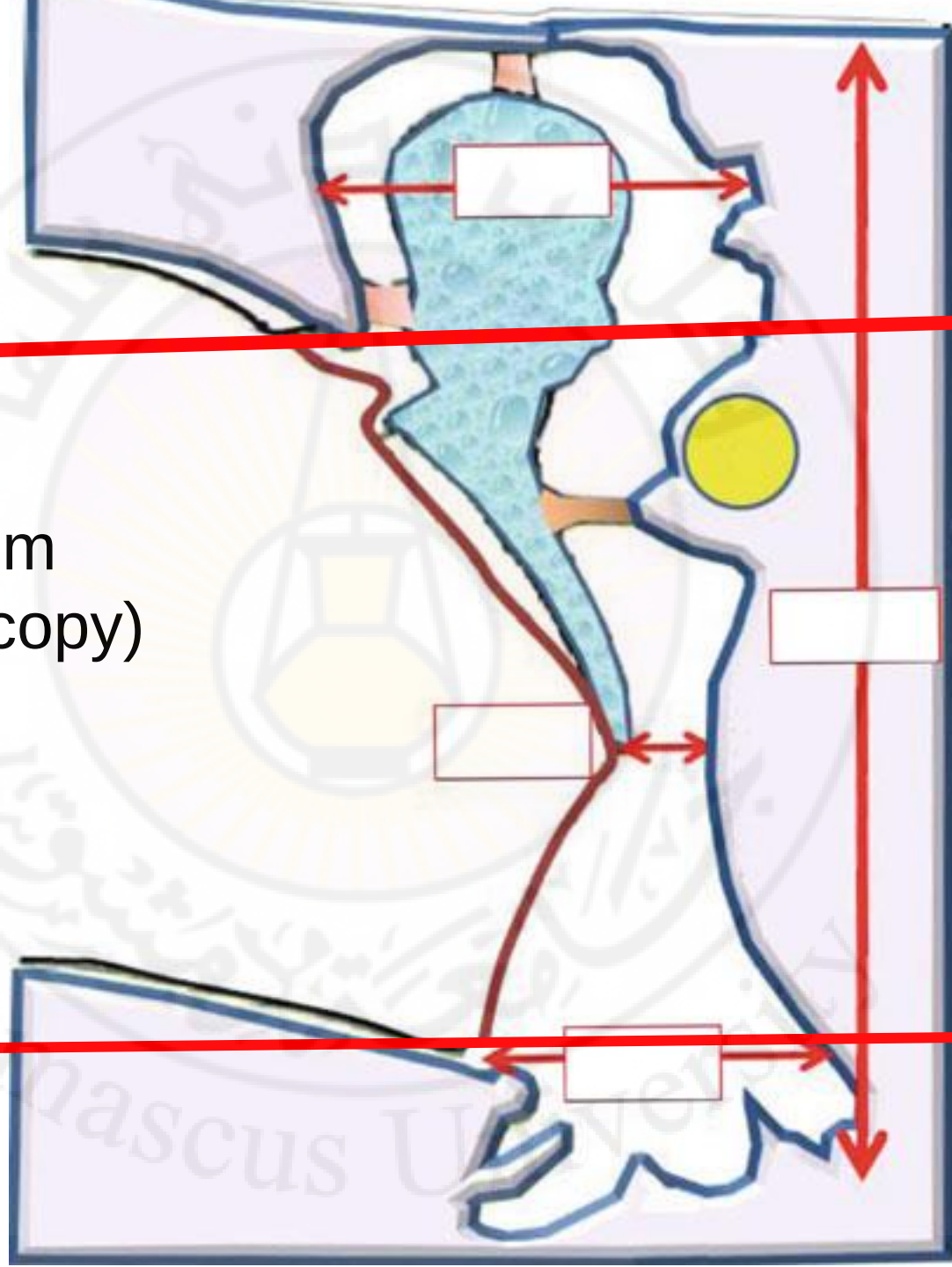


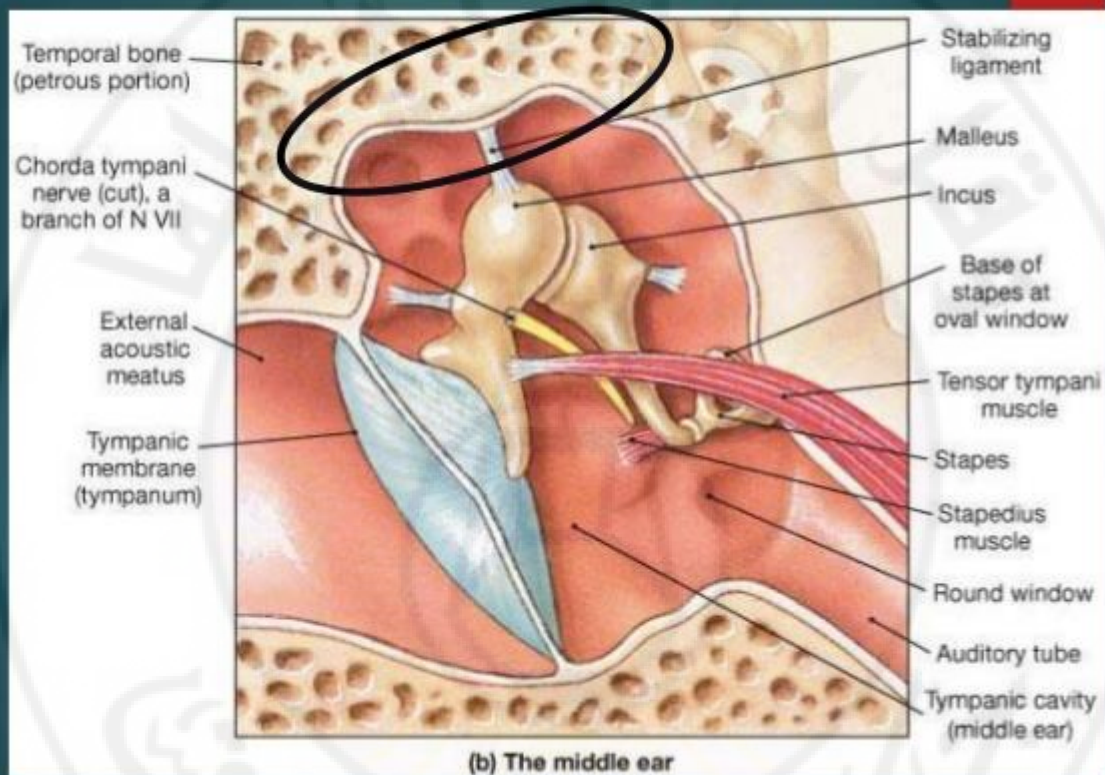


Attics

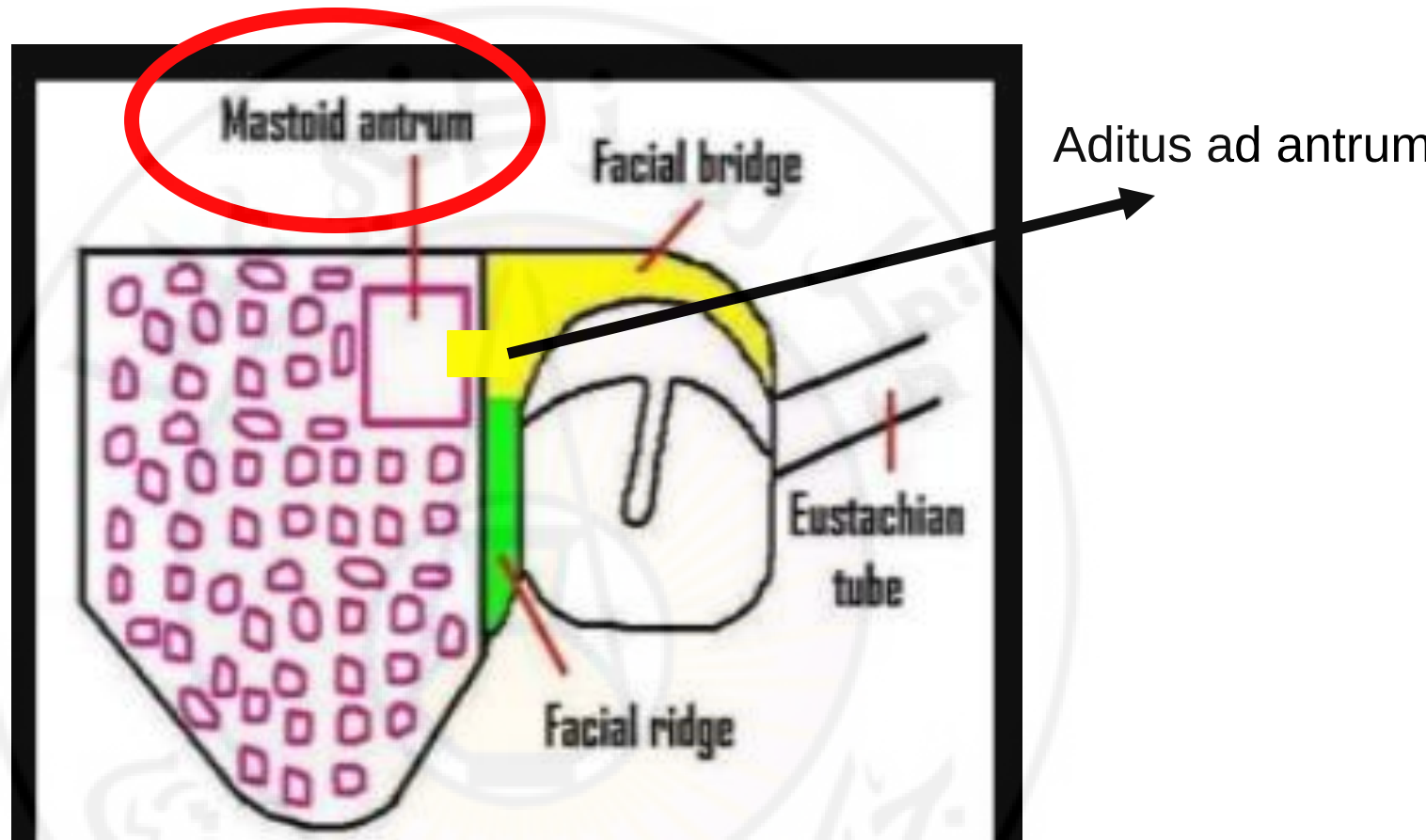
Mesotympanum
(seen by otoscopy)

hypotympanum





Attics : is the upper extension of **mesotympanum**



(Attic) connects posteriorly with the (antrum) by the (aditus ad antrum)

Figure of 8

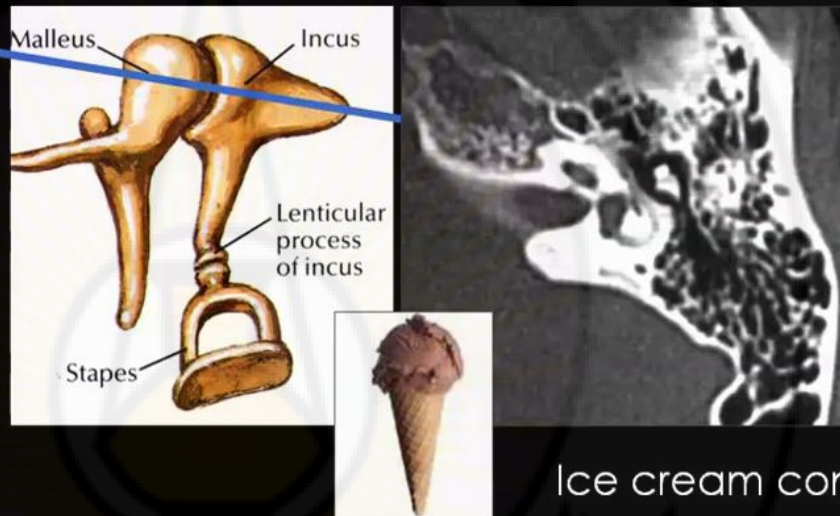
Middle ear cavity



- ♦ Ice cream cone
- ♦ Incus
- ♦ Malleus
- ♦ Aditus ad antrum
- ♦ Mastoid antrum
- ♦ Incudo - malleal joint

(Attic) connects posteriorly with the (antrum) by the (aditus ad antrum) creating the “figure of 8”

Middle ear anatomic land mark

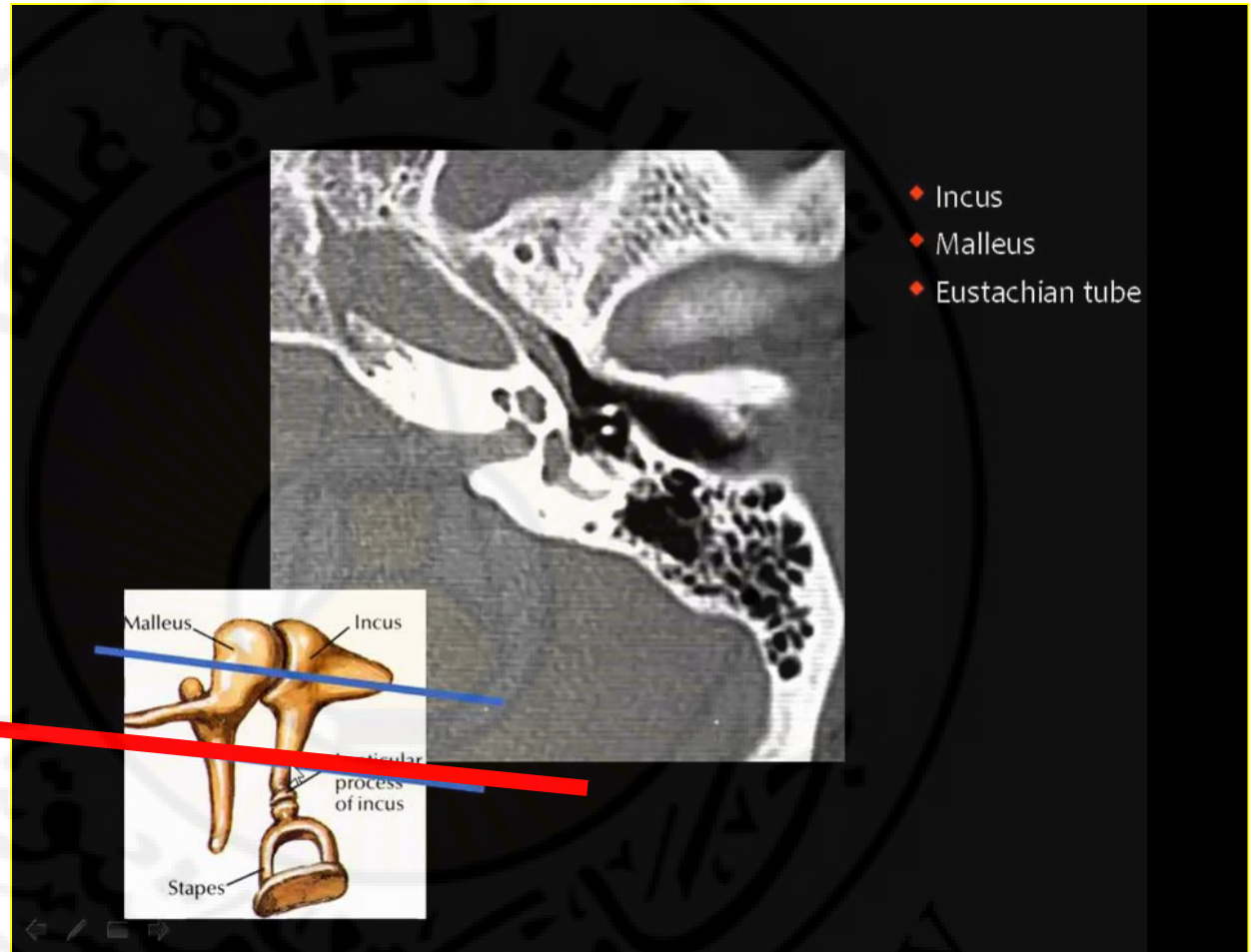


Slice at level of attics and antrum (figure of 8) shows the “ice cream cone”.

Ice cream cone consists of : head of malleus (ice cream) + body and short process of incus (the cone).

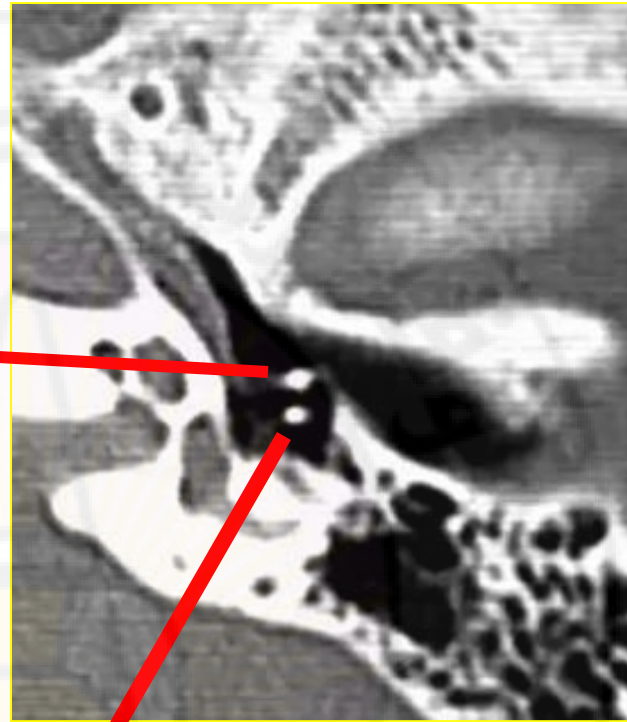


Ice cream cone



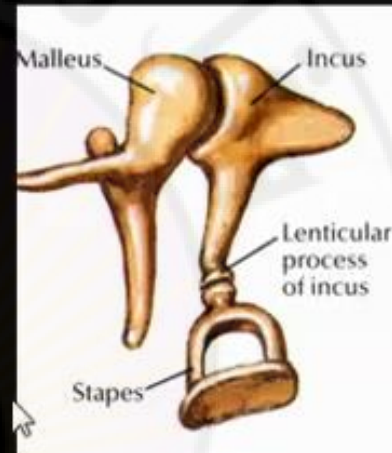
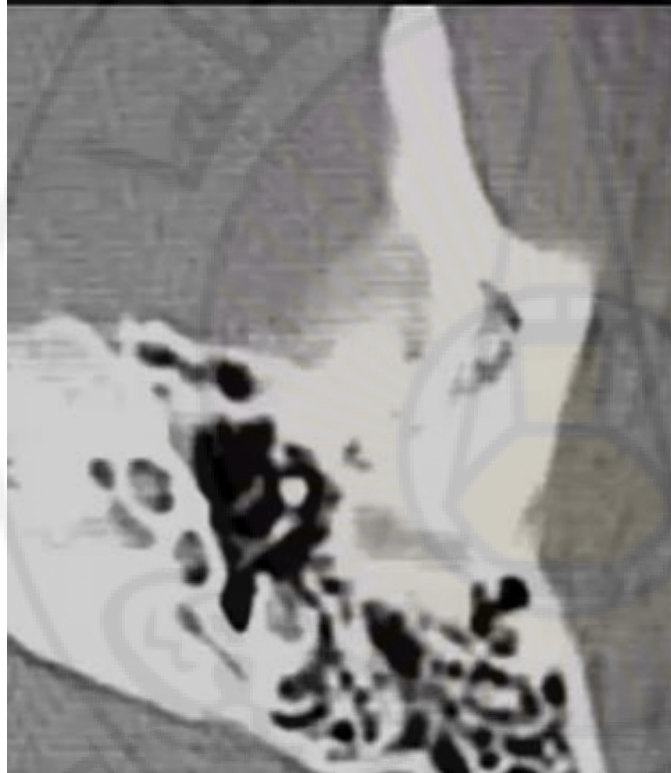
Going further down reveals a scissor that cross the handle of malleus (the anterior dot) and the long process of incus (the posterior dot)

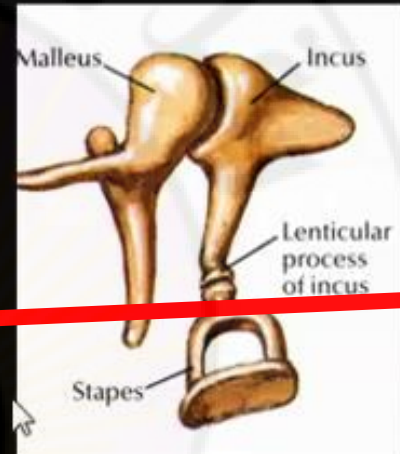
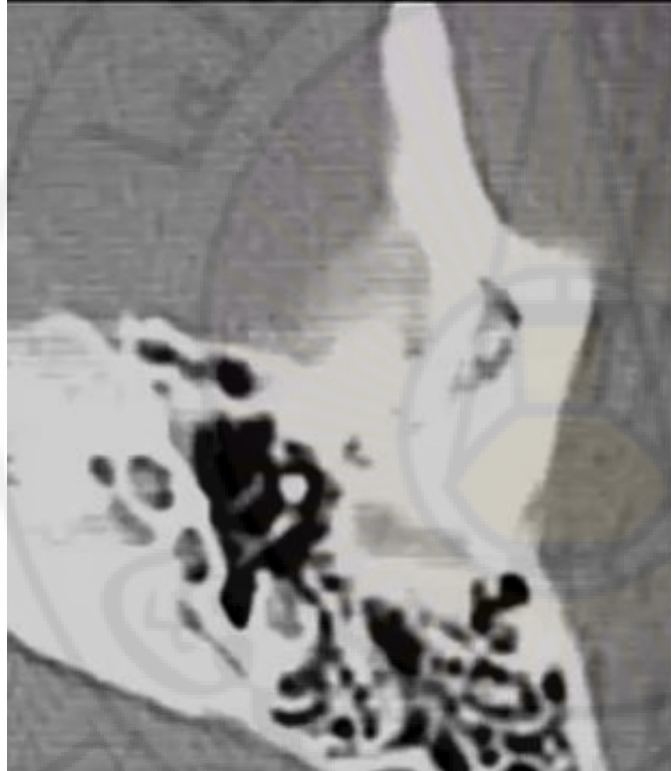
the handle of malleus
(the anterior dot) and



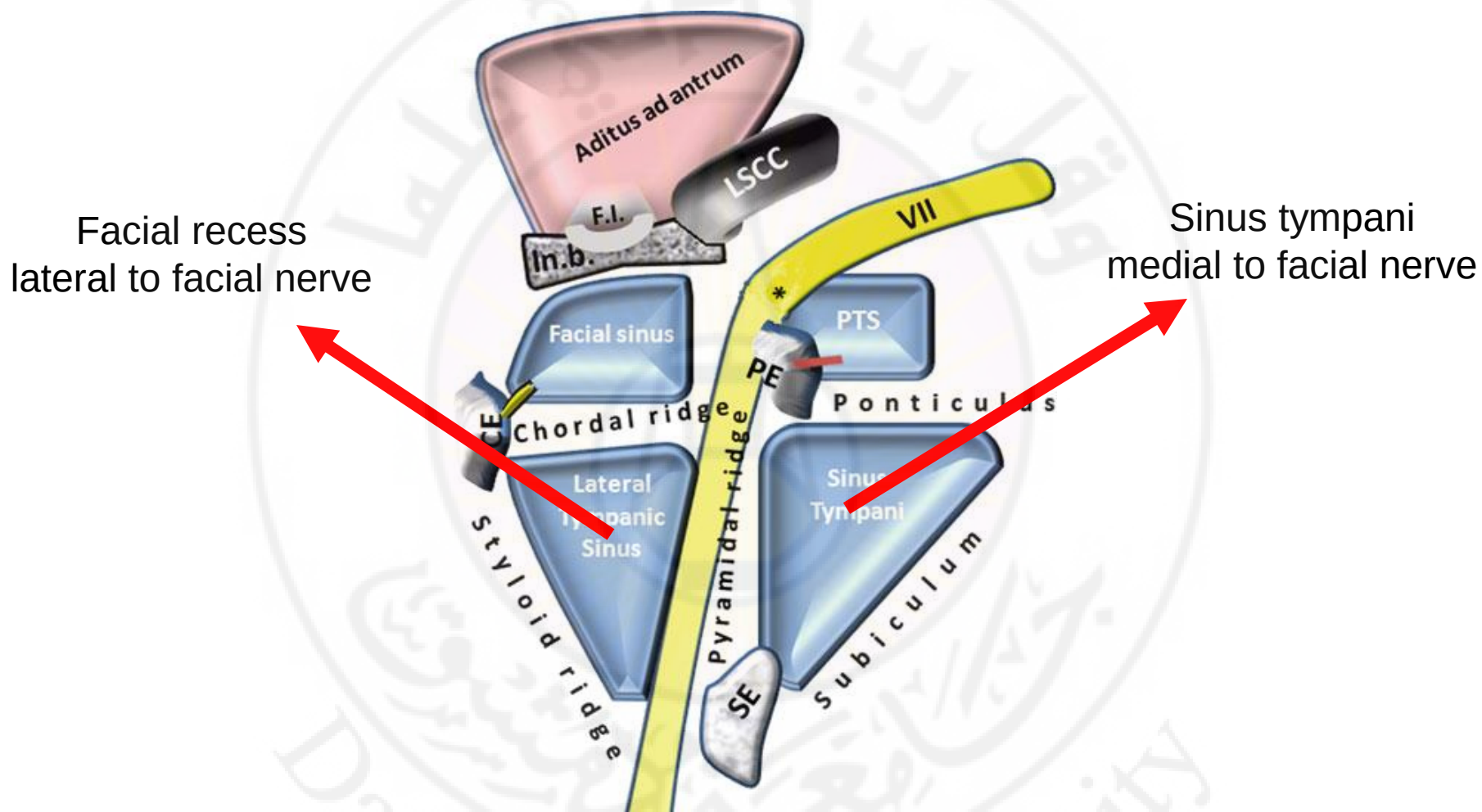
the long process of icus (the posterior dot)

Damascus University

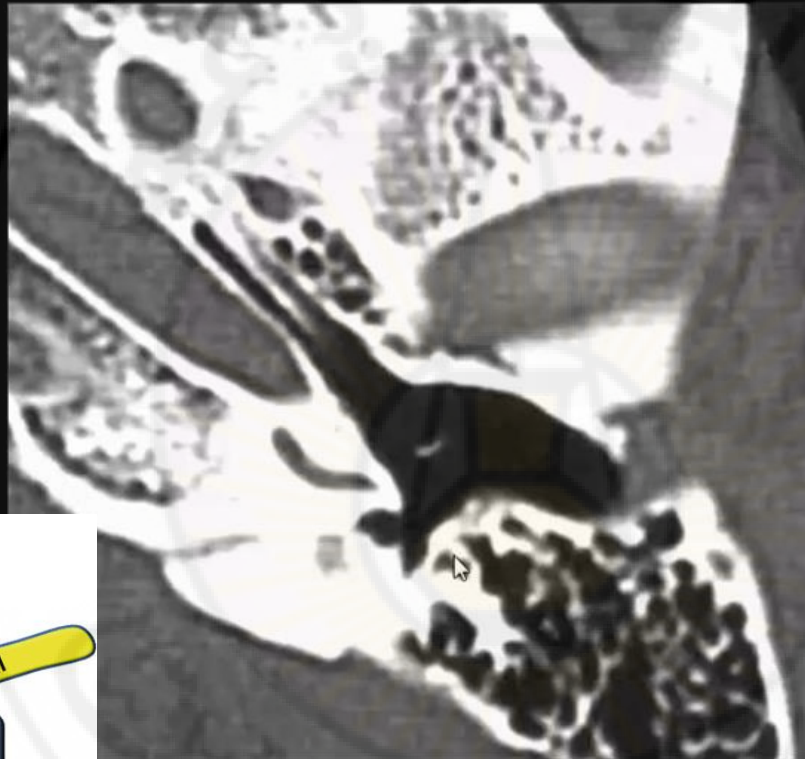




A slice that crosses the crura of stapes !



Facial nerve crossing the posterior wall of tympanic cavity

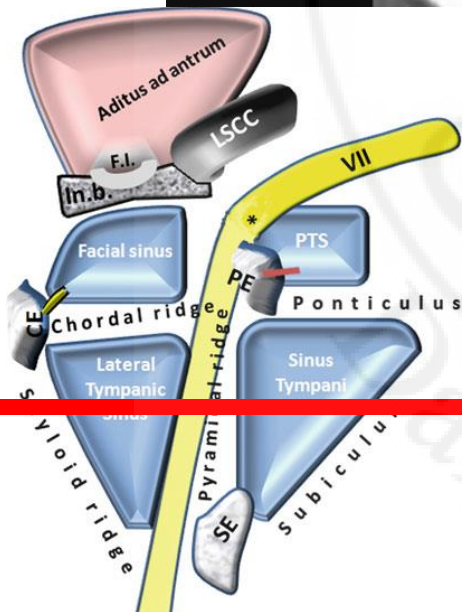


- ♦ Sinus tympani
- ♦ Facial recess
- ♦ Tympanic P.
- ♦ Eustachian tube
- ♦ Mastoid

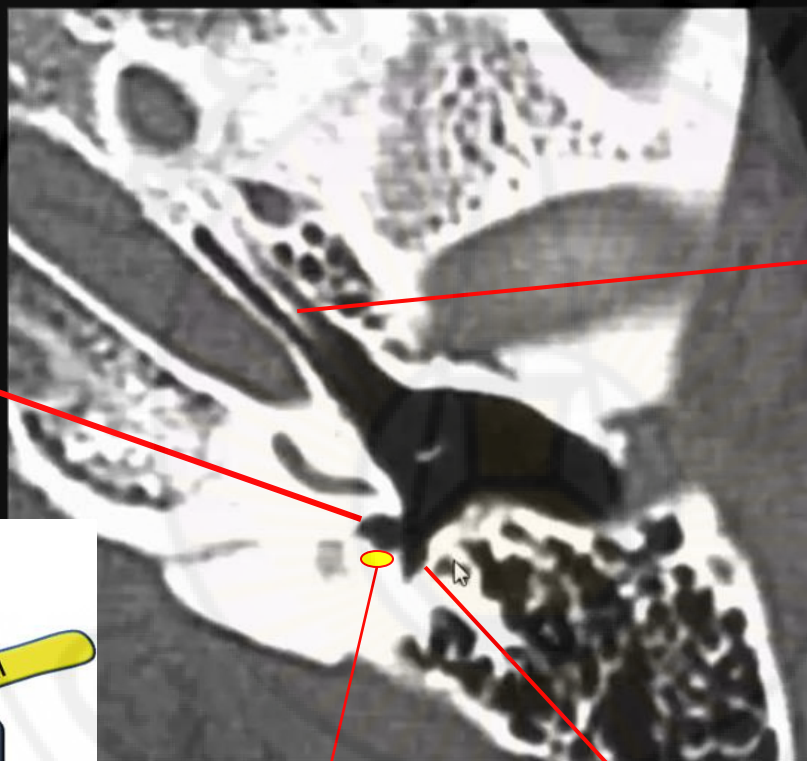


Sea lion

Hypo tympanum



Sinus tympani
medial to
facial nerve



- ♦ Sinus tympani
- ♦ Facial recess
- ♦ Tympanic P.
- ♦ Eustachian tube
- ♦ Mastoid

Eustachian
tube

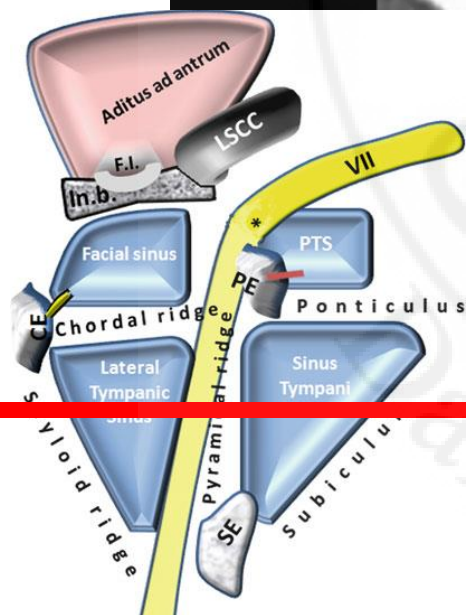


Sea lion

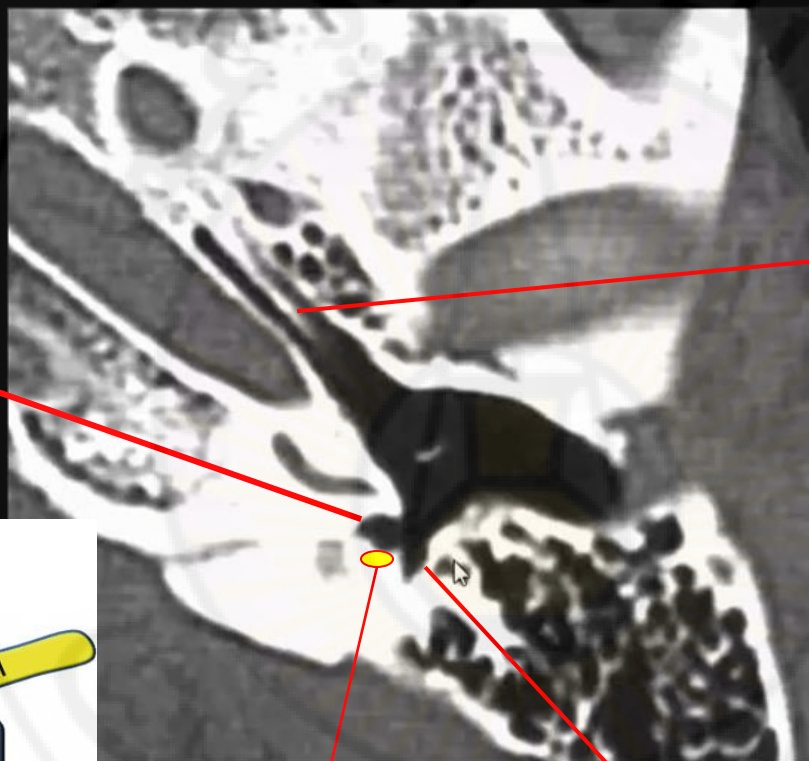
Hypo tympanum

Facial nerve

Facial recess
lateral to facial nerve



Sinus tympani
medial to
facial nerve



- ♦ Sinus tympani
- ♦ Facial recess
- ♦ Tympanic P.
- ♦ Eustachian tube
- ♦ Mastoid

Eustachian
tube

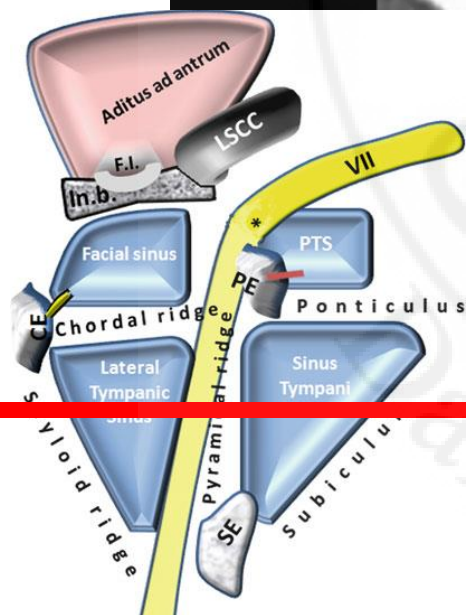


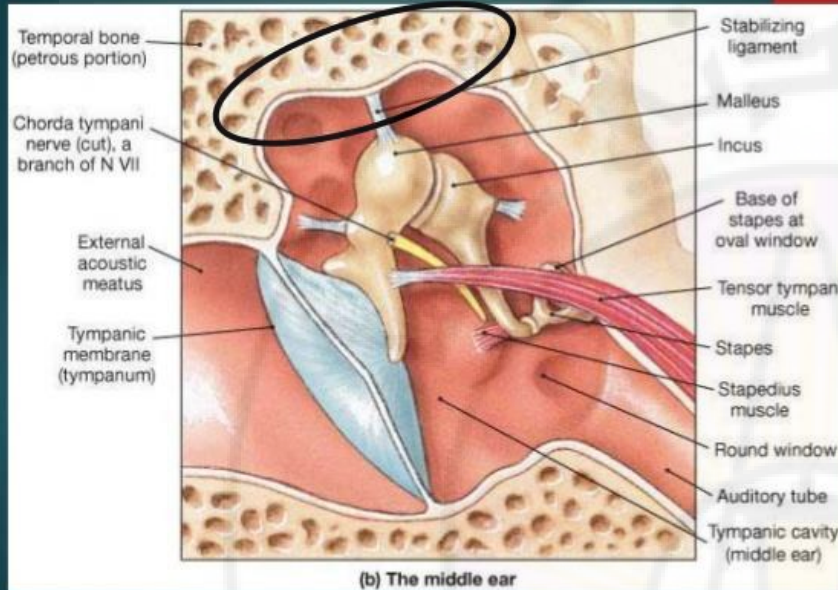
Sea lion

Hypo tympanum

Facial nerve

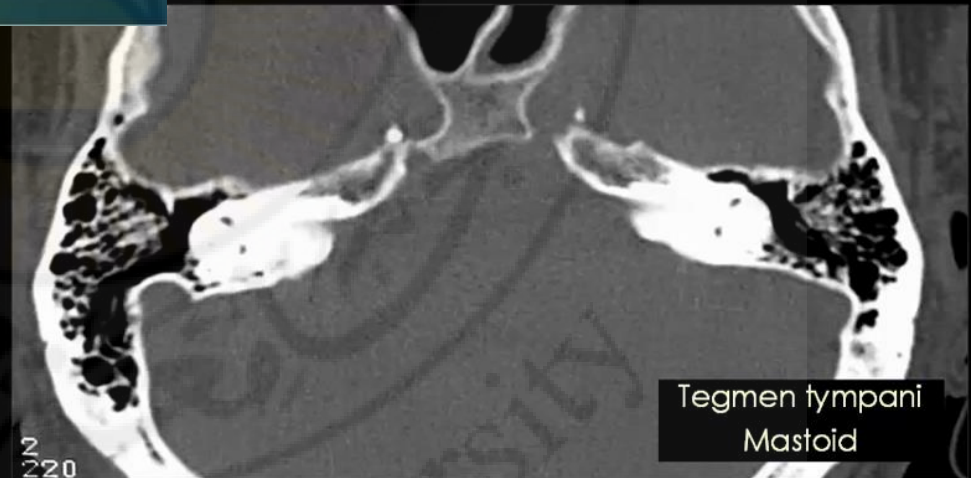
Facial recess
lateral to facial nerve





Middle ear cavity is separated from brain cavity by a bony roof called (the **tegmen**)

A slice in the attics above the level of ossicles

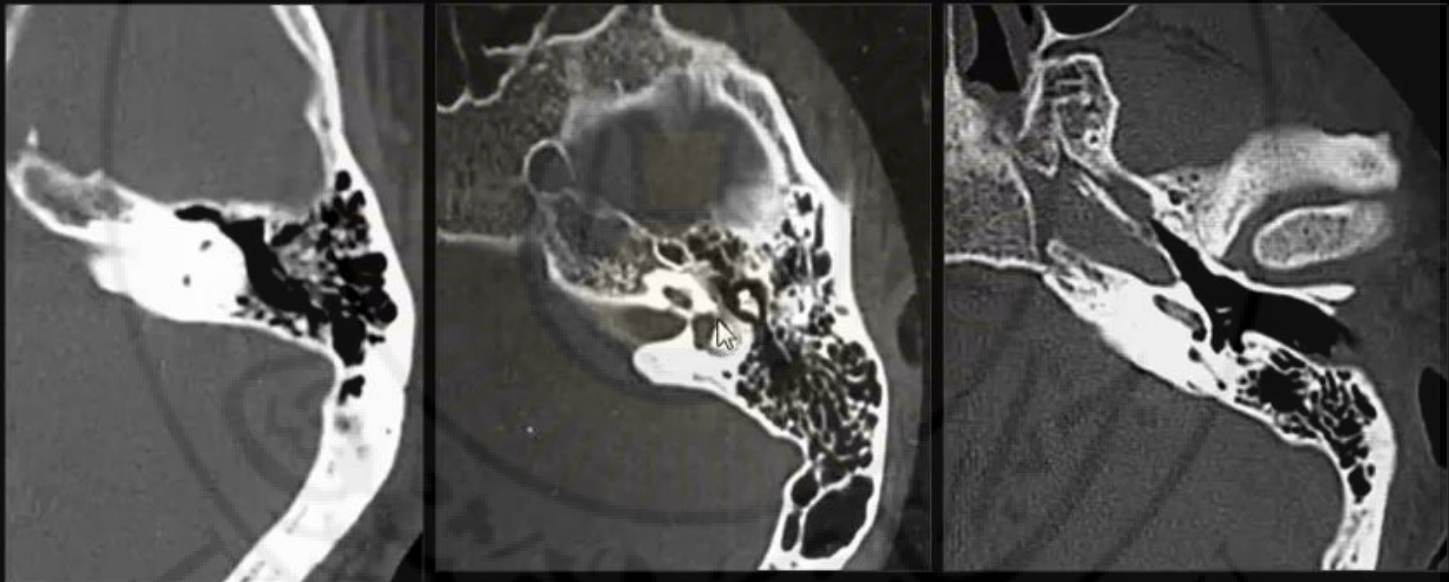


Tegmen



- Middle ear cavity is separated from brain cavity by a bony roof called (the tegmen)

Middle ear

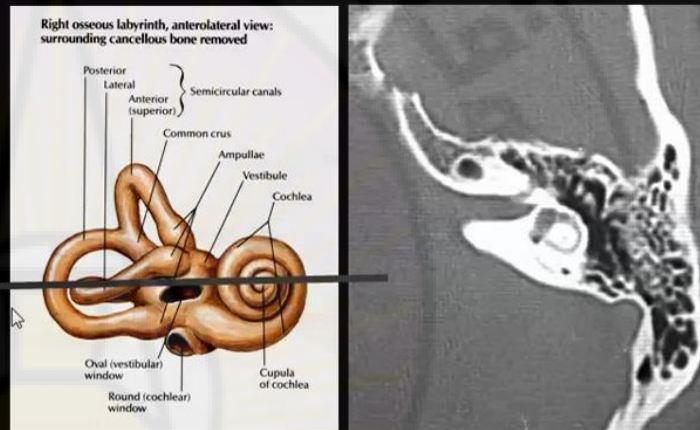


Inner ear structures

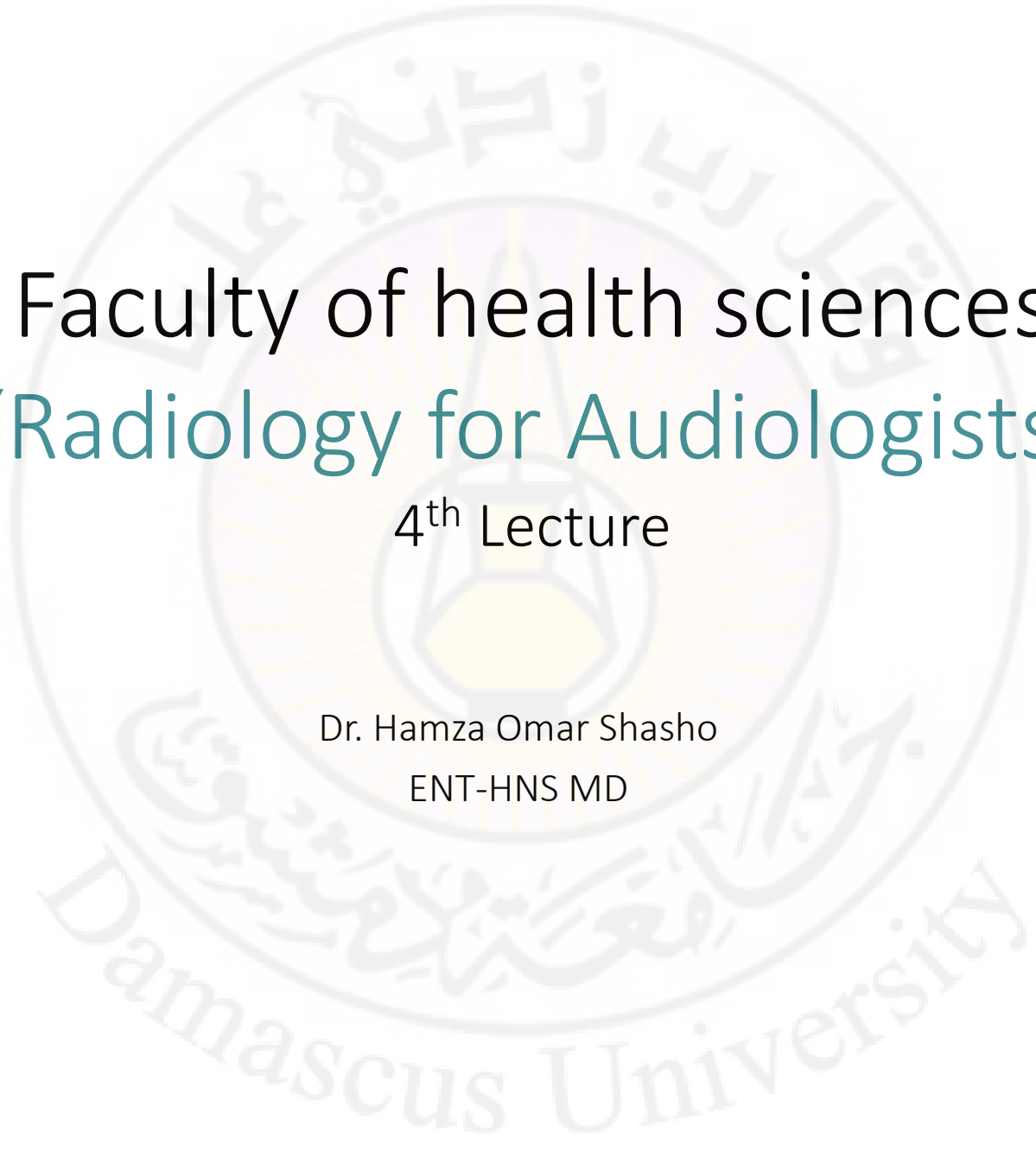
- ♦ Vestibule
- ♦ Semicircular canals
- ♦ Cochlea
- ♦ Internal auditory canal
- ♦ Cochlear aqueduct
- ♦ Vestibular aqueduct



Inner ear anatomic landmark



Lateral semicircular canal

The background of the slide features a large, faint watermark of the Damascus University seal. The seal is circular, with the university's name in Arabic at the top and 'Damascus University' in English at the bottom. In the center is a shield with a sunburst and a sword.

Faculty of health sciences

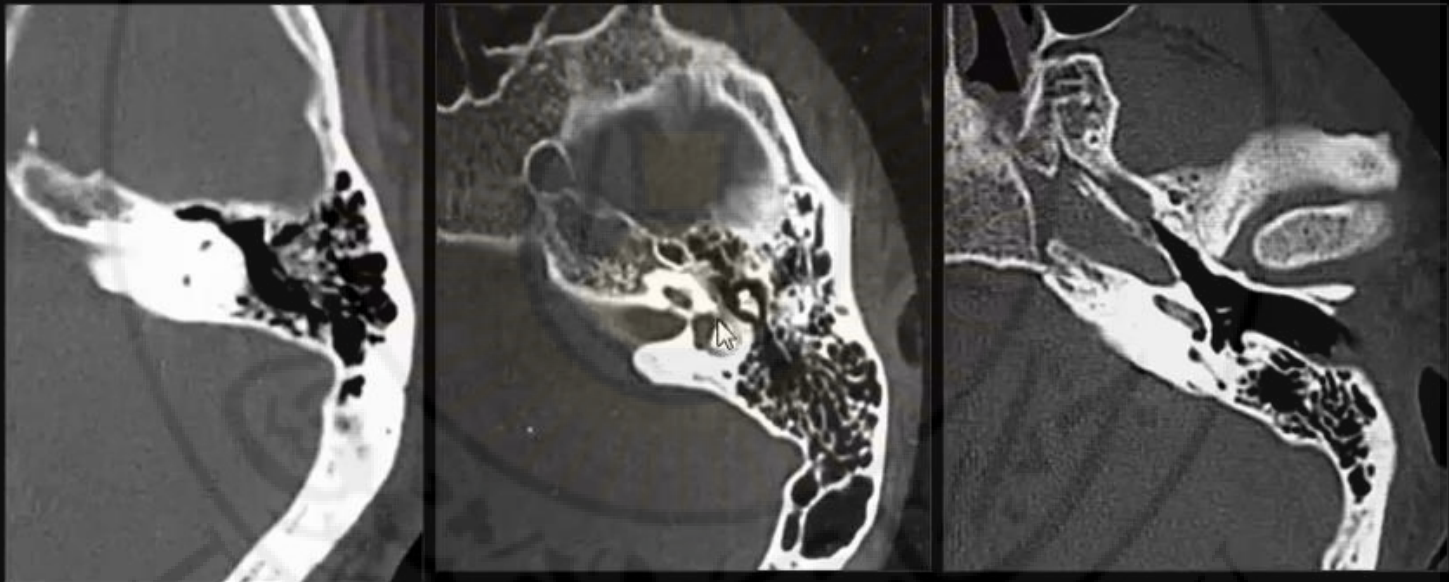
“Radiology for Audiologists”

4th Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

Middle ear

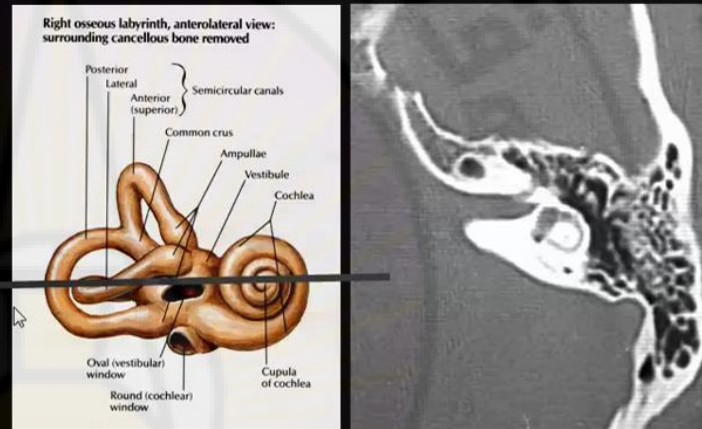


Inner ear structures

- ◆ Vestibule
- ◆ Semicircular canals
- ◆ Cochlea
- ◆ Internal auditory canal
- ◆ Cochlear aqueduct
- ◆ Vestibular aqueduct

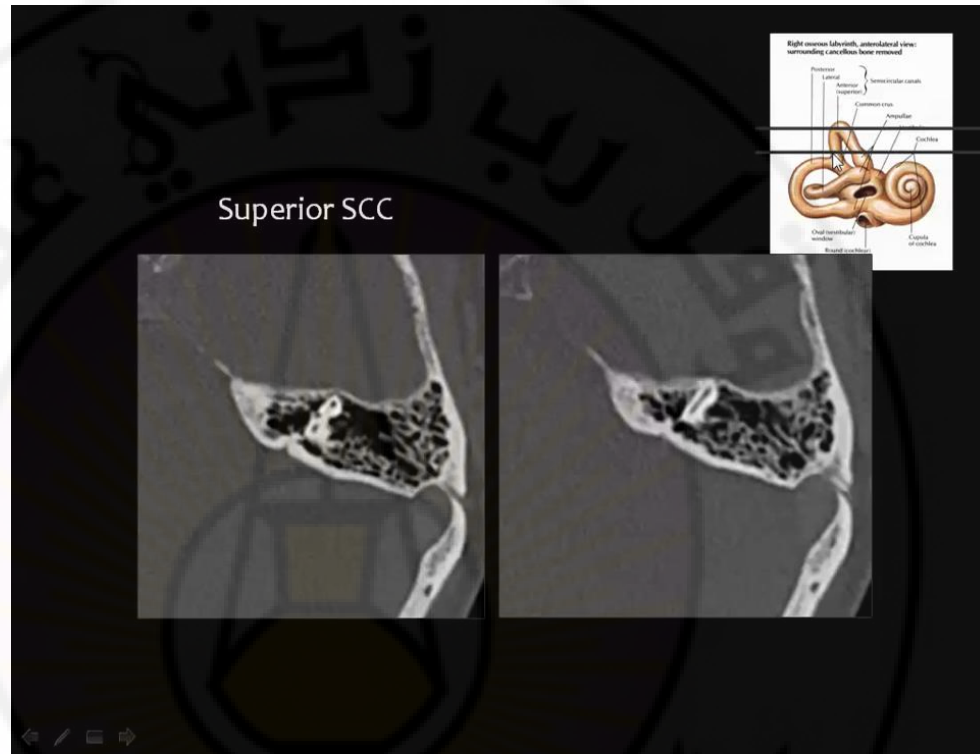


Inner ear anatomic landmark



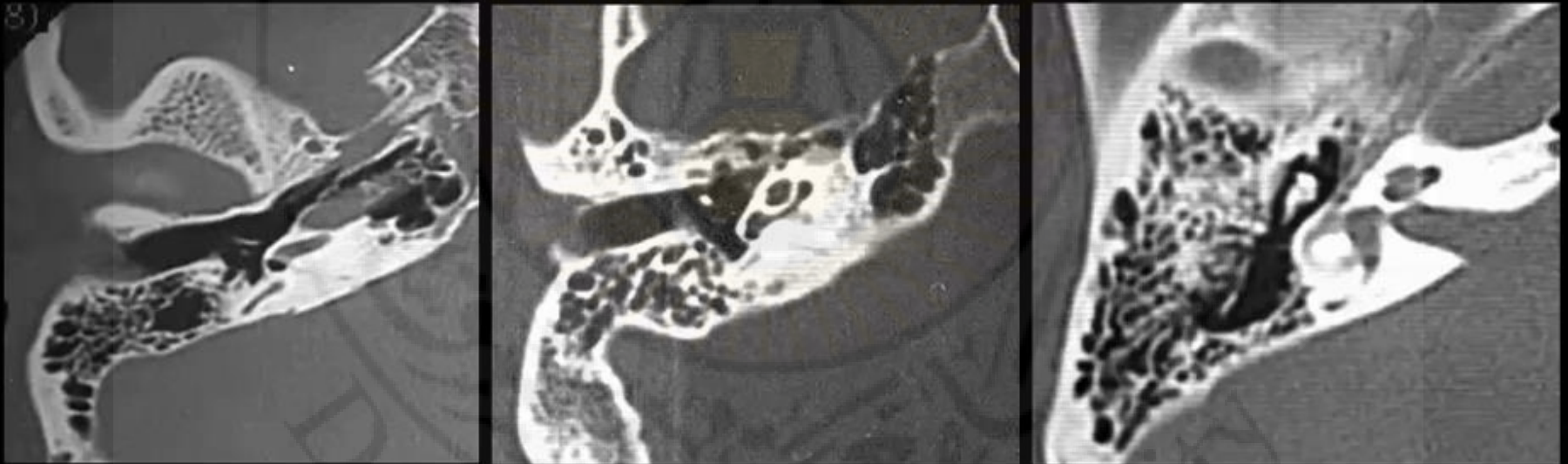
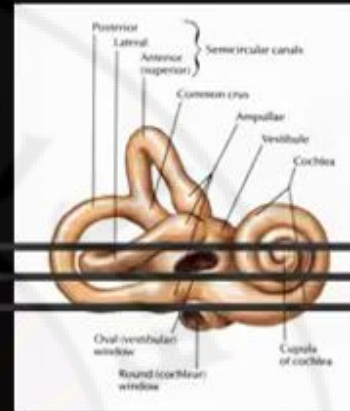
Lateral semicircular canal

- Lateral SemiCircular Canal : appears at the same slice of “Ice cream cone” sign.
- This slice crosses the anterior and posterior limbs of posterior Scc.
- Internal auditory meatus.

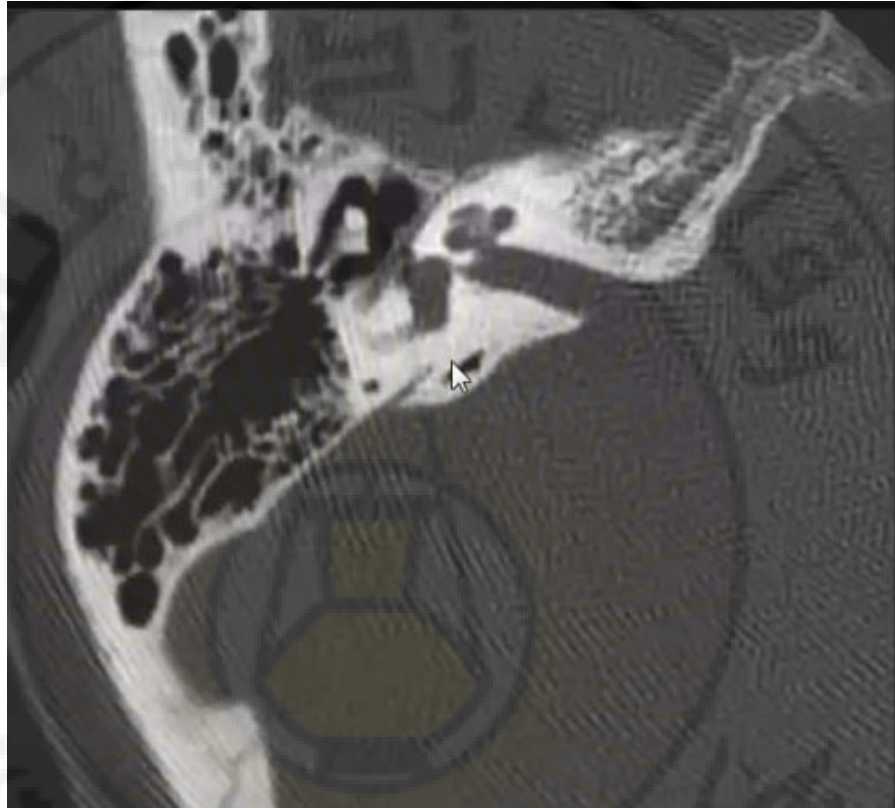


Upper slices of petrous bone reveals the superior(anterior) Semicircular canal .. The first canal to appear when going Downwards

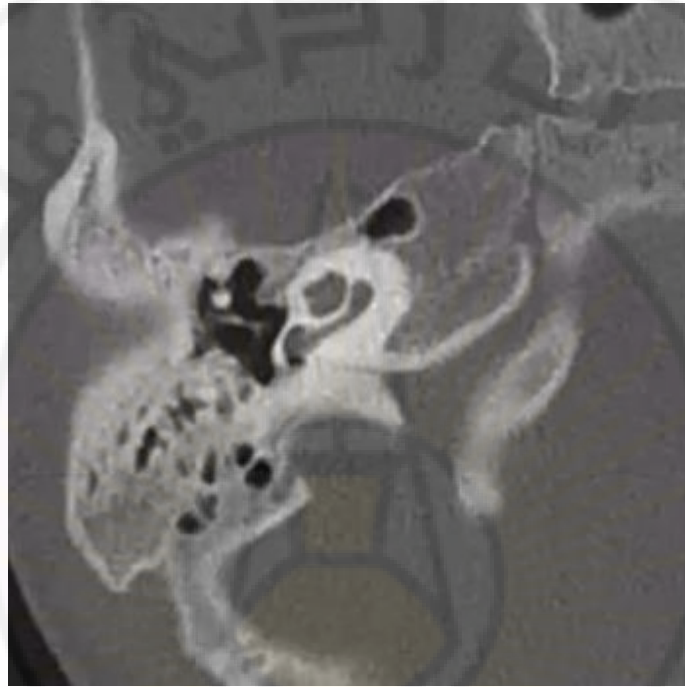
Cochlea



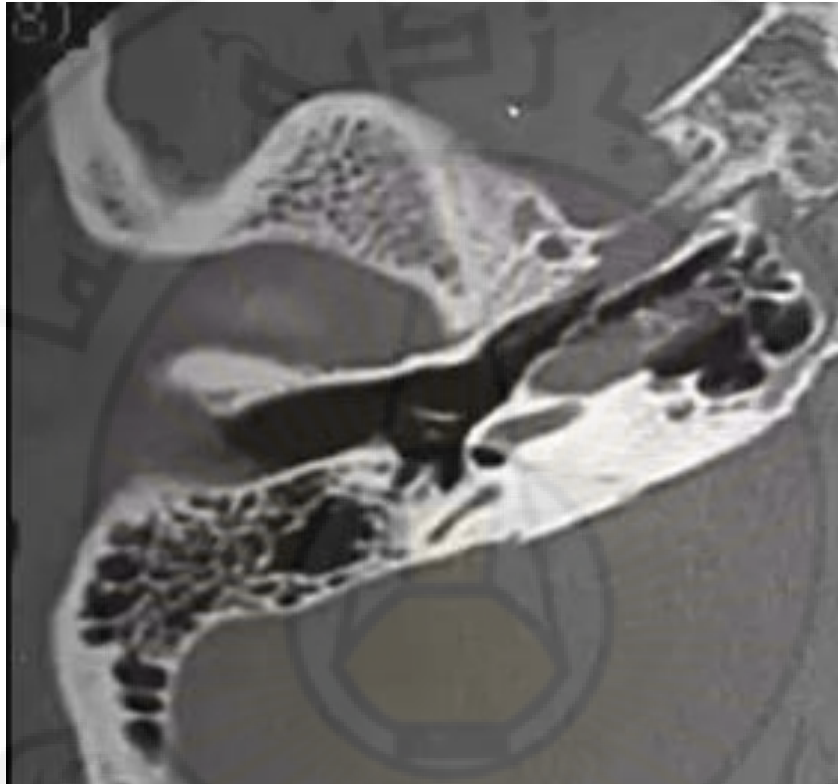
Damascus University



- The cochlea is located at a lower level relative to the vestibule And canals .
- At the level of the lateral semicircular canal the **dome** of cochlea might appear (hat sign) in addotion to the entry of cochlear nerve to the cochlea.

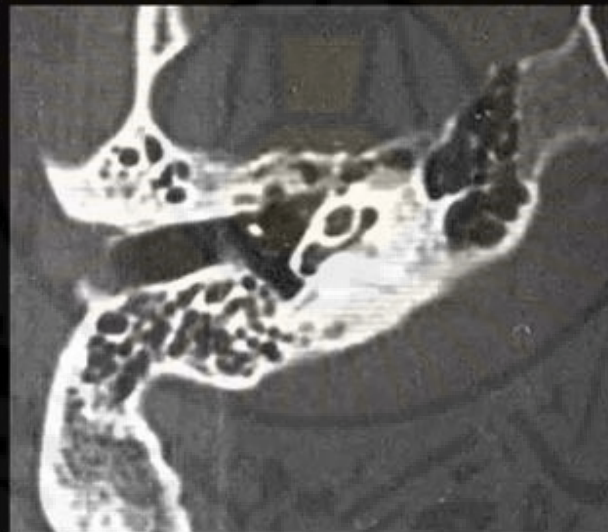
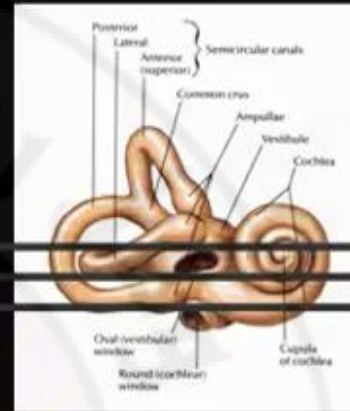


- Going further down : “dish and food” sign appears representing One and a half turn of cochlea.

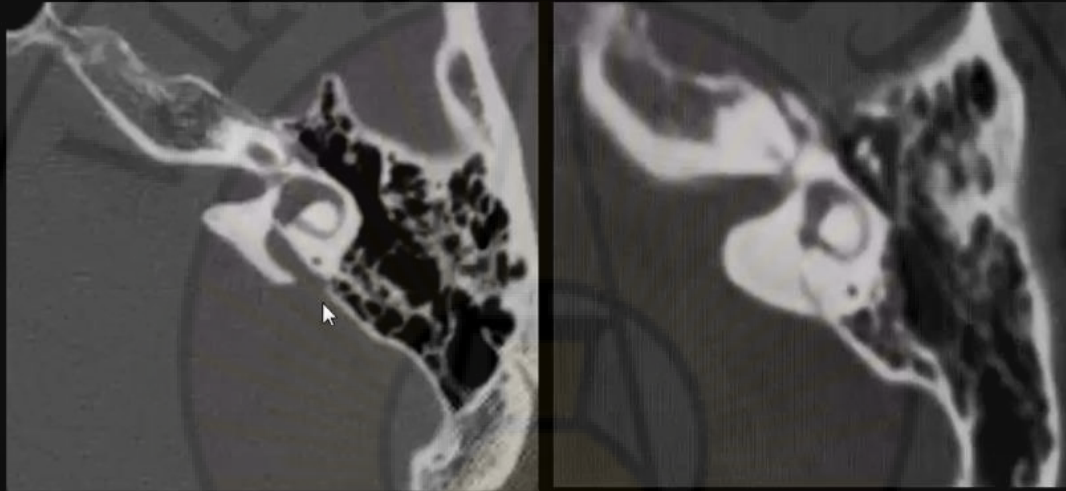


- Going further down : “worm or banana” sign appears representing the basal Turn of cochlea.
- Round window niche takes place at the posterior end of basal turn.
- Same slice as “sea lion”

Cochlea

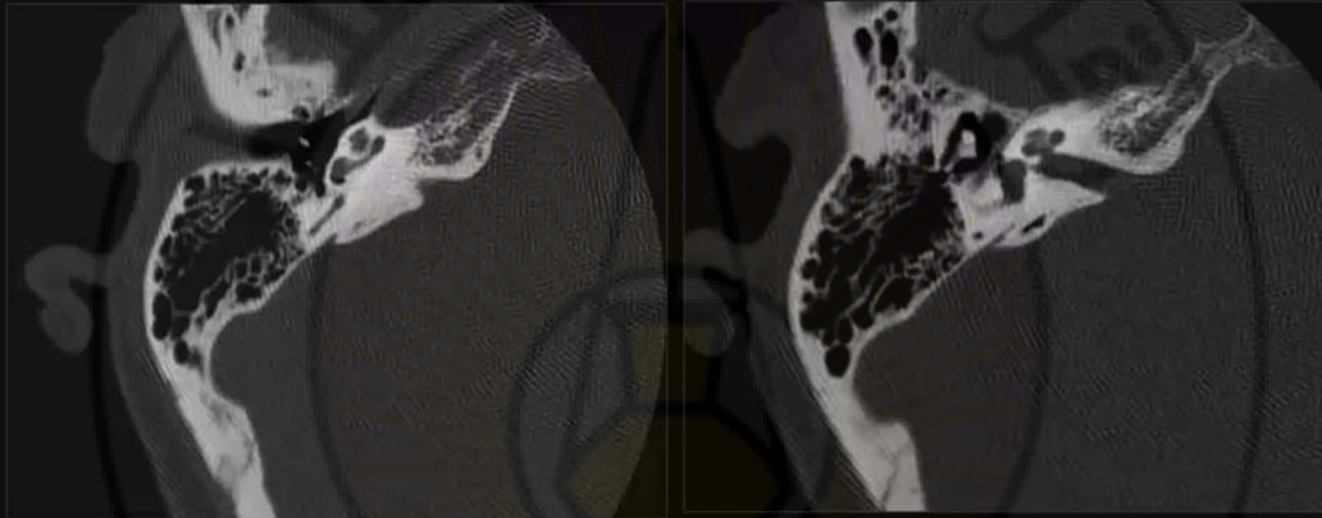


Vestibular aqueduct



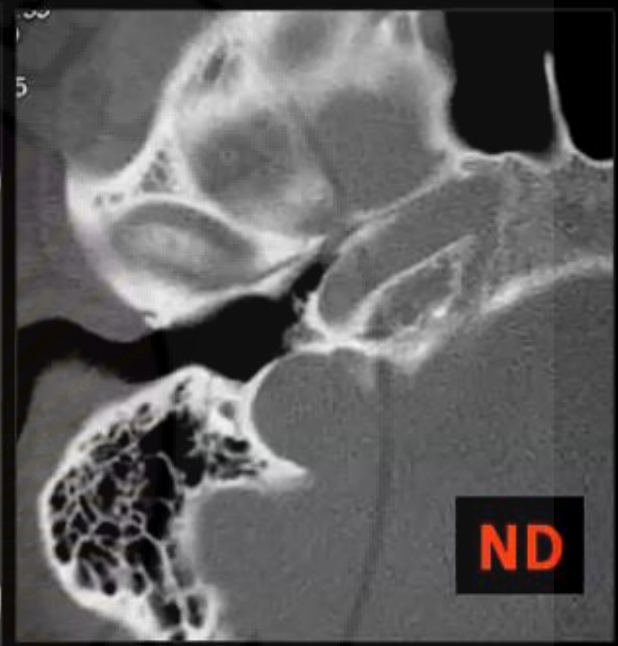
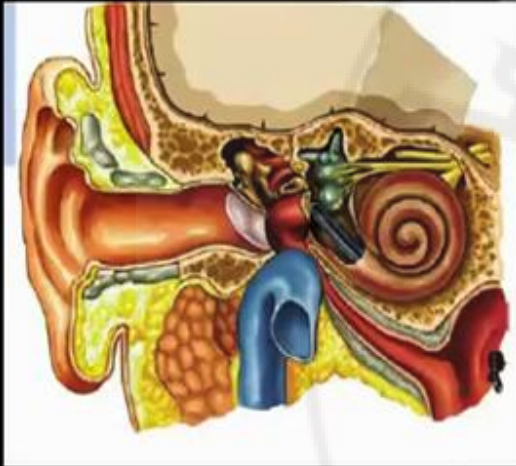
- Vestibular aqueduct takes place posterior to posterior semicircular canal
- Width of vestibular aqueduct is less than 1.5 mm (approximately equal to width of Post. scc)
- EVAS (enlarged vestibular aqueduct syndrome) : width of aqueduct exceeding 1.5 mm → SNHL + vestibular Sx

Cochlear aqueduct



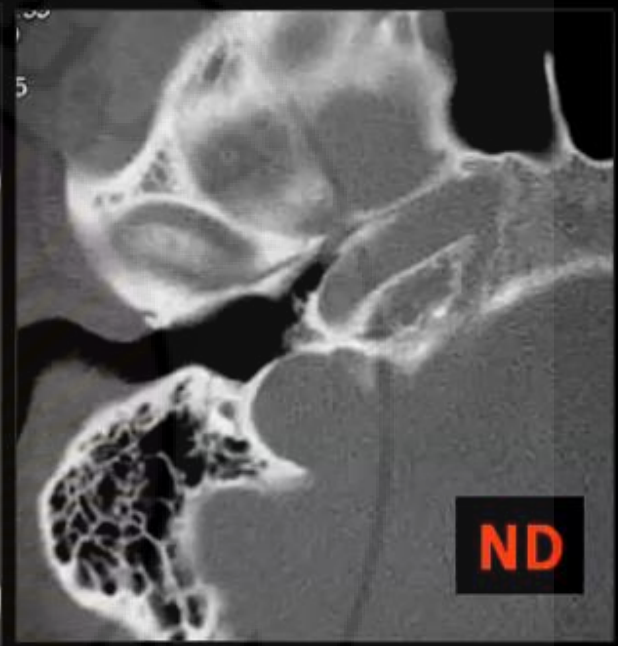
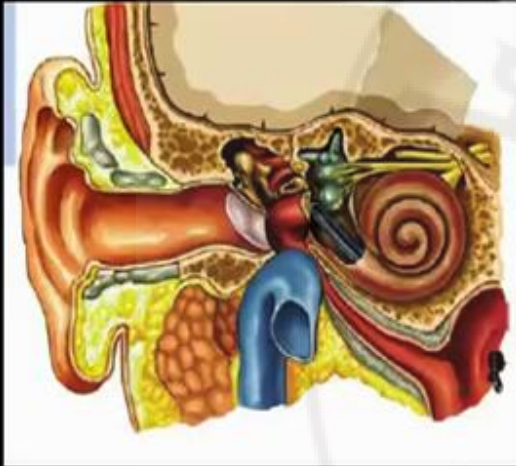
- Cochlear aqueduct : appears at a slice below the internal auditory meatus.

Jugular bulb



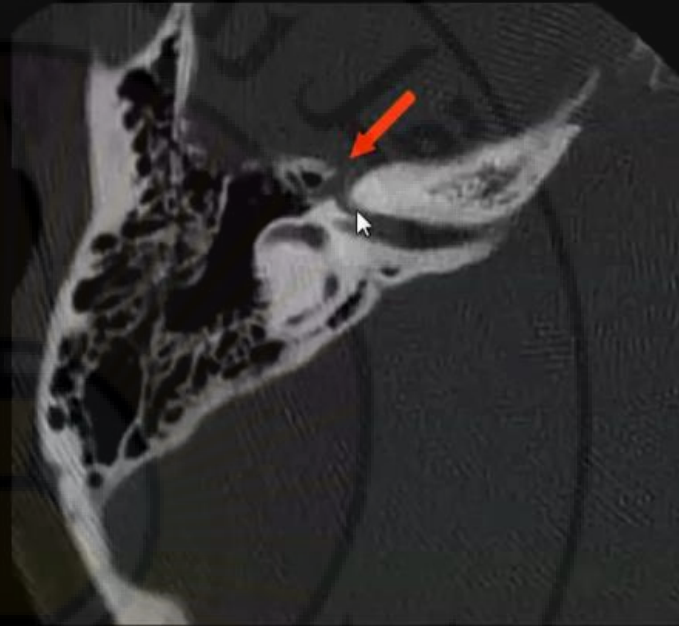
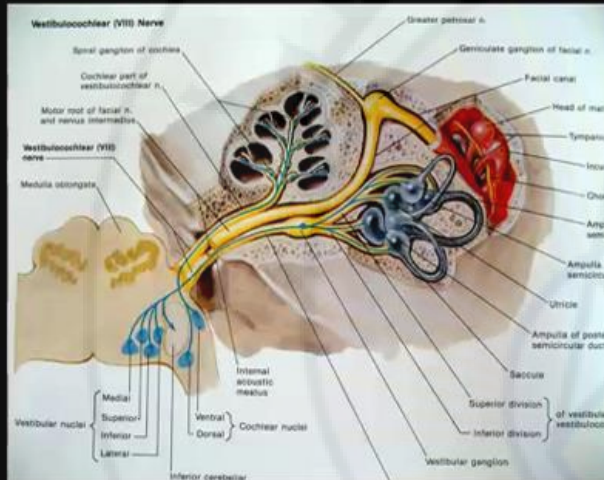
- Lies below the floor of tympanic cavity .
- Might be high-riding and/or dehiscent → pulsatile tinnitus.

Jugular bulb



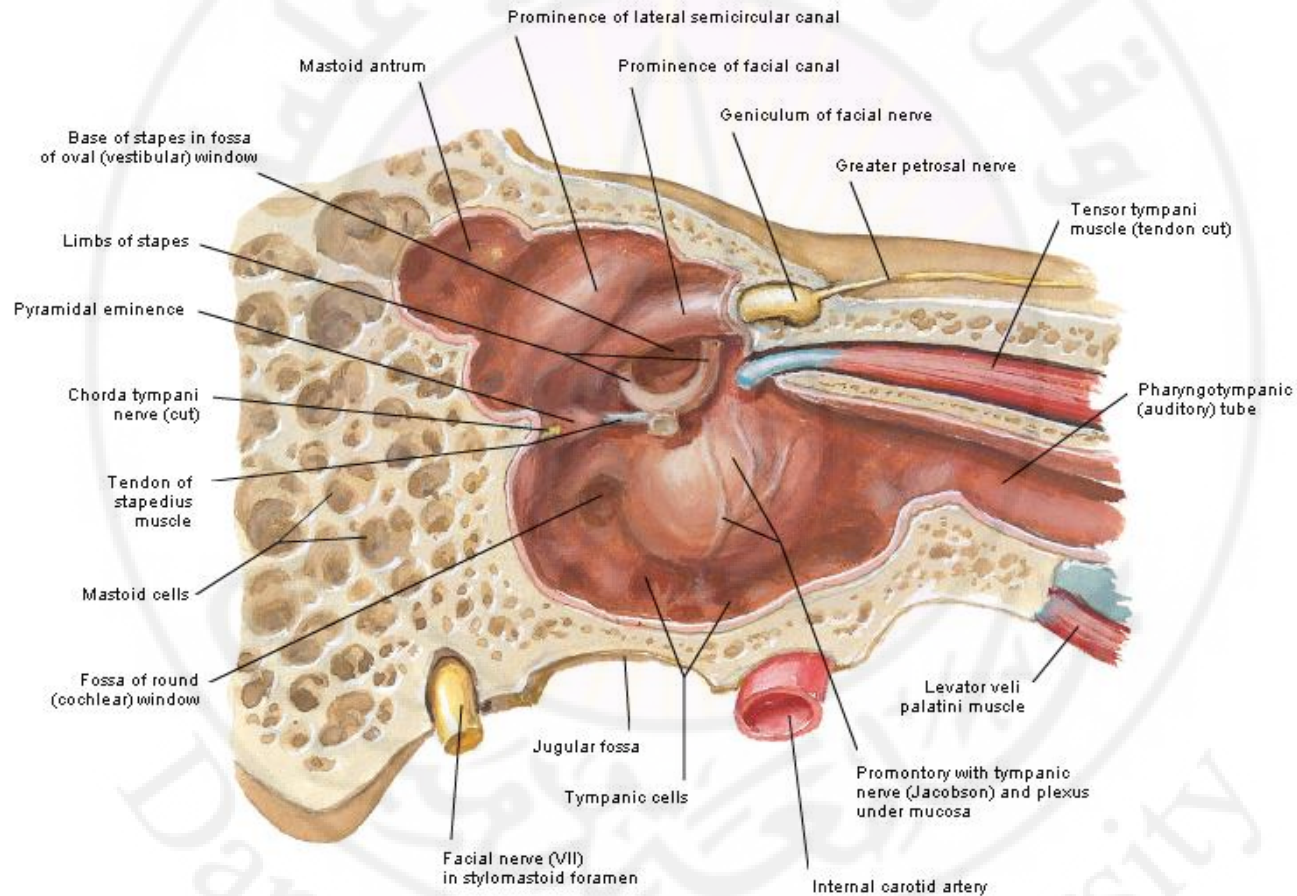
- Lies below the floor of tympanic cavity .
- Might be high-riding and/or dehiscent → pulsatile tinnitus.

Facial nerve anatomy



Facial nerve originates in the cerebello-pontine angle then enters the internal auditory meatus along with the cochlea-vestibular nerve then it forms a “genu” that contains neuronal bodies (the geniculate ganglion) then it crosses the medial wall of tympanic cavity below the lateral semicircular canal and above the oval window.

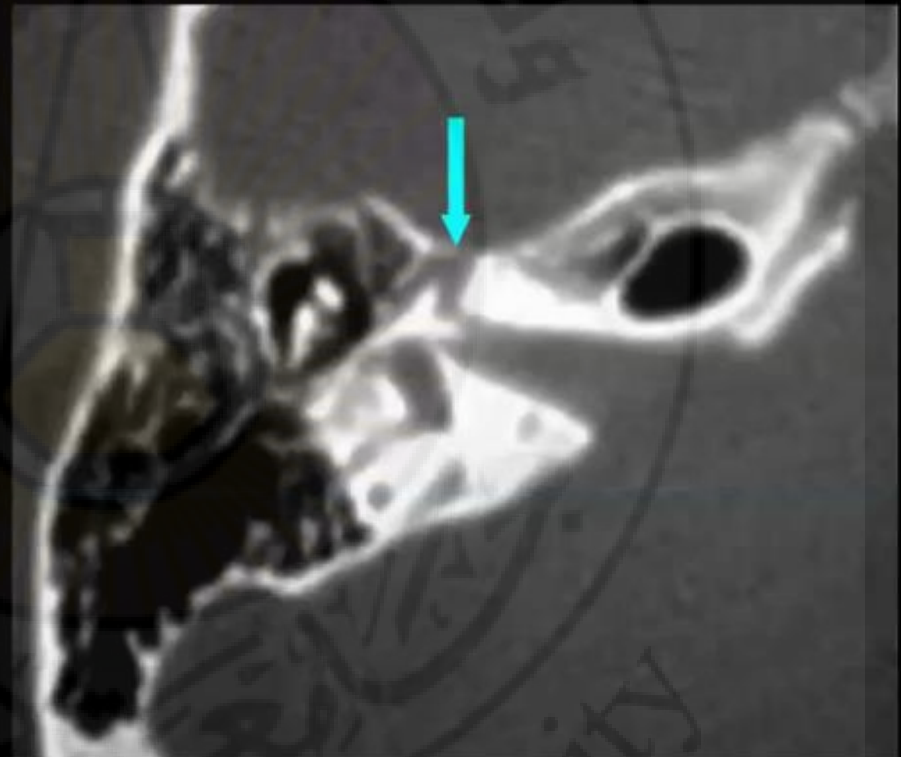
Tympanic Cavity - Medial Wall Lateral View



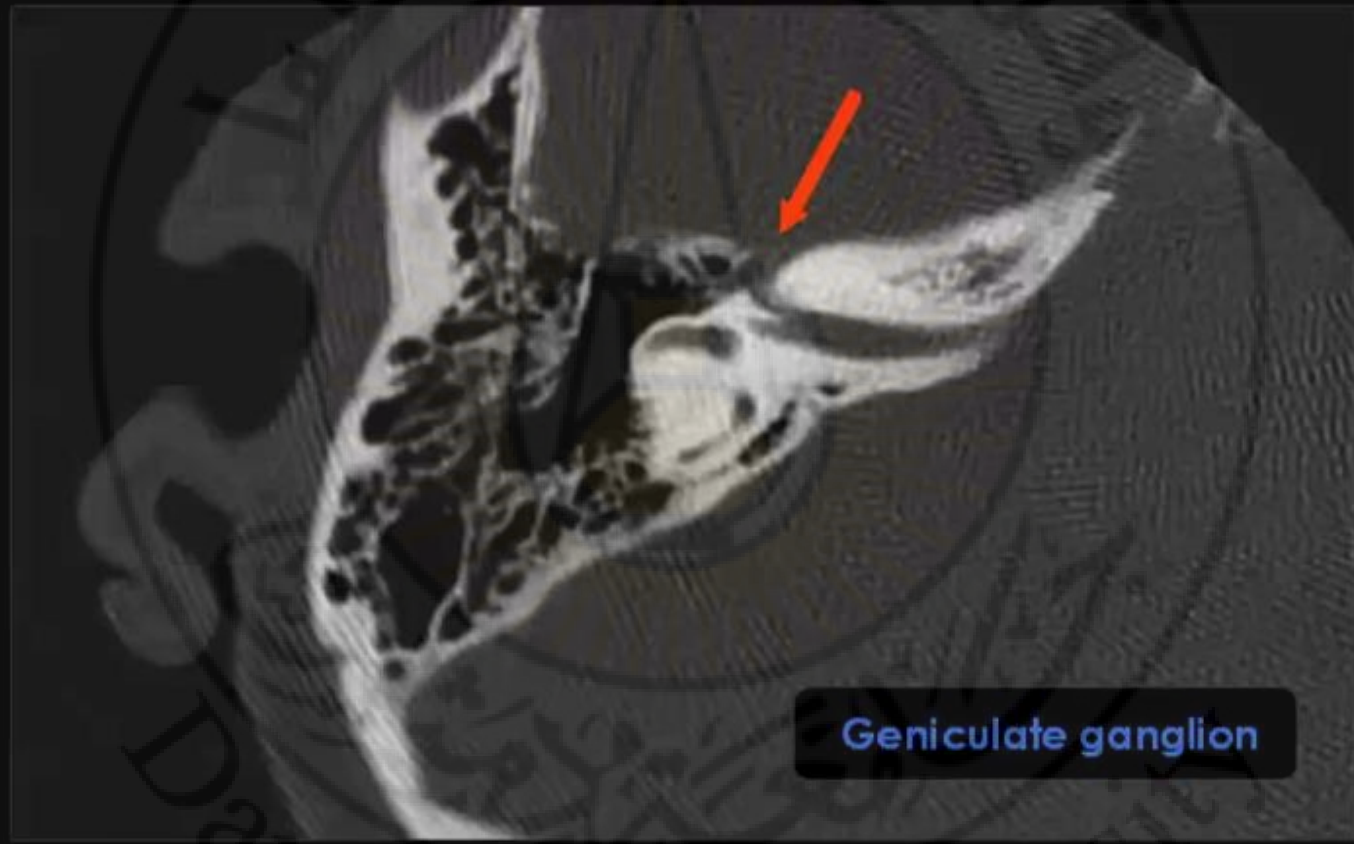
Facial nerve crossing the medial wall of tympanic cavity below the lateral semicircular canal and above the oval window.

Facial nerve anatomy

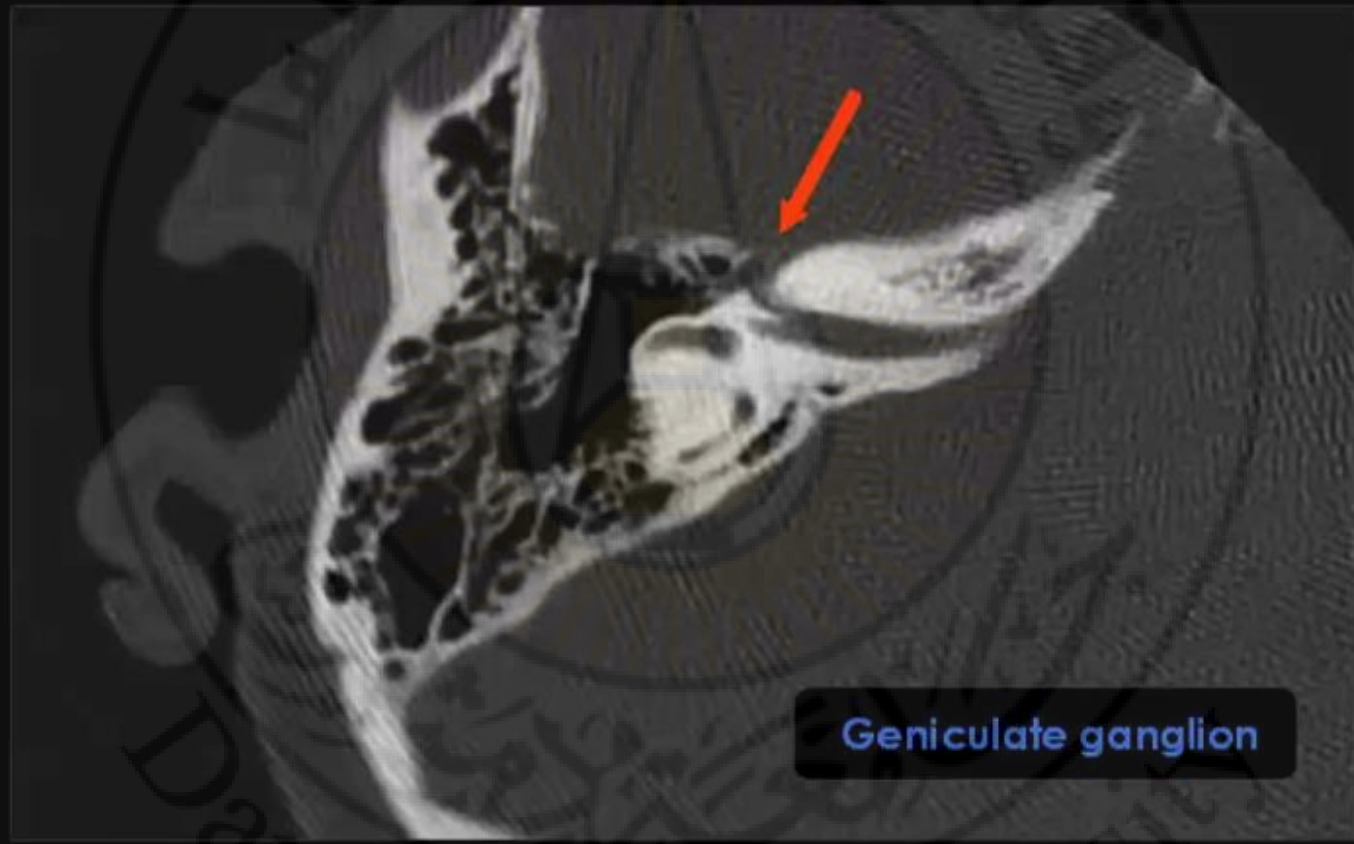
- ◆ Middle ear cavity
- ◆ Mastoid
- ◆ Lateral SCC
- ◆ Posterior SCC
- ◆ Dome of cochlea
- ◆ IAC
- ◆ Facial nerve
- ◆ **Geniculate ganglion**



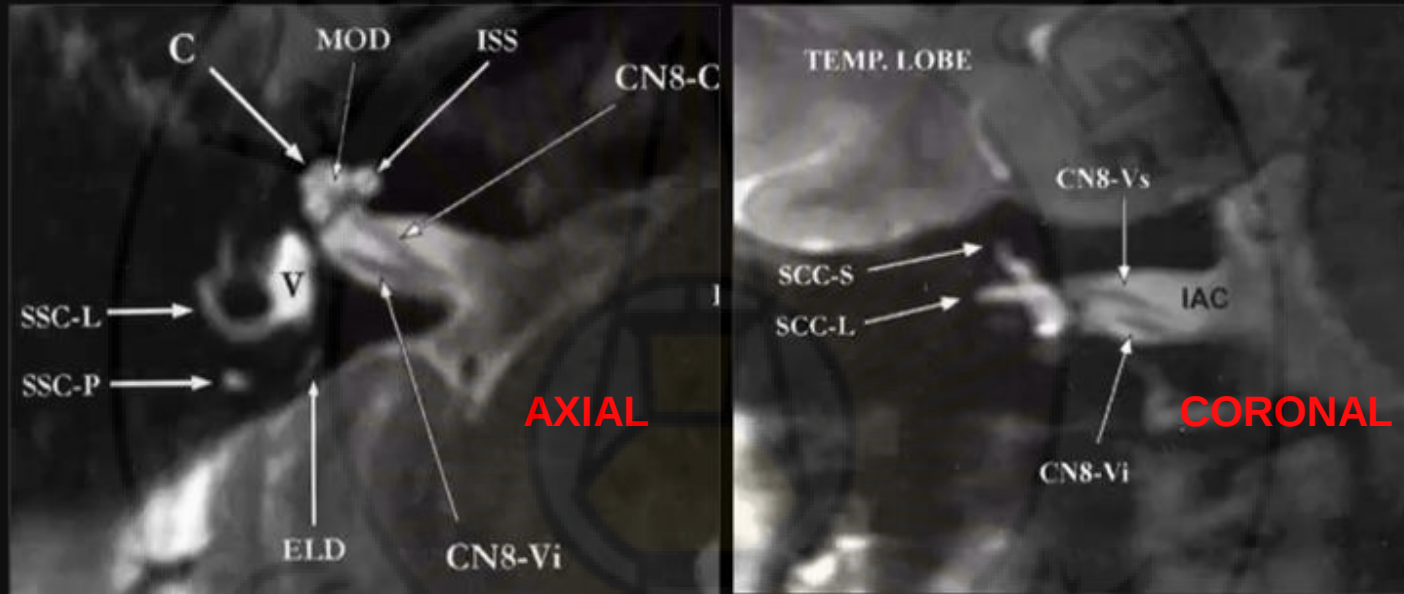
Facial nerve anatomy



Facial nerve anatomy



Nerves inside the IAC

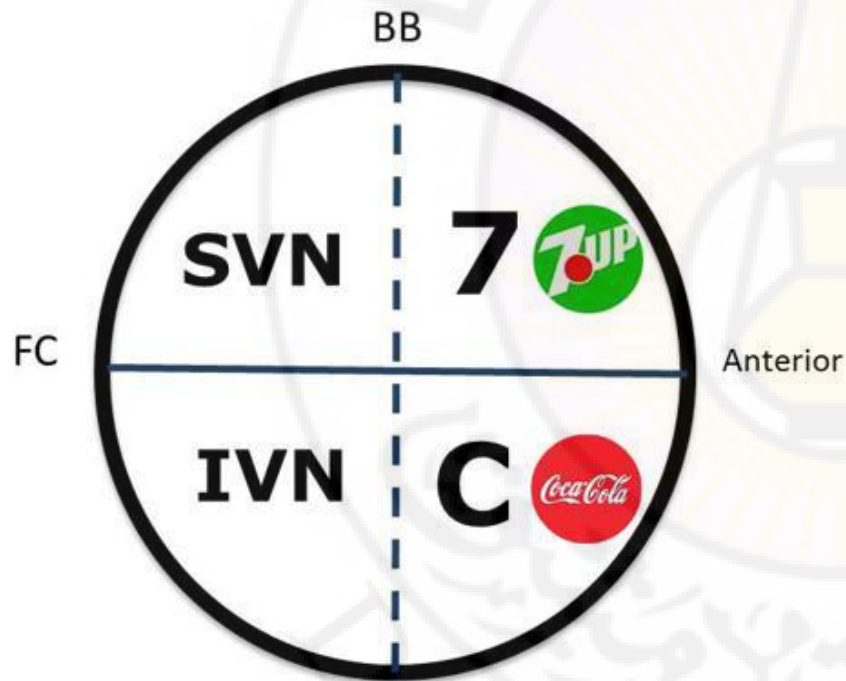


Nerves inside internal auditory meatus (best seen on T2 sequence) :

- Facial nerve
- Cochlear nerve
- Vestibular nerve (superior division)
- Vestibular nerve (inferior division)

Internal Auditory Canal Anatomy

7up, coke down - Mnemonic



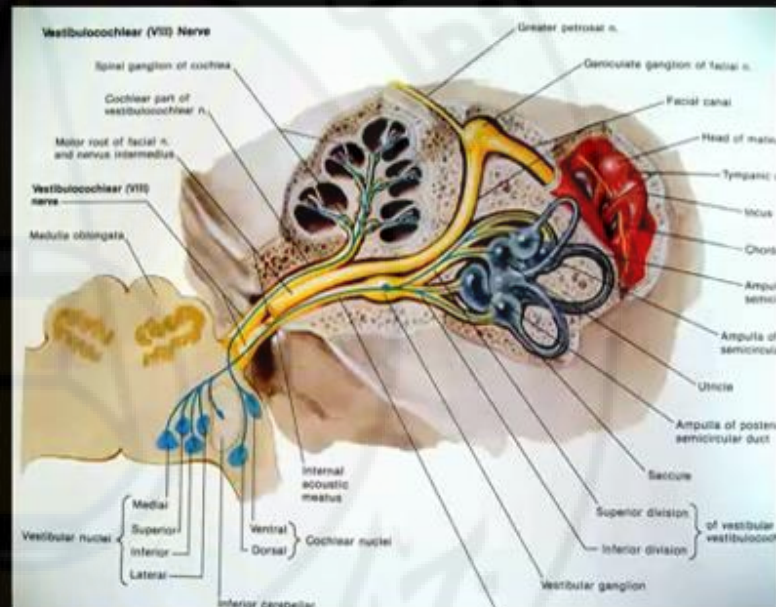
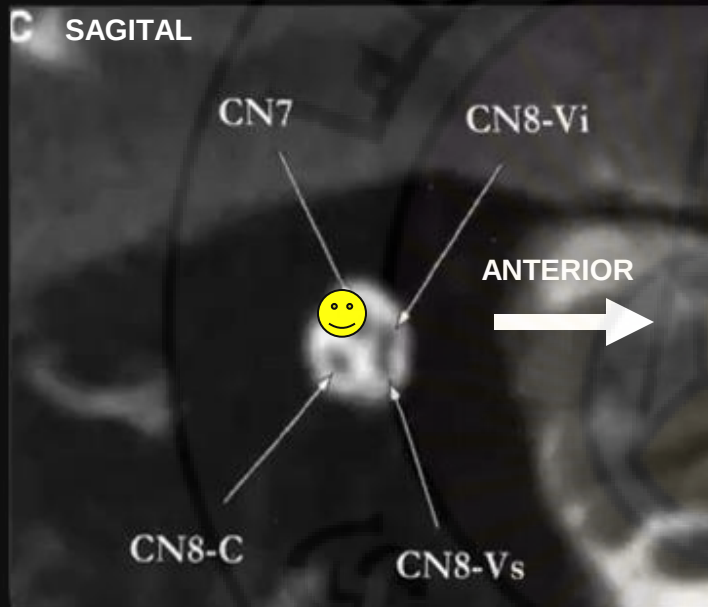
7up, coke down

is a mnemonic to remember the relative position of nerves inside the internal auditory canal (IAC).

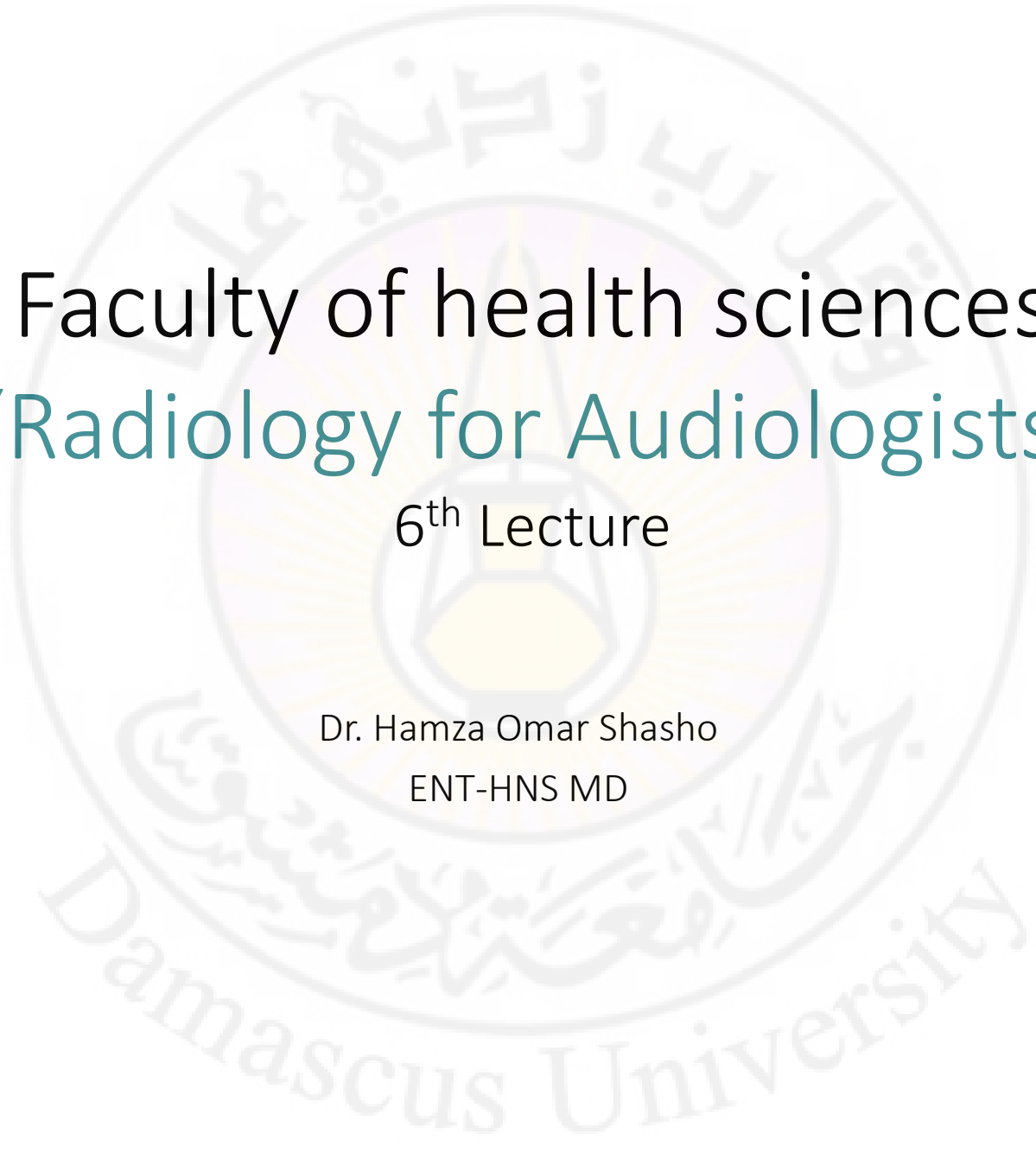
- BB : *Bill's bar*
- FC : *Falciform crest*
- SVN : *Superior vestibular nerve*
- IVN : *Inferior vestibular nerve*
- 7 : *Facial (VII) nerve*
- C : *Cochlear nerve*

Nerves inside the IAC

C SAGITAL



Distinguishing one from another requires **sagittal** section **T2** images.

The background of the slide features a large, faint watermark of the Damascus University seal. The seal is circular, with the university's name in Arabic at the top and 'Damascus University' in English at the bottom. In the center is a shield with a yellow base and a purple upper section, topped by a sword and surrounded by a sunburst.

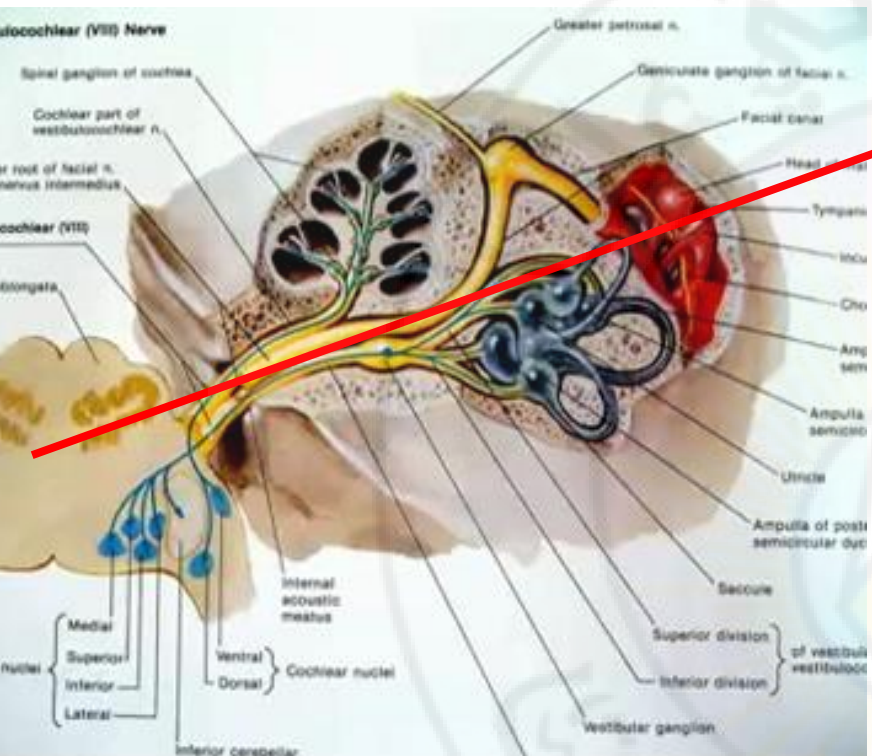
Faculty of health sciences

“Radiology for Audiologists”

6th Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD



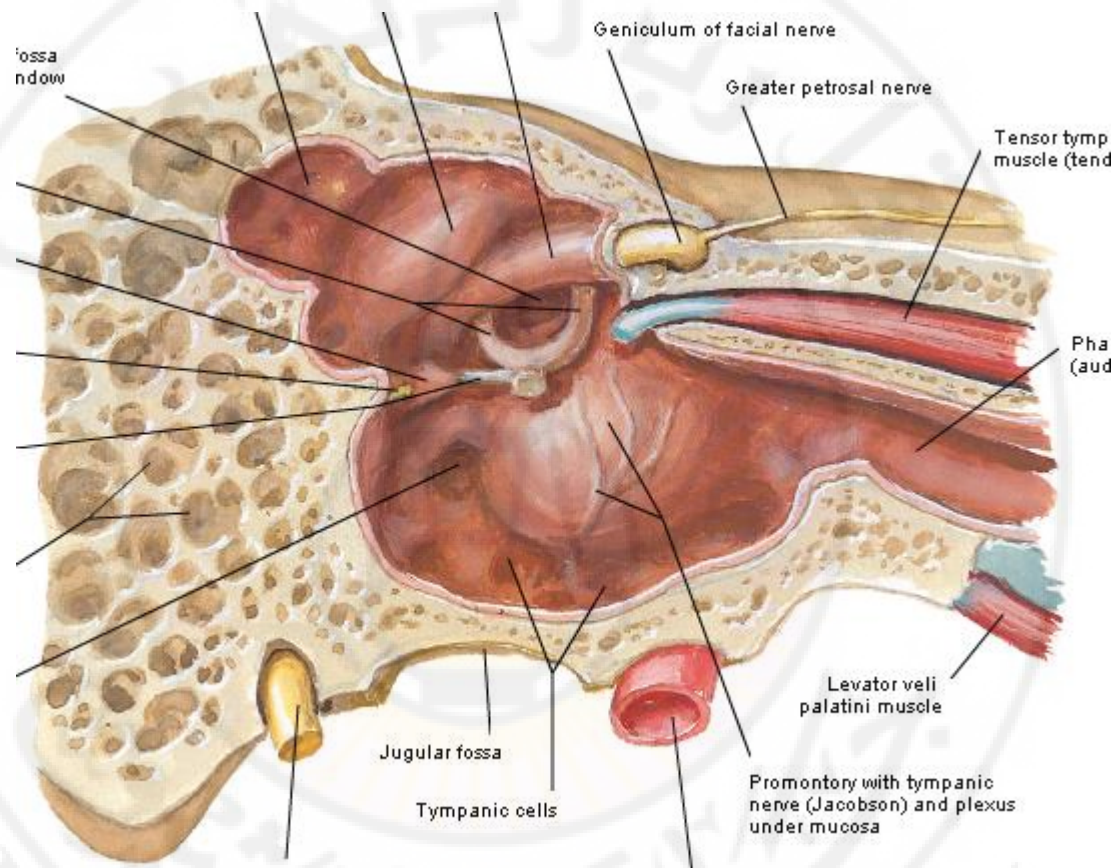
Coronal images

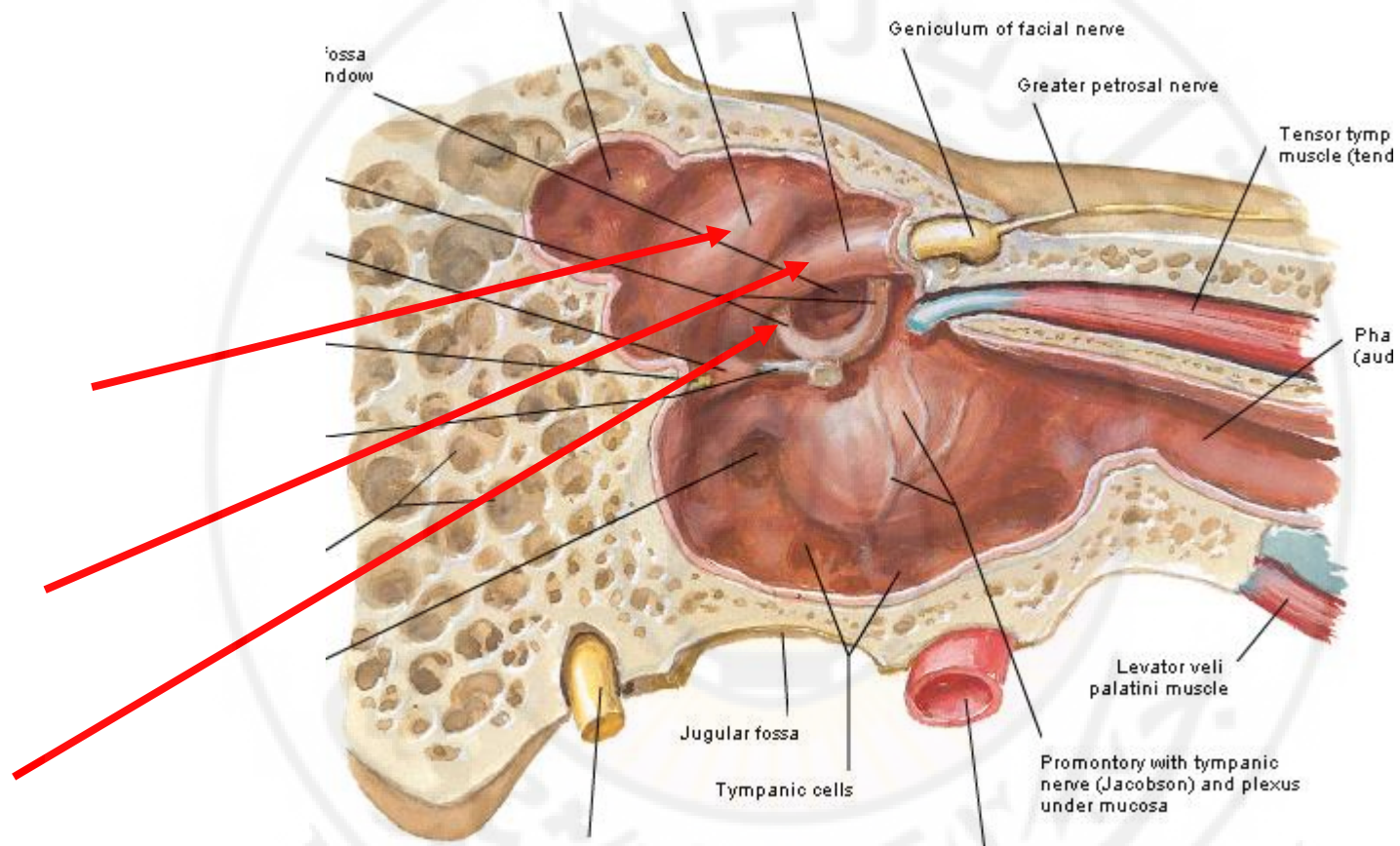
- ◆ Tegmen tympani
- ◆ Oval window
- ◆ Facial nerve



Coronal view :

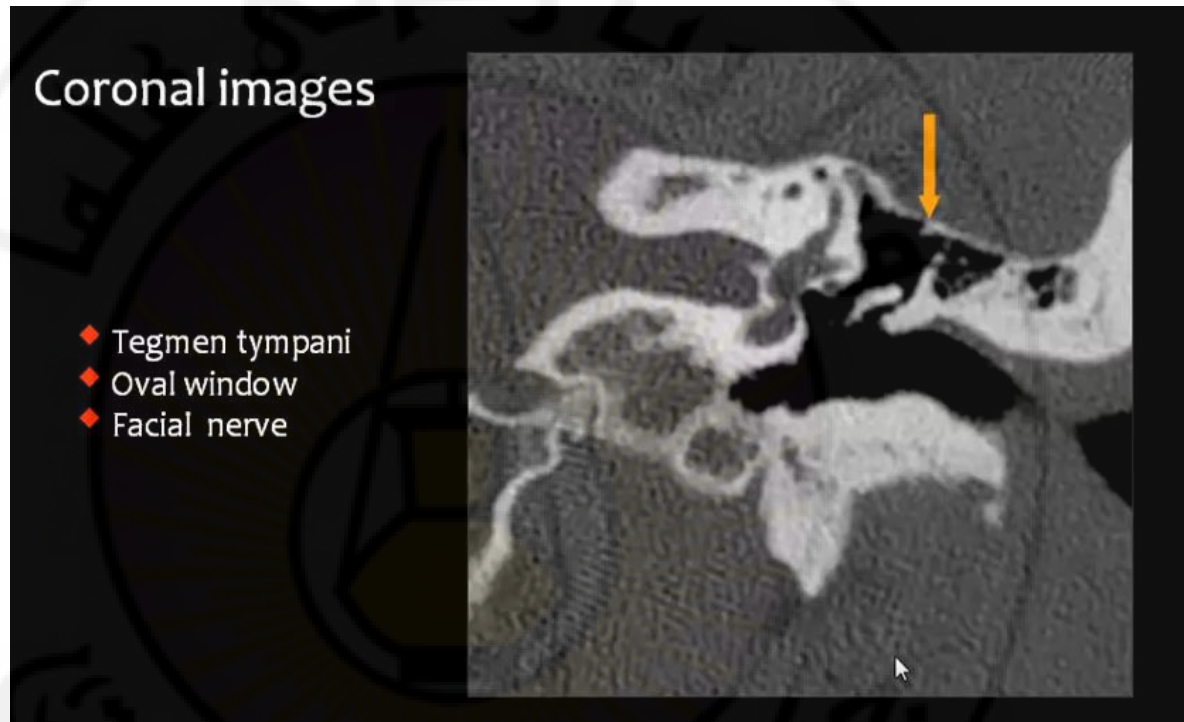
- Tegmen tympani : separating tympanic cavity from intracranium
- Tympanic segment of facial nerve : crossing below the lateral semicircular canal
- Oval window : attached to stepes below tympanic segment of facial nerve





up to down :

Lateral semi circular canal → tympanic segment of facial nerve → oval window

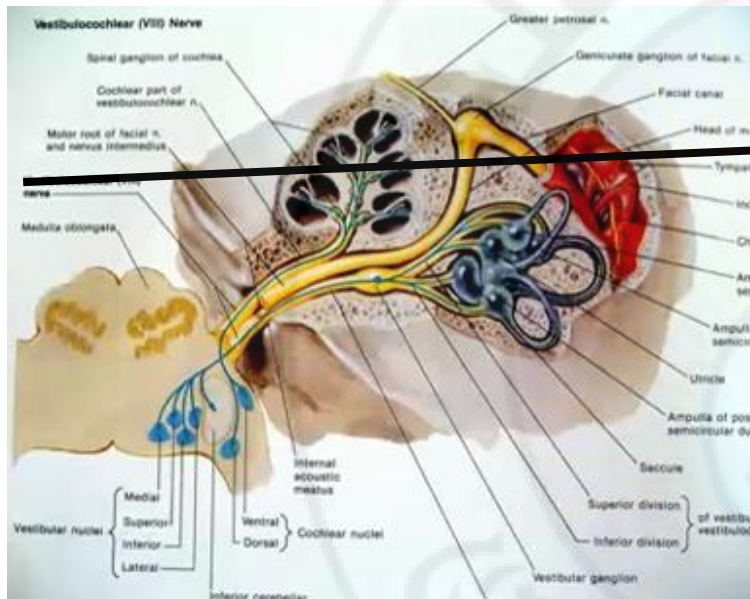


Facial nerve dehiscence:

most common in tympanic segment making the nerve susceptible to injury.

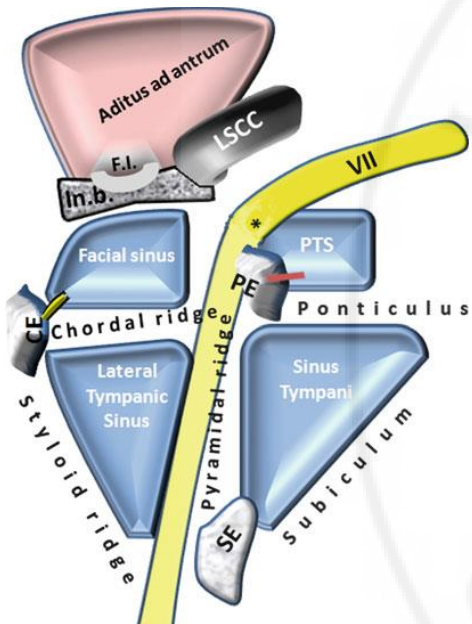
Ex: 1)facial nerve palsy following otitis media

2)iatrogenic injury during middle ear surgery



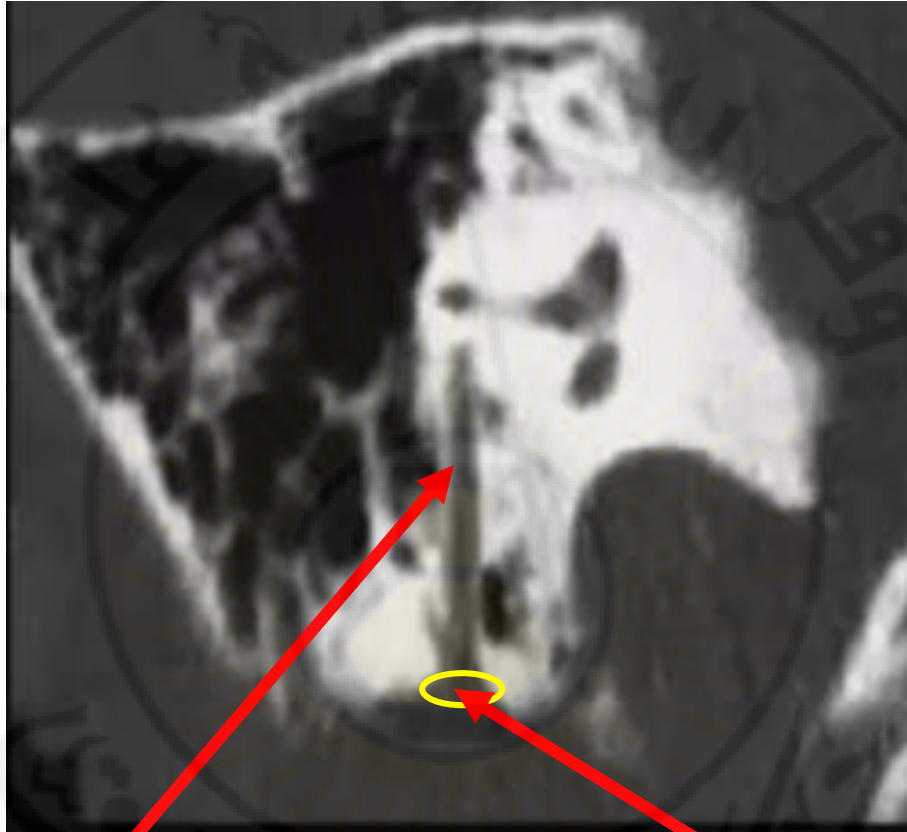
Coronal view:

A slice just behind the geniculate ganglion crossing both the labyrinthine segment
And tympanic segment (“**snail eyes**” sign)



Coronal view:

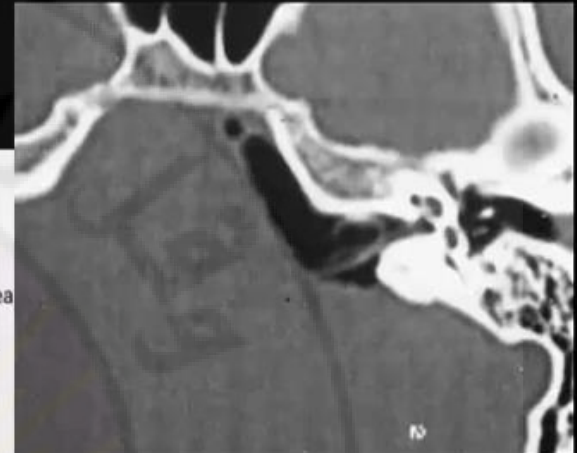
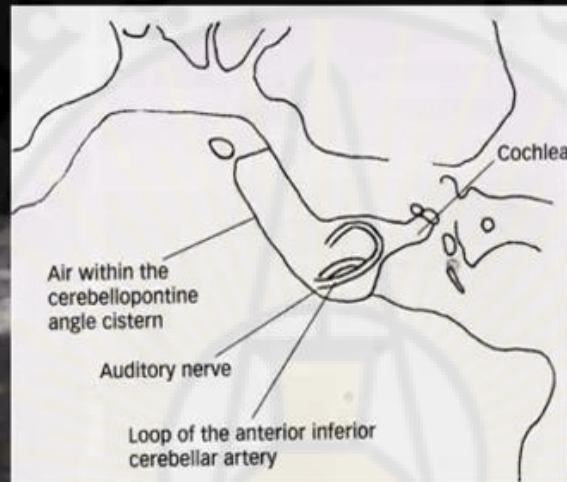
Mastoid segment of facial nerve exiting the skull through stylomastoid foramen



Coronal view:

Mastoid segment of facial nerve exiting the skull through stylomastoid foramen

Vessels at the CP angle



vascular coil originating from the anterior inferior cerebellar artery (AICA) can be seen indenting the cranial nerves entering the right internal auditory canal.

Pressure of the loop against nerves of internal auditory meatus leads to audiovestibular symptoms (vestibular paroxysma) and/or facial spasm.

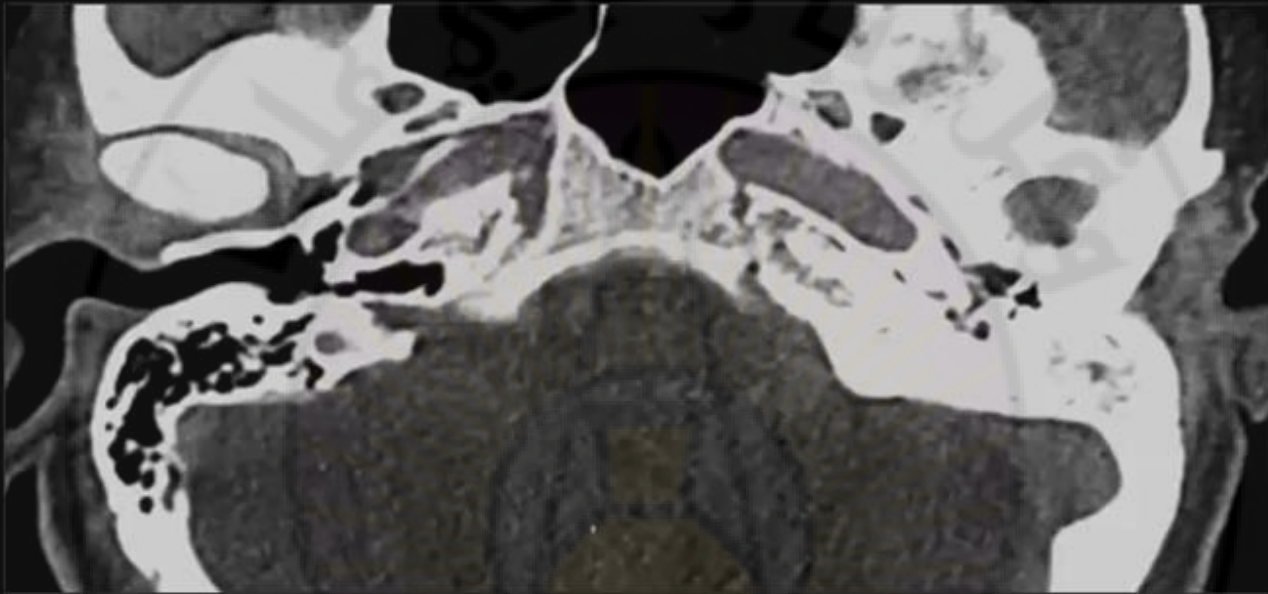
External ear atresia

- ♦ Abnormal embryogenesis of the 1st & 2nd branchial arches
- ♦ The canal is obstructed by bone or soft tissue
- ♦ CT to assess associated middle ear anomalies



Soft tissue filling the external canal with fused malleus and incus

- Atresia might be : soft tissue atresia or bony atresia
- Might be accompanied with middle ear and facial nerve anomalies.
- Usually inner ear normal
- Otoscopy is impossible so radiology is the only reliable way to assess The ear.



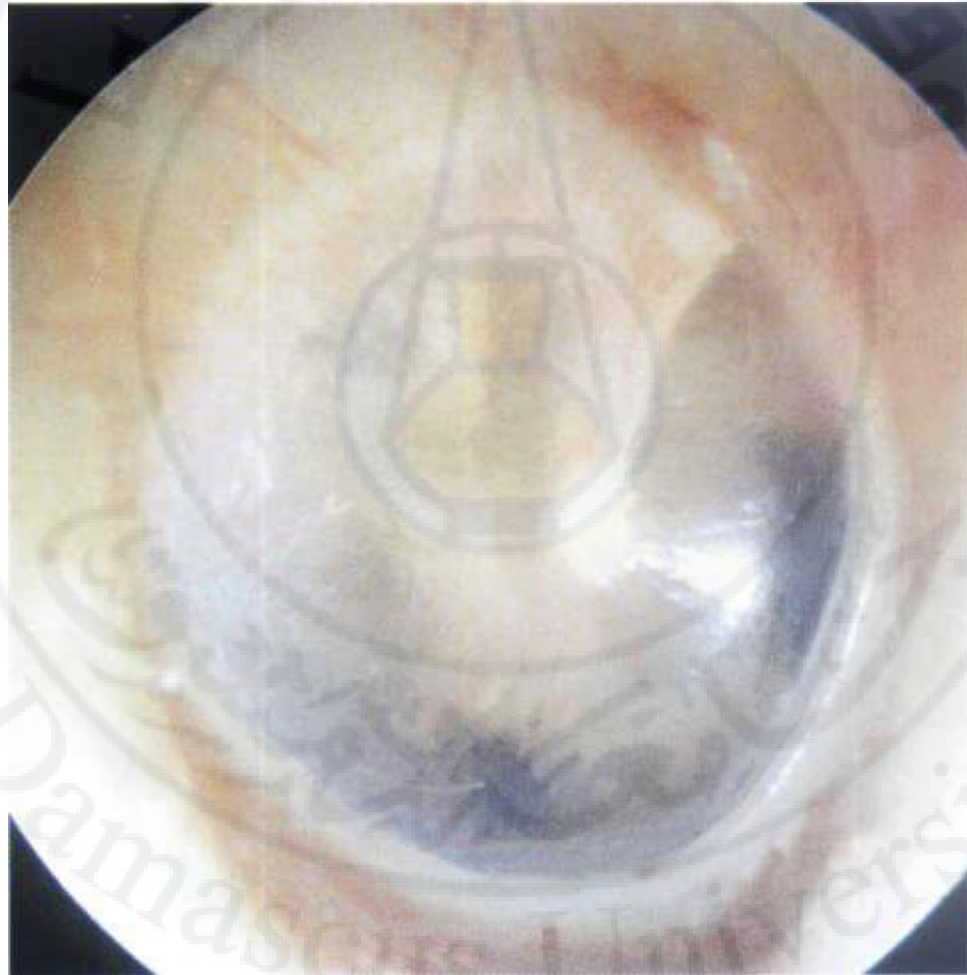
Bony atresia of the left external auditory canal

External auditory canal atresia

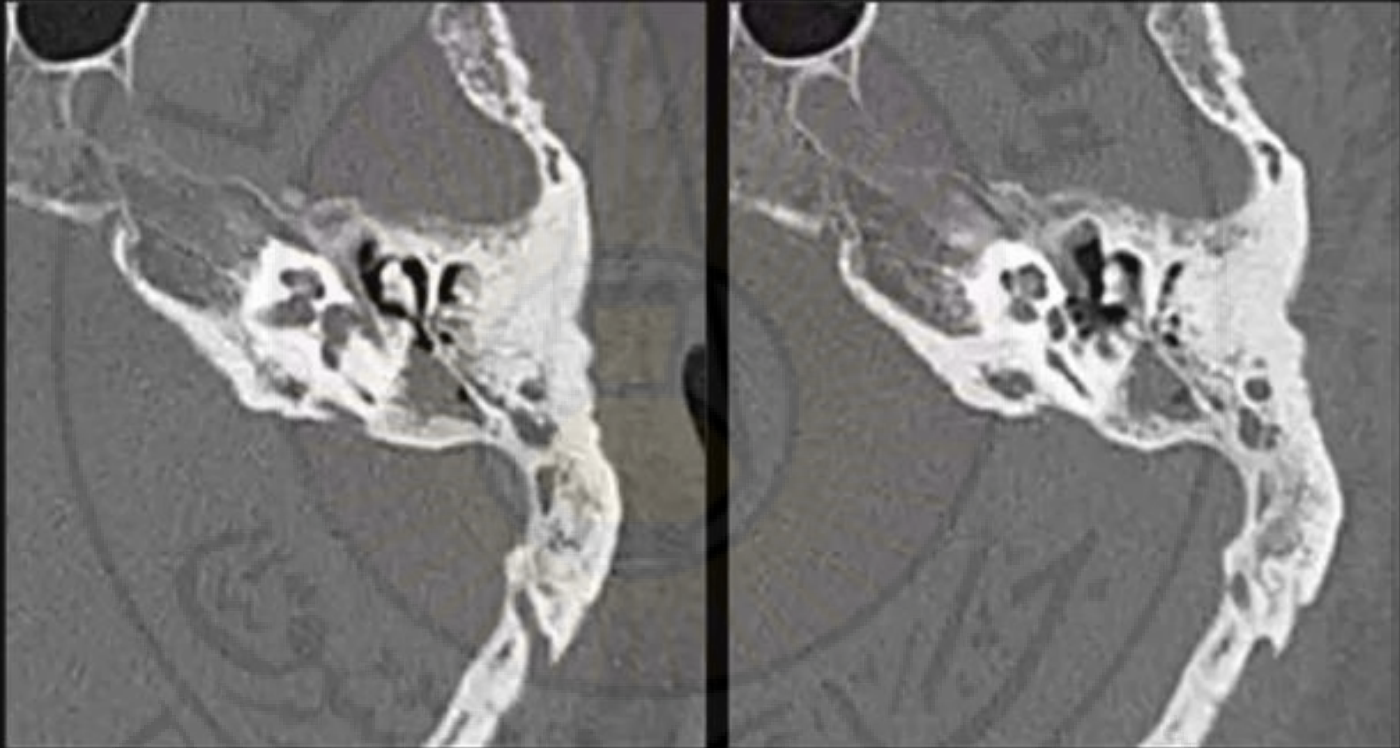


Left ear bony atresia .. Ossicles fused together .. Fused ossicles to middle ear walls ..

Normal tympanic membrane



Middle ear infection



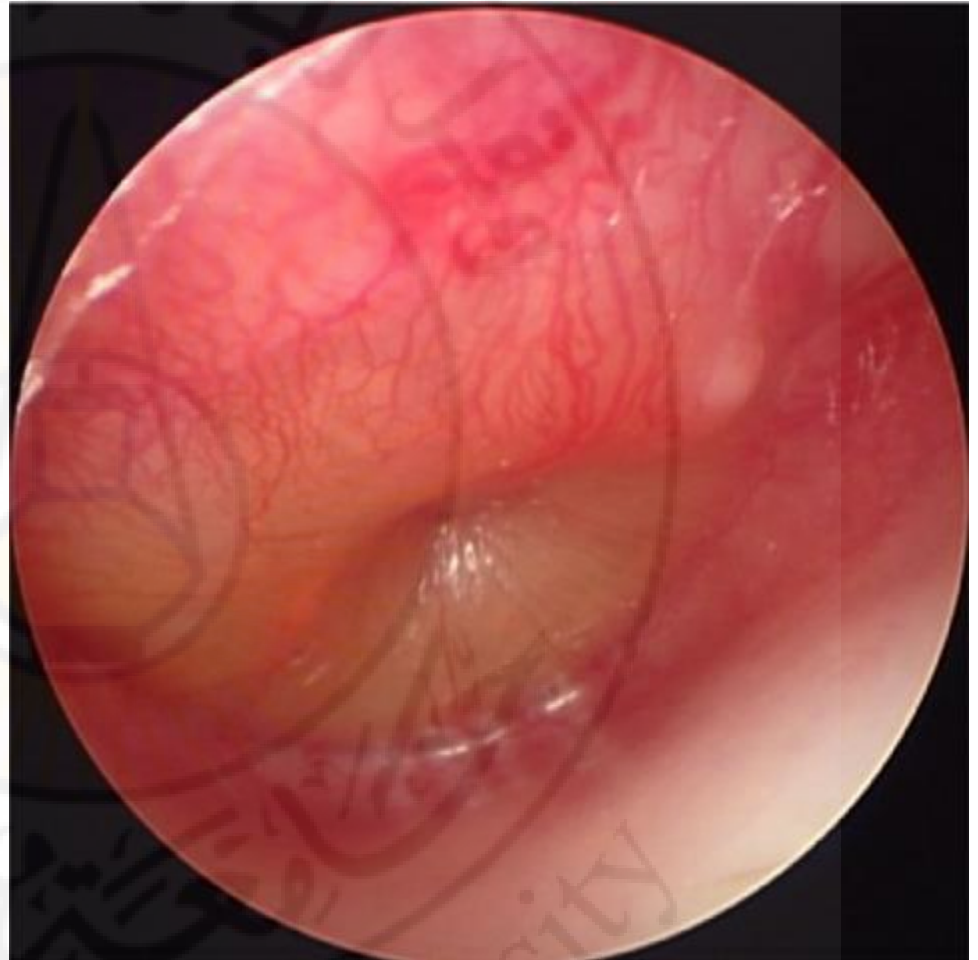
Otitis media and mastoiditis

Types of otitis media : acute otitis media .. Chronic otitis media with or without Cholesteatoma .. Otitis media with effusion

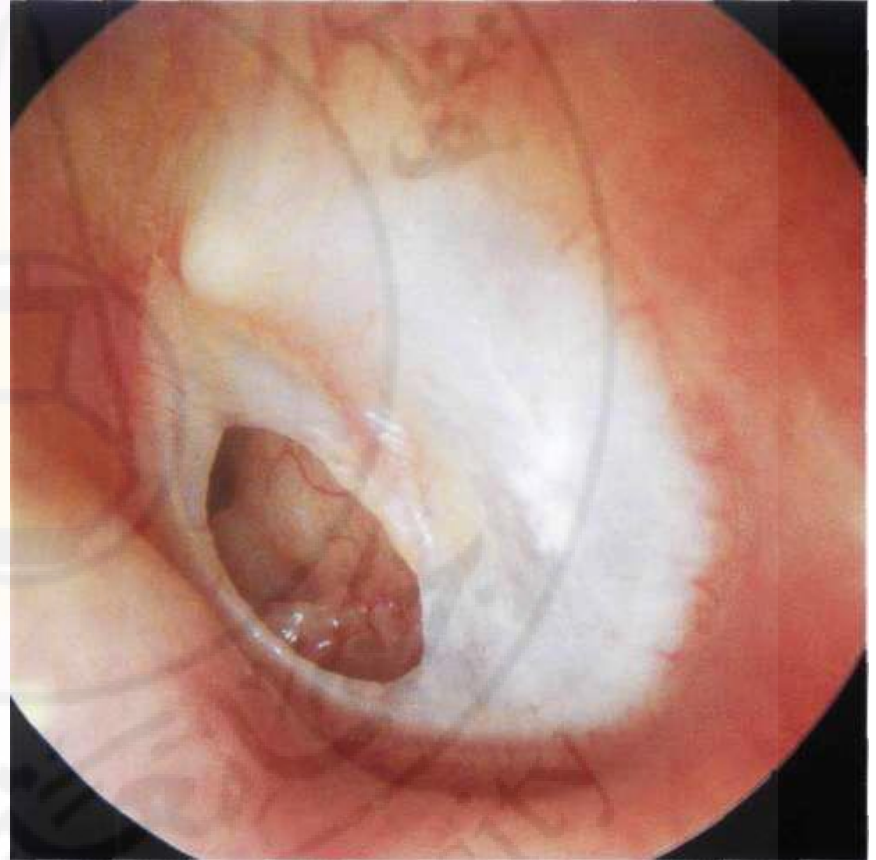
Middle ear infection



Otitis media and mastoiditis



Acute otitis media : acute pain .. Sometimes followed by short-term otorrhea that relieves the pain .. Hearing loss



Chronic otitis media (dry) : hearing loss

Middle ear infection

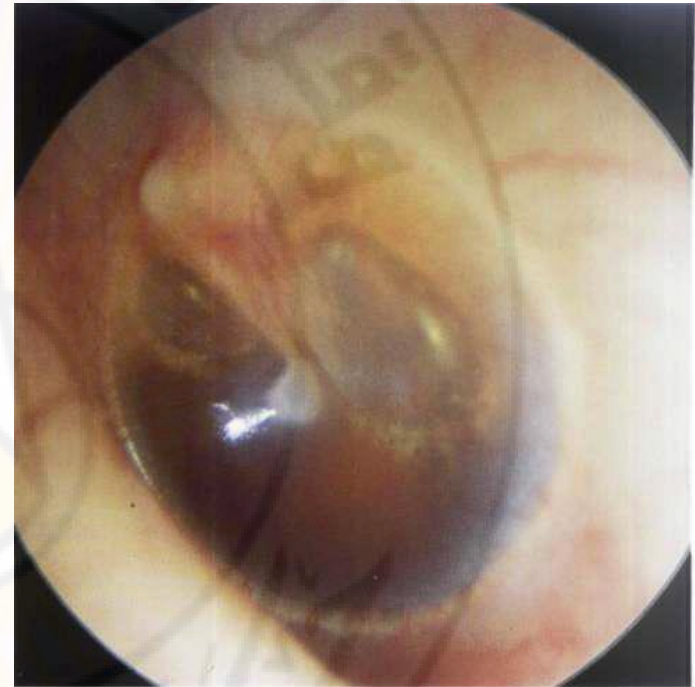


Otitis media and mastoiditis



Chronic otitis media (active) (chronic otorrhea, no pain)

Otitis media with effusion (OME)

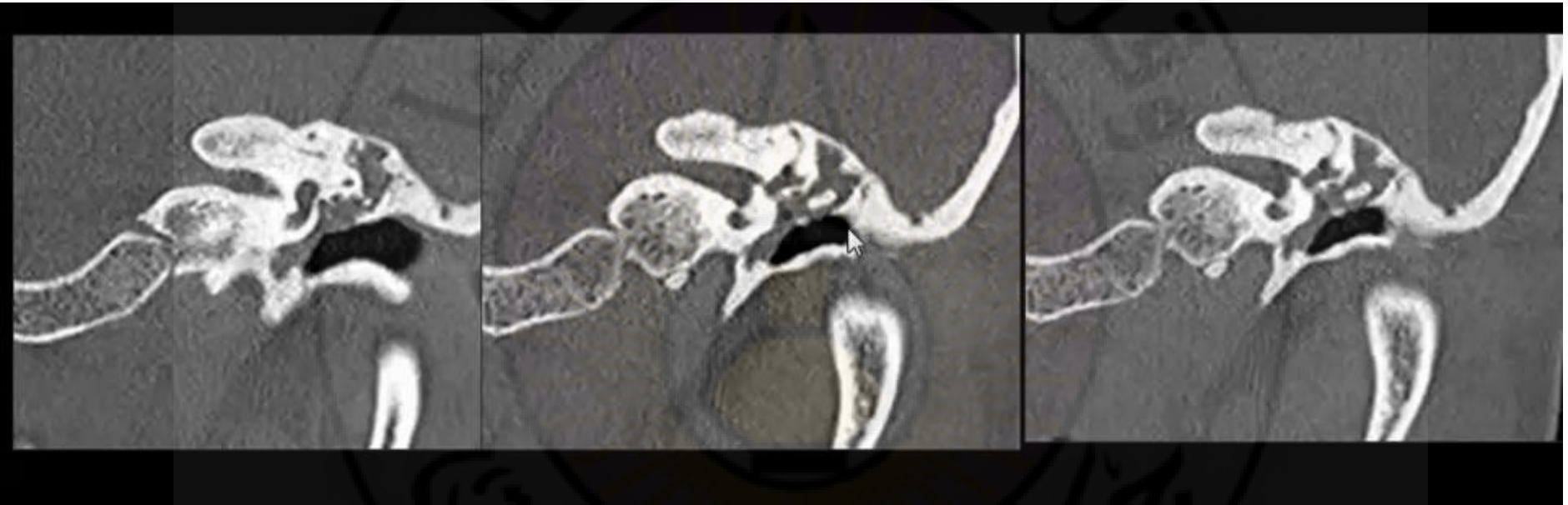


Clinically : hearing loss .. Recurrent acute otitis media.

Otoscopy : retracted transopaque drum.

Radiology : Middle ear filled with fluid , no bony erosion.

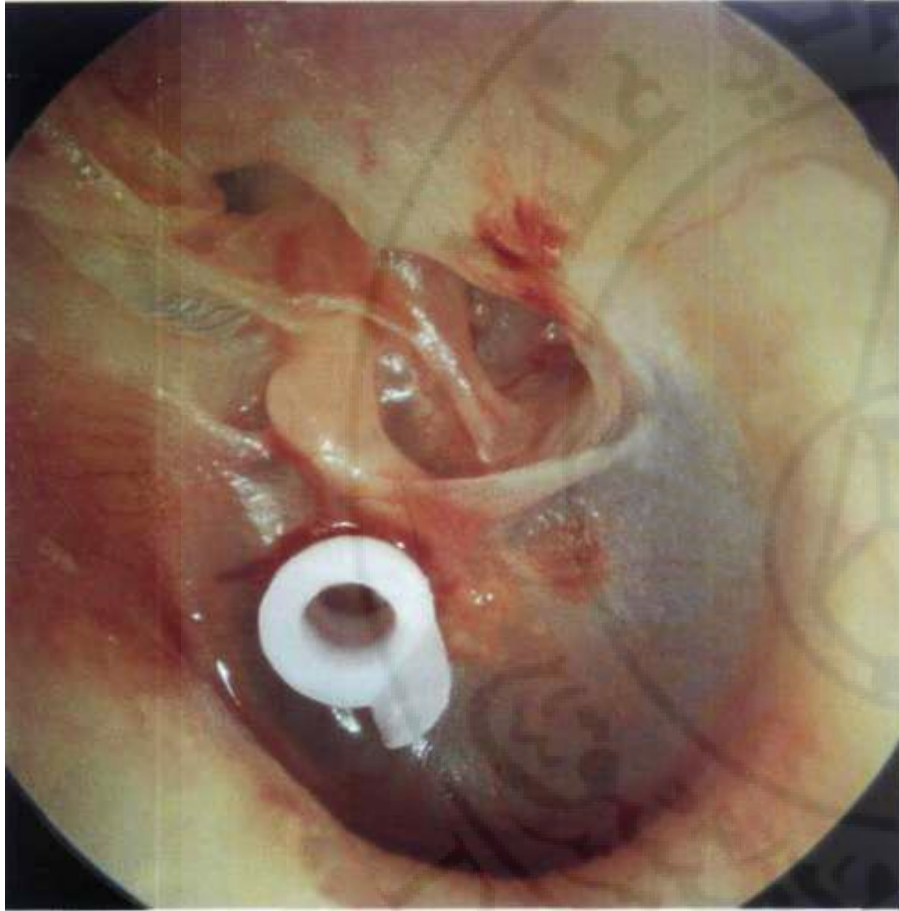
Otitis media with effusion (OME)



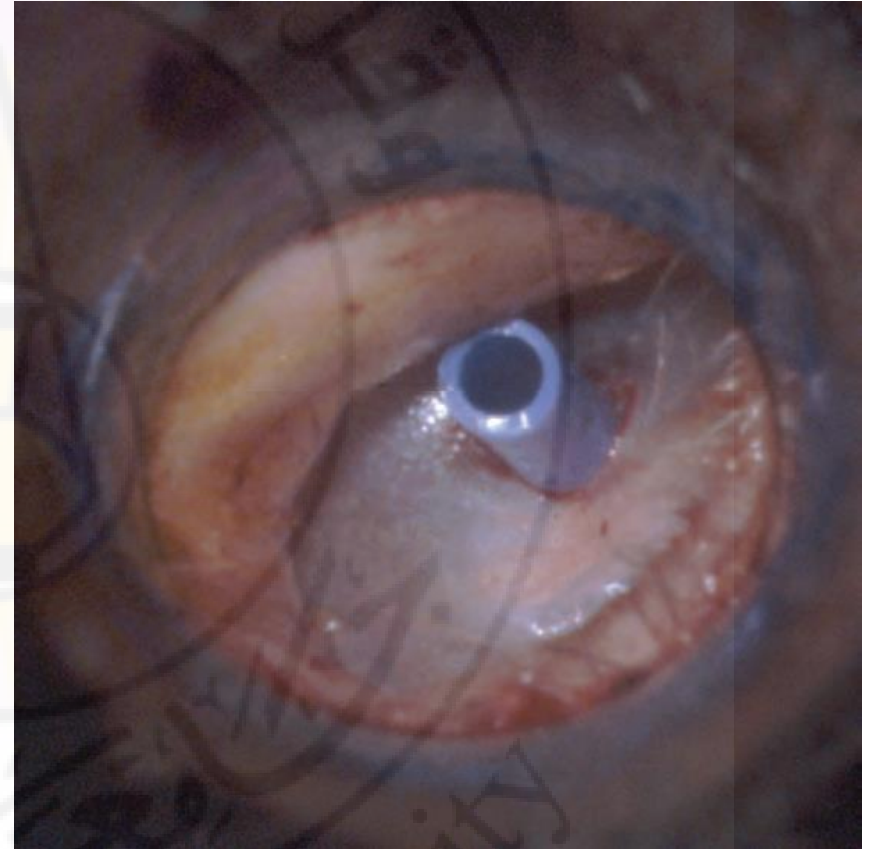
Clinically : hearing loss .. Recurrent acute otitis media.

Otoscopy : retracted transopaque drum.

Radiology : Middle ear filled with fluid , no bony erosion.



Grommet tube

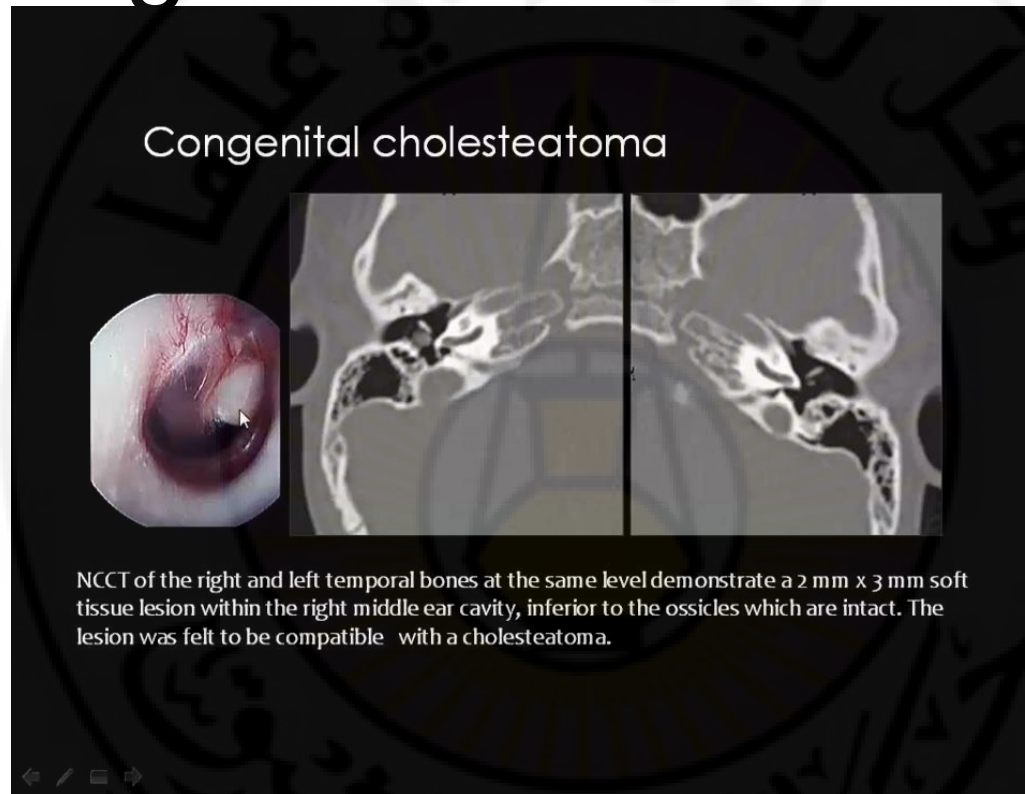


T tube

cholesteatoma

- Presence of skin in middle ear !!!
- Misnomer : neither composed of cholesterol nor a tumour
- Accumulation of squamous epithelium causing infection and bony erosion
- Types :
 - 1) congenital
 - 2) acquired

Congenital cholesteatoma



Clinically : asymptomatic .. Hearing loss .. Infection .. OME (occlusion of tympanic Opening of Eustachian tube.

Otoscopy : whitish mass behind an intact ear drum.

Radiology : non - enhancing soft tissue mass inside middle ear cavity

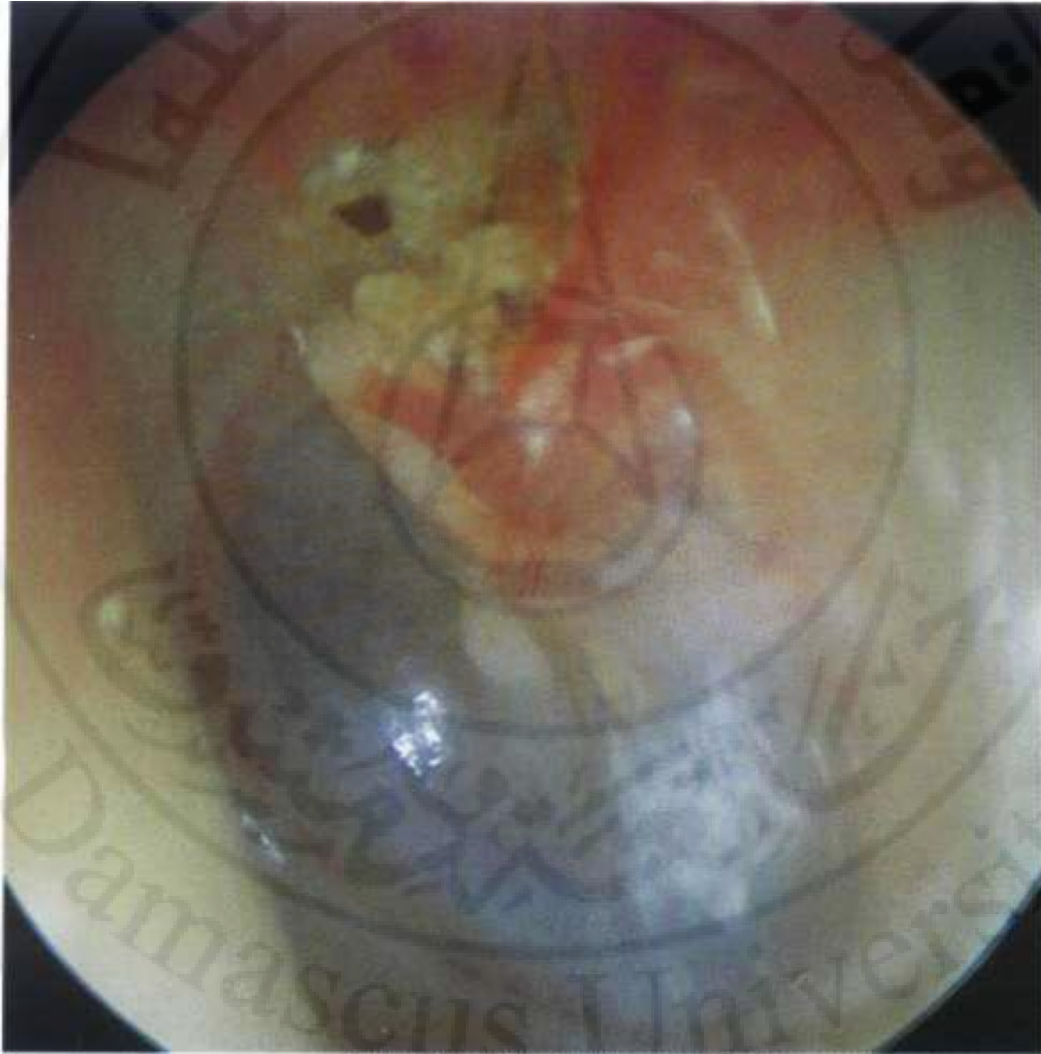
Acquired cholesteatoma

Formation of pars flaccida acquired cholesteatoma



Negative pressure due to long standing Eustachian tube dysfunction leads to retraction Of tympanic membrane forming a retraction pocket with accumulation of squamous Epithelium and formation of acquired choslesteatoma.

Acquired cholesteatoma



Acquired cholesteatoma

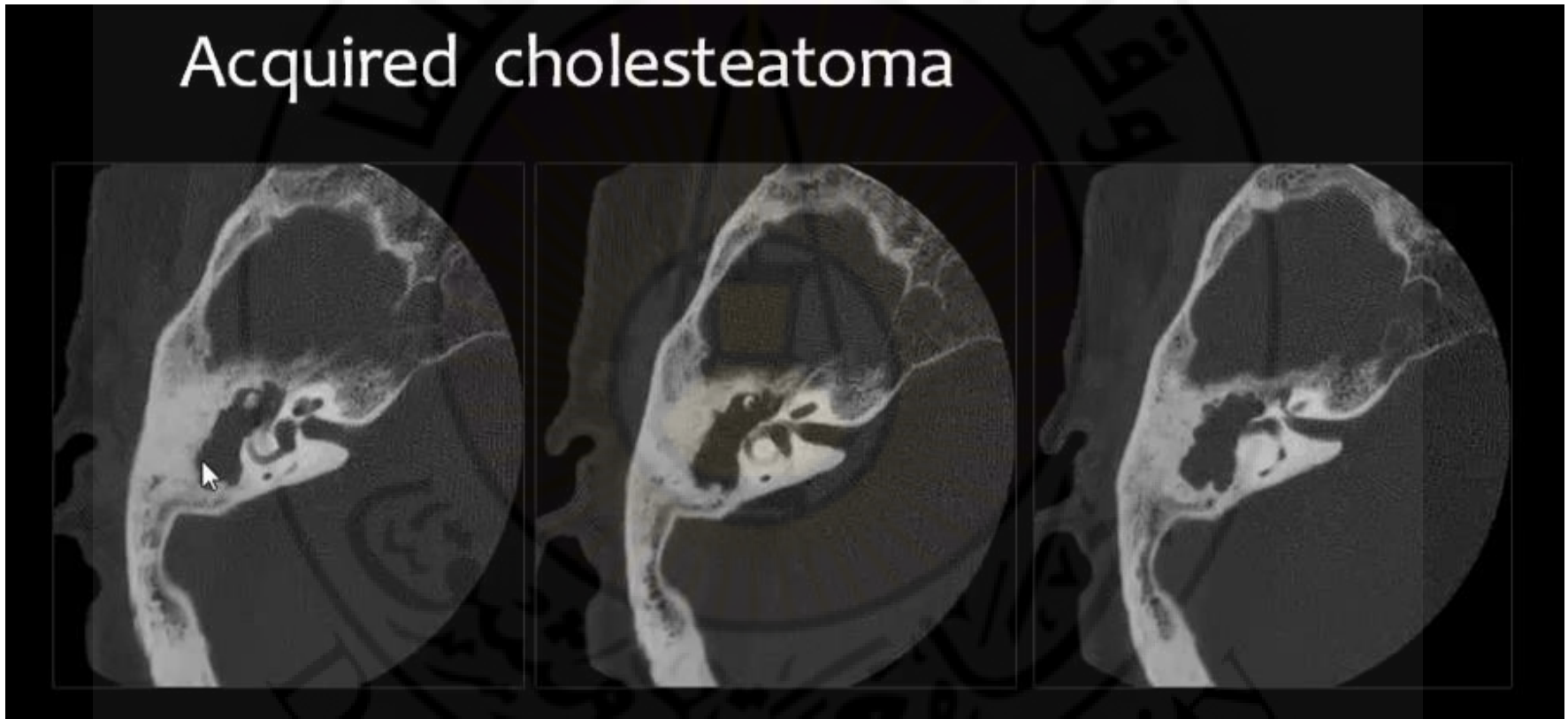
Acquired cholesteatoma

- ◆ Pars flaccida [Prussak's space] [attic]
- ◆ Pars Tensa [sinus cholesteatoma]
- ◆ A complication of chronic otitis media
- ◆ Non dependant, non enhancing lesion
- ◆ Bone erosion may be present



- ◆ Ossicles intact in
- ◆ 30% attic cholesteatoma
- ◆ 10% sinus cholesteatoma

Acquired cholesteatoma



Cholesteatoma involving the attic and antrum .. **Note** the expansion of “additus ad antrum”

Complications of cholesteatoma

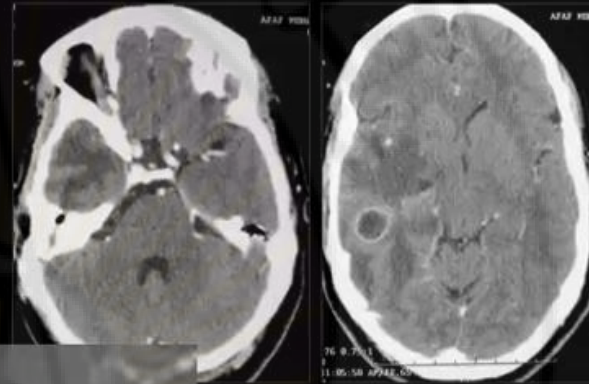
- ◆ Erosion of the facial canal → facial palsy
- ◆ Erosion of the SCC → labyrinthine fistula
- ◆ Erosion of the tegmen tympani → intracranial extension
 - ◆ Dural sinus thrombosis
 - ◆ Brain abscess



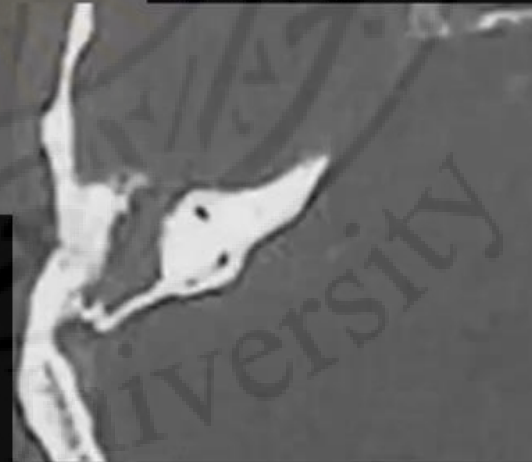
Complications of cholesteatoma



Acquired
cholesteatoma



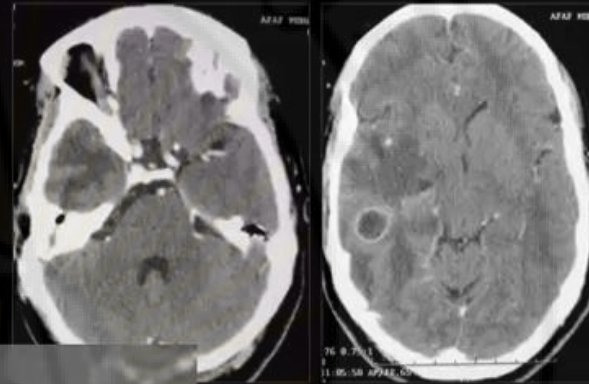
Erosion of the tegmen tympani
with intracranial extension and
abscess formation



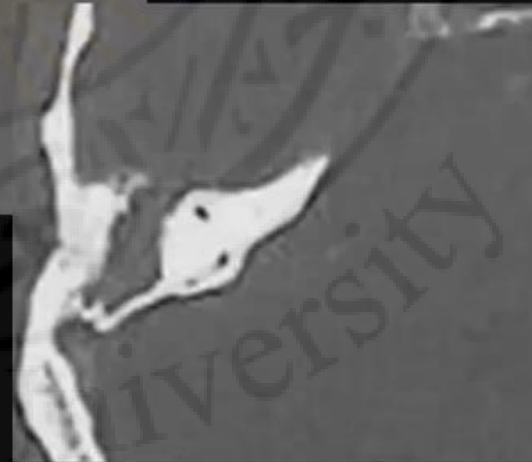
Complications of cholesteatoma



Acquired
cholesteatoma



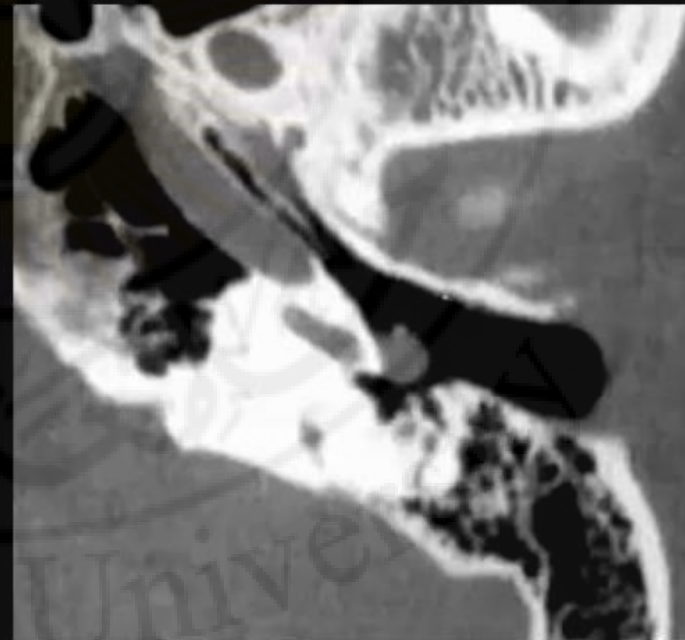
Erosion of the tegmen tympani
with intracranial extension and
abscess formation



Glomus tumour

Glomus tympanicum

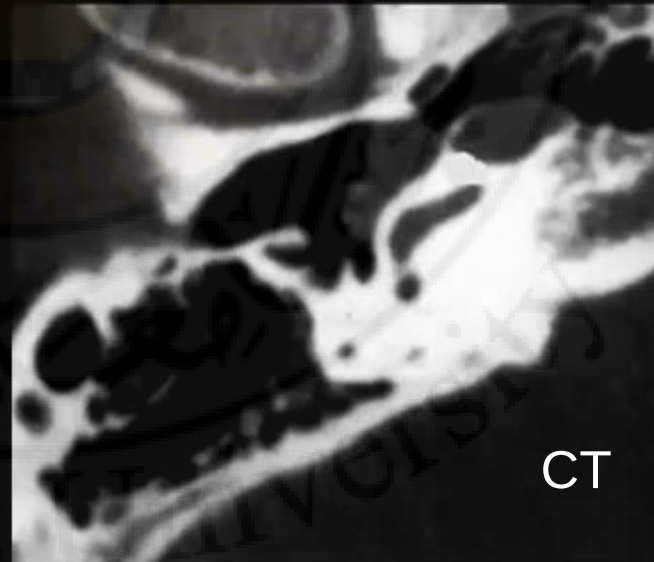
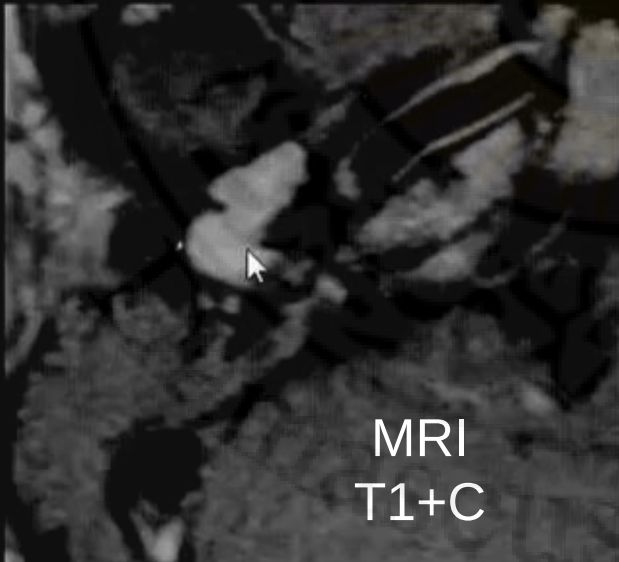
- ♦ Male: Female = 1:3
- ♦ Pulsatile tinnitus, CHL
- ♦ Vascular retro tympanic mass



Glomus tumour

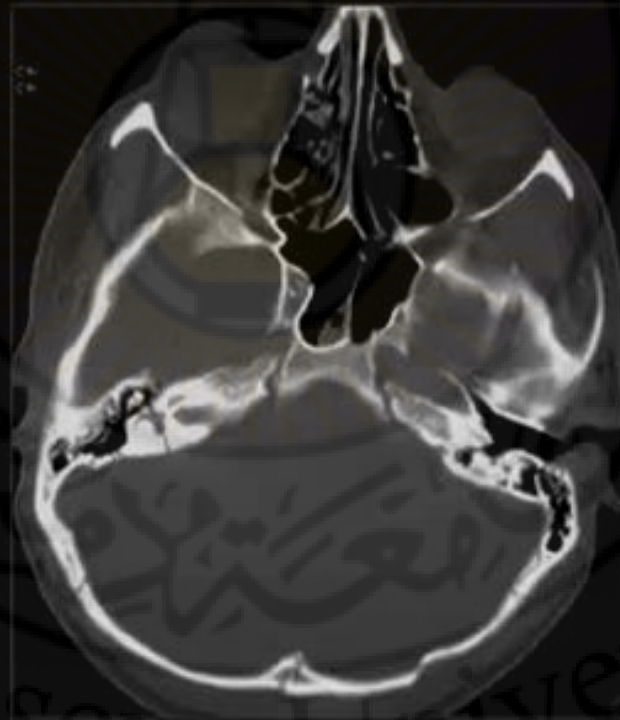
Glomus tympanicum

- ◆ Nodular soft tissue in the middle ear
- ◆ Typically do not cause bone erosion
- ◆ Intense enhancement



Fractures

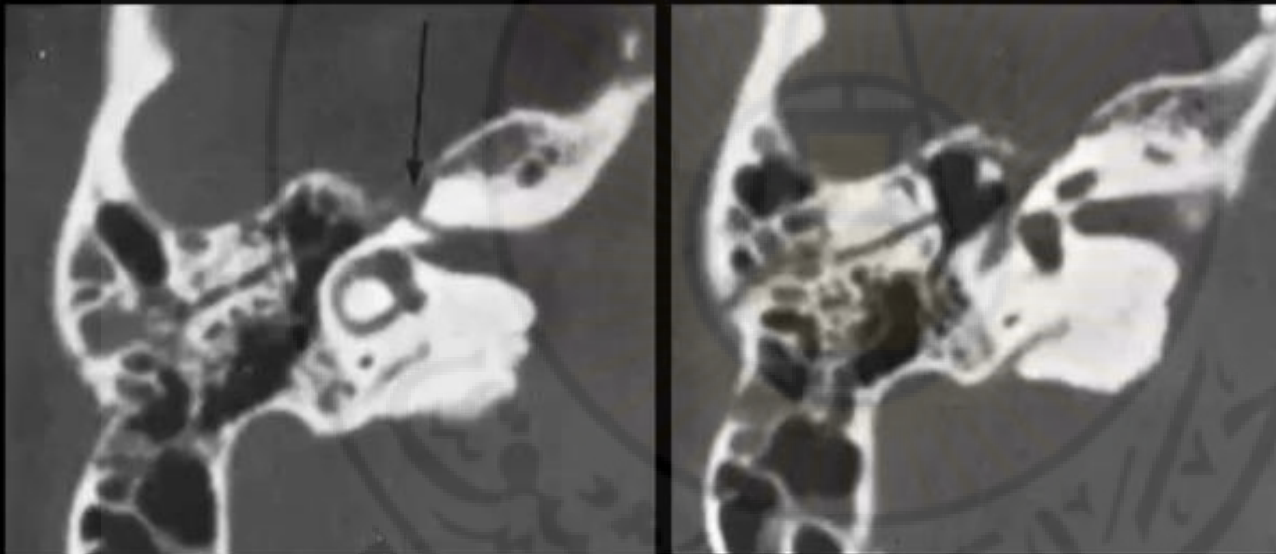
Transverse fracture 10%- 30% usually involves the inner ear → SNHL
Facial nerve injury 50%



Transverse fracture affecting the vestibule, SSC and facial nerve canal

Fractures

Longitudinal fractures 79%- 90% usually involve the middle ear → CHL

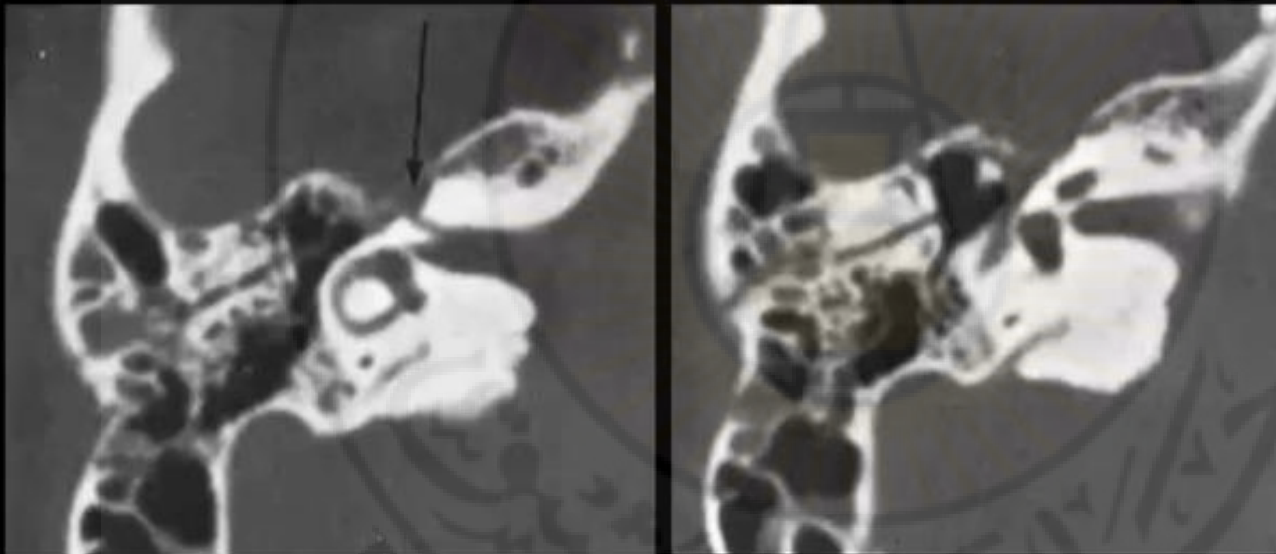


Long fracture with incus dislocation

- ♦ Otorrhea, hemo tympanum
- ♦ Conductive or SNHL
- ♦ Vertigo, facial nerve palsy
- ♦ CSF leakage, meningitis

Fractures

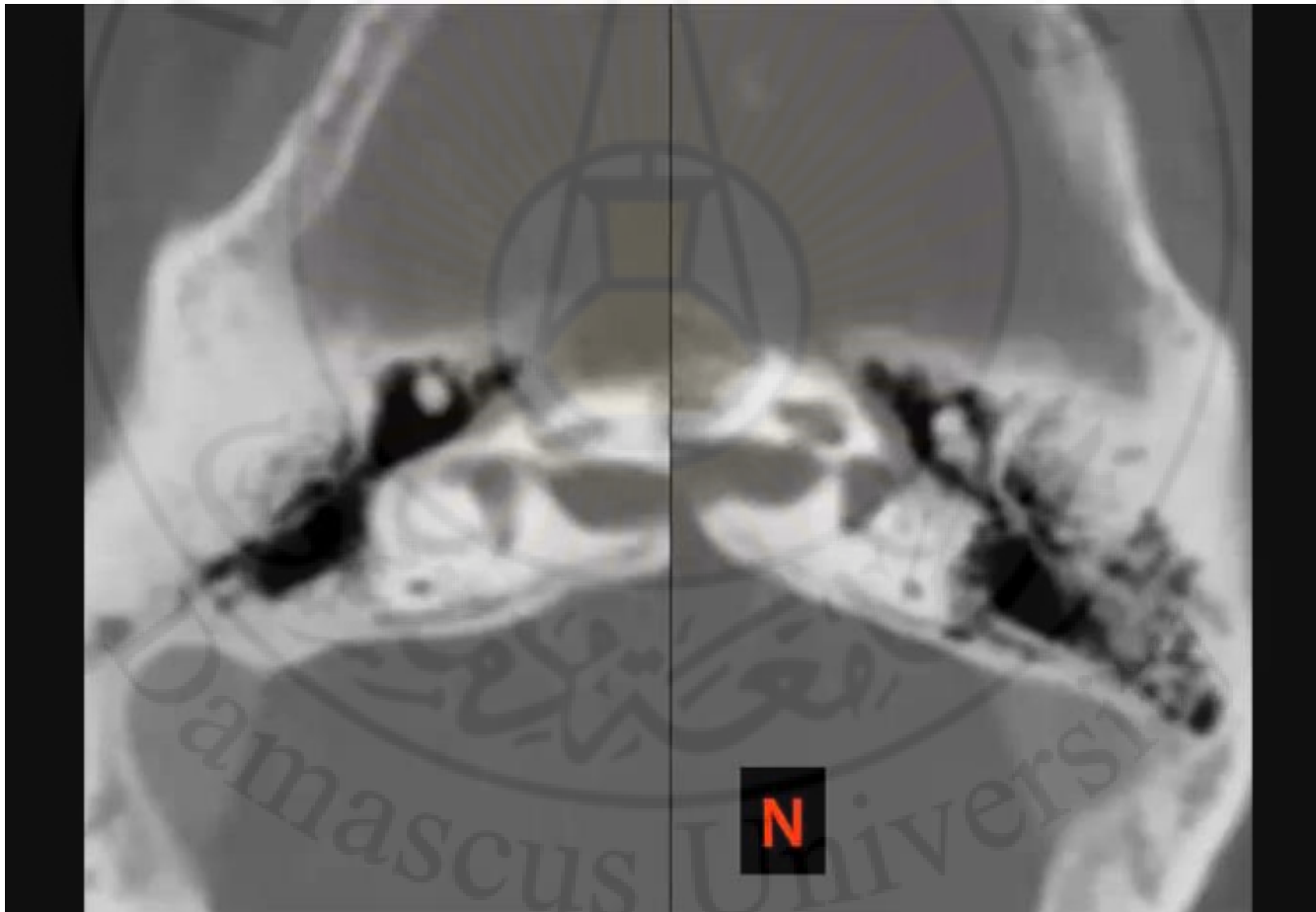
Longitudinal fractures 79%- 90% usually involve the middle ear → CHL



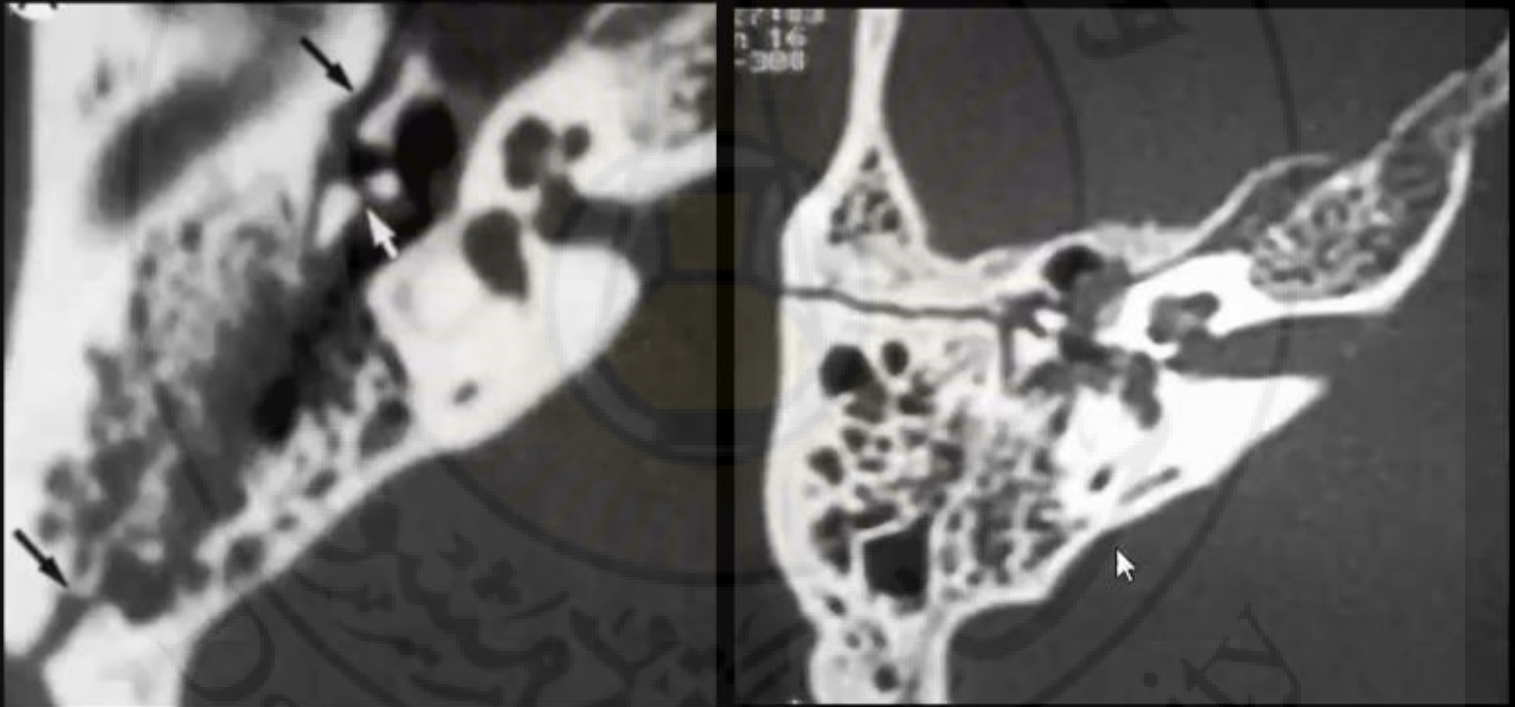
Long fracture with incus dislocation

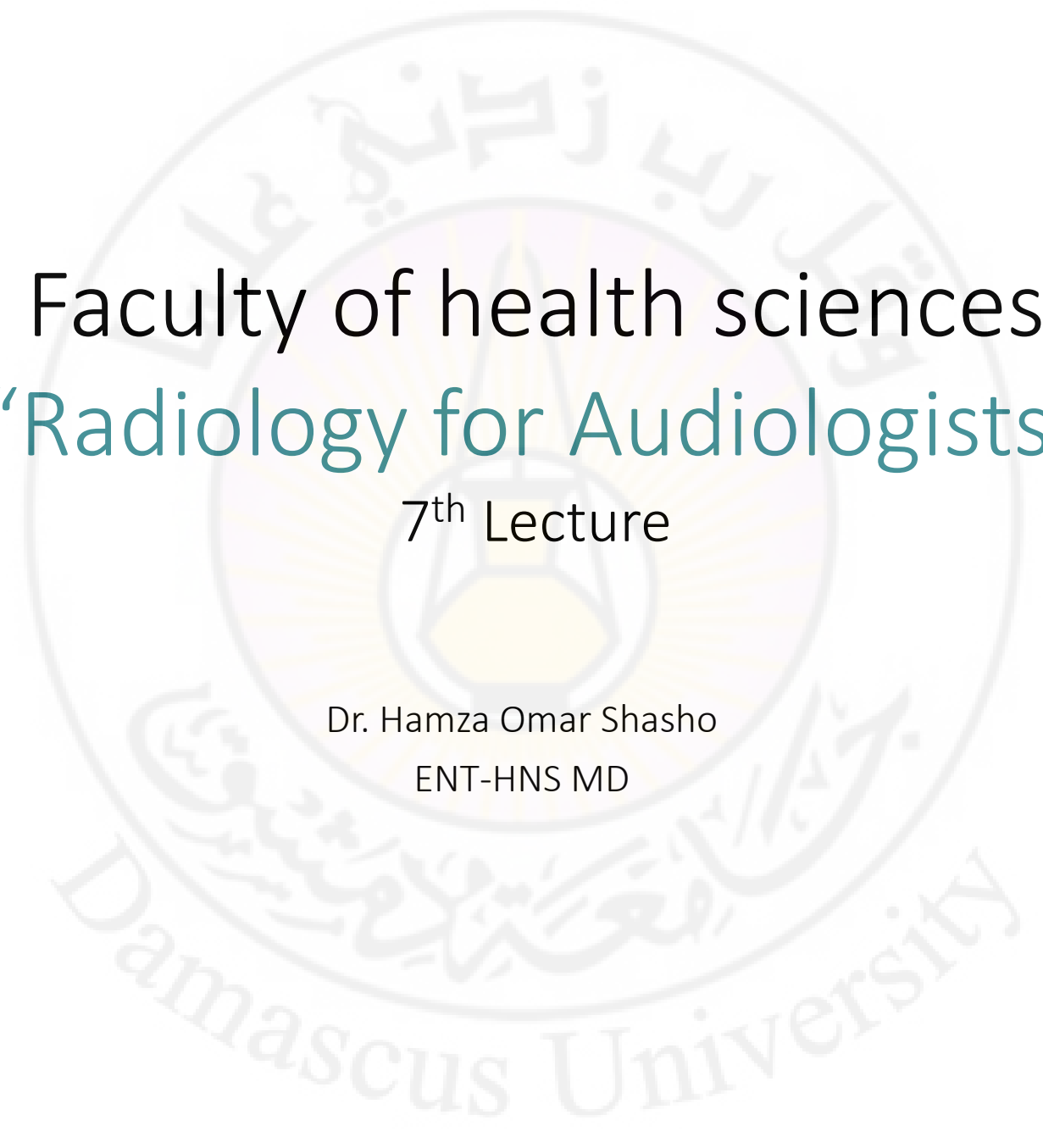
- ♦ Otorrhea, hemo tympanum
- ♦ Conductive or SNHL
- ♦ Vertigo, facial nerve palsy
- ♦ CSF leakage, meningitis

Dislocation of the mallo-incudal joint



Dislocation of the mallo-incudal joint





Faculty of health sciences

“Radiology for Audiologists”

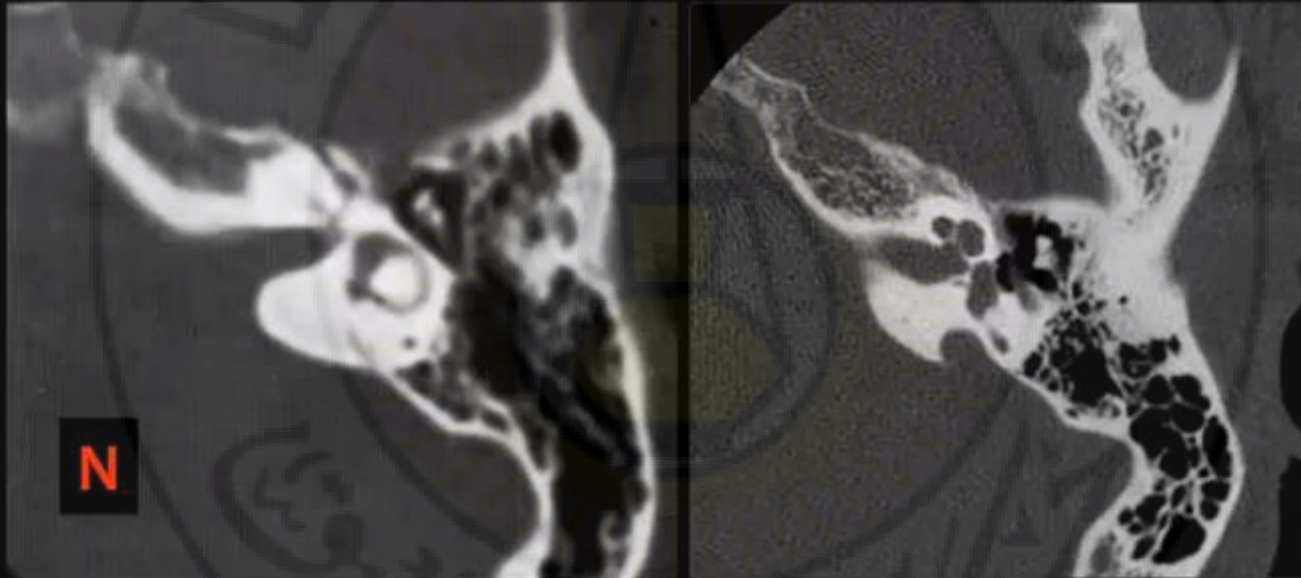
7th Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

Large endolymphatic duct and sac

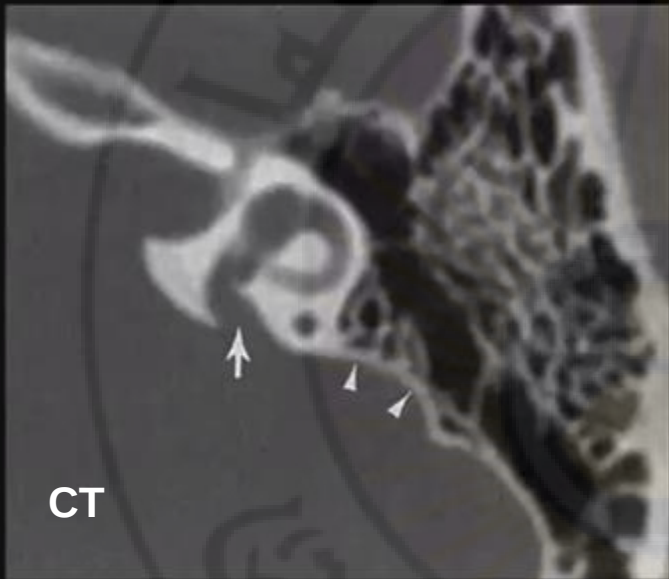
- ◆ Enlargement of the endolymphatic system
- ◆ Enlargement of the vestibular aqueduct [VAS]
- ◆ Normal vestibular aqueduct = 1.5 mm
- ◆ A common cause of SNHL



Axial view :

- Located posterior to the posterior semicircular canal.
- Normal : less than 1.5 mm (can also be compared to the diameter of posterior limb of posterior semicircular canal).

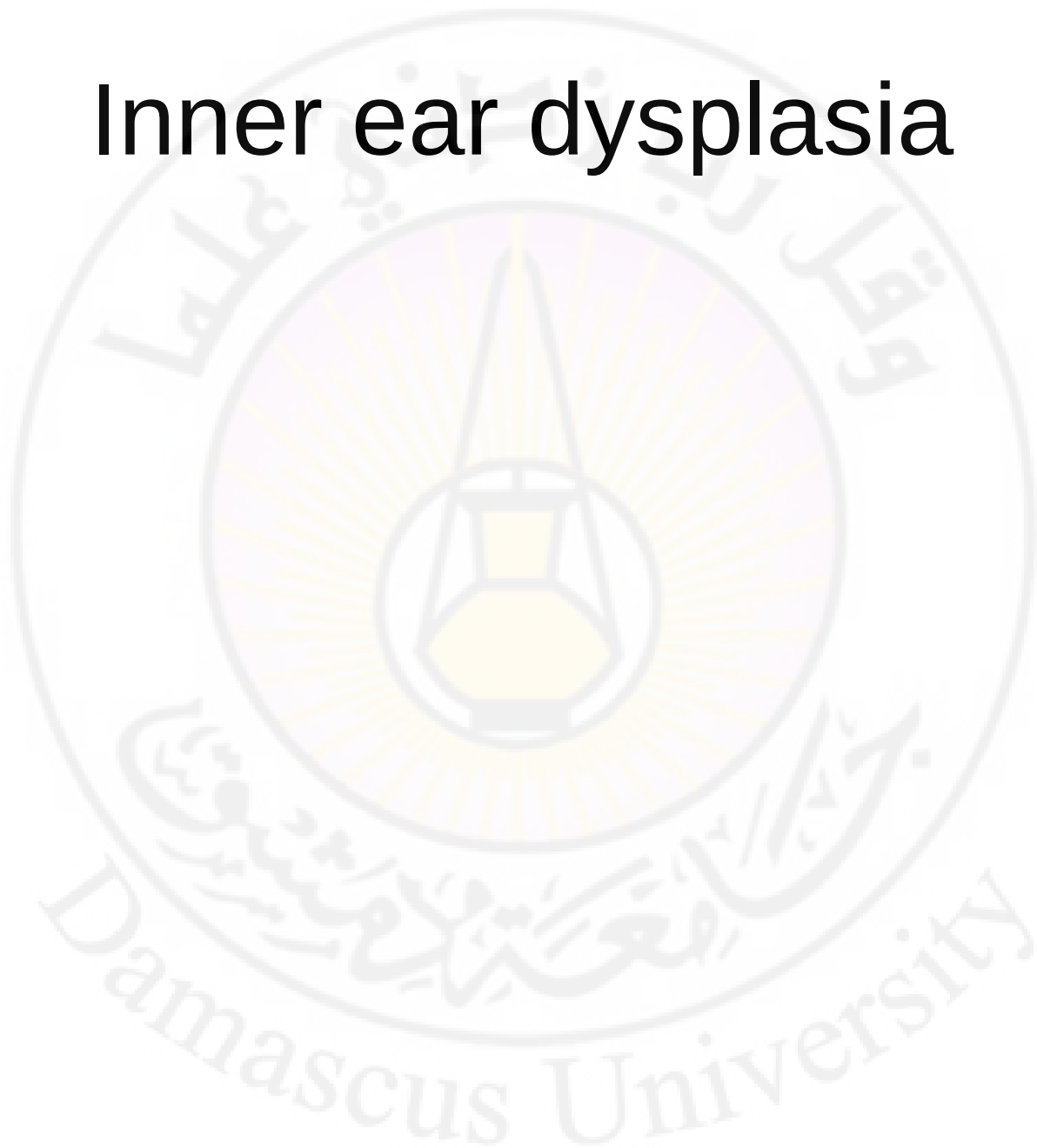
Vestibular aqueduct syndrome



VESTIBULAR AQUEDUCT

ENDOLYMPHATIC SAC

Inner ear dysplasia



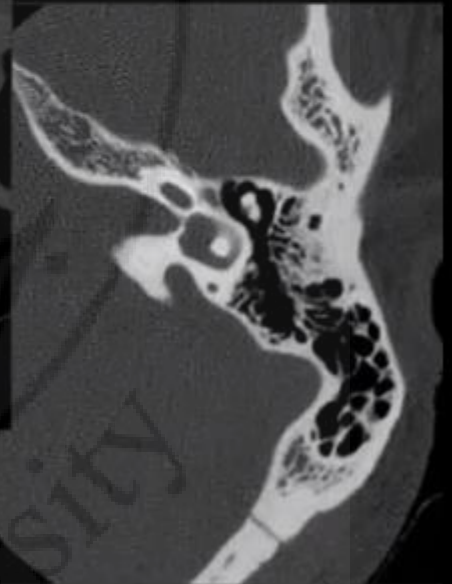
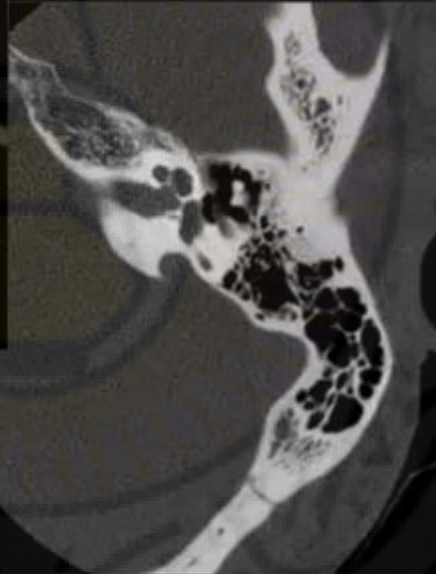
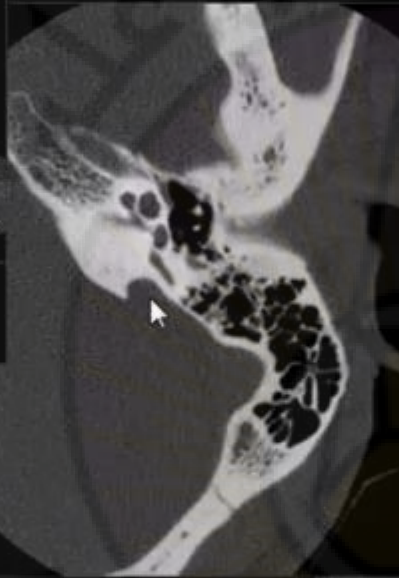
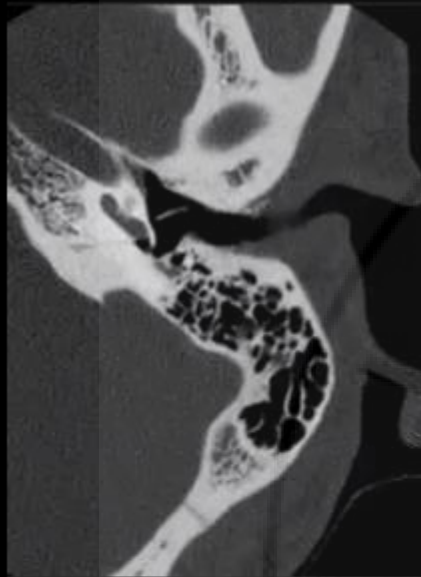
**Michel
anomaly**

F 2Y

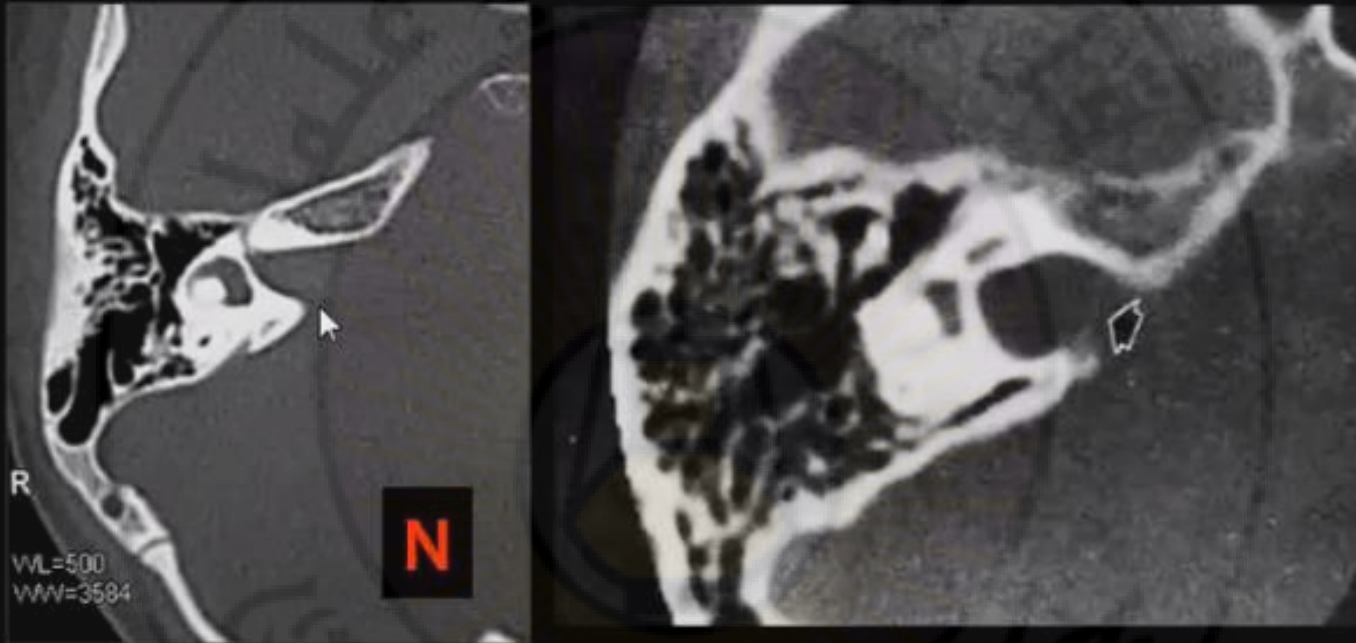
Michel anomaly :
Absence of inner ear

Mondini malformation

- ◆ The vestibule is enlarged
- ◆ Short broad semicircular canals
- ◆ The vestibular aqueduct is enlarged.
- ◆ The cochlea demonstrates on 1.5 turns.
- ◆ The more apical turns are replaced by a single cystic cavity



Mega internal auditory canal



Might present as an asymptomatic normal variation .however, MRI must be ordered to exclude tumours (acoustic neuroma).

Acoustic neuroma

- Misnomer : vestibular schwannoma
- Vestibular schwannomas are the most common CPA and IAC tumour, accounting for 70–80% of lesions, with meningioma and metastases less common.
- MRI is preferred for detecting tumours and delineating extent.
- T2 weighted images provide excellent CSF high signal and clear delineation of the cranial nerves traversing the IAC (low signal)
- Post-contrast thin section T1 weighted images can help pick up small or subtle lesions, and assist in follow-up..

Acoustic neuroma

Small lesions appear homogenous on T2 sequences, and show homogenous enhancement. Larger lesions may show heterogeneity on T2 and post contrast sequences due to areas of cystic change.

Lesions may be purely intra-cannalicular, extend through the IAC meatus to the cisternal compartment (producing a typical 'ice cream cone' appearance) or, less commonly, may be purely cisternal.

Larger lesions may cause mass effect upon the brainstem and 4th ventricle.

Acoustic neuroma

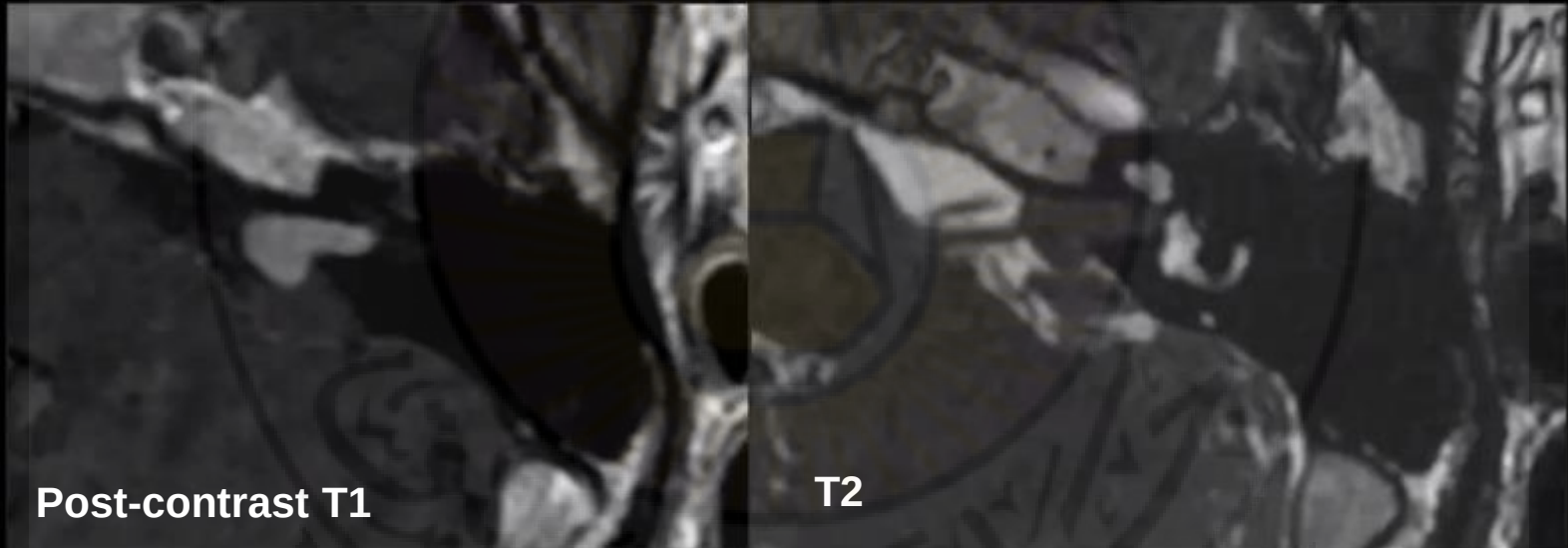
Occasionally, lesions may undergo acute internal haemorrhage with rapid expansion and development of :

- SSNHL
- cerebellar signs and vomiting.

Acoustic neuroma

M 44Y

Progressive left hearing loss, tinnitus



ICE CREAM CONE SIGN: refer to vestibular schwannoma with both extracannalicular and intracannalicular components.

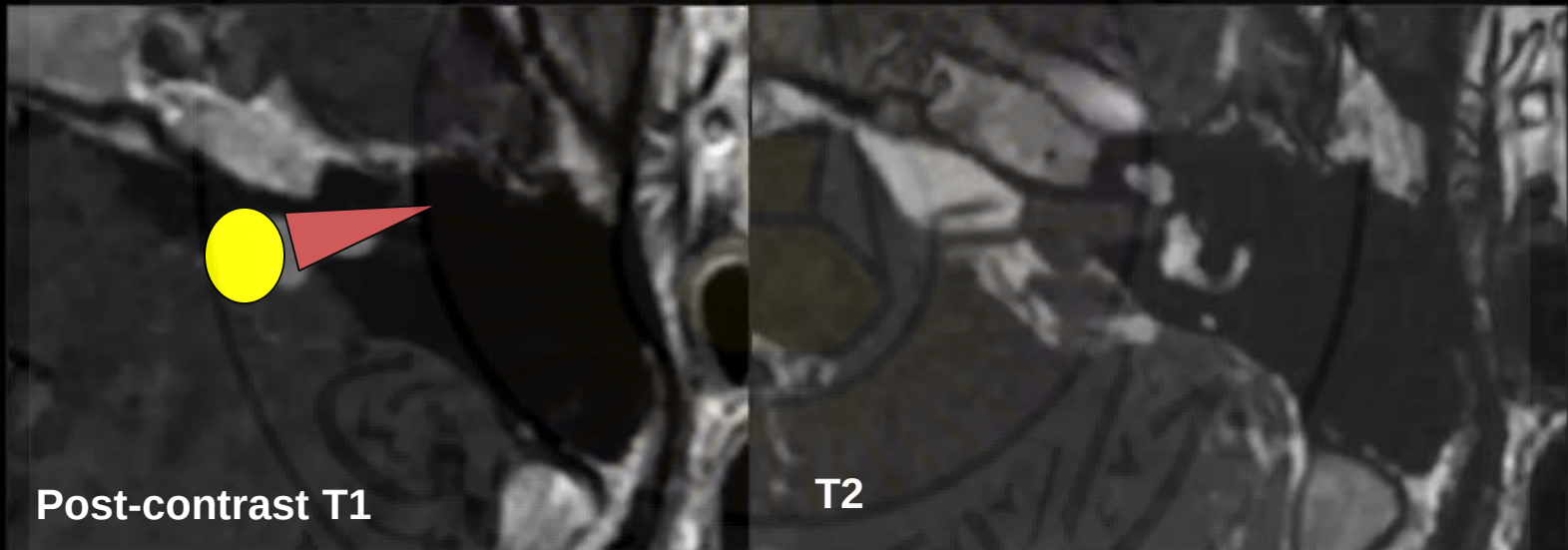
CONE → intra-cannalicular component of tumour

Ice cream → extra-cannalicular component of tumour

Acoustic neuroma

M 44Y

Progressive left hearing loss, tinnitus

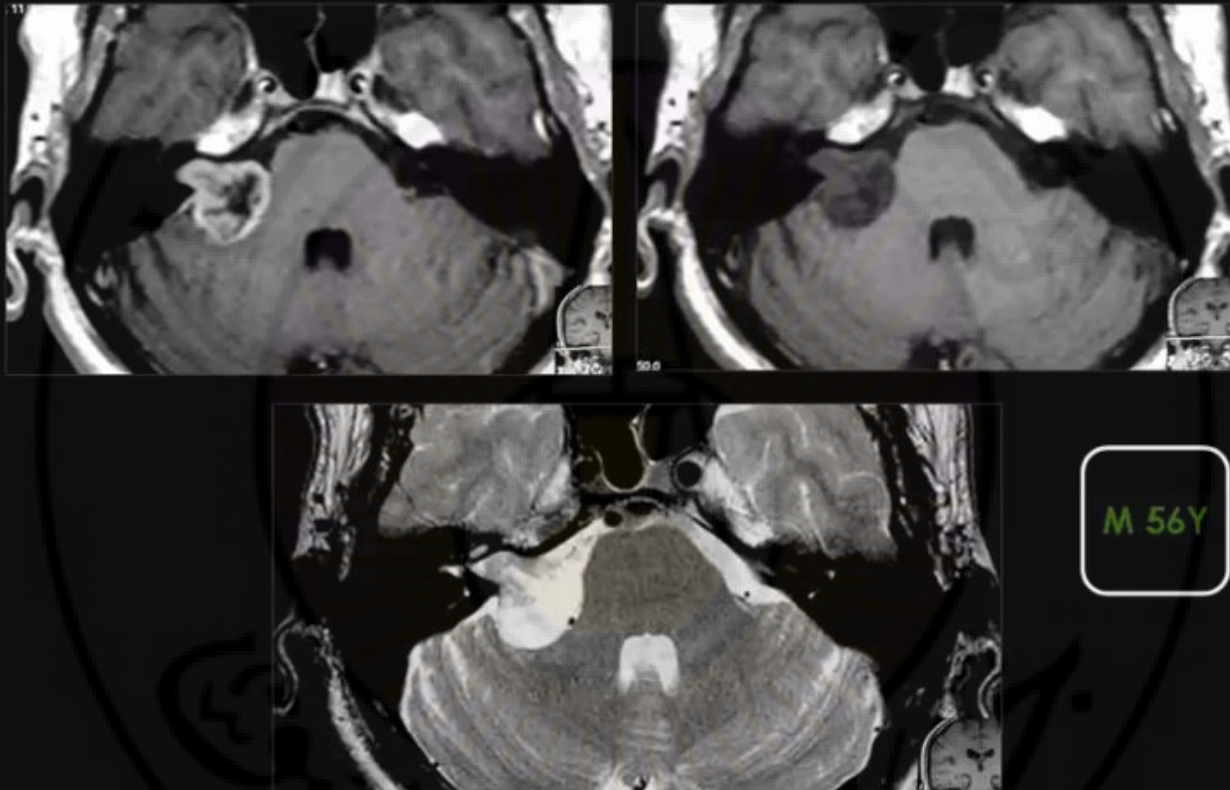


ICE CREAM CONE SIGN: refer to vestibular schwannoma with both extracannalicular and intracannalicular components.

CONE → intra-cannalicular component of tumour

Ice cream → extra-cannalicular component of tumour

Acoustic neuroma



- v.Shwannoma (intra + extra cannalicular components) with cystic degeneration
- Note the ice cream cone sign

Otosclerosis

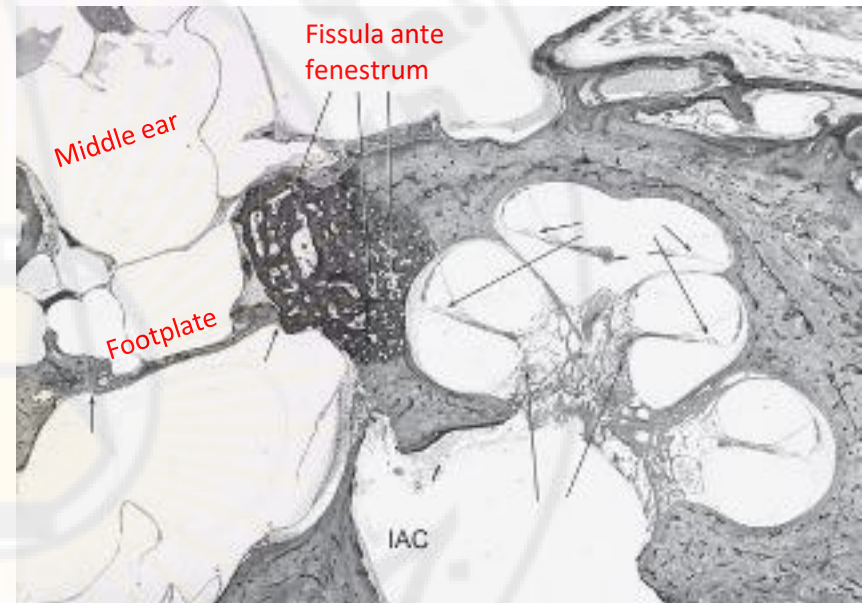
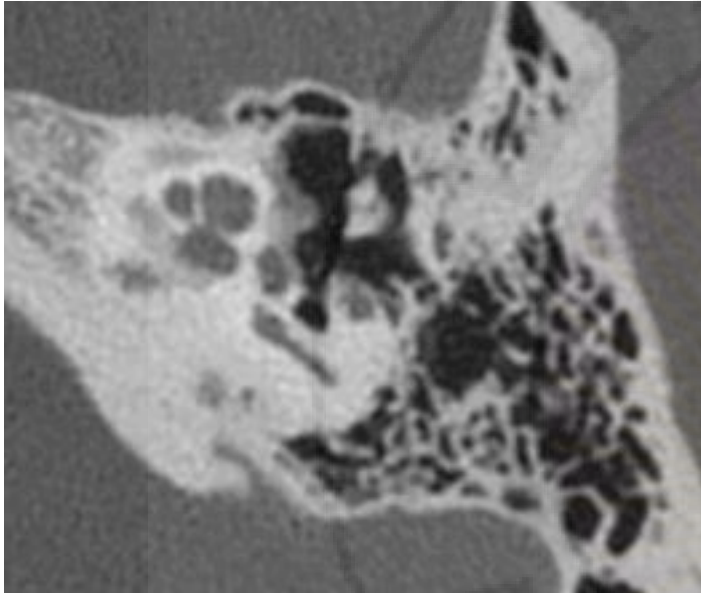
Diagnosis : CHL + Normal Otoscopy + Absent Reflexes

Imaging is not always employed in the diagnosis of typical otosclerosis with CHL, but may be utilized in patients with sensorineural or mixed hearing loss, or an atypical history. CT is the imaging method of choice, as it depicts the early bone changes associated with otosclerosis in both fenestral and retrofenestral disease.

Otosclerosis

Thin section CT shows low-density (demineralized) plaques in early disease, which typically affects the **fissula antefenestrum** at the anterior border of the oval window. The otosclerotic plaque can extend to involve the stapes foot-plate, occlude the oval window and extend to the cochlear promontory and round window region. Disease is often bilateral (up to 85% of cases).

Otosclerosis



Axial CT scan of the left middle ear through the stapes footplate showing lucency anterior to the stapes footplate (1) and around the cochlear (2).

Otosclerosis

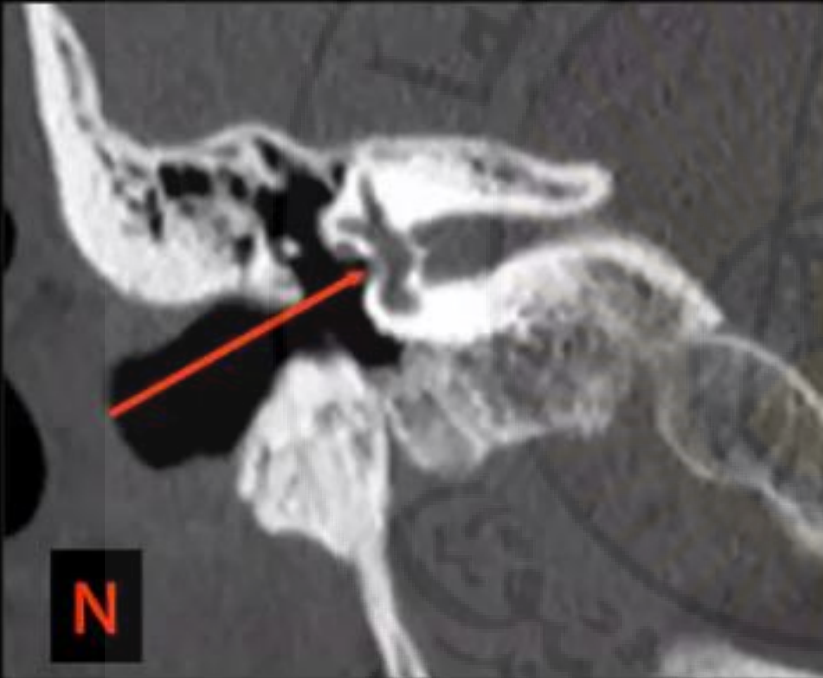
Retrofenestral disease is the less common of the two types of otosclerosis – and often considered a continuation of fenestral disease. Low density is seen extending around the otic capsule, termed the fourth ring of Valvassori.

Again, disease is usually bilateral.

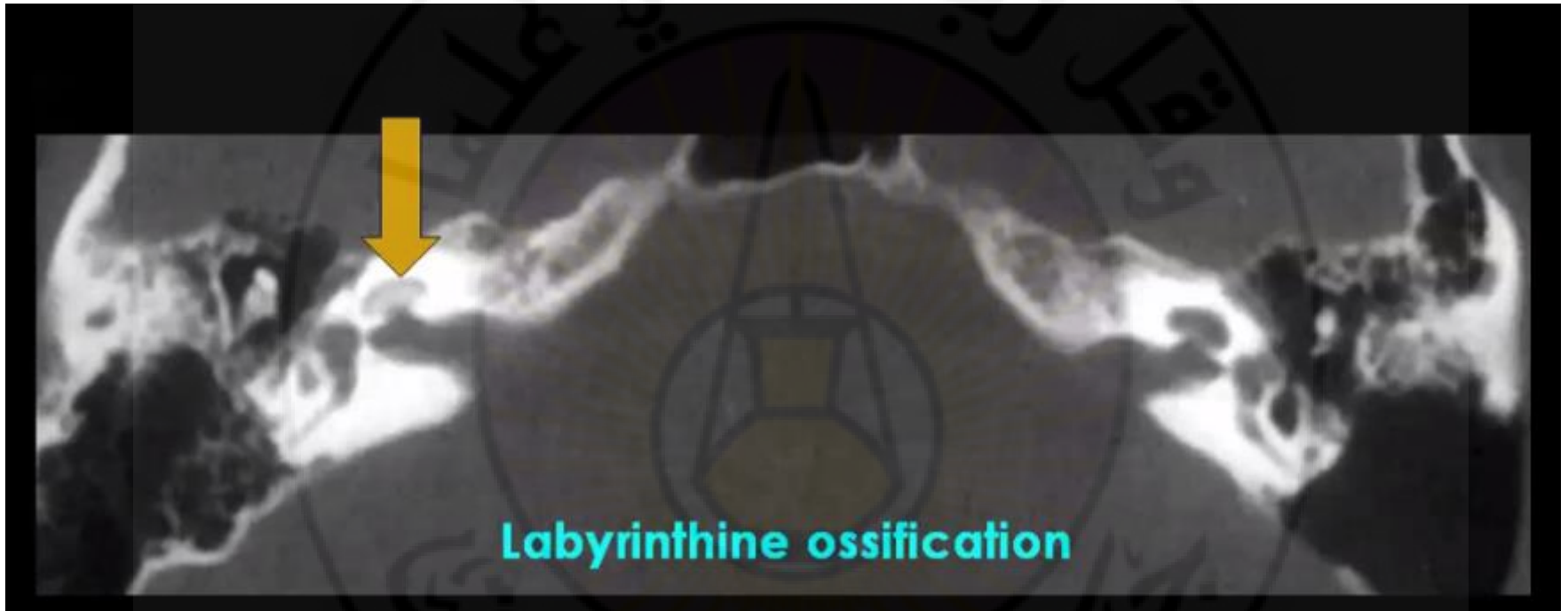
low density foci turns dense when matured

Otosclerosis

Obliteration of the oval window by bony plate

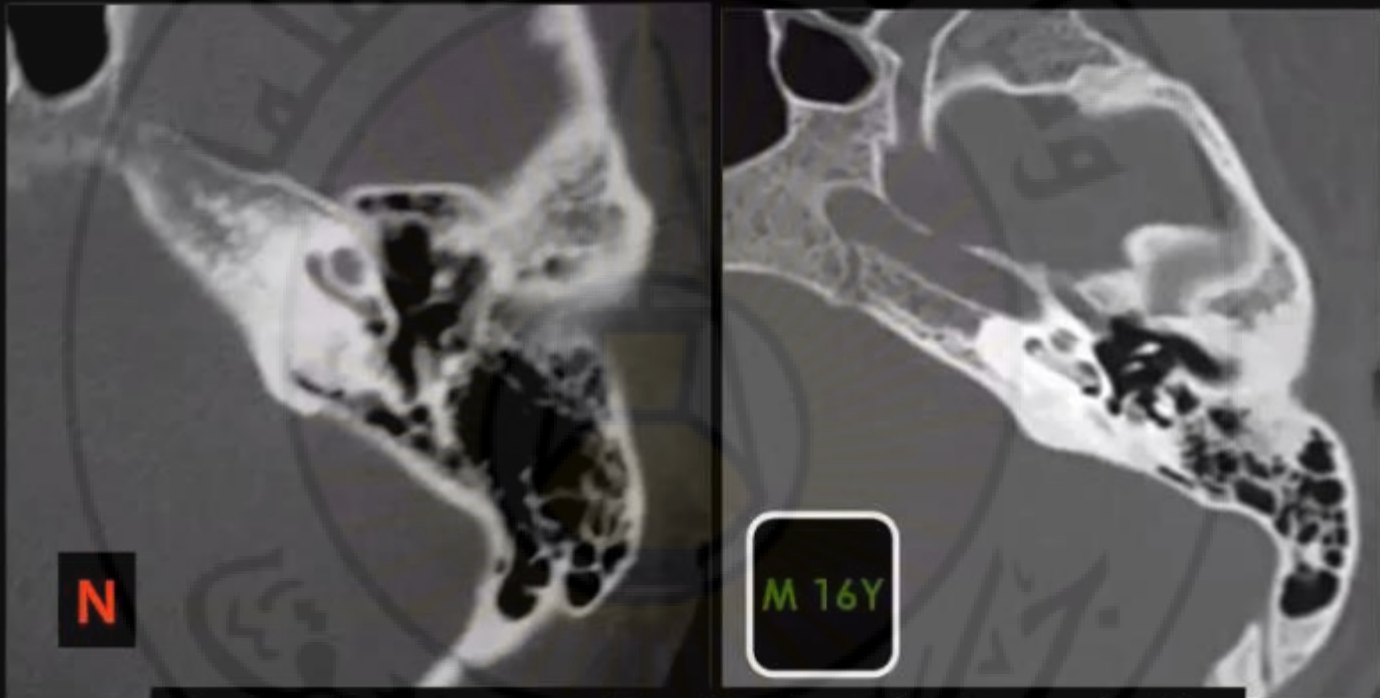


Matured dense otosclerotic plaque obliterating the oval window



- Sclerosis inside cochlea that may render insertion of CI electrode impossible
- Causes:
 1. Infections (labyrinthitis , **meningitis**)
 2. Trauma
 3. idiopathic
- Must be identified as early as possible to perform an urgent CI surgery

Labyrinthitis ossificans



Profound sensory-neural hearing loss following meningitis

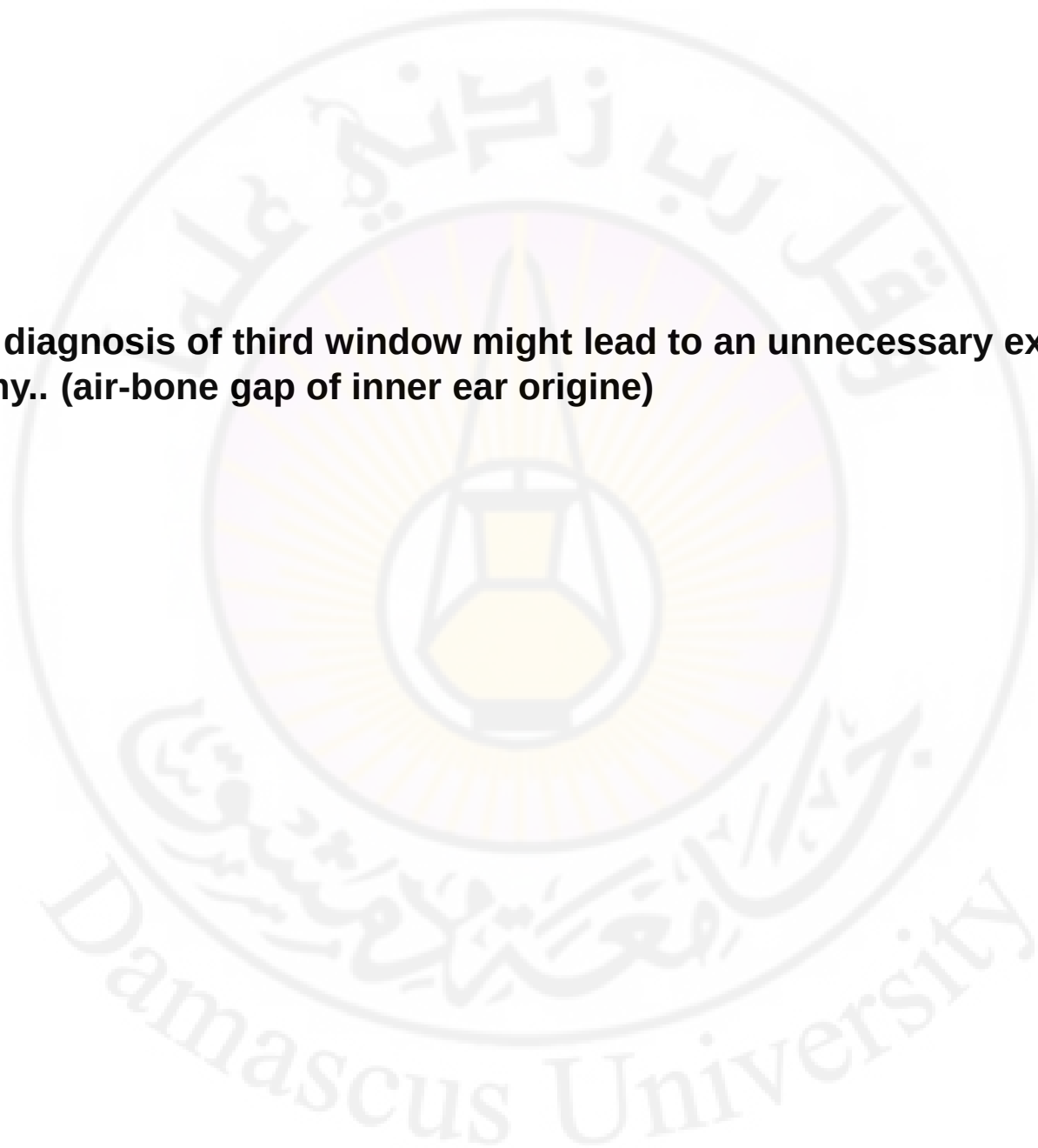
Third window mechanism:

- 1) Superior semicircular canal dehiscence syndrome (most common)**
- 2) Enlarged vestibular aqueduct syndrome**
- 3) Enlarged internal acoustic meatus**
- 4) Enlarged cochlear aqueduct**

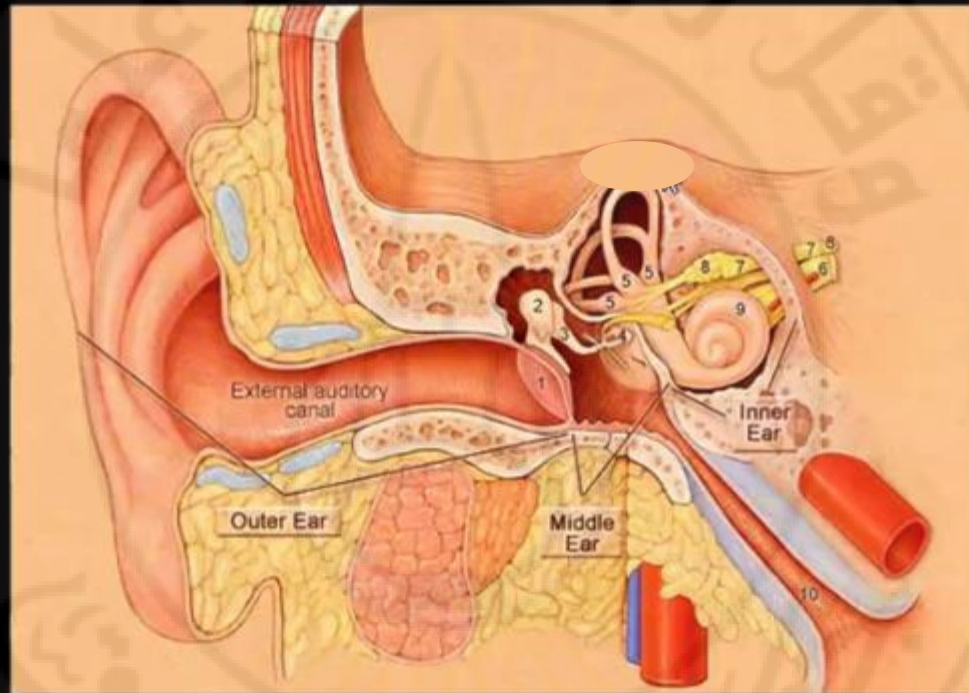
Presentation:

- Air bone gap (of inner ear origine) with intact acoustic reflexes**
- Pressure-induced vertigo**
- Tullio phenomenon (vertigo induced by loud sounds)**
- Autophony**
- Pulsatile tinnitus**

Missing the diagnosis of third window might lead to an unnecessary exploratory tympanotomy.. (air-bone gap of inner ear origine)

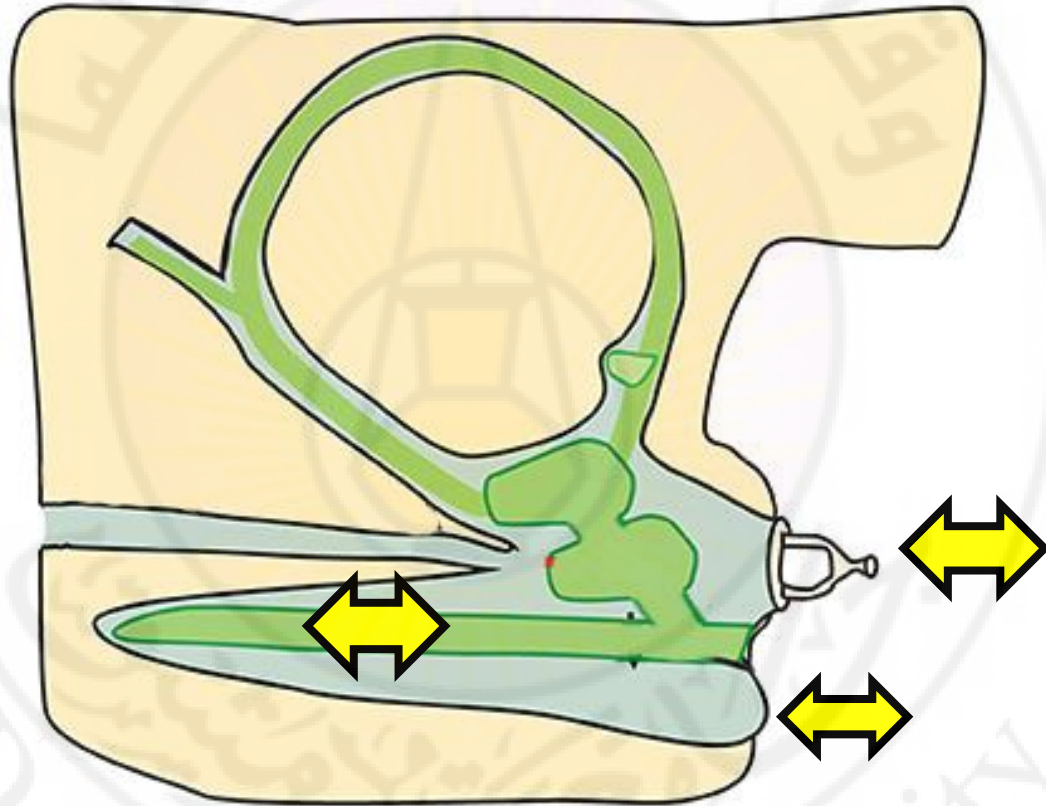


SSC dehiscence syndrome



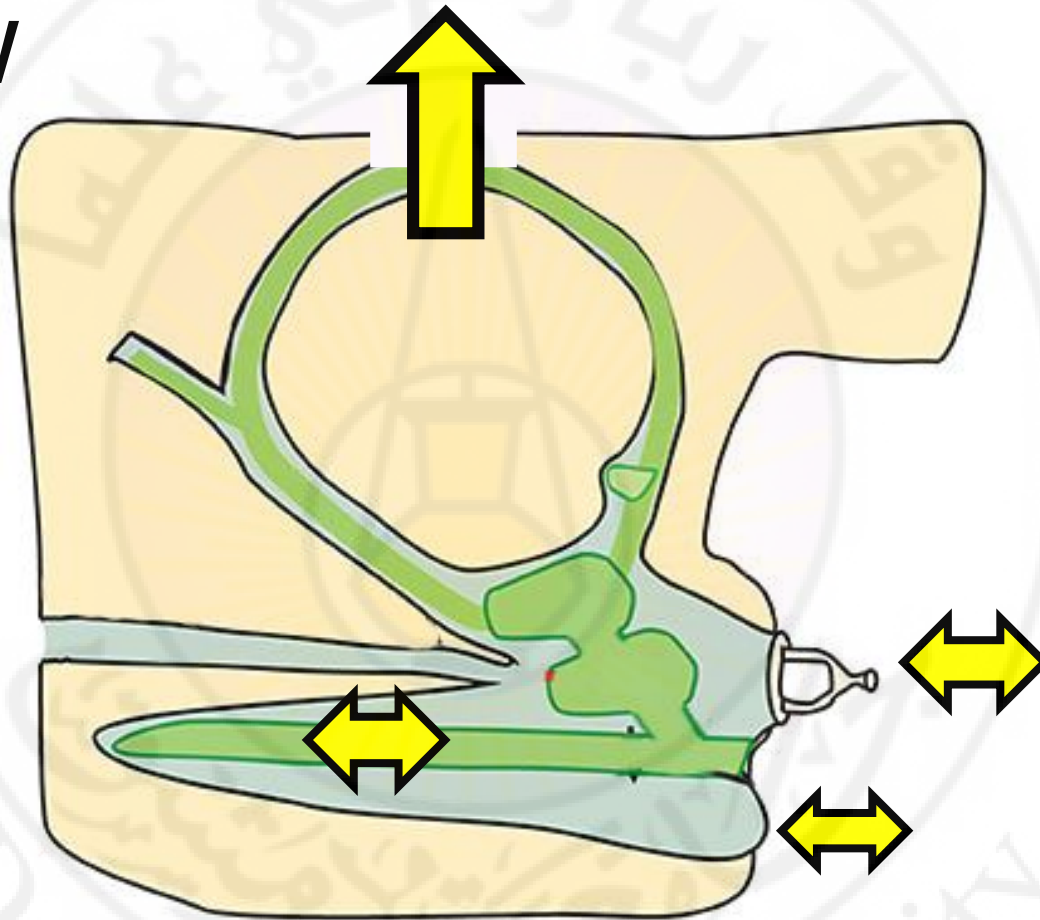
Might present as an asymptomatic normal variation .

Normal



Third window

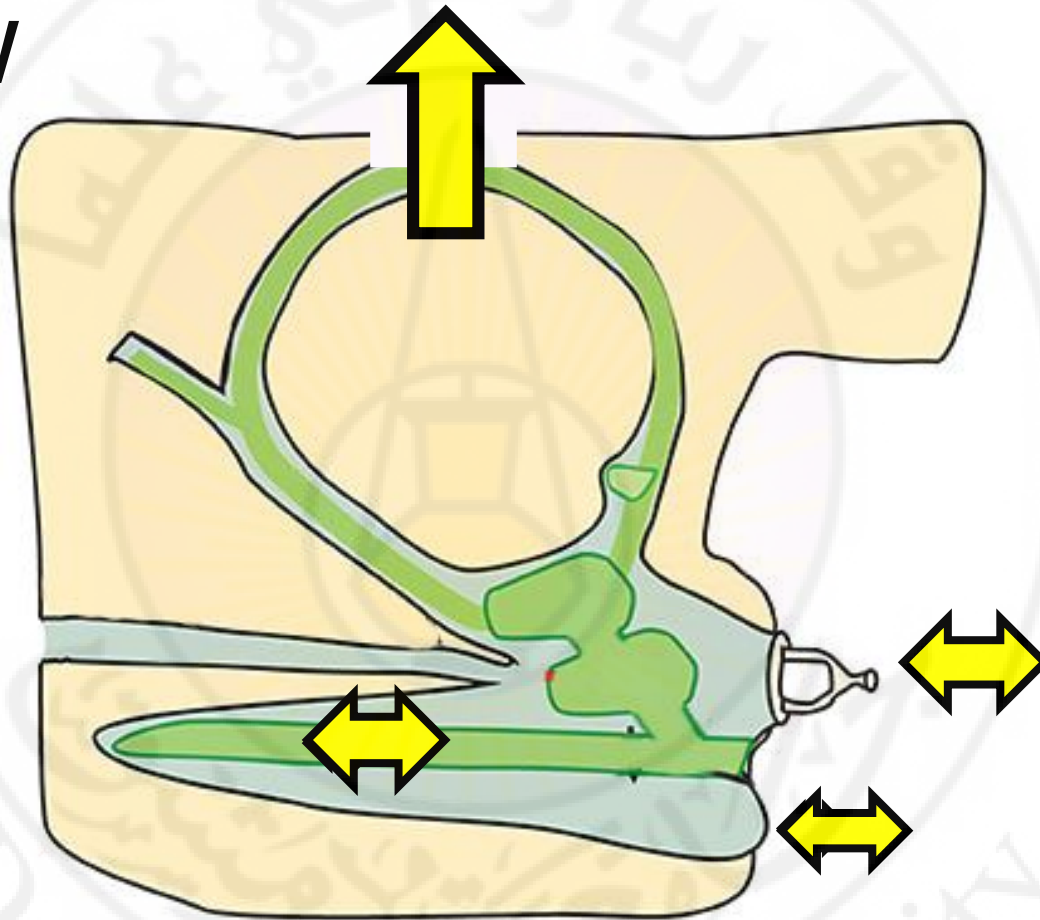
Air-conduct



Damascus University

Third
window

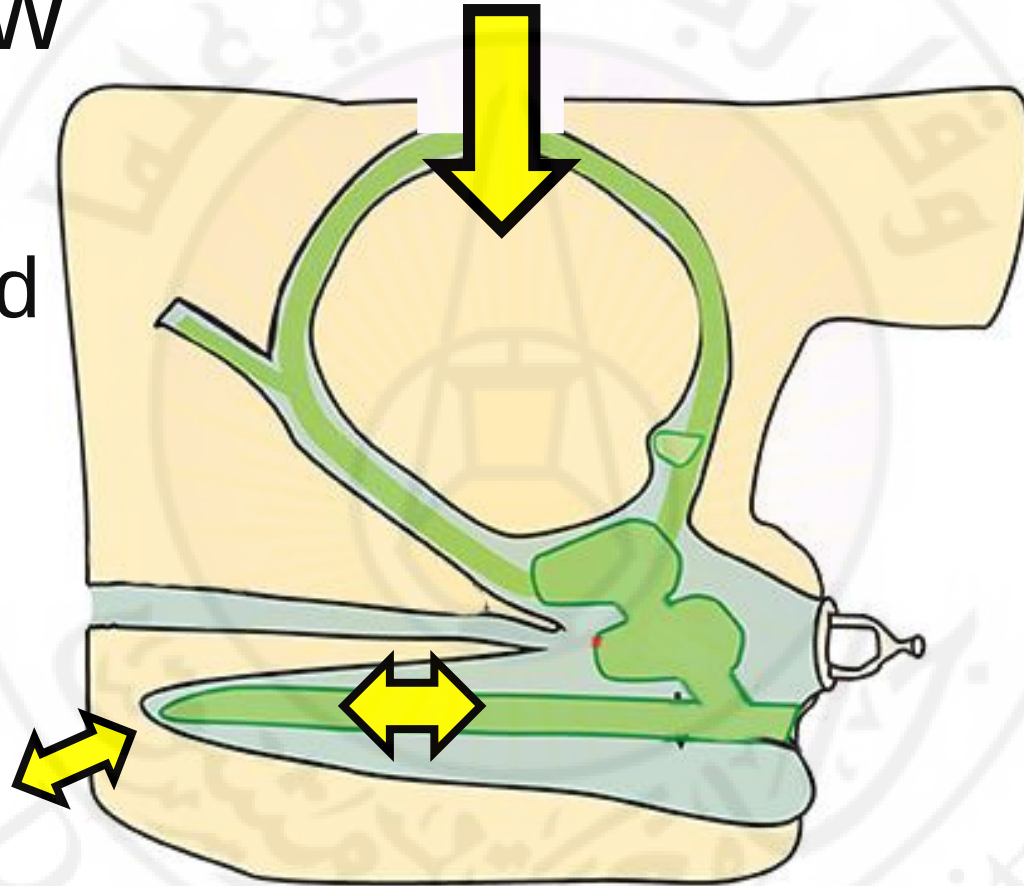
Air-conduct



Elevated Air conduction thresholds

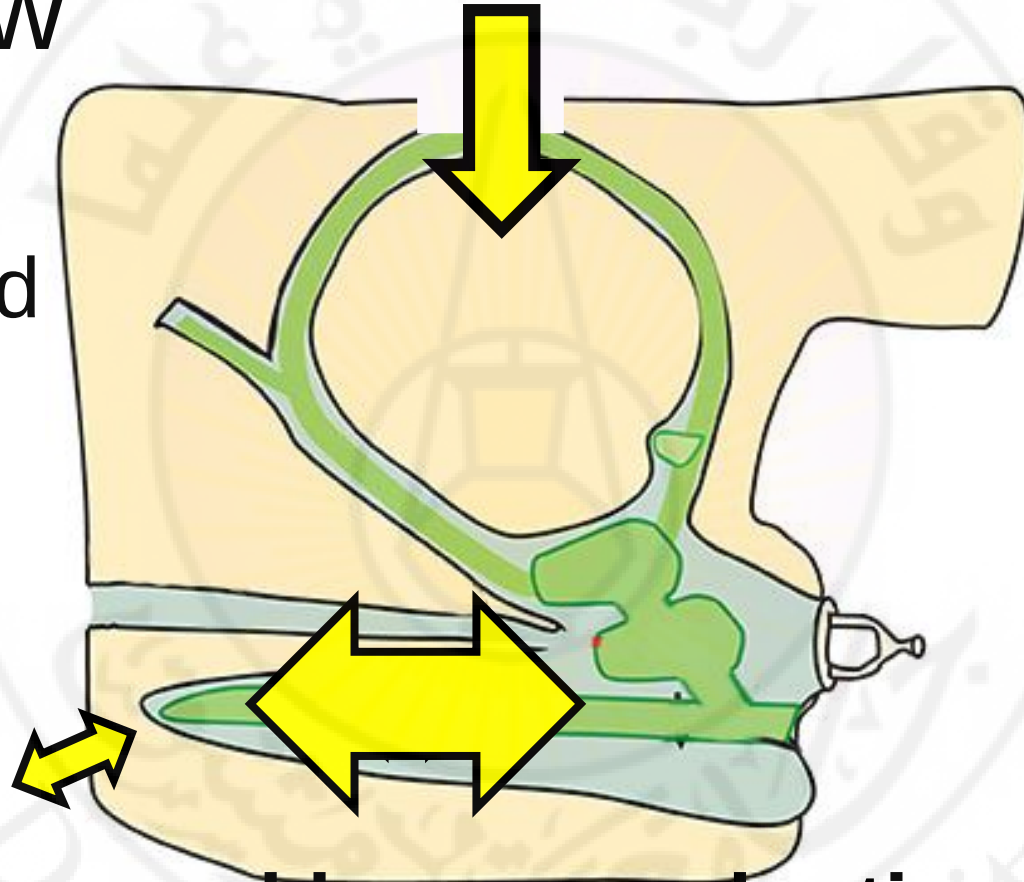
Third window

Bone-cond



Third
window

Bone-cond

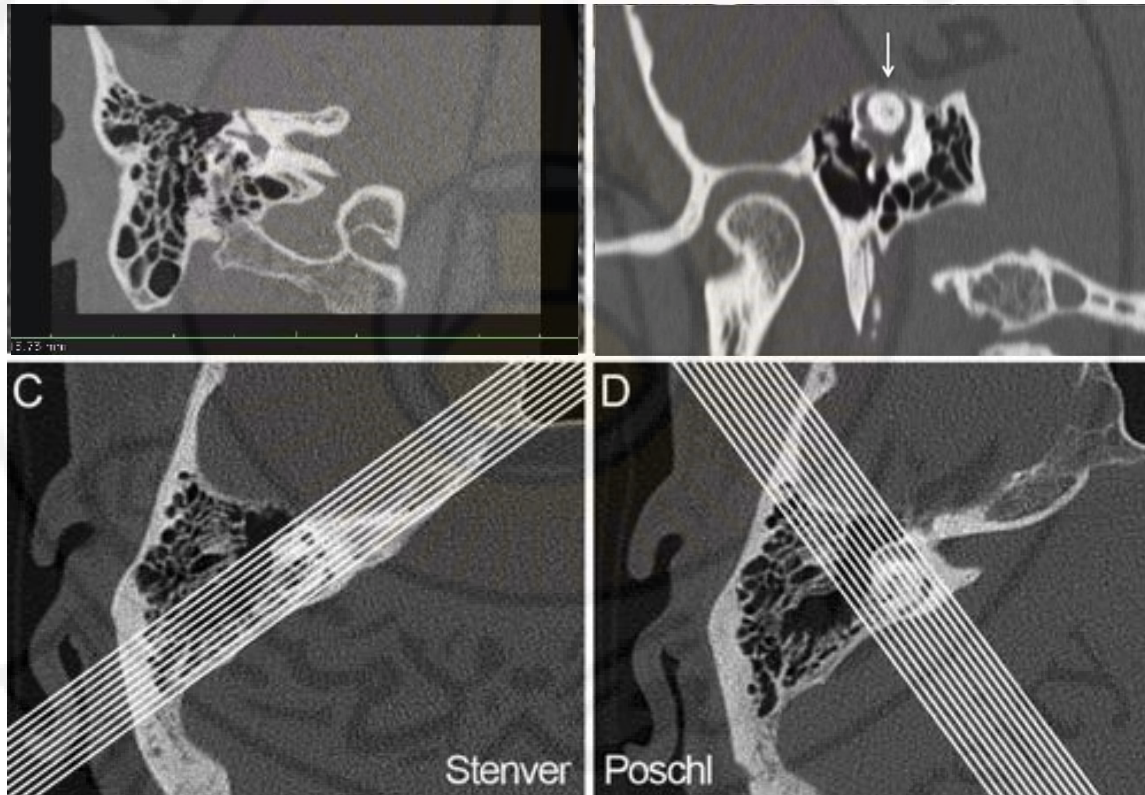


**Decreased bone conduction
thresholds**



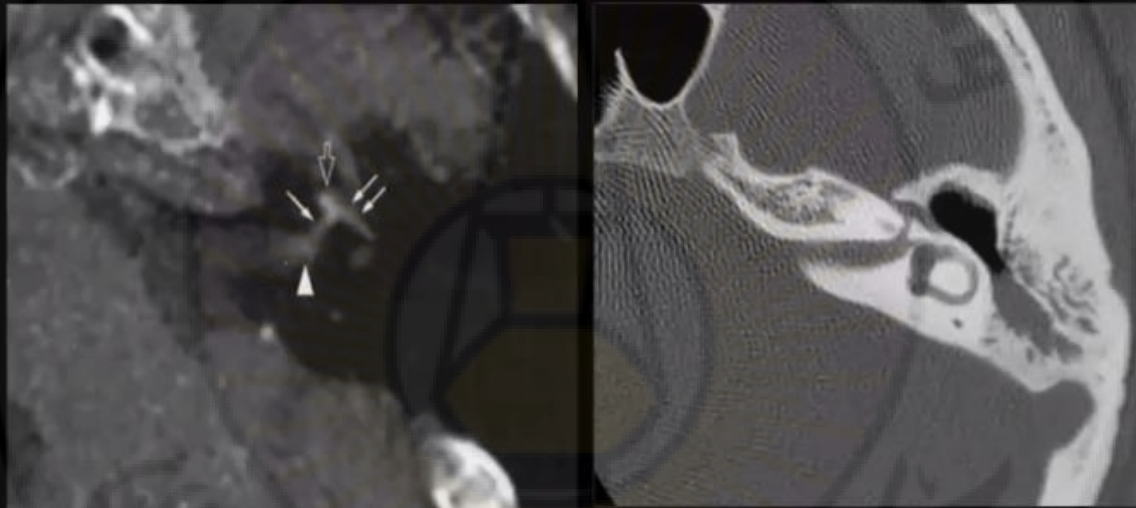
Coronal view shows SSCDS

Cross-sectional imaging



Facial neuritis

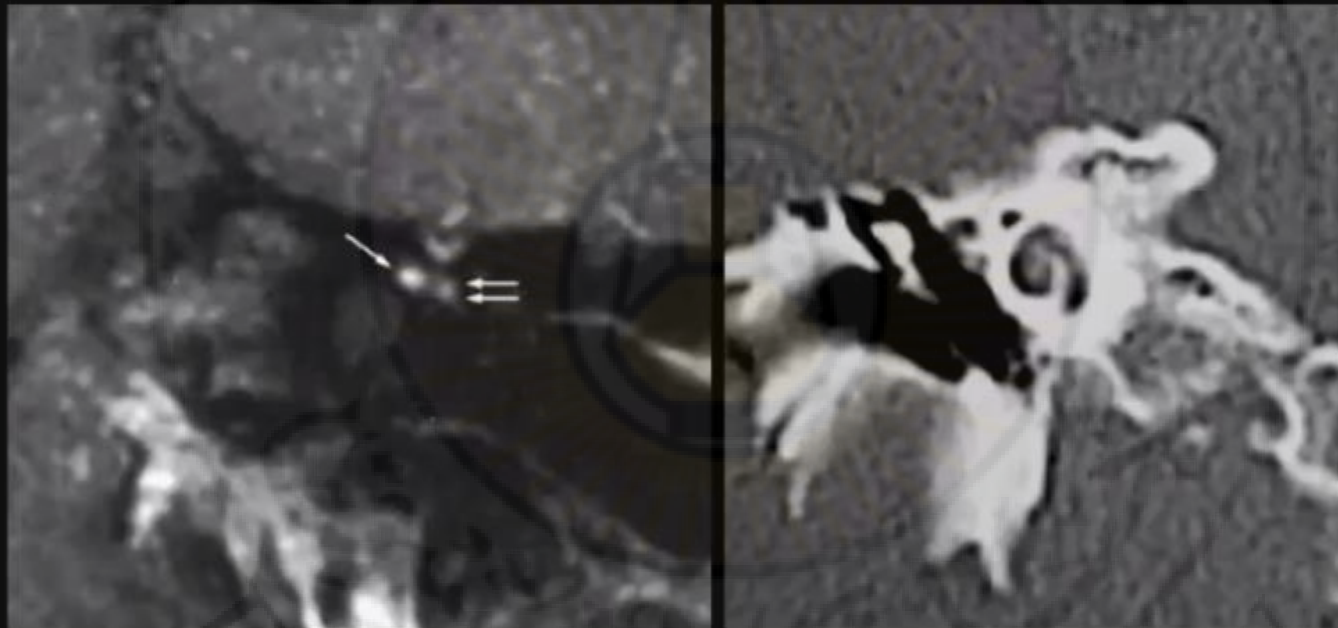
- ◆ Non specific inflammation (Bell's palsy)
- ◆ Idiopathic, herpes simplex infection



- ◆ Enhancement of the facial nerve with no enlargement or nodularity
- ◆ Comparison with the other ear is important

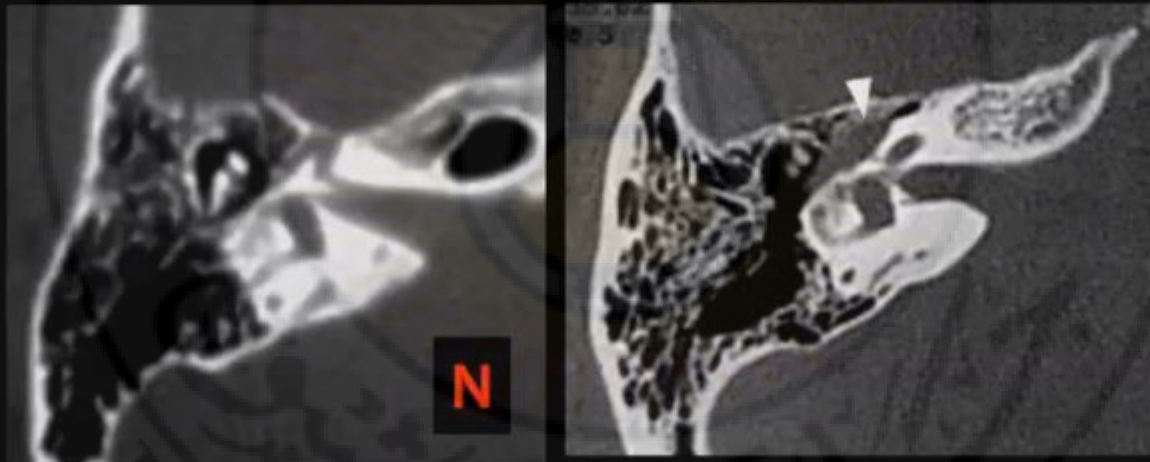
Facial neuritis

- ◆ Classical clinical presentation → **no need for imaging**
- ◆ Unresolving or progressive ? **tumor**

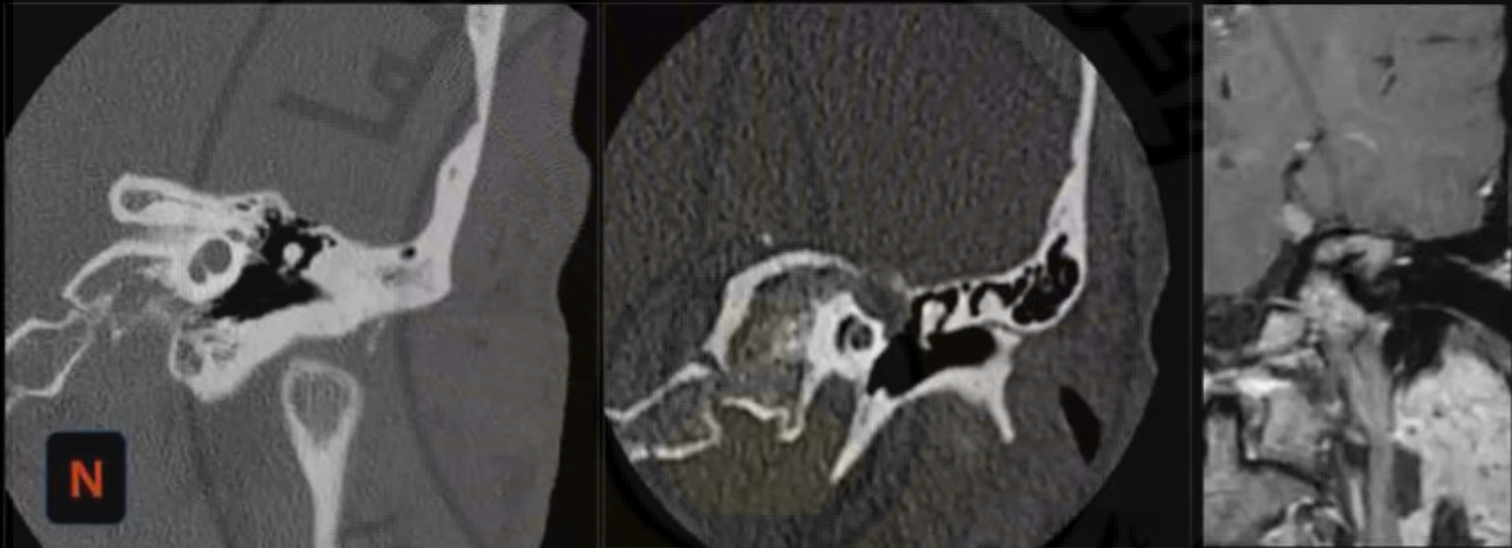


Facial nerve Schwannoma

- ◆ Uncommon
- ◆ May involve a segment, **geniculate ganglion**, or multiple segments
- ◆ The motor axons of the facial nerve are less sensitive to compression
 - ◆ Facial neuroma inside the IAC → SNHL
 - ◆ Intra canalicular facial neuroma can't be differentiated from acoustic neuroma



Facial nerve schwannoma



Facial nerve schwannoma involving the region of the geniculate ganglion

Cochlear
Nerve
atrophy

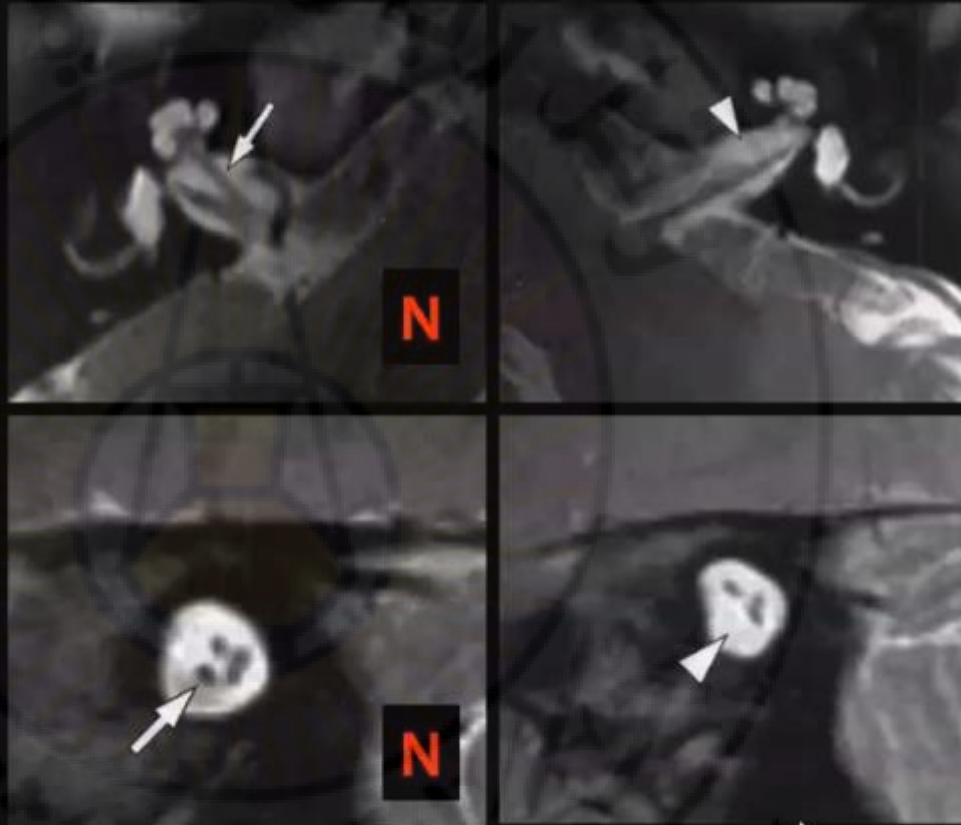
- ♦ Vascular
- ♦ Inflammatory
- ♦ Traumatic

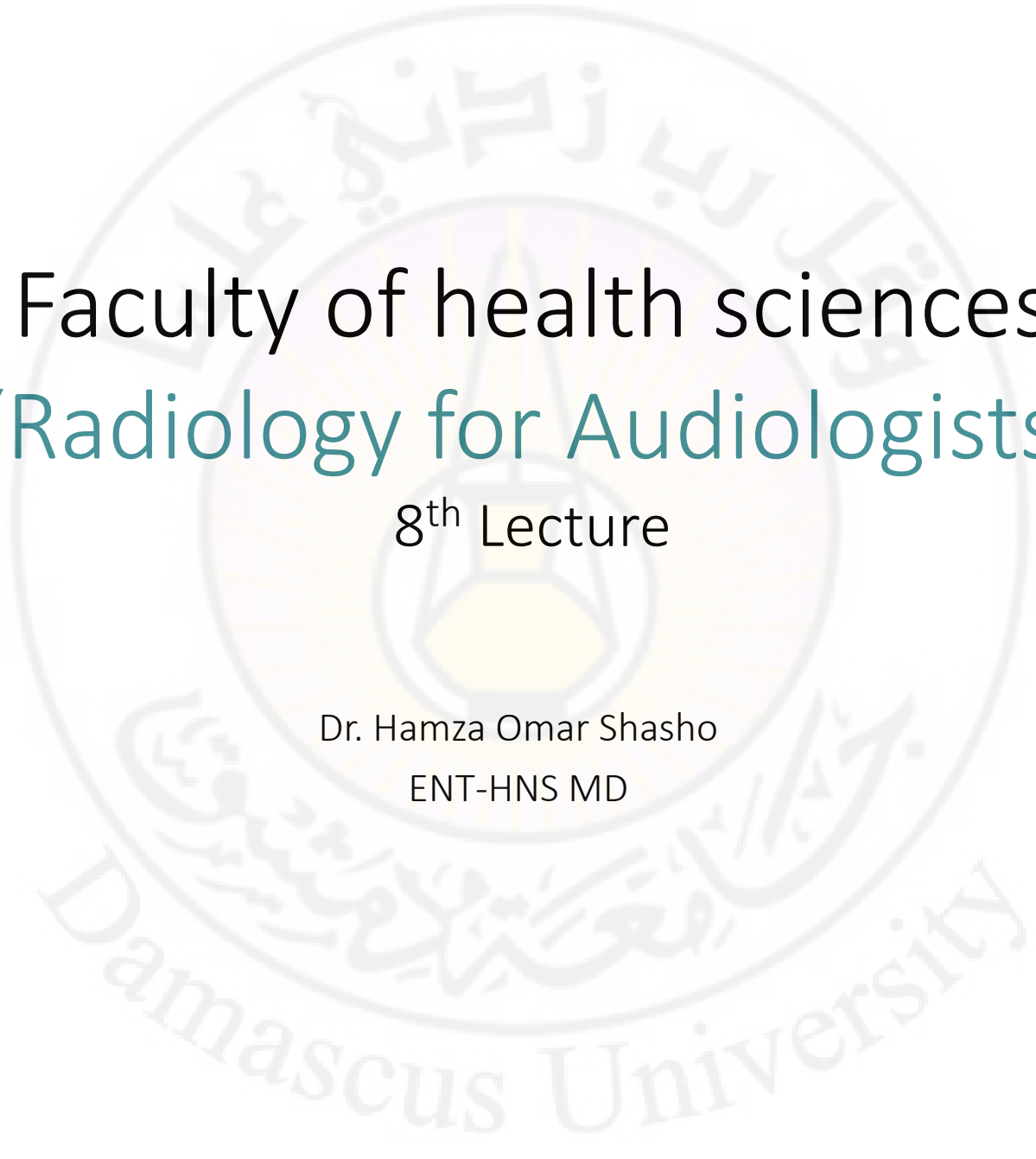


Nerve degeneration



SNHL



The background of the slide features a large, faint watermark of the Damascus University seal. The seal is circular, with the university's name in Arabic at the top and 'Damascus University' in English at the bottom. In the center is a shield with a yellow base and a purple upper section, topped by a sunburst.

Faculty of health sciences

“Radiology for Audiologists”

8th Lecture

Dr. Hamza Omar Shasho
ENT-HNS MD

Otosclerosis

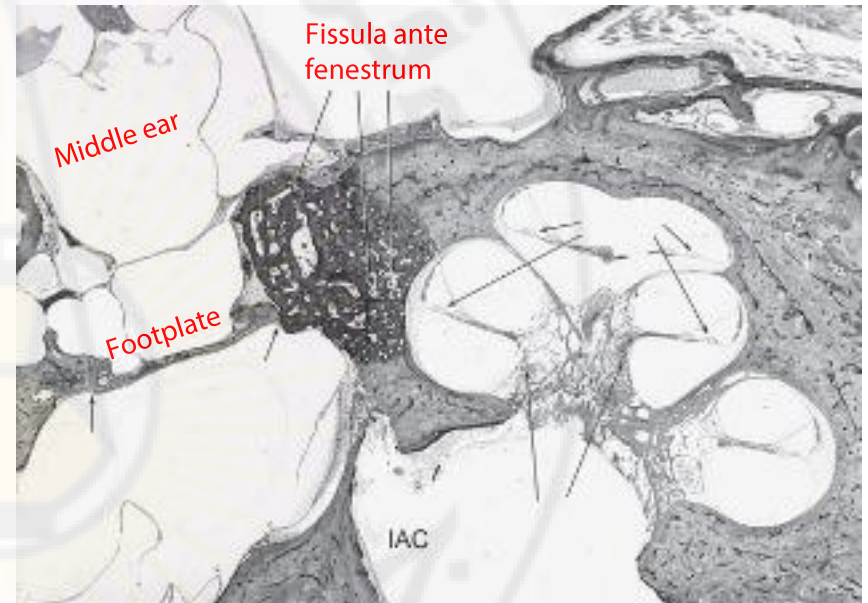
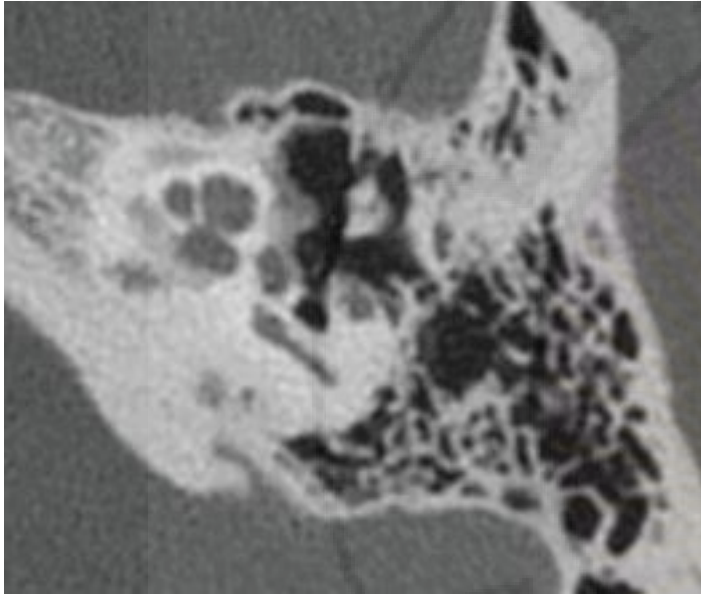
Diagnosis : CHL + Normal Otoscopy + Absent Reflexes

Imaging is not always employed in the diagnosis of typical otosclerosis with CHL, but may be utilized in patients with sensorineural or mixed hearing loss, or an atypical history. CT is the imaging method of choice, as it depicts the early bone changes associated with otosclerosis in both fenestral and retrofenestral disease.

Otosclerosis

Thin section CT shows low-density (demineralized) plaques in early disease, which typically affects the **fissula antefenestrum** at the anterior border of the oval window. The otosclerotic plaque can extend to involve the stapes foot-plate, occlude the oval window and extend to the cochlear promontory and round window region. Disease is often bilateral (up to 85% of cases).

Otosclerosis



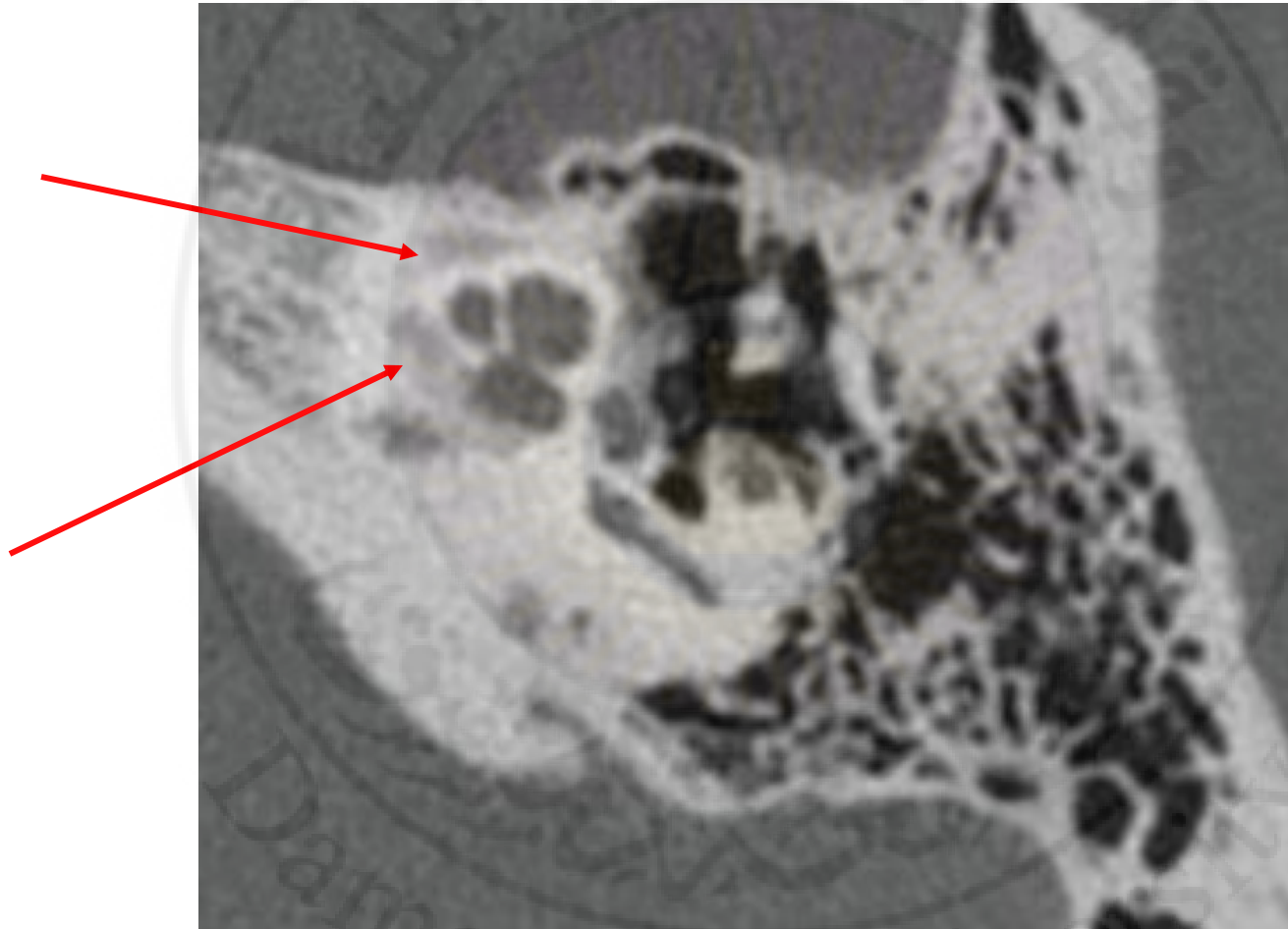
Axial CT scan of the left middle ear through the stapes footplate showing lucency anterior to the stapes footplate (1) and around the cochlear (2).

Otosclerosis

Retrofenestral disease is the less common of the two types of otosclerosis – and often considered a continuation of fenestral disease. Low density is seen extending around the otic capsule, termed the fourth ring of Valvassori.

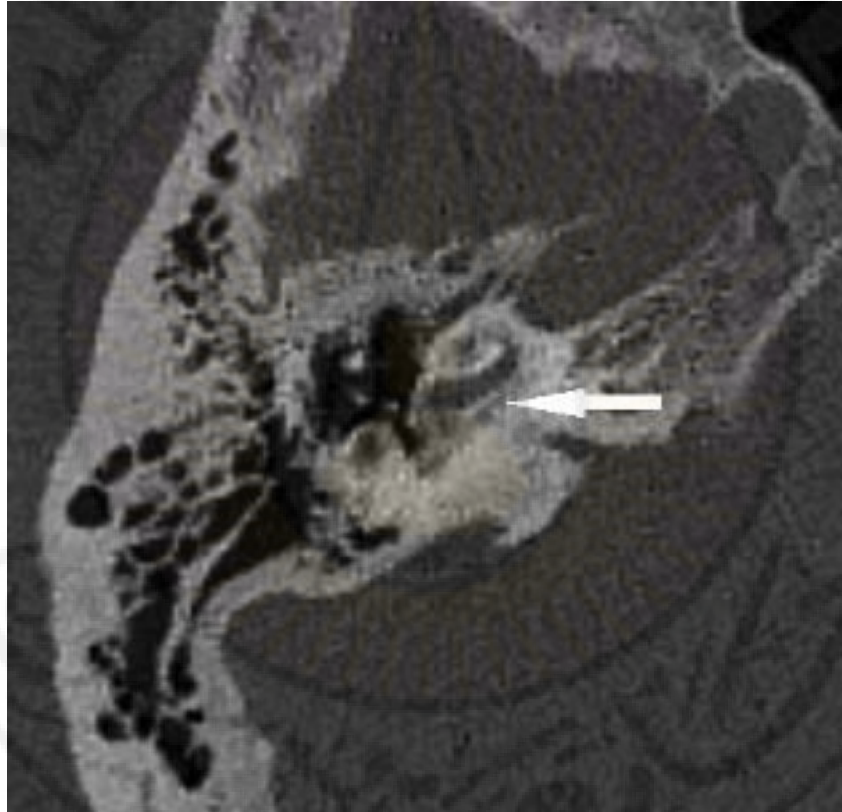
Again, disease is usually bilateral.

Otosclerosis



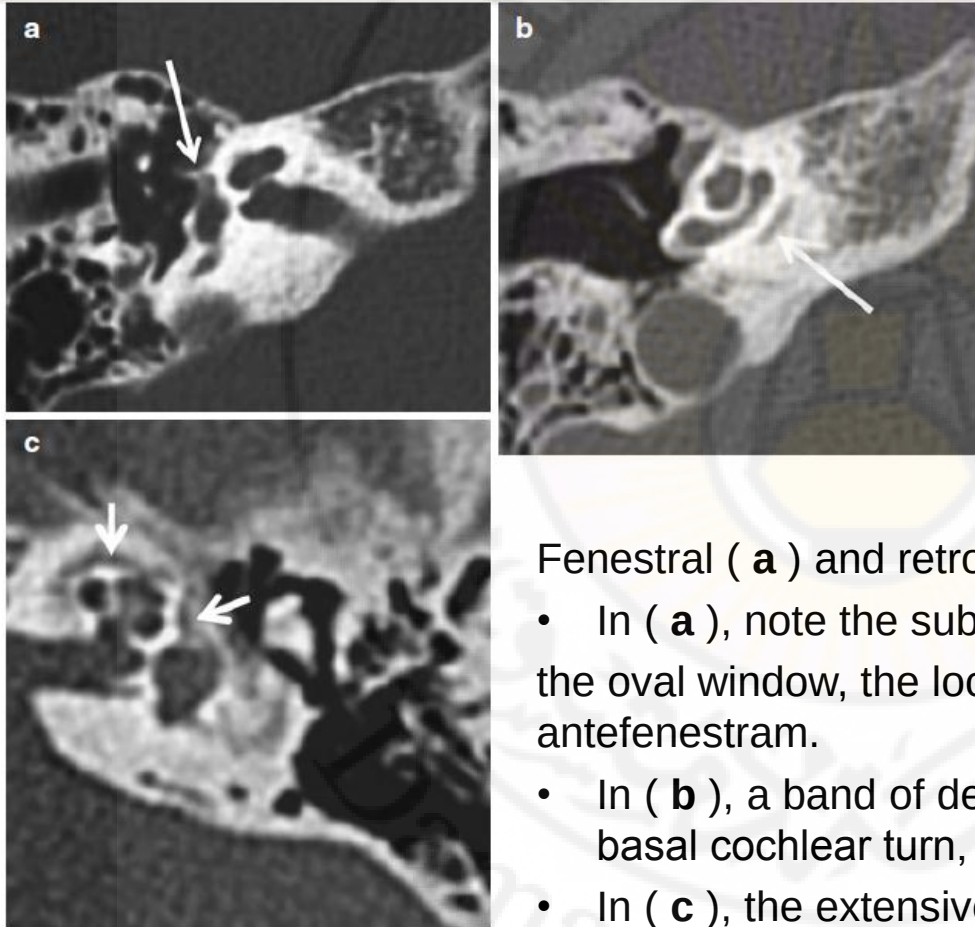
Lucency around cochlea representing retrofenestral otosclerosis
Clinically : ***cochlear otosclerosis***

Otosclerosis



Lucency around cochlea representing retrofenestral otosclerosis
Clinically : ***cochlear otosclerosis***

Otosclerosis

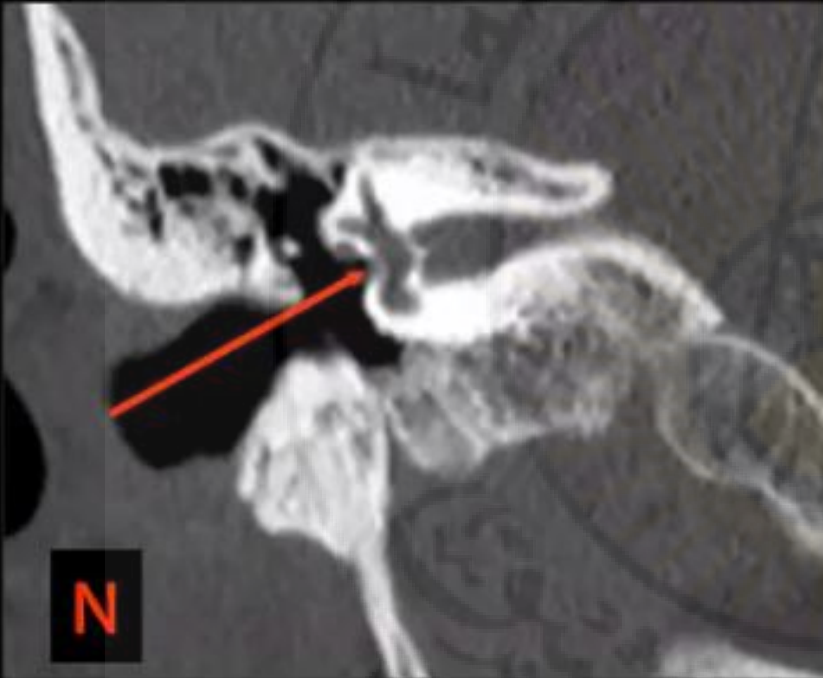


Fenestral (**a**) and retrofenestral otosclerosis (**b** , **c**).

- In (**a**), note the subtle focus of demineralization anterior to the oval window, the location of the embryonic fissula antefenestram.
- In (**b**), a band of demineralization is present parallel to the basal cochlear turn, the “fourth” turn sign.
- In (**c**), the extensive demineralization around the cochlea produces the “Halo” sign (*arrows*)

Otosclerosis

Obliteration of the oval window by bony plate



Matured dense otosclerotic plaque obliterating the oval window

low density foci turns dense when matured

Cholesteatoma in MRI

more importantly can now detect **recurrence**, replacing routine second-look surgery in many centres. Functional MRI utilizes diffusion weighted imaging (DWI), which characterizes tissues based upon the mobility of water molecules within them. Inflammatory disease will have good water mobility, whereas cholesteatoma, with tightly packed keratin and limited extracellular space, show reduced water diffusion. MRI allows imaging of sufficient resolution to detect cholesteatoma down to **2 or 3** mm diameter, without post-contrast sequences.

Cholesteatoma in MRI

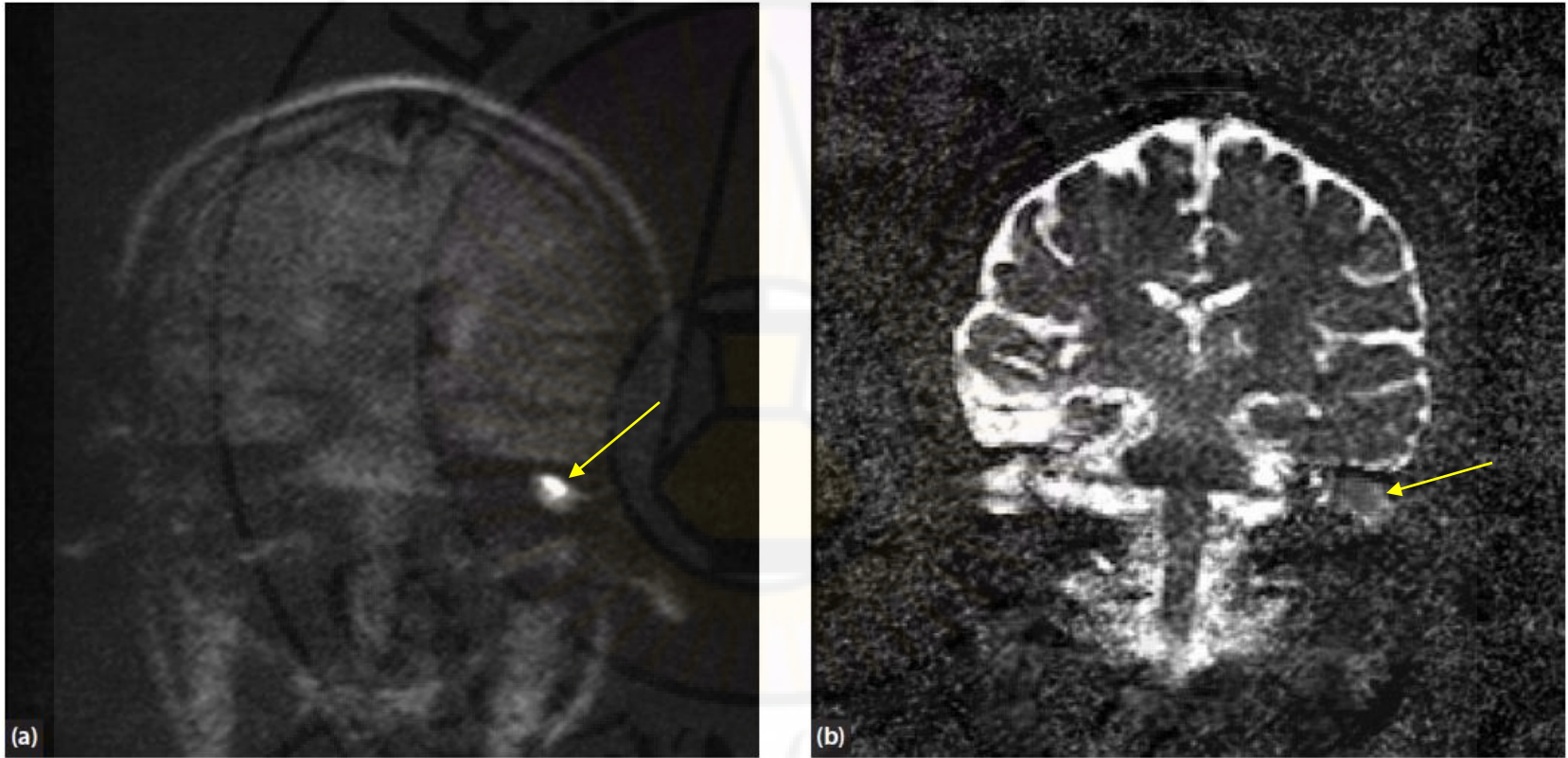


Figure 97.10 Coronal DWI MRI shows left sided high signal on the b1000 sequence (a) with matched low signal on the ADC map (b), compatible with left sided cholesteatoma.

Positive scans : typically show **high** signal on **DWI**, with matched **low** signal on the Apparent Diffusion Coefficient Map (**ADC**).

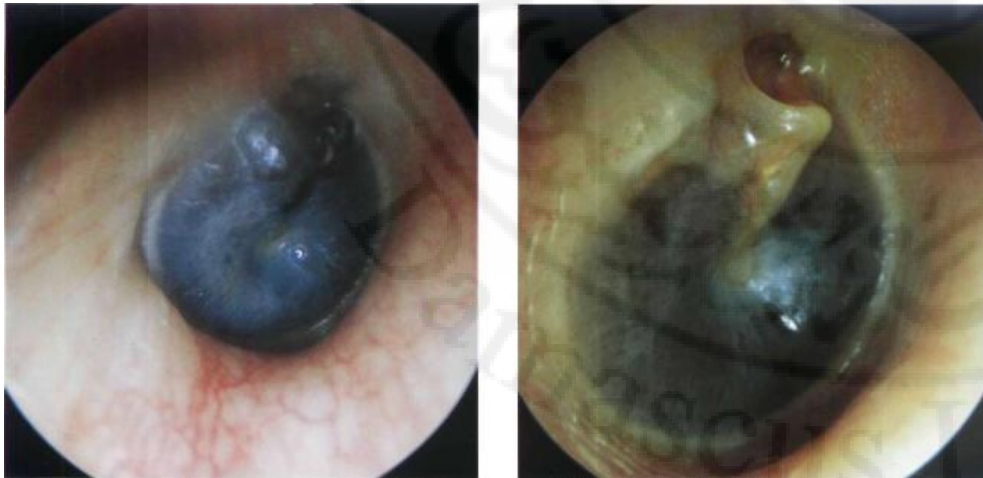
Cholesteatoma



Axial CT shows right sided epitympanic cholesteatoma, with erosion of lateral semicircular canal (arrow). Note normal bone covering of left lateral semicircular canal.

Cholesterol granuloma

Regardless of the aetiology of cholesterol granuloma, it is the repeated haemorrhage and accumulation of blood products that creates typical imaging appearances of high T1 and T2 signal intensity on MRI scan. There is no appreciable enhancement post-contrast. Diffusion weighted MRI does not show restriction. CT often shows a degree of smooth bone erosion.



Paragangliomas

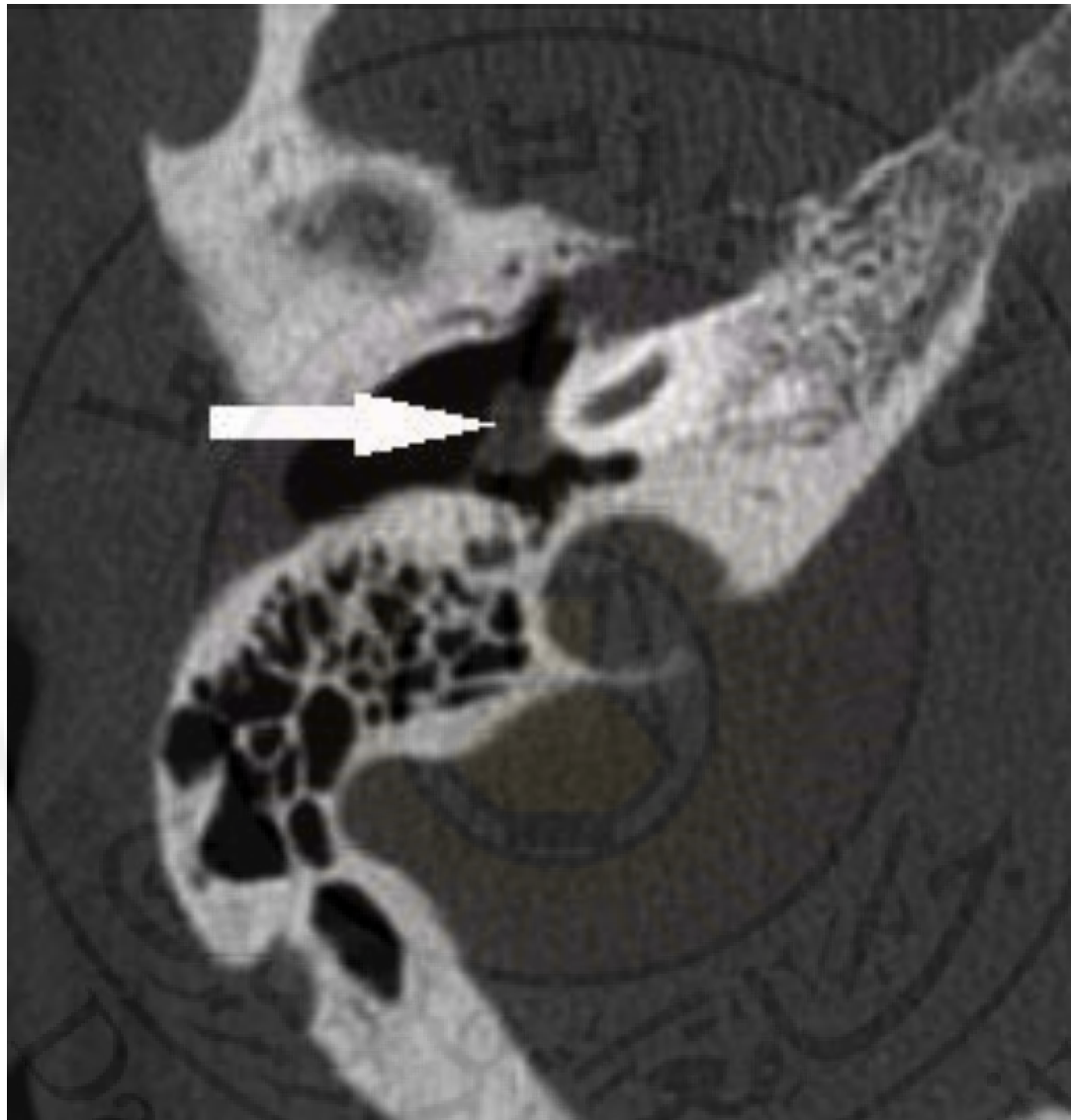
Temporal bone paragangliomas include glomus tympanicum, glomus jugulare and jugulotympanicum lesions, the latter being a combination of the former two.

Glomus tympanicum paragangliomas are the most common middle ear tumour. On CT, tumours are seen as a nodular area of soft tissue located on the cochlear promontory.

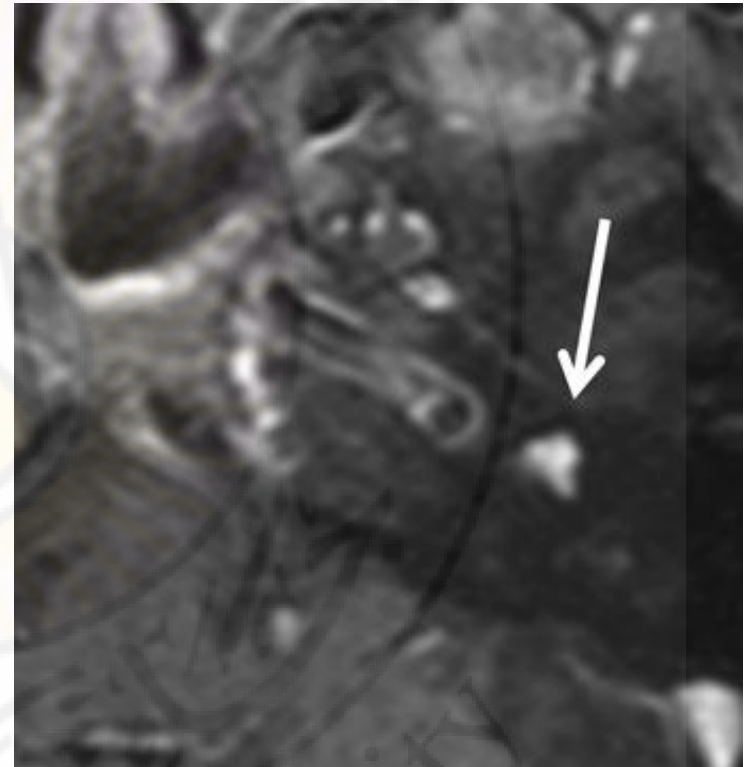
Lesions are often small but may extend to the TM and attic if larger, but do not normally cause erosion of the ossicular chain.

Glomus jugulare tumours are the most common lesions to arise in the jugular foramen.

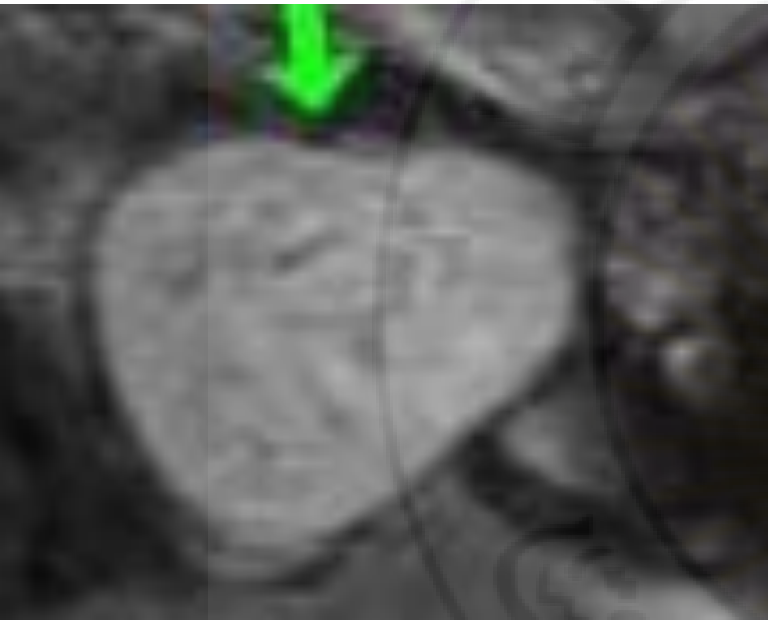
MRI scanning shows prominent post-contrast enhancement of lesions. Larger tumours may show a classical 'salt and pepper' appearance, which is a combination of flow voids from intratumoural vessels, and areas of microhaemorrhage.



- Figure 97.15 Axial CT shows a well demarcated soft tissue nodule
- behind the right TM, overlying the cochlear promontory – typical of
- a glomus tympanicum tumour.



- Glomus tympanicum. In (**a**), a sessile mass is seen overlying the promontory. It demonstrates
- intense enhancement in (**b**).



T1 : salt and pepper sign

- **Salt** : microhemorrhagic foci
- **Pepper** : flow voids of vessels

Inner ear anomalies

On both CT and MRI, it is useful to have a checklist of what normal inner ear should look like (Box 8.2). The normal cochlea should contain three turns (apical, mid, basal), a central bony modiolus, a spiral interscalar septum and a cochlear aperture. The vestibule and the three semicircular canals must always be accounted for as one or more semicircular canals may be absent. The normal vestibular aqueduct does not exceed the width of the adjacent posterior semicircular canal in caliber.

Inner ear anomalies

Box 8.2. Checklist of Inner Ear Anatomy

Presence of three ($2\frac{3}{4}$) distinct cochlear turns

Presence of a modiolus

Presence of an interscalar septum

Patent cochlear aperture

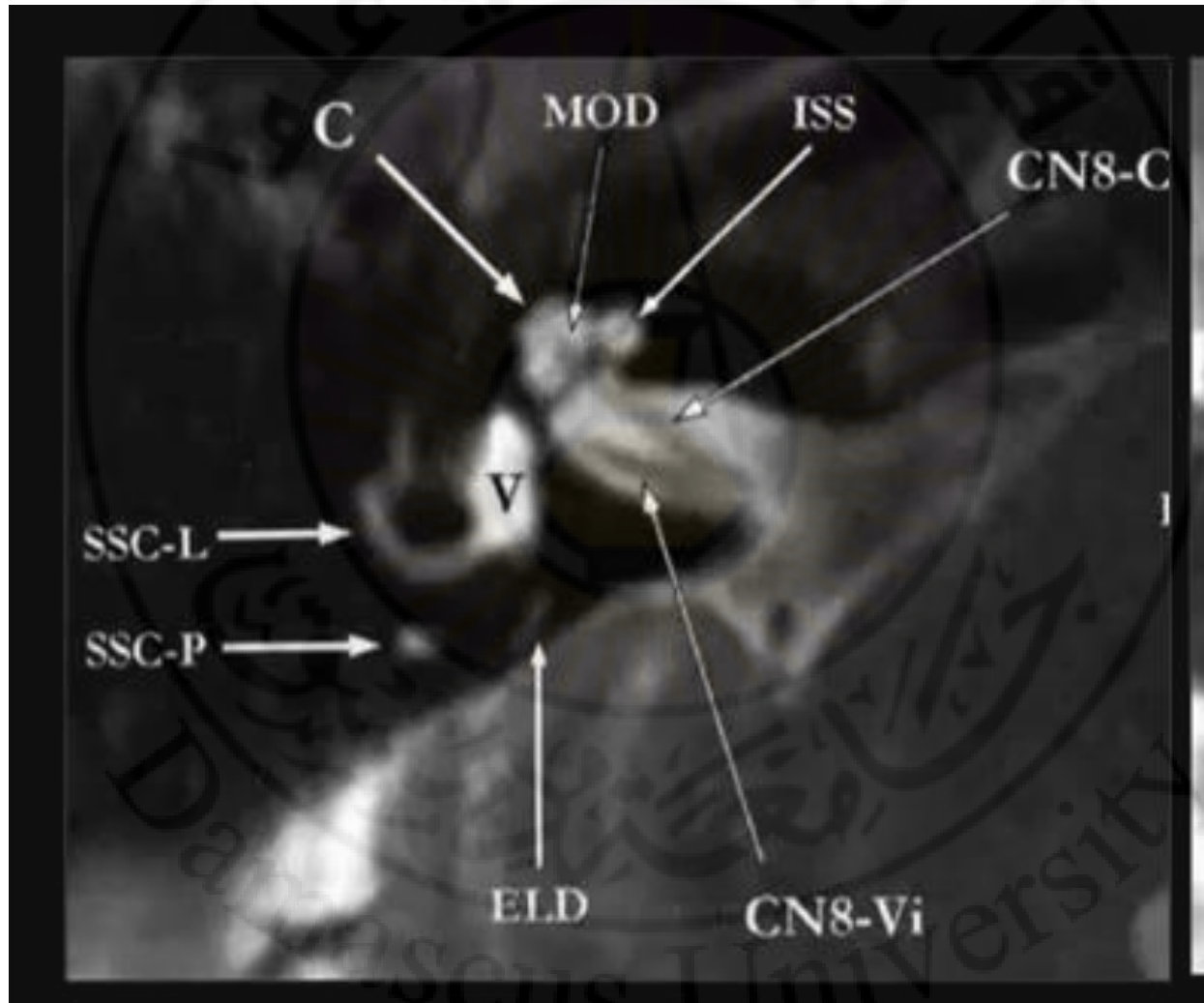
Size of the internal auditory canal

Presence of all three semicircular canals

Size of the vestibule

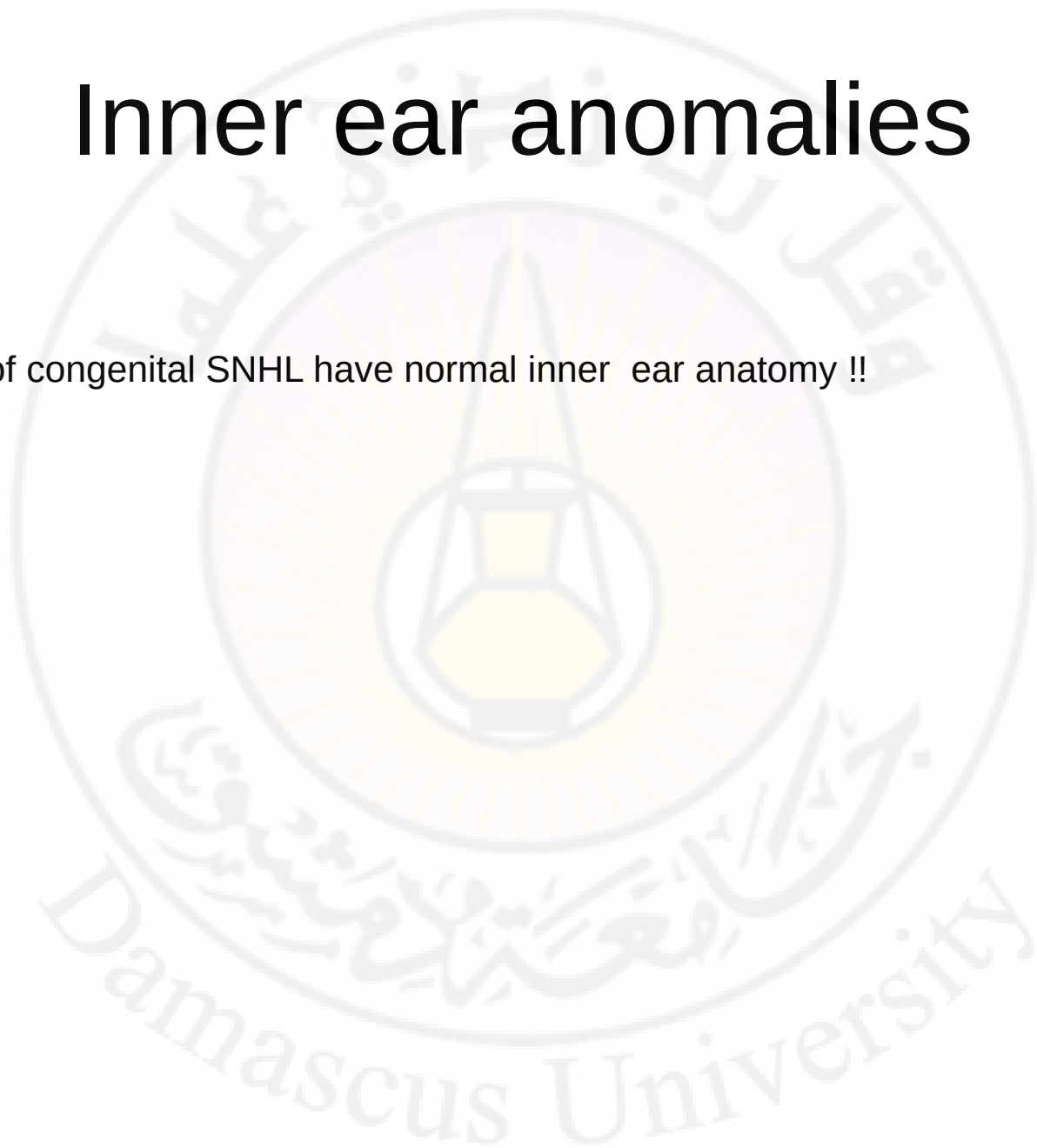
Caliber of the vestibular aqueduct – the diameter should not exceed that of the adjacent posterior semicircular canal

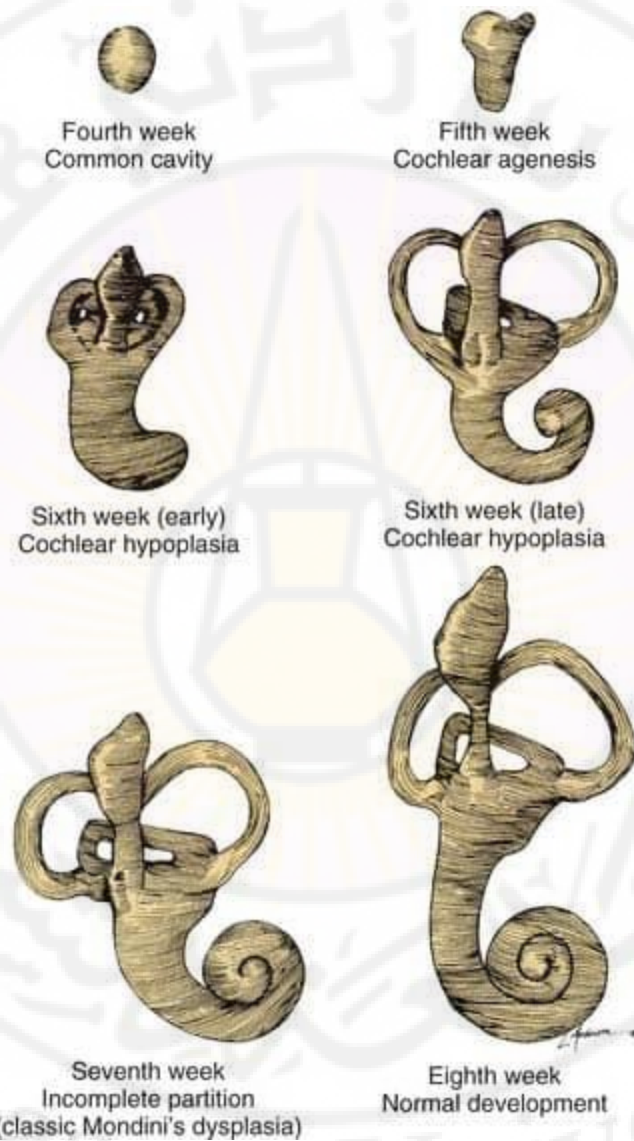
Normal inner ear



Inner ear anomalies

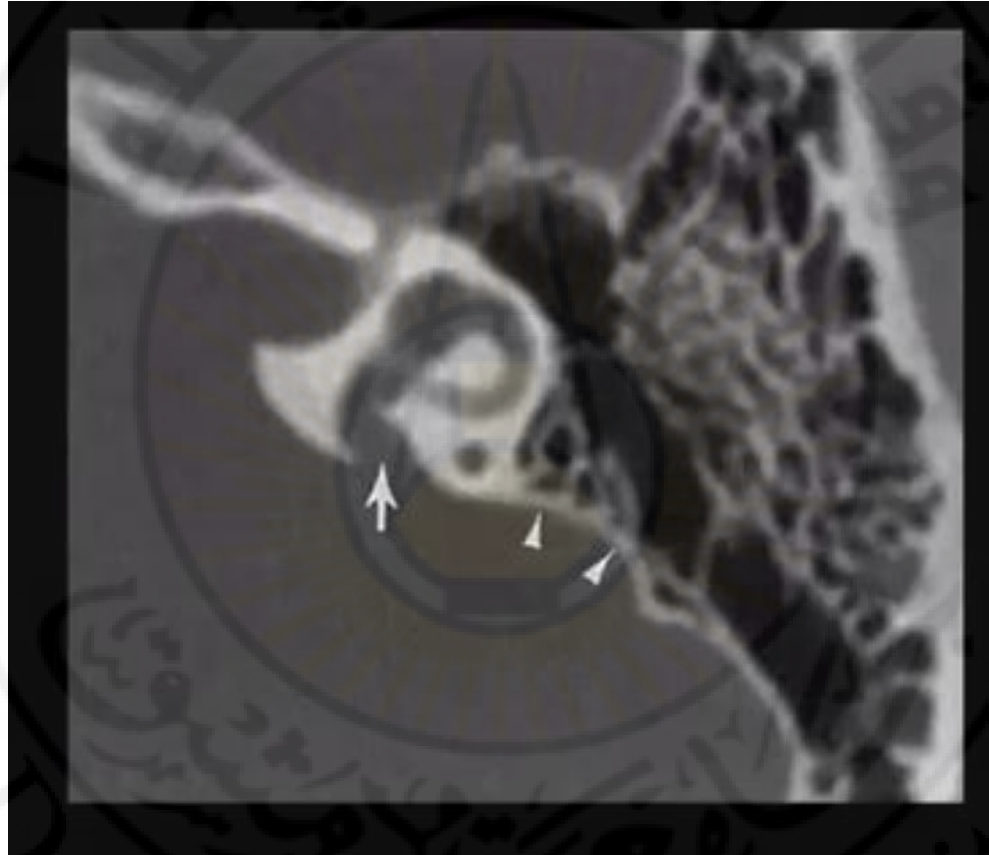
Most cases of congenital SNHL have normal inner ear anatomy !!





Inner ear anomaly originate from embryologic development arrest !!

Inner ear anomalies



Enlarged vestibular aqueduct syndrome (EVAS):

Most common inner ear anomaly

Inner ear anomalies

Michel aplasia:

**Most severe form of congenital inner
Ear malformation ,characterized by
Complete absence of inner ear
Structure (cochlea , semicircular canals
And vestibule and cochlear aqueducts)**

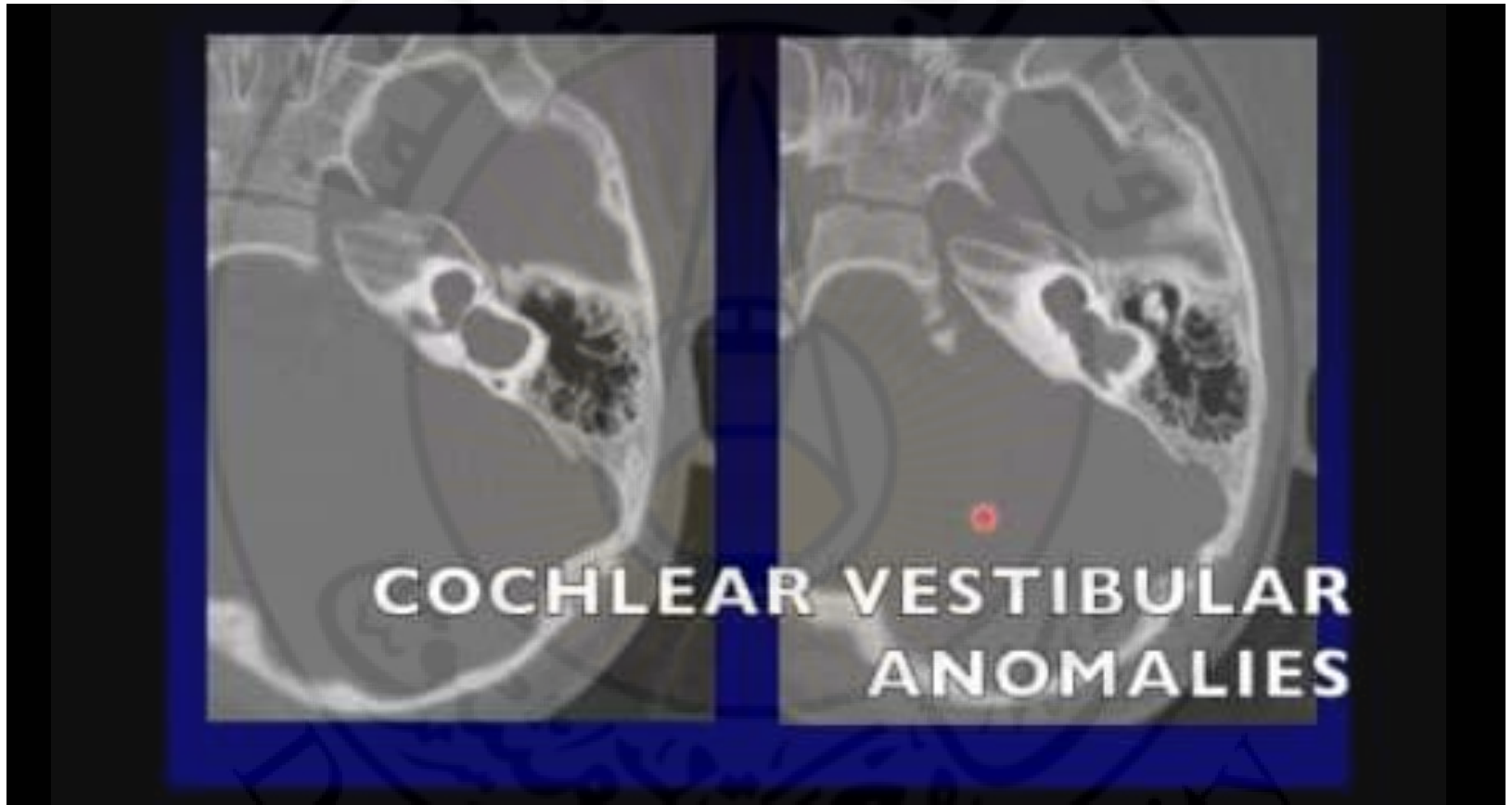


Inner ear anomalies



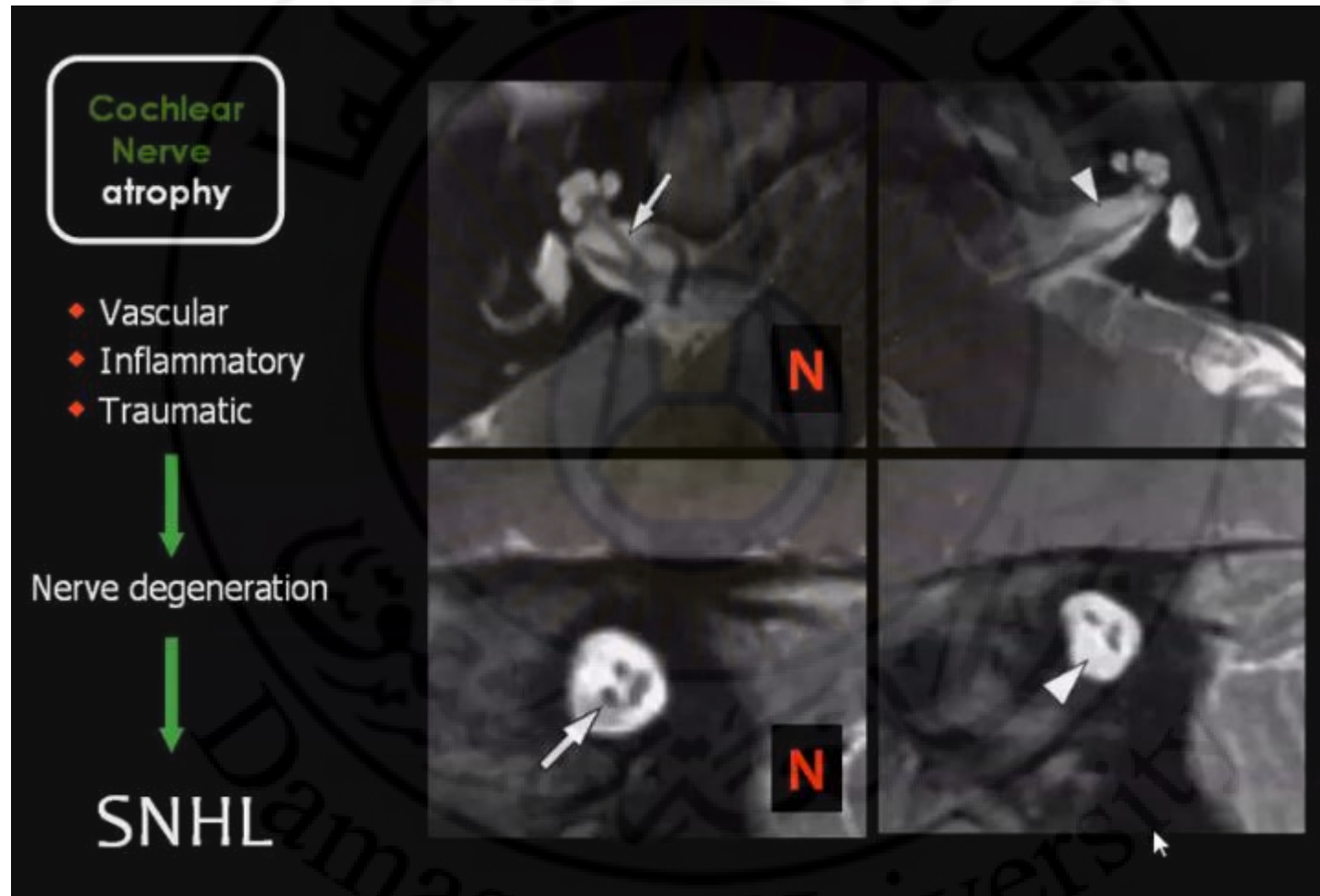
Common cavity anomaly : inner ear consists of a single cavity with no distinguishable structures

Inner ear anomalies

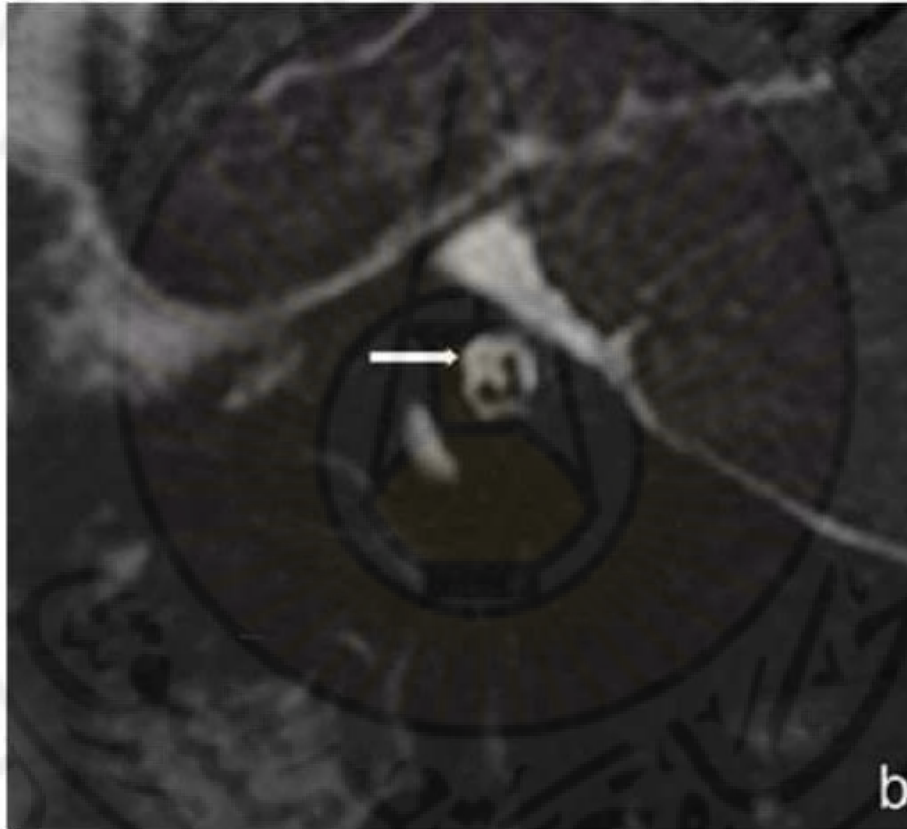


Cochlear vestibular anomalies: cochlea and vestibule are formed but disfigured.

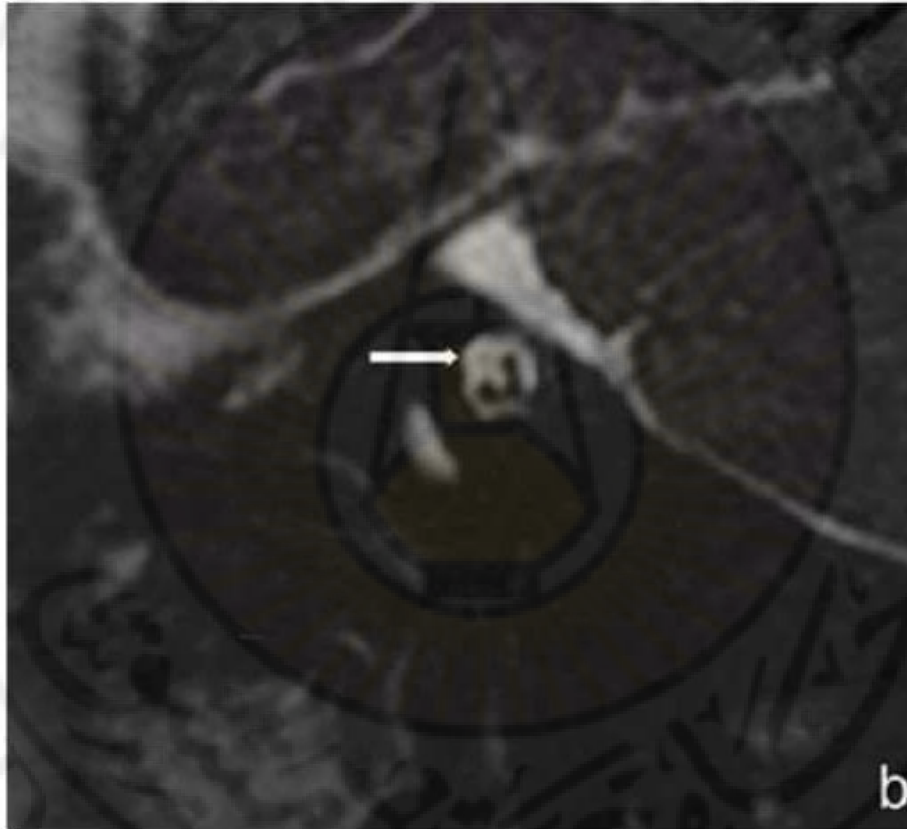
Inner ear anomalies



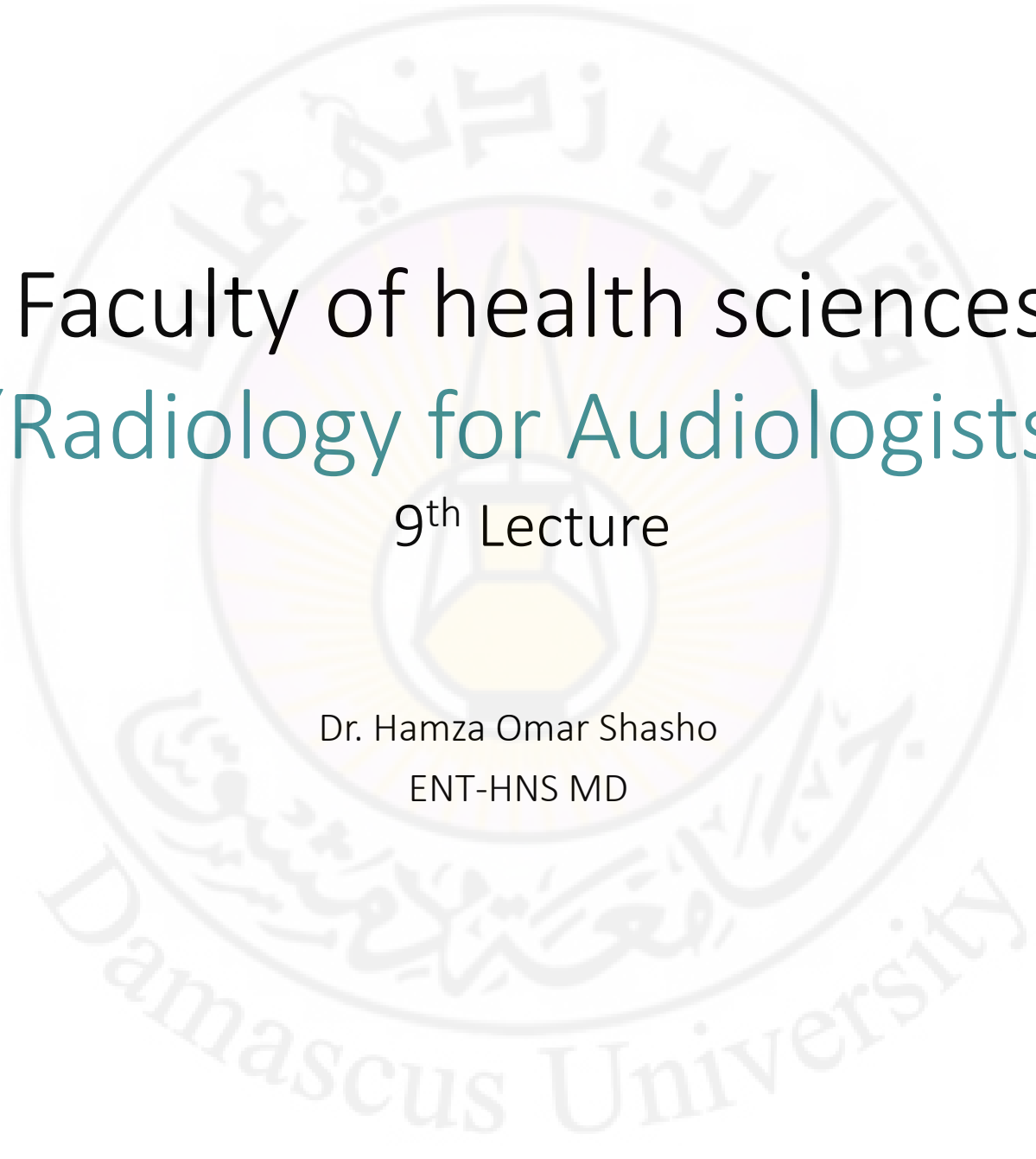
Inner ear anomalies



Inner ear anomalies



Facial nerve aplasia



Faculty of health sciences

“Radiology for Audiologists”

9th Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

NEUROIMAGING is an umbrella term encompassing a variety of methods and technologies. Collectively these varied techniques are oftentimes referred to as “brain scans.”

Structural Imaging

Functional Imaging

Damascus University

Structural Imaging

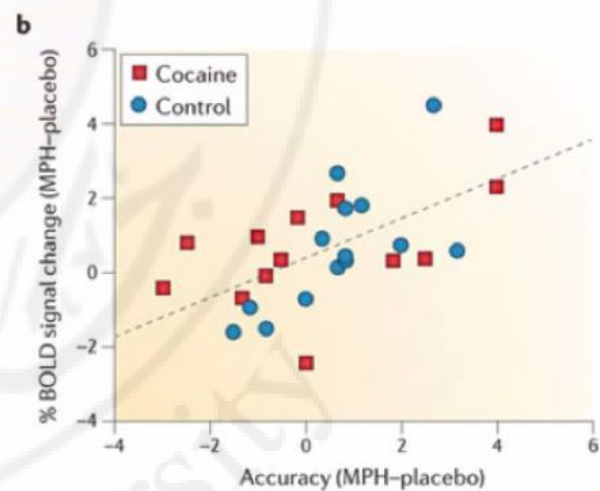
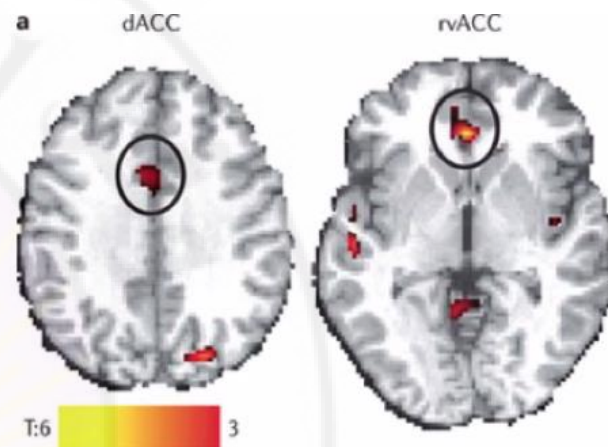
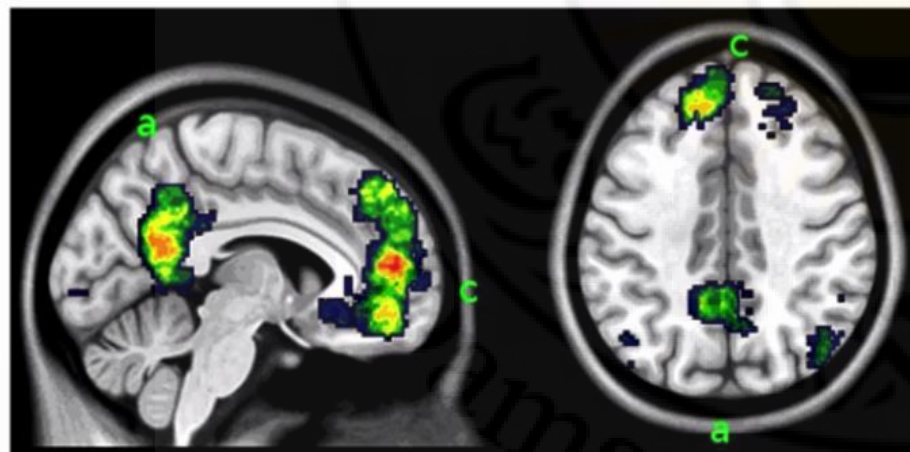
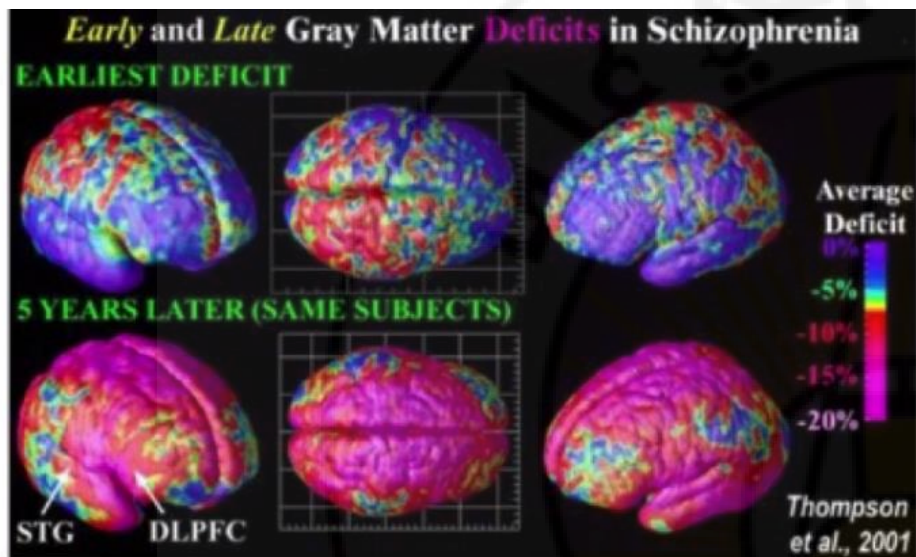
Structural imaging provides images of the brain's anatomical structure. This type of imaging helps in the diagnosis of brain injury, and the diagnosis of certain diseases.

The two types of structural imaging techniques are computerized tomography (CT), and magnetic resonance imaging (MRI).

Functional Imaging

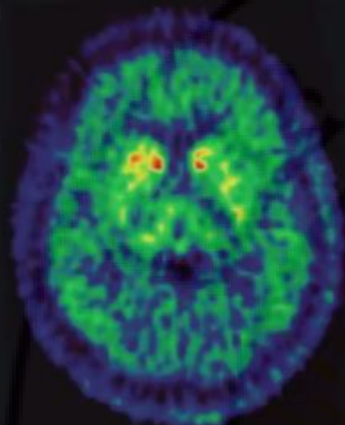
Functional imaging provides images of the brain as patients complete tasks, such as solving math problems, reading, or responding to stimuli such as auditory sounds or flashing lights. The area or areas of the brain that are involved with completing or responding to these tasks “light up,” giving researchers a visual 3-D view of the parts of the brain involved with each type of task.

Three main types of functional imaging technologies are: positron emission tomography (PET); regional cerebral blood flow (rCBF); and functional magnetic resonance imaging (fMRI).

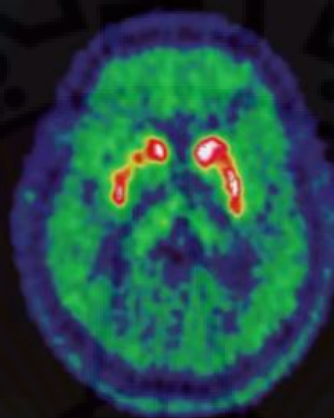


a ^{18}F -dopa DDC PET

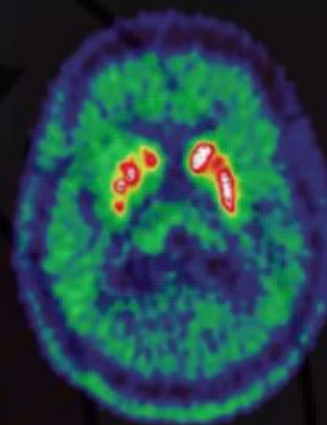
Fetal tissue transplants



Pre-op



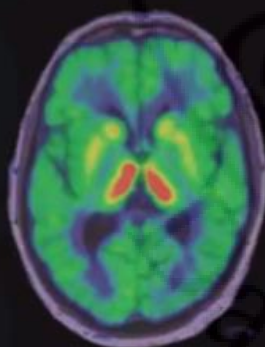
1 year post-op



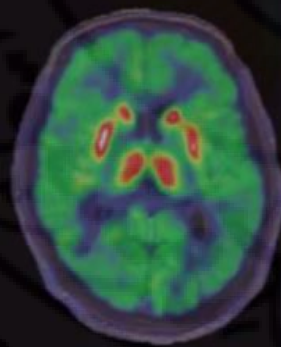
2 years post-op

b ^{11}C -DASB SERT PET

Fetal tissue transplants



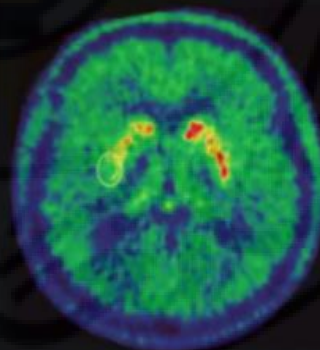
No operation



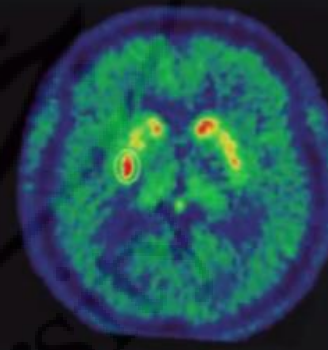
1 year post-op

c ^{18}F -dopa DDC PET

BDNF infusions



Pre-op



2 years post-op

Head CT in Acute Situation

- Anytime someone has head trauma with altered mental status they should have a head CT
- You are looking for acute blood, which is **bright**
- All MD's should know what acute blood looks like and be able to describe its general location:

	Location (causes)
• Epidural	between skull and dura (trauma)
• Subdural	between dura and arachnoid (trauma)
• Subarachnoid (SAH) rupture)	cisterns or sulci (trauma, aneurysm)
• Intraventricular (IVH)	ventricles (trauma, HTN hemorrhage)
• Intraparaenchymal (IPH)	brain tissue (trauma, tumor, HTN hem)

Bleeding might be traumatic or non-traumatic (eg :Hypertension)

Examples of bleeding in different locations

Epidural hemorrhage:
Bi-convex /
lenticular in
shape

subdural hemorrhage:
crescent-
shape

EDH
Blood spread
limited by
suture lines

SDH
Blood crosses
suture lines

Midline shift

IPH

Cerebral hemorrhage

EDH

Contusion/Hematoma

SDH

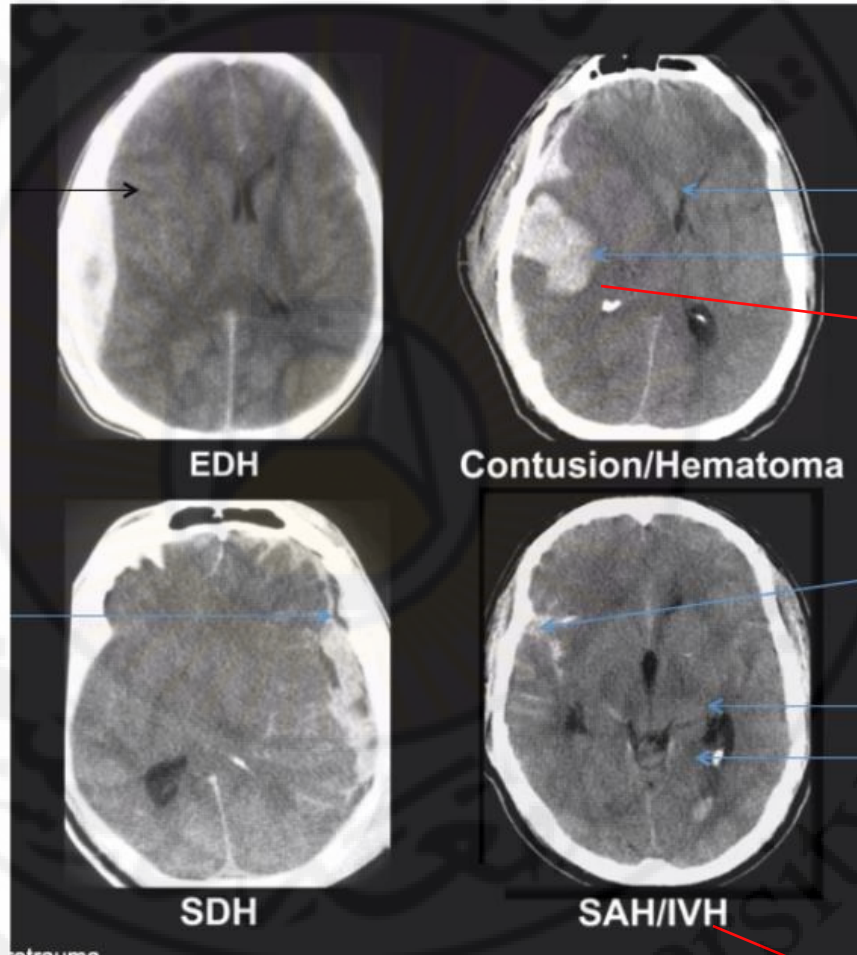
SAH/IVH

SAH filling sulci

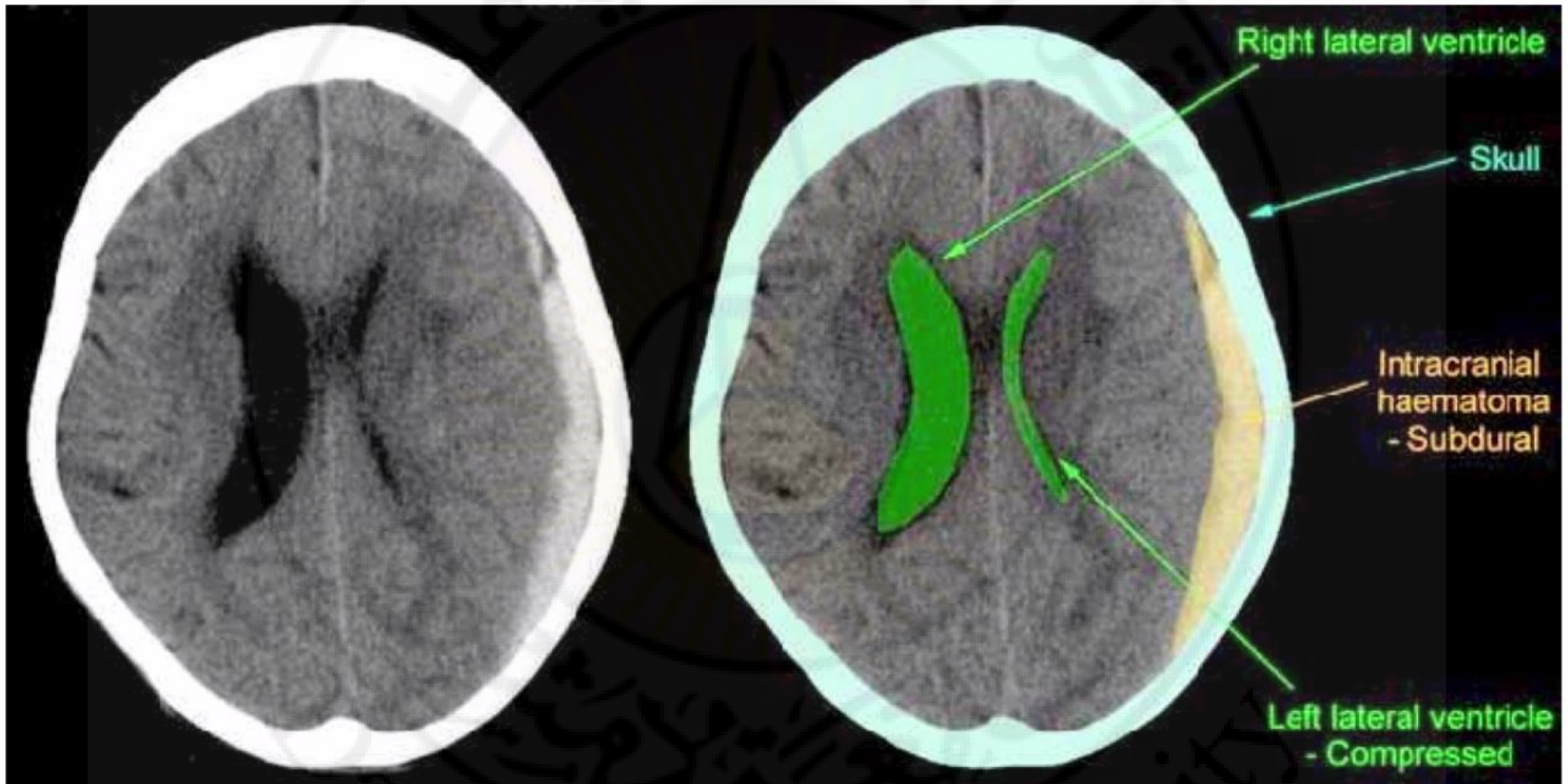
Calcified choroid
Plexus (normal)

IVH

Subarachnoid hemorrhage and
intraventricular hemorrhage

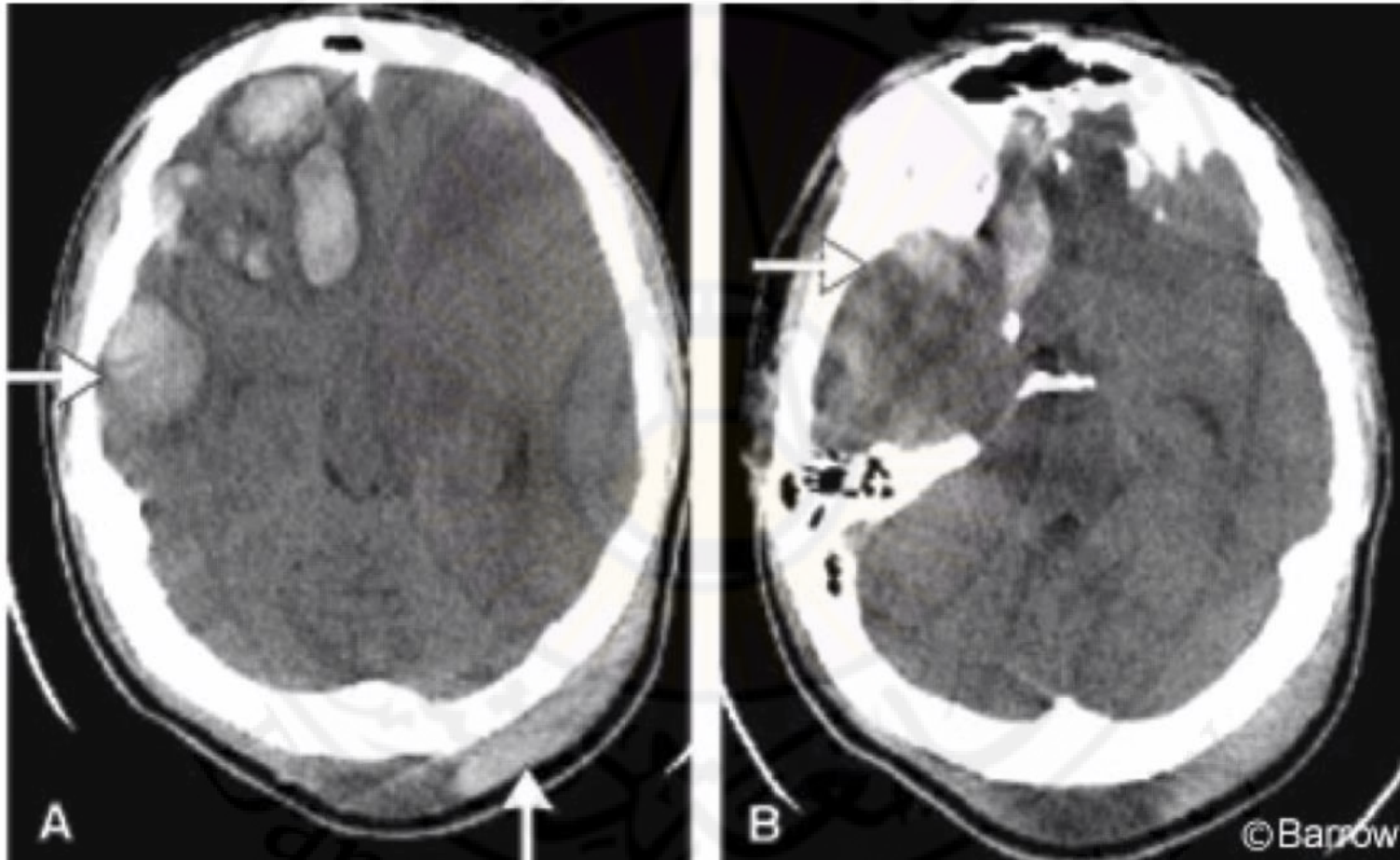


subdural hemorrhage: crescent-shape

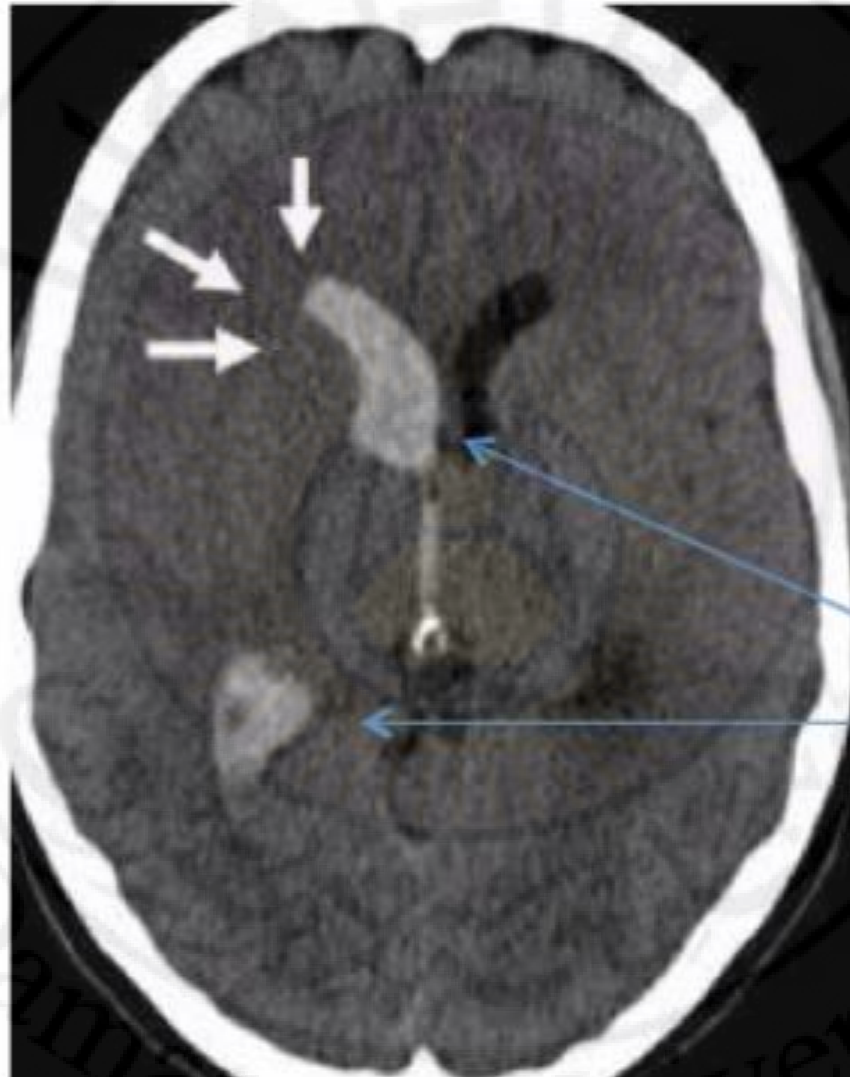


Cerebral hemorrhage

“Multifocal foci”



intraventricular
hemorrhage



IVH



Subarchnoid hemorrhage

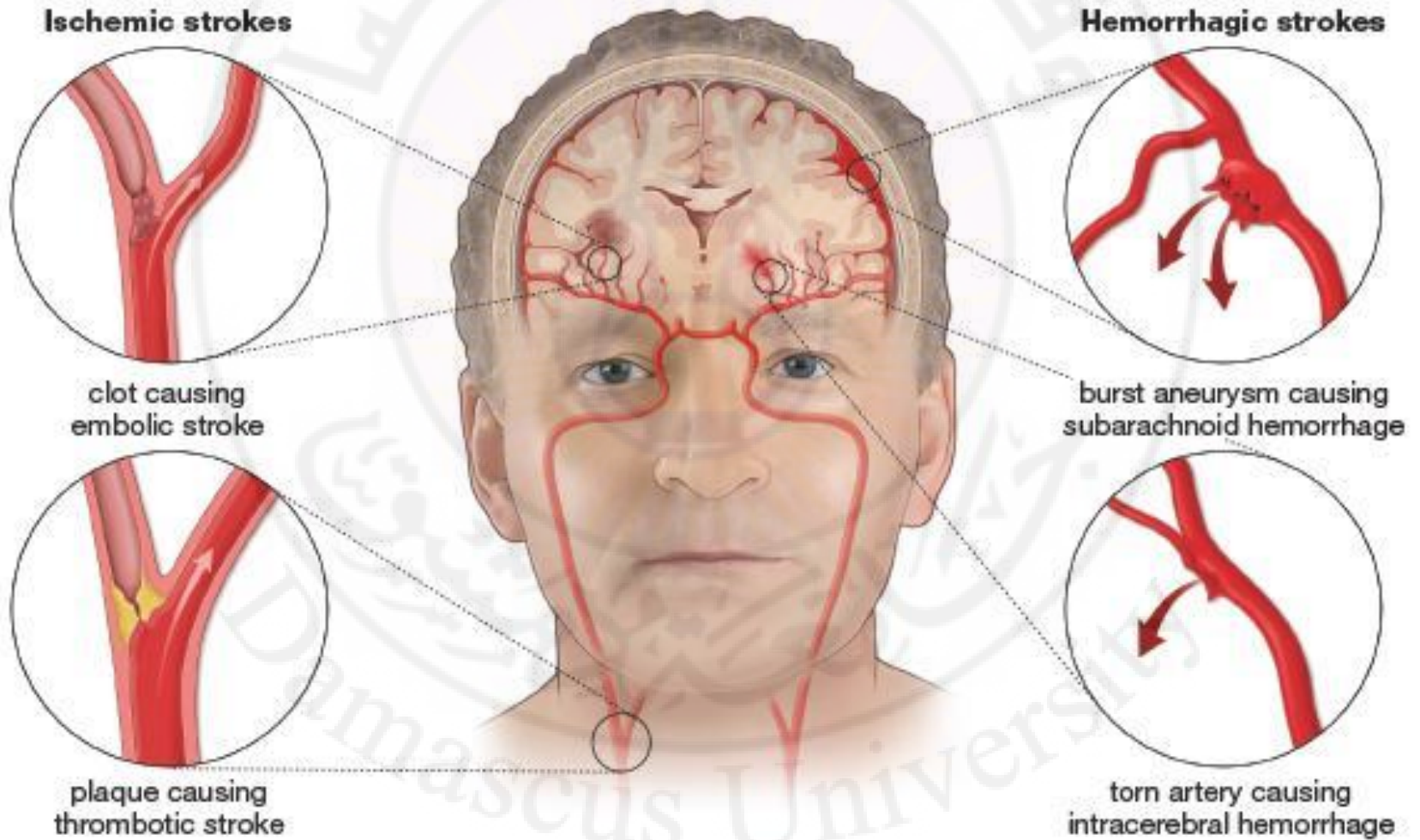
SAH in the basilar cistern
and extending out into the
fissures

A classic CT after rupture
of a Circle of Willis aneurysm

So called "Star of Death"

Cerebro-vascular accident (Stroke)

Compromised perfusion to brain due to:
Bleeding (hemorrhagic stroke) or ischemia (ischemic stroke)



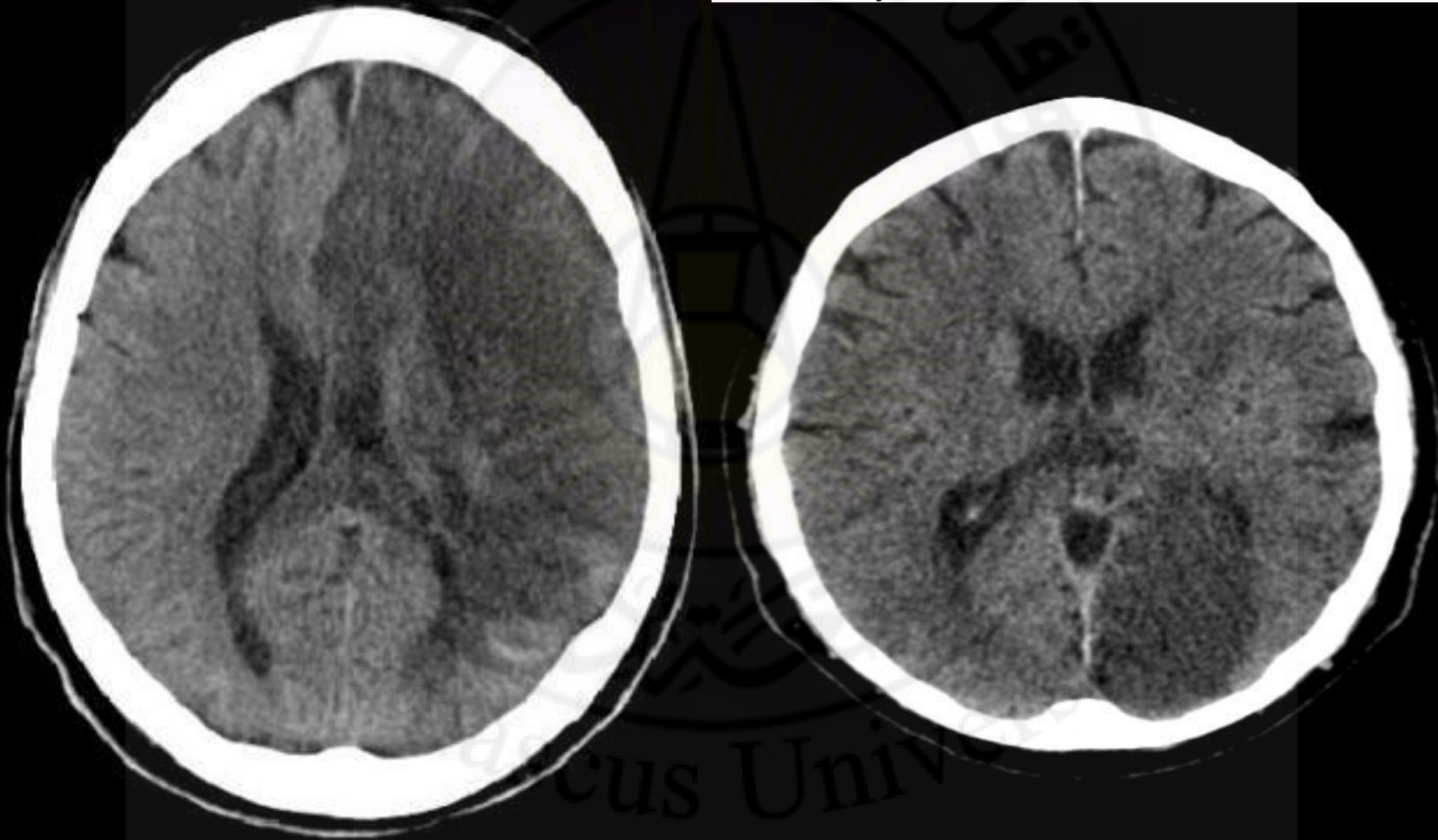
Are there steady clinical symptoms?

An ischemic stroke typically presents with rapid onset neurological deficit, which is determined by the area of the brain that is involved. The symptoms often evolve over hours and may worsen or improve.

The vascular territory affected will determine the exact symptoms and clinical behavior of the lesion

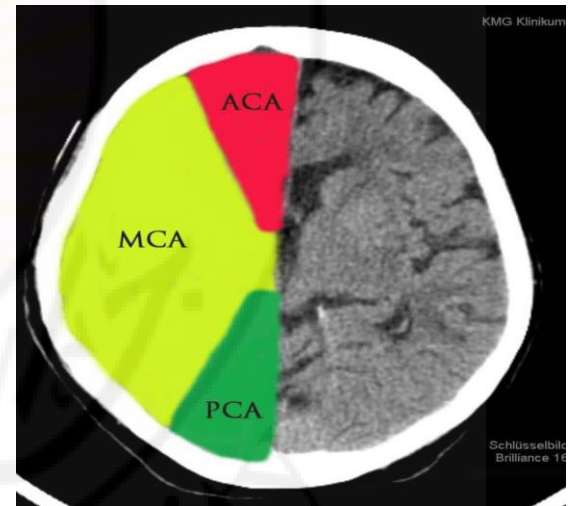
Ischemic stroke

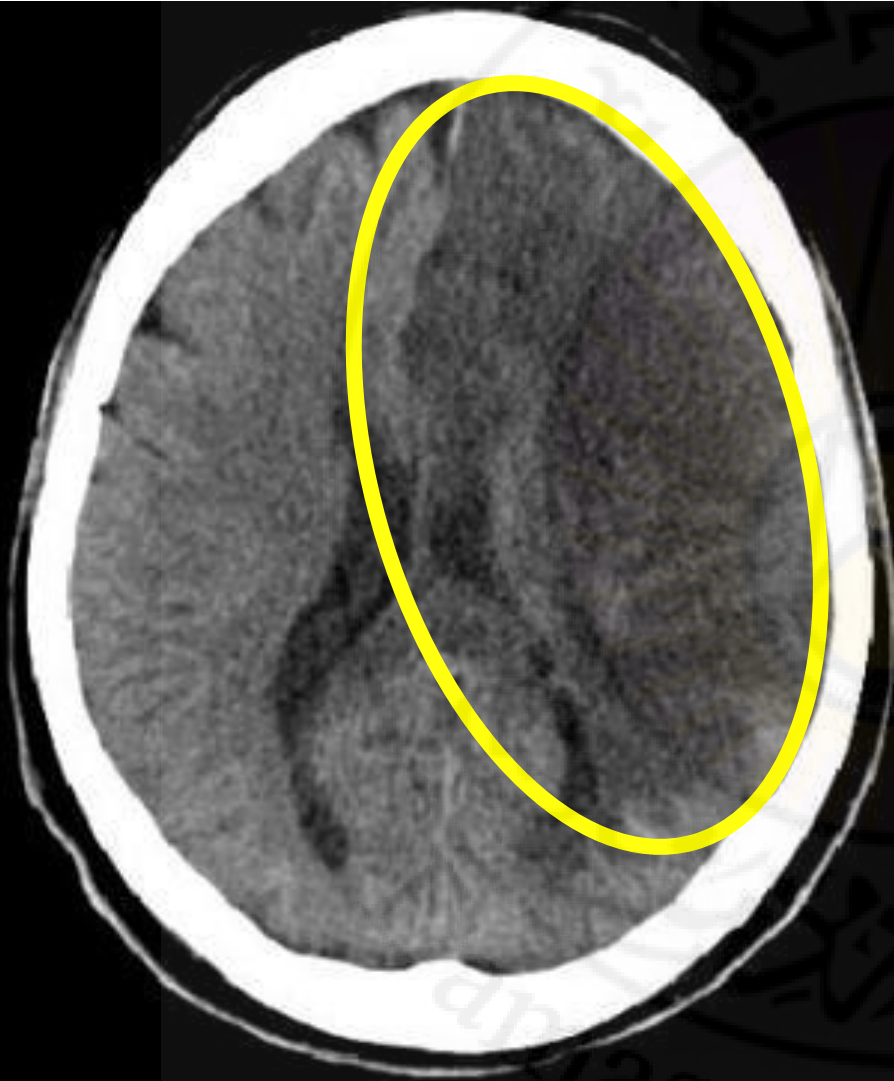
Ischemic stroke on CT presents with Areas of low density



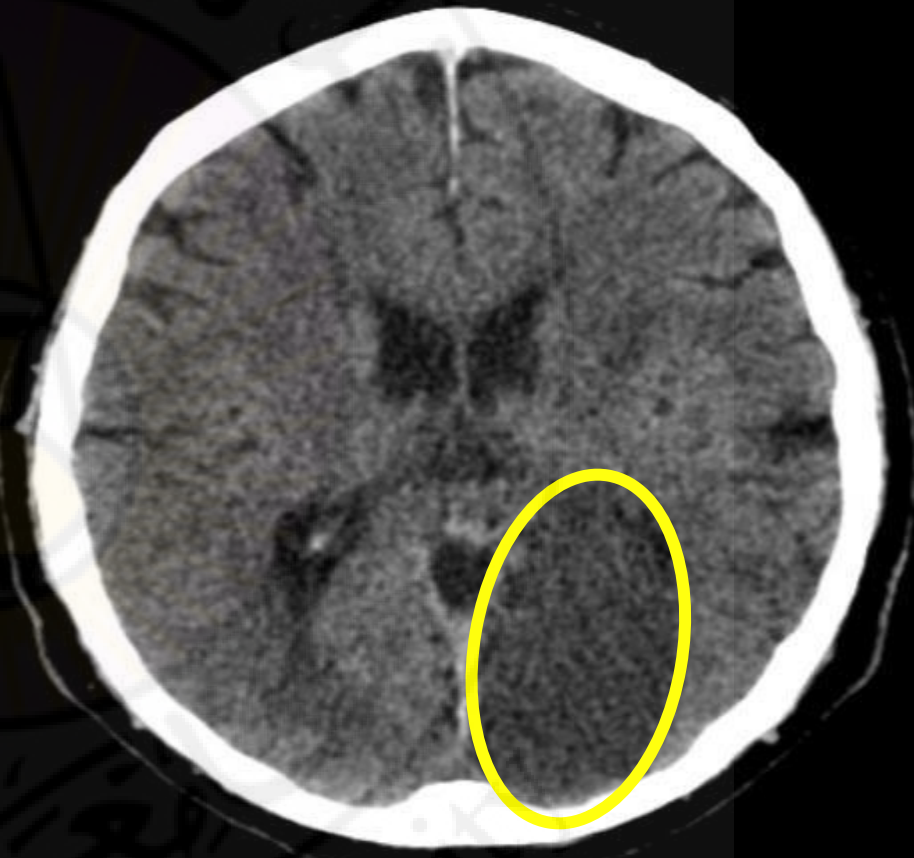
Cerebral arteries and territories of perfusion

- Anterior cerebral artery (ACA)
- Middle cerebral artery (MCA)
- Posterior cerebral artery (PCA)





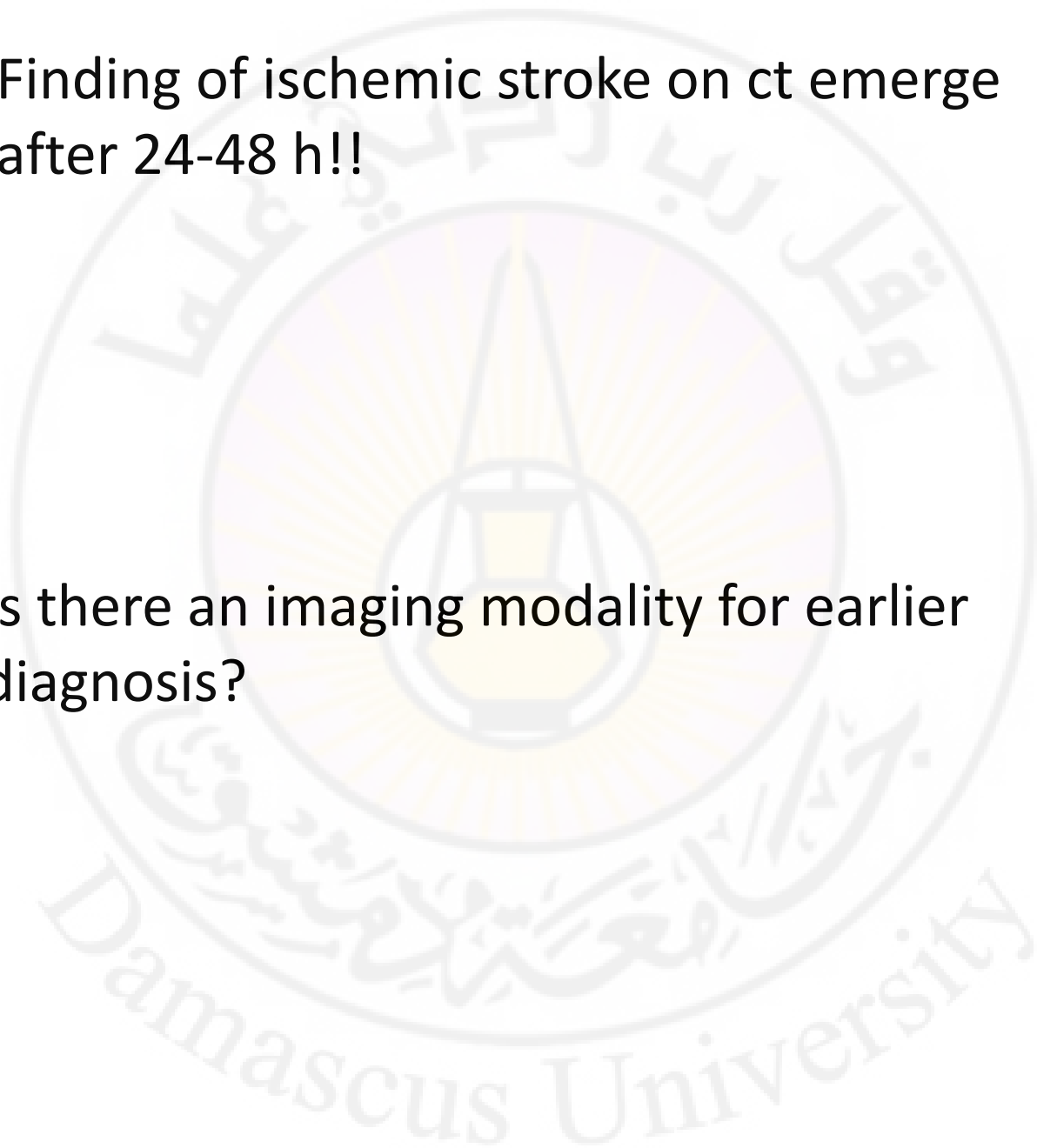
ACA + MCA stroke



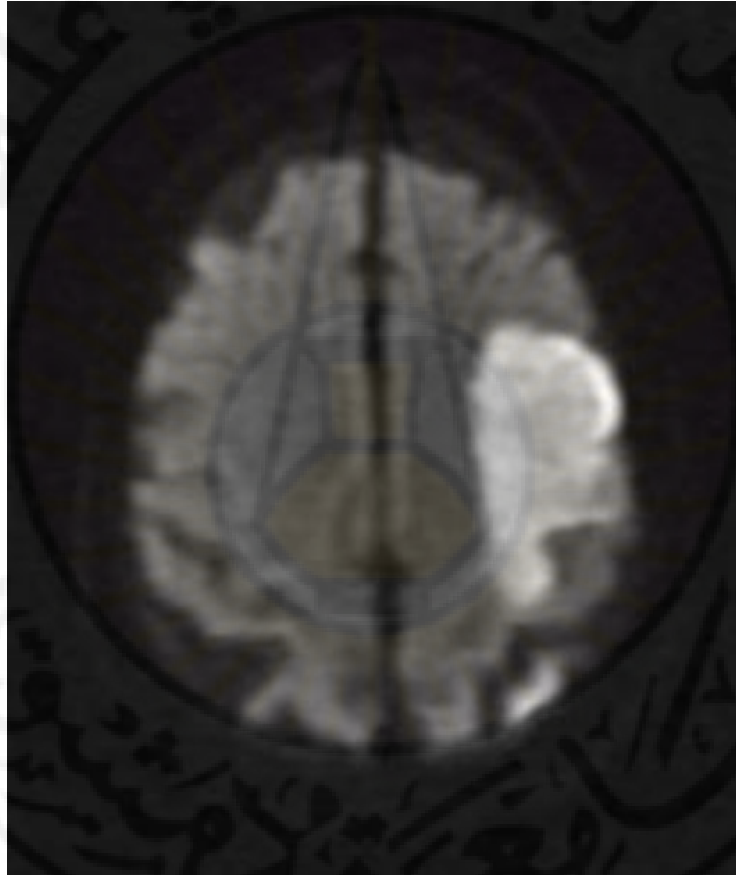
PCA stroke

Finding of ischemic stroke on ct emerge
after 24-48 h!!

Is there an imaging modality for earlier
diagnosis?



Yes , **MRI (DWI)**

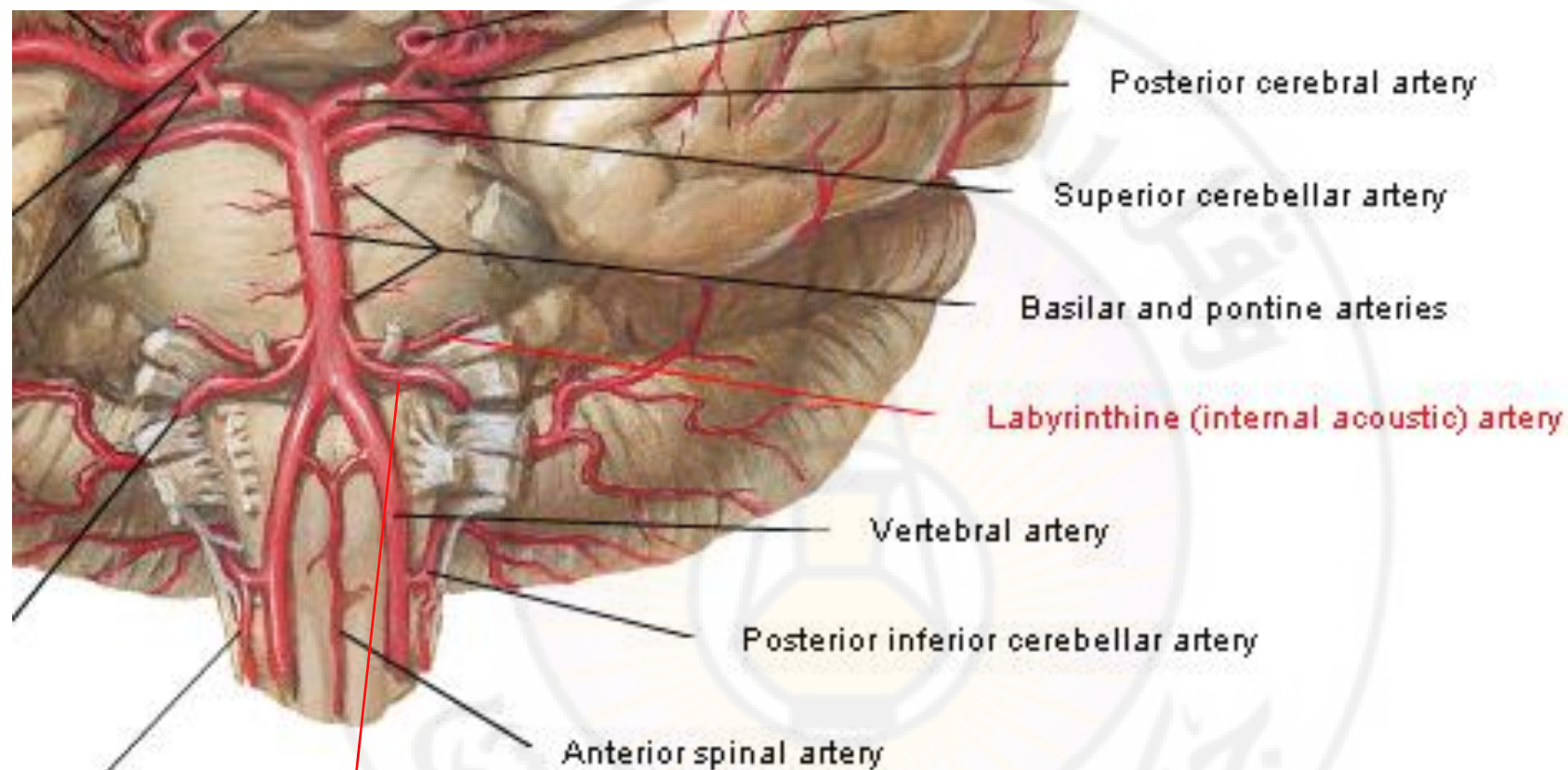


Restricted perfusion in stroke generate high signal on DWI sequence within few hours !!

Could a patient of stroke present with
SNHL?

YES , IF ANTERIOR INFERIOR CEREBELLAR
ARTERY IS AFFECTED

AICA Stroke



AICA

Dr. H. H. H.

Damascus University

Hemorrhagic stroke

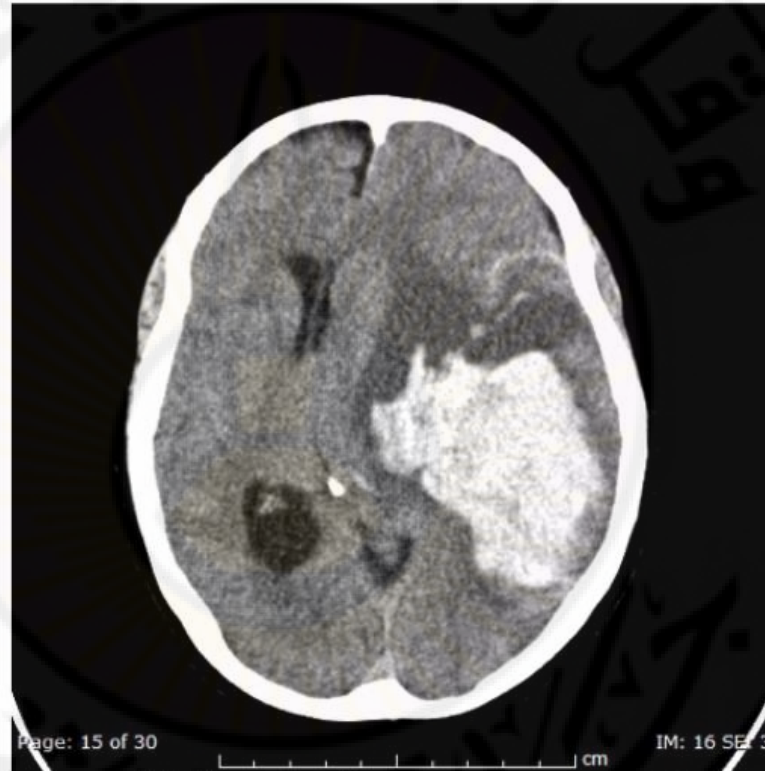
Case example

- 68 y/o female brought in by ambulance to ED after rapid mental status deterioration
- Obtunded on exam
- BP: 210/106
- Considering hypertensive hemorrhage
- Head CT shows...

Hemorrhagic stroke

Acute bleeding on CT presents with Areas of high density

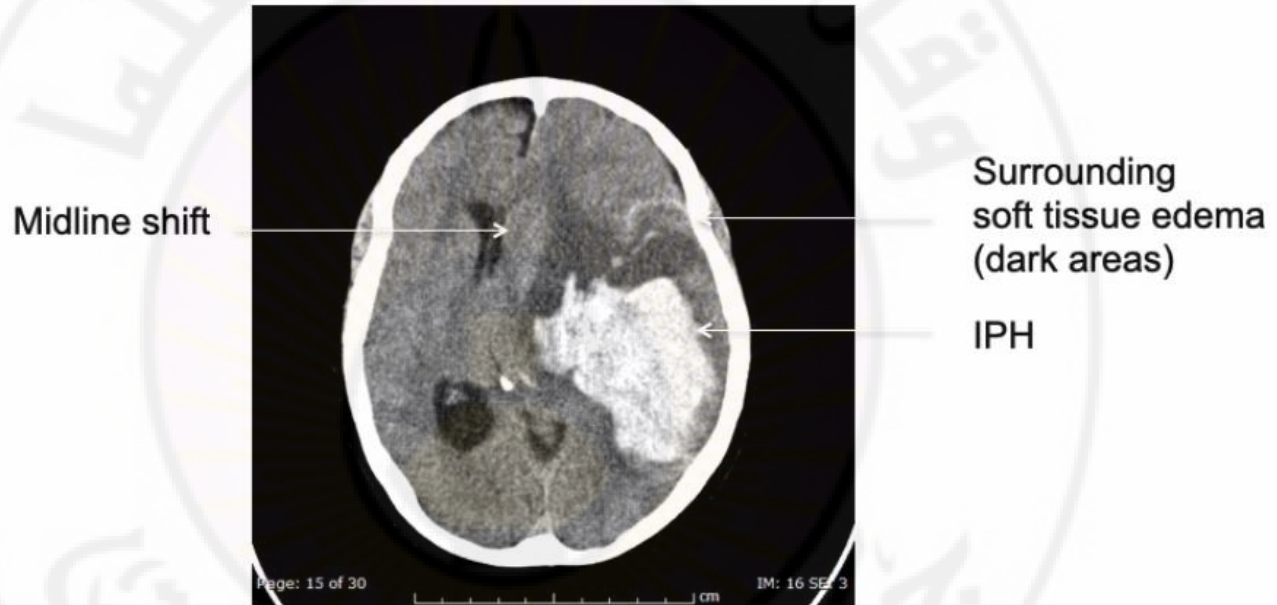
Case example



What do you see?

Try to describe it as you would present it.

Case example



This is a non-contrast, axial head CT showing...
...a large left-sided intraparenchymal hemorrhage with surrounding edema and significant midline shift”

Brain abscess

A brain abscess: is a focal area of necrosis starting in an area of cerebritis surrounded by a membrane .

It is a potentially life threatening condition requiring prompt radiological identification

Brain abscess

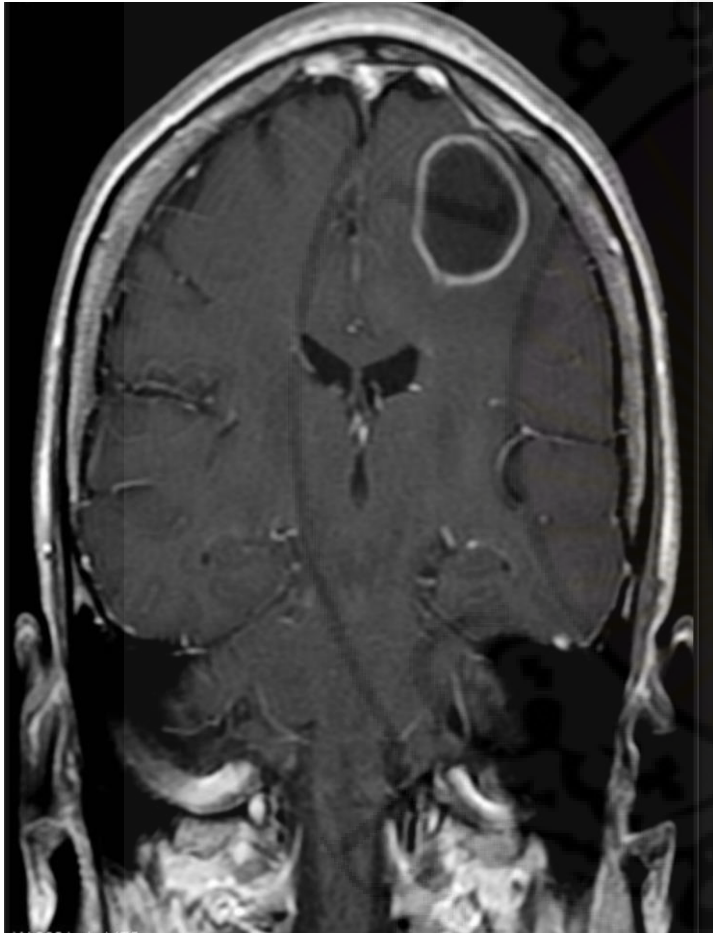
Clinical presentation:

0- inflammatory symptoms (fever , fatigue)

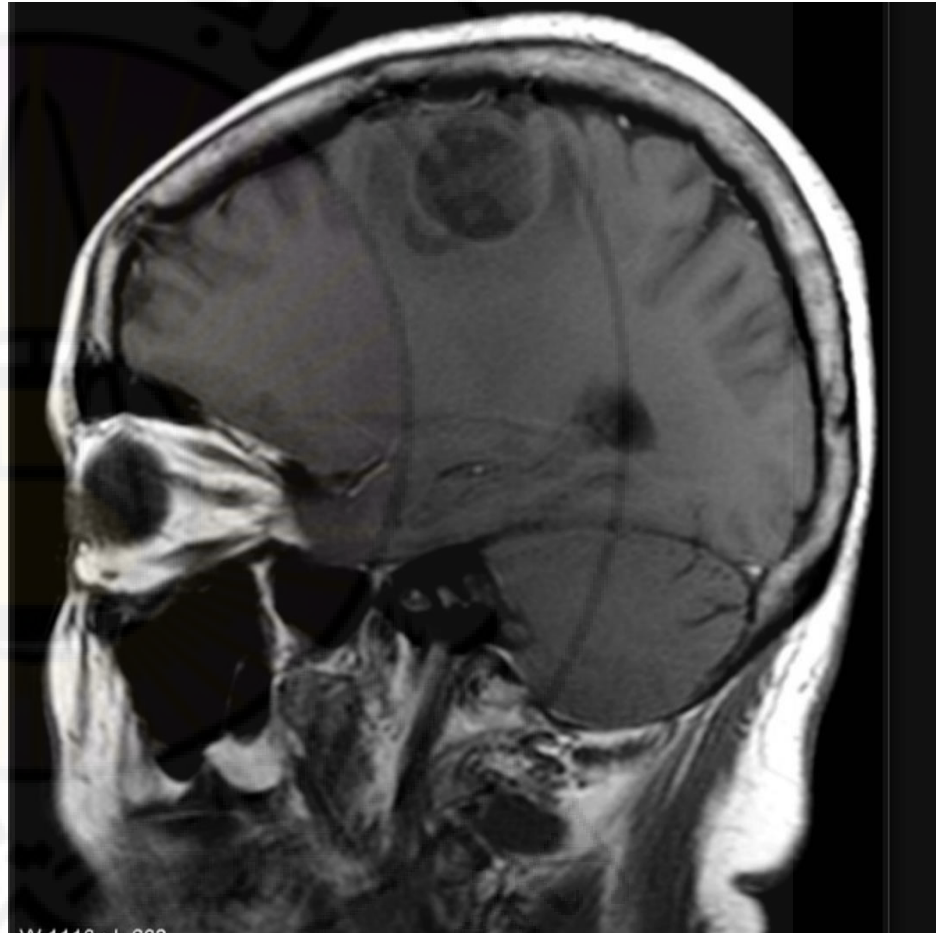
1- Raised intracranial pressure

2- Seizures and focal neurological deficits are the most common forms of presentation

3-Many abscesses rupture into the ventricular system,which results in a sudden and dramatic worsening of the clinical presentation and often heralds a poor outcome.



Ct post-contrast

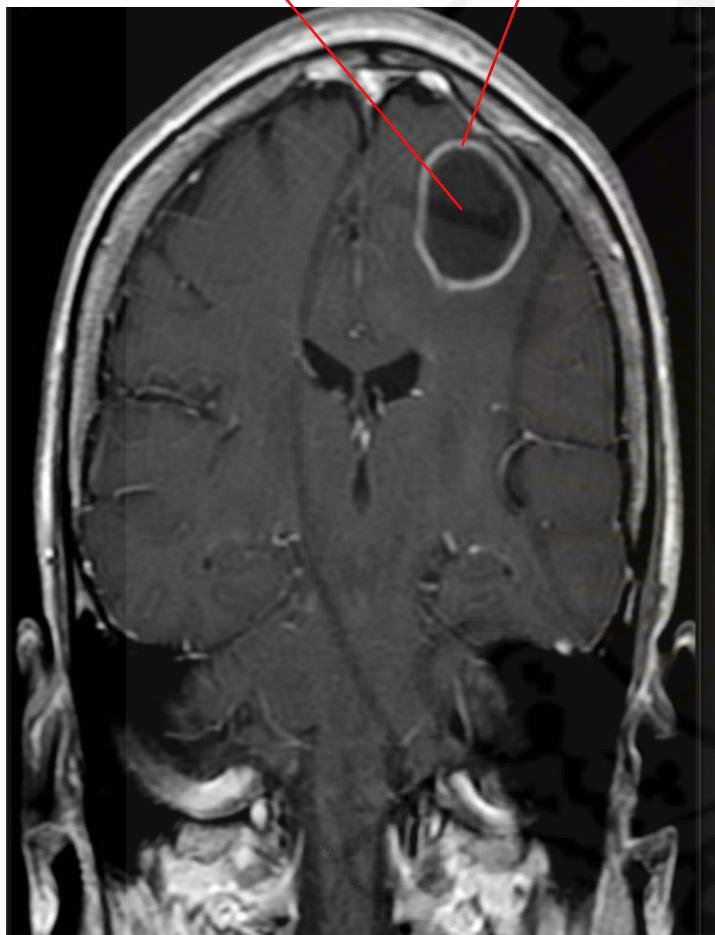


Ct pre-contrast

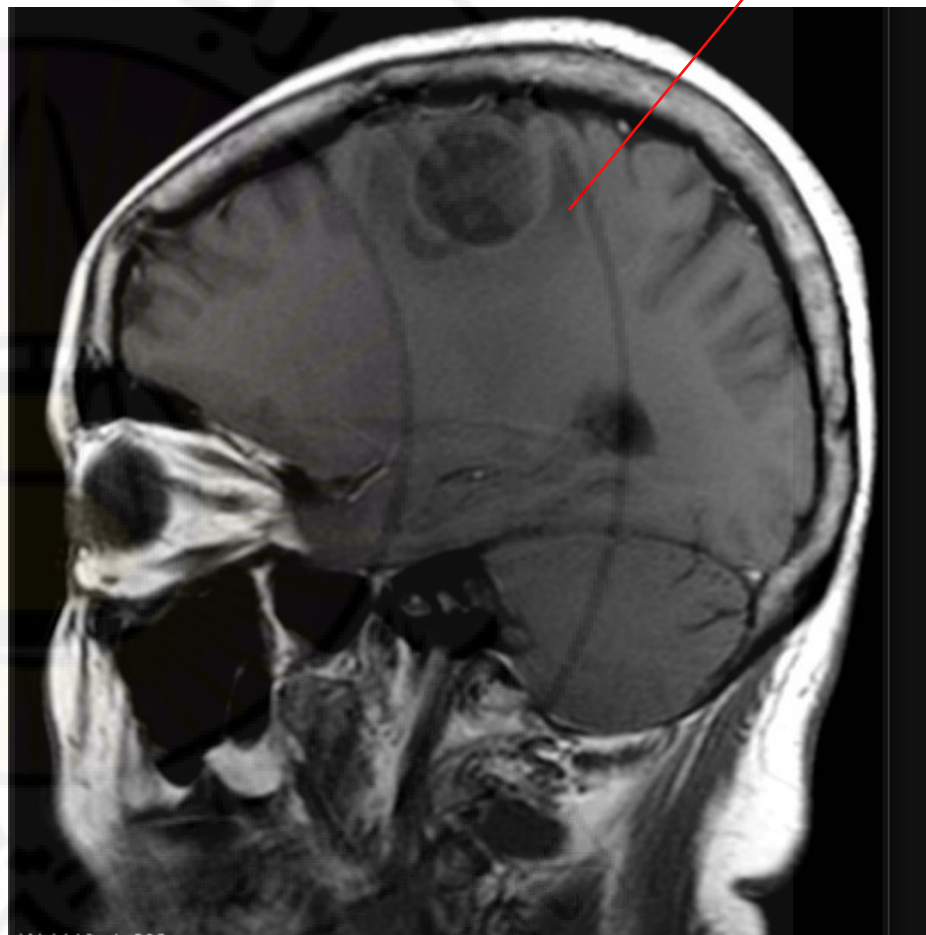
Low density of area
representing necrotic area
(abscess cavity)

Ring-like lesion: representing the contrast-enhancing
wall of abscess

Edema surrounding abscess



Ct post-contrast



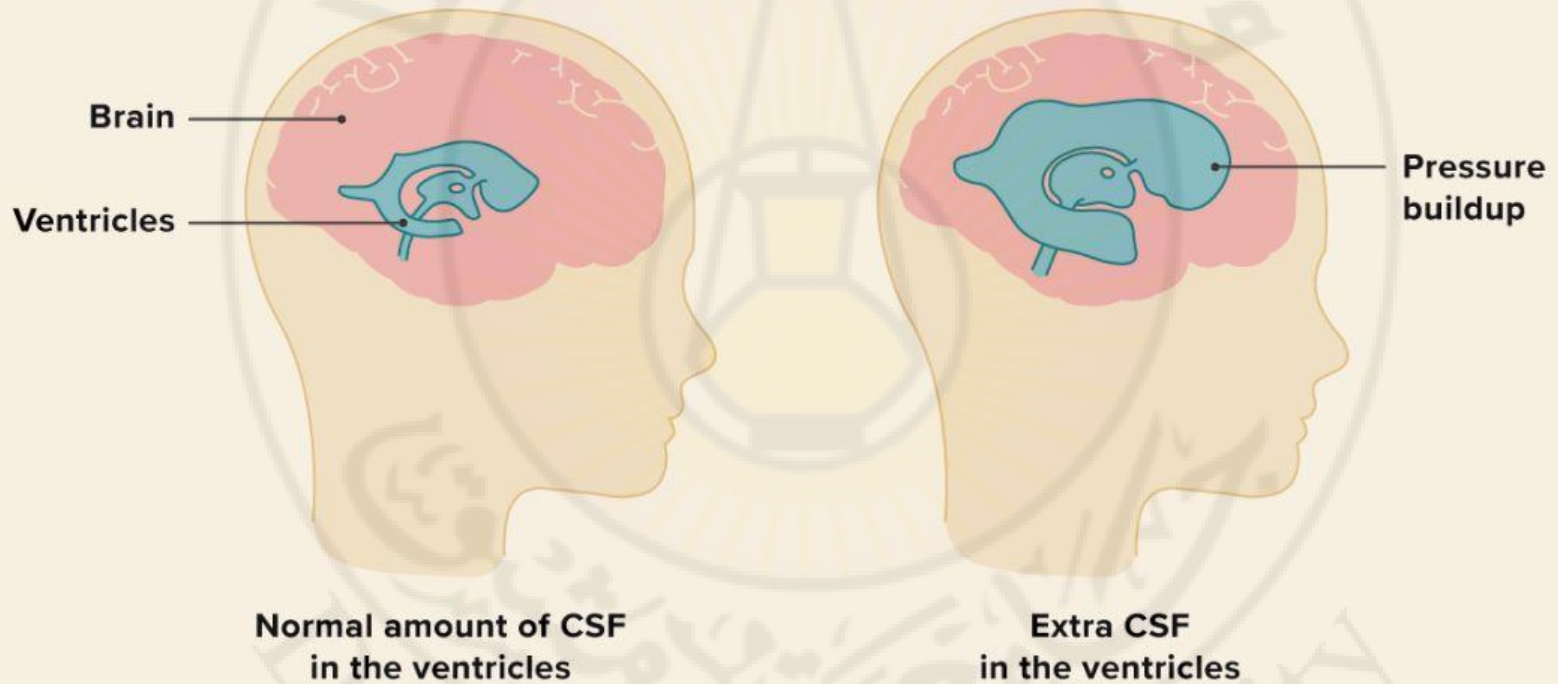
Ct pre-contrast

WHAT IS HYDROCEPHALUS?

- ❖ an increase in the volume of CSF causes [ventriculomegaly] due to:

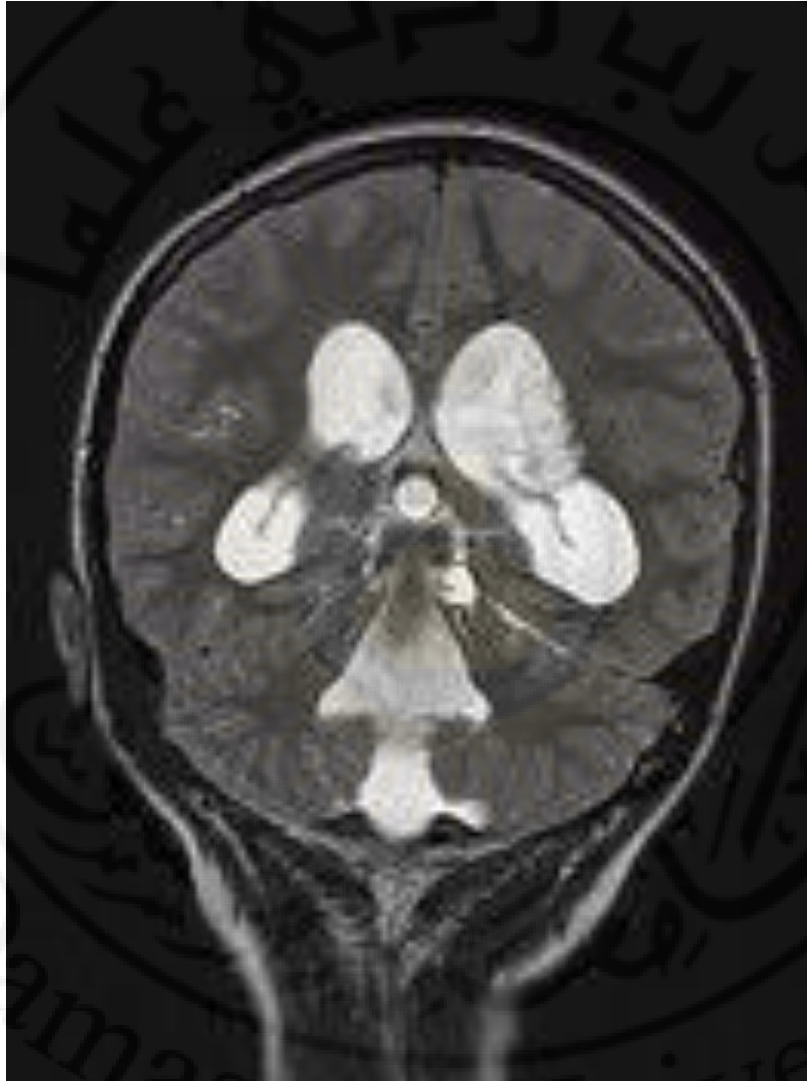
Insufficient passage of the CSF from its point of production in the ventricles into the systemic circulation

HYDROCEPHALUS



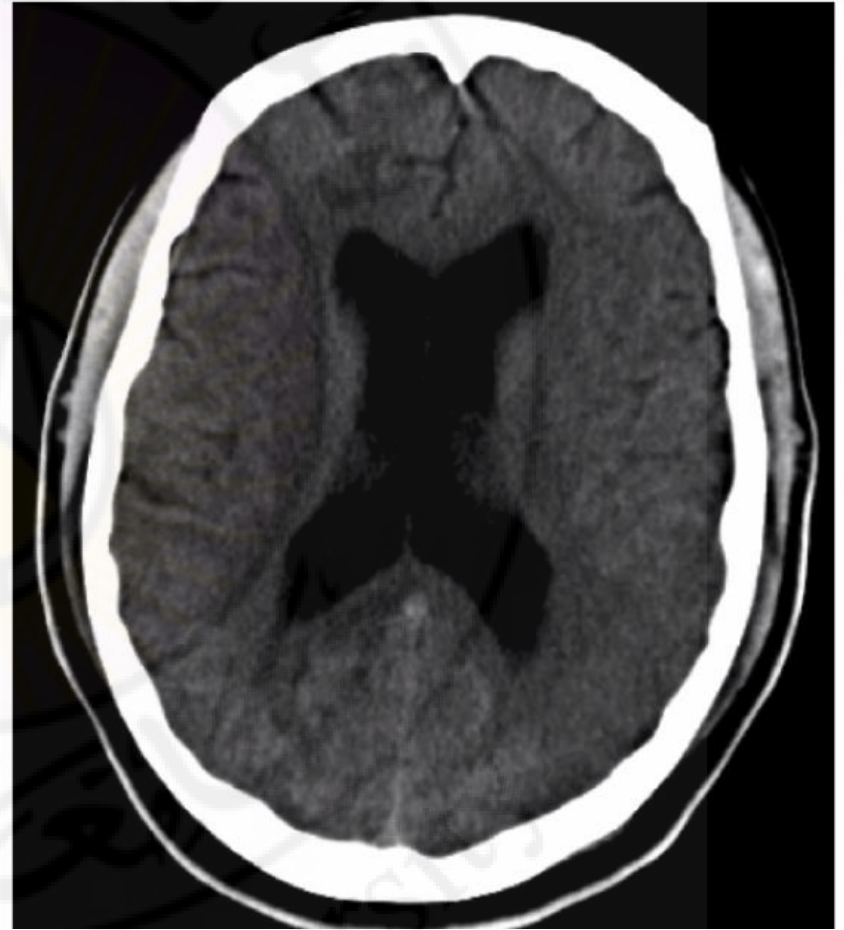
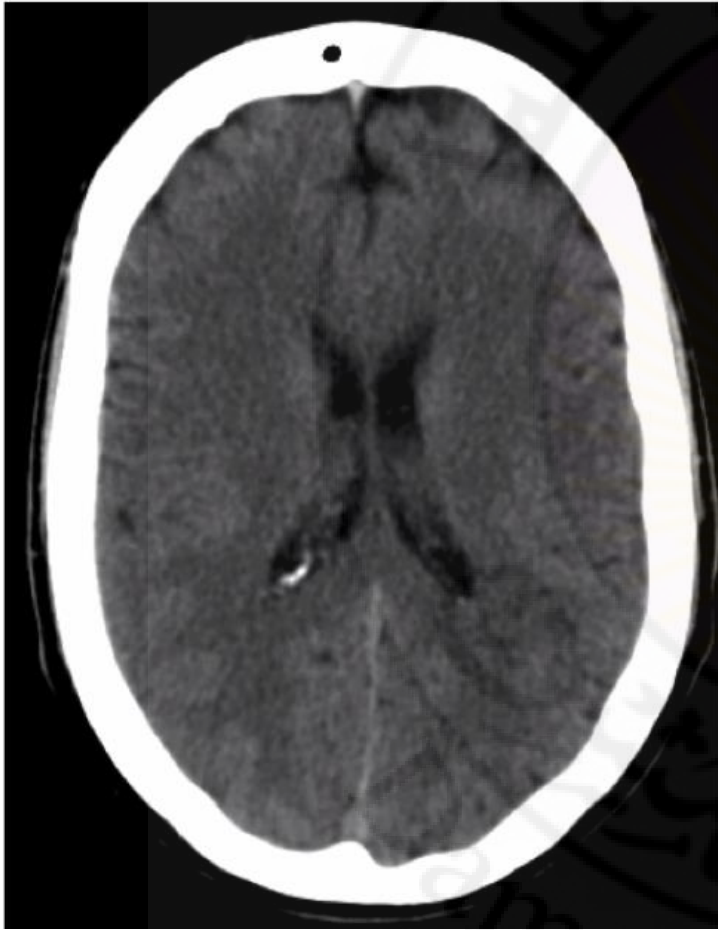


CT CORONAL : DILATED LATERAL VENTRICLES

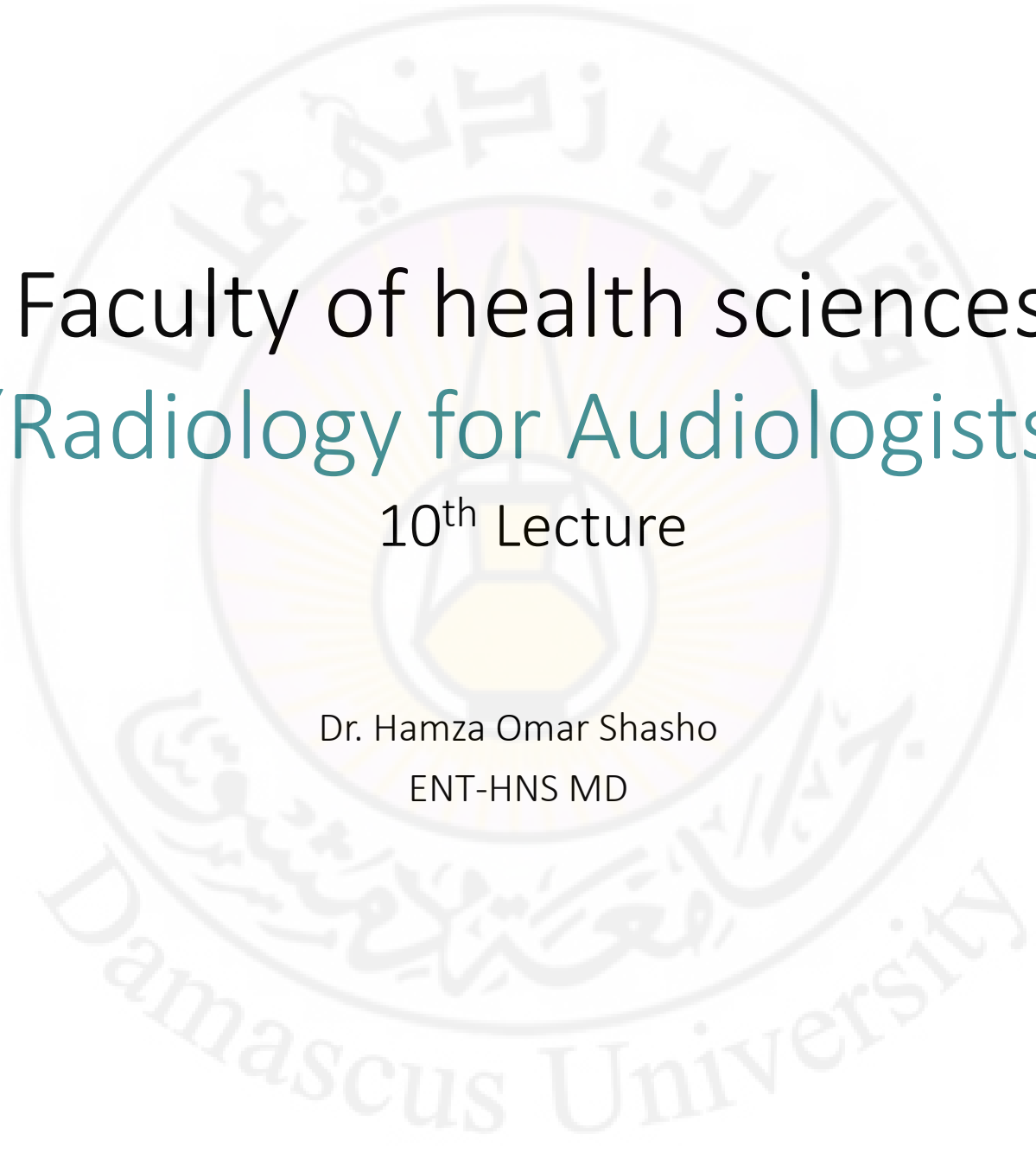


MRI CORONAL T2 : DILATED VENTRICLES

Ventriculomegaly 2 different 30 years old patients



CT AXIAL : DIALTED LATERAL VENTRICLE

The background of the slide features a large, faint watermark of the Damascus University seal. The seal is circular, with the university's name in Arabic at the top and 'Damascus University' in English at the bottom. In the center is a shield with a sunburst and a sword.

Faculty of health sciences

“Radiology for Audiologists”

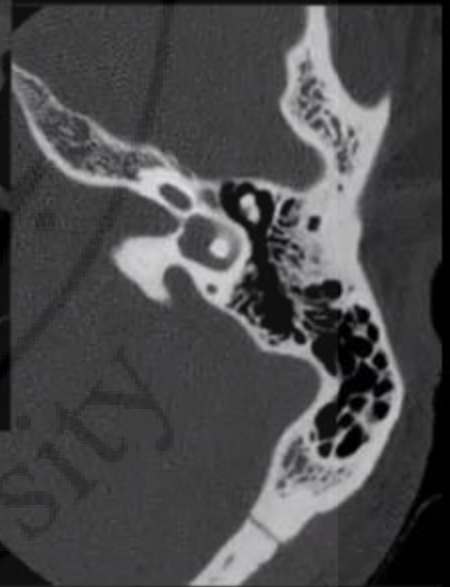
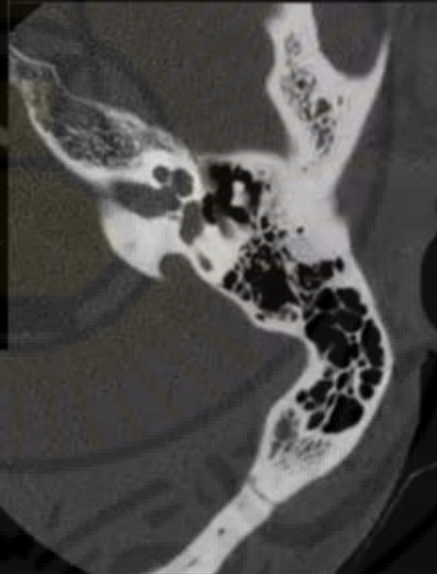
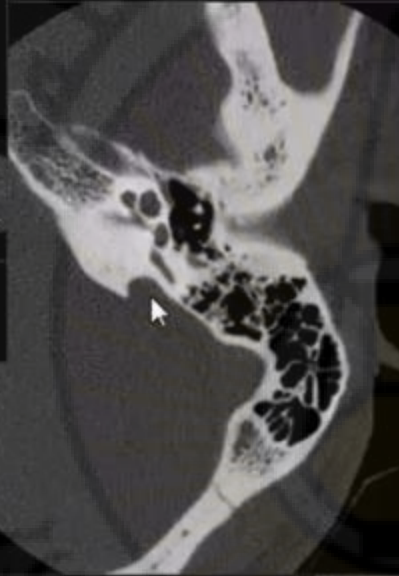
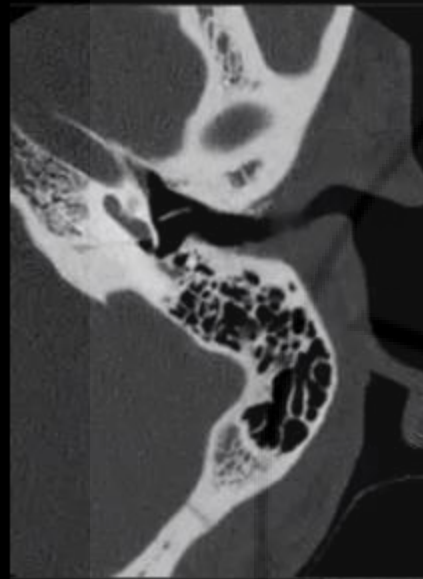
10th Lecture

Dr. Hamza Omar Shasho

ENT-HNS MD

Mondini malformation

- ♦ The vestibule is enlarged
- ♦ Short broad semicircular canals
- ♦ The vestibular aqueduct is enlarged.
- ♦ The cochlea demonstrates on 1.5 turns.
- ♦ The more apical turns are replaced by a single cystic cavity



Multiple sclerosis

- One of the demyelinating diseases
- Etiology still unknown
- Common acquired chronic demyelinating disease.
- Second most common cause of neurological impairment in young adult , after trauma.
- Might present with audiovestibular Sx (retrocochlear hearing loss)
- Neural ABR is an alternative method to diagnose MS
- Gold standard imaging modality : MRI with contrast
- MRI:

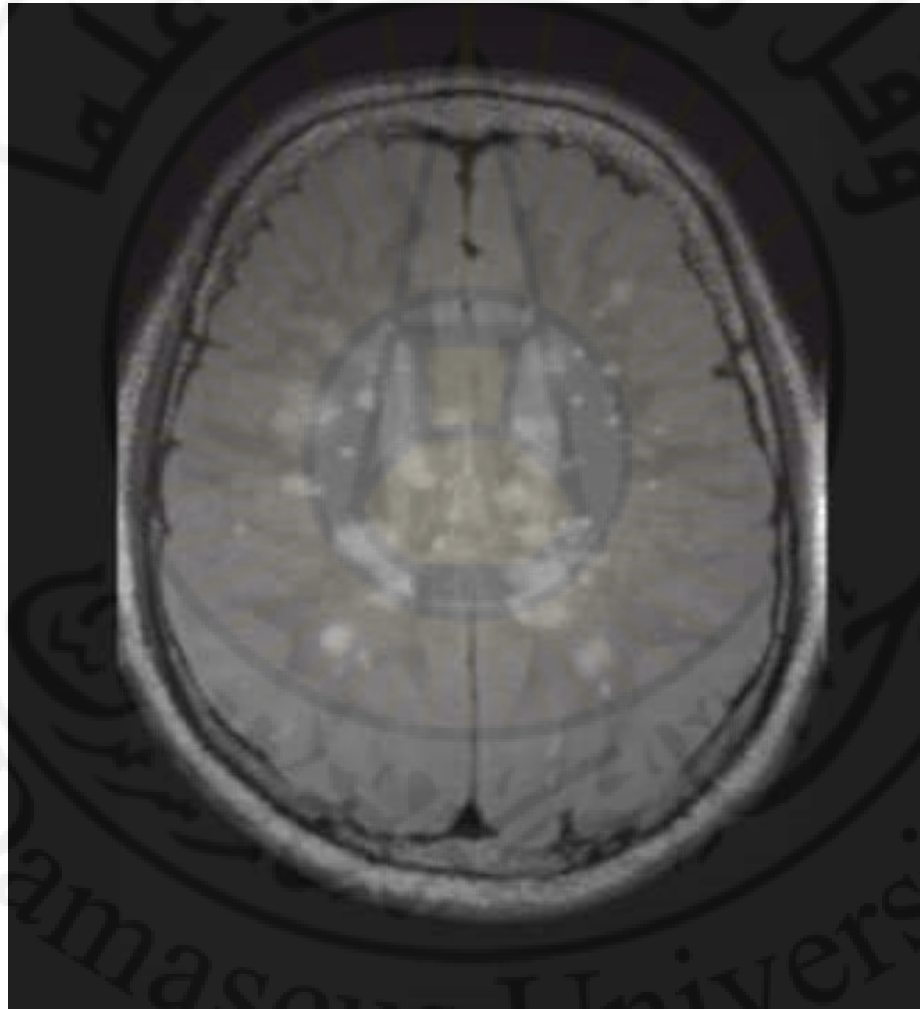
T1: hypointense

T2: hyperintense (more sensitive to detect infratentorial plaques)

FLAIR: hyperintense (more sensitive to detect juxtacortical and periventricular plaques)

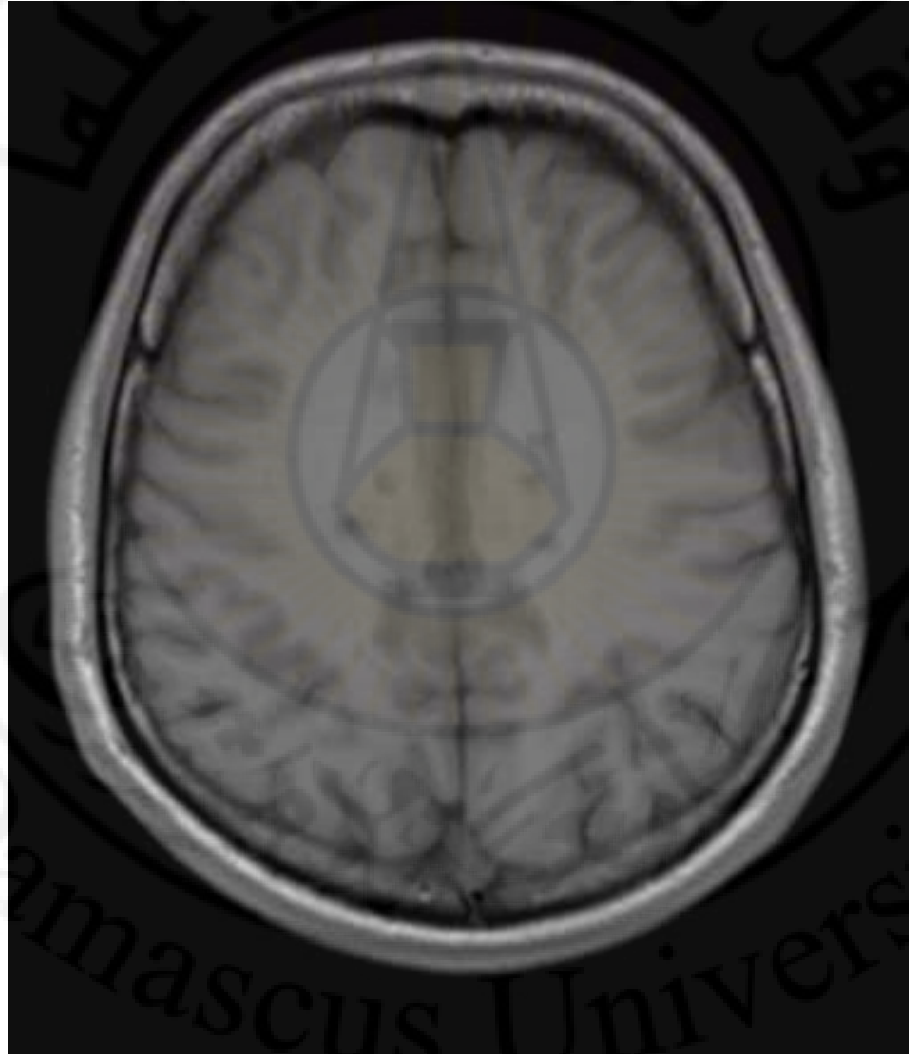
T1 +c: active plaques show enhancement

Multiple sclerosis



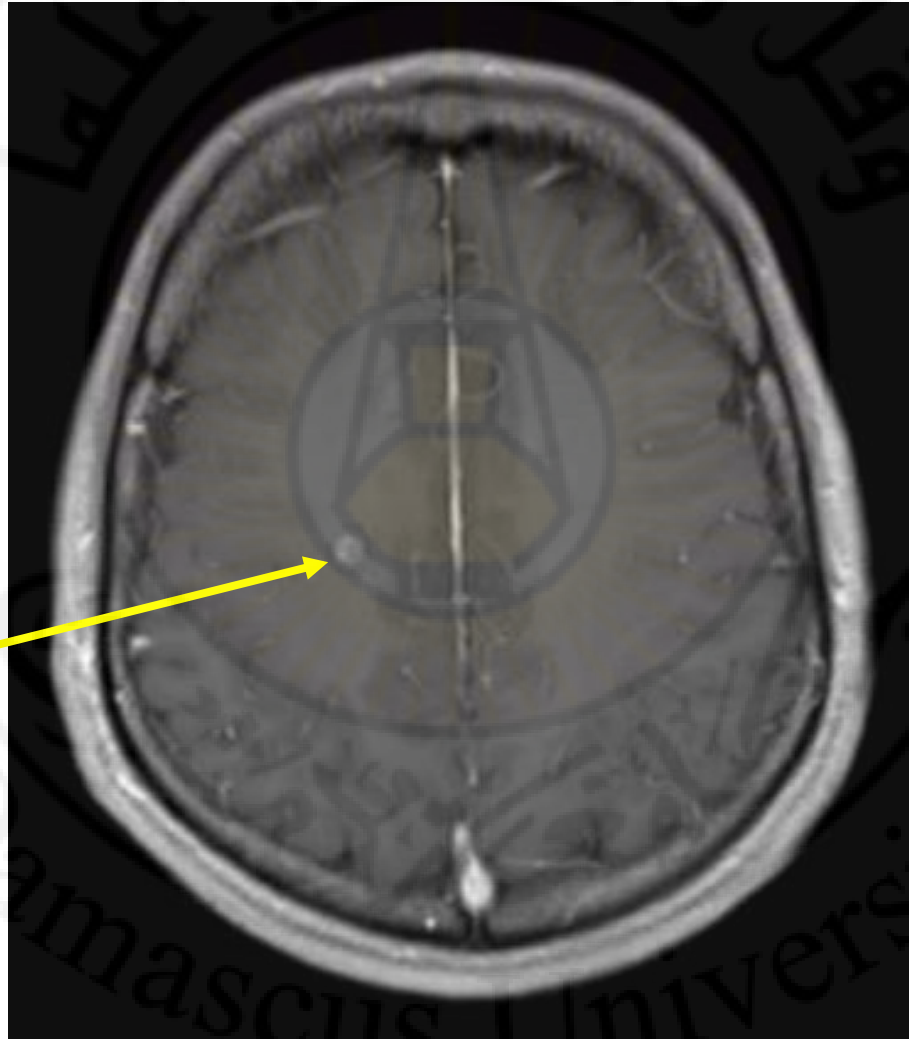
flair

Multiple sclerosis



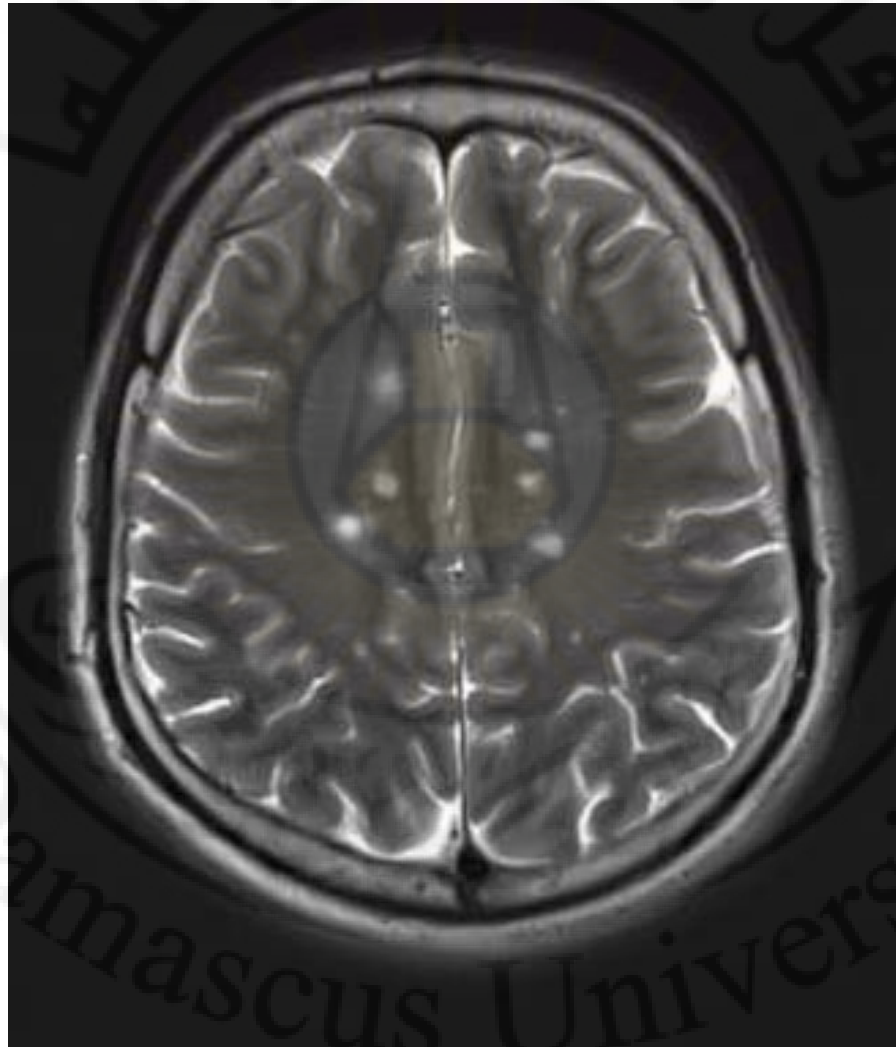
T1

Multiple sclerosis



T1 +C

Multiple sclerosis



T2

Arnold chiari malformation

- **Congenital malformation characterized by : caudal displacement of cerebellum and brainstem through the foramen magnum .**
- **Pathogenesis: underdevelopment of posterior cranial fossa resulting in overcrowding of its components that herniate into the cervical column**
- **Presentation:**

Might be asymptomatic

Might present later in life

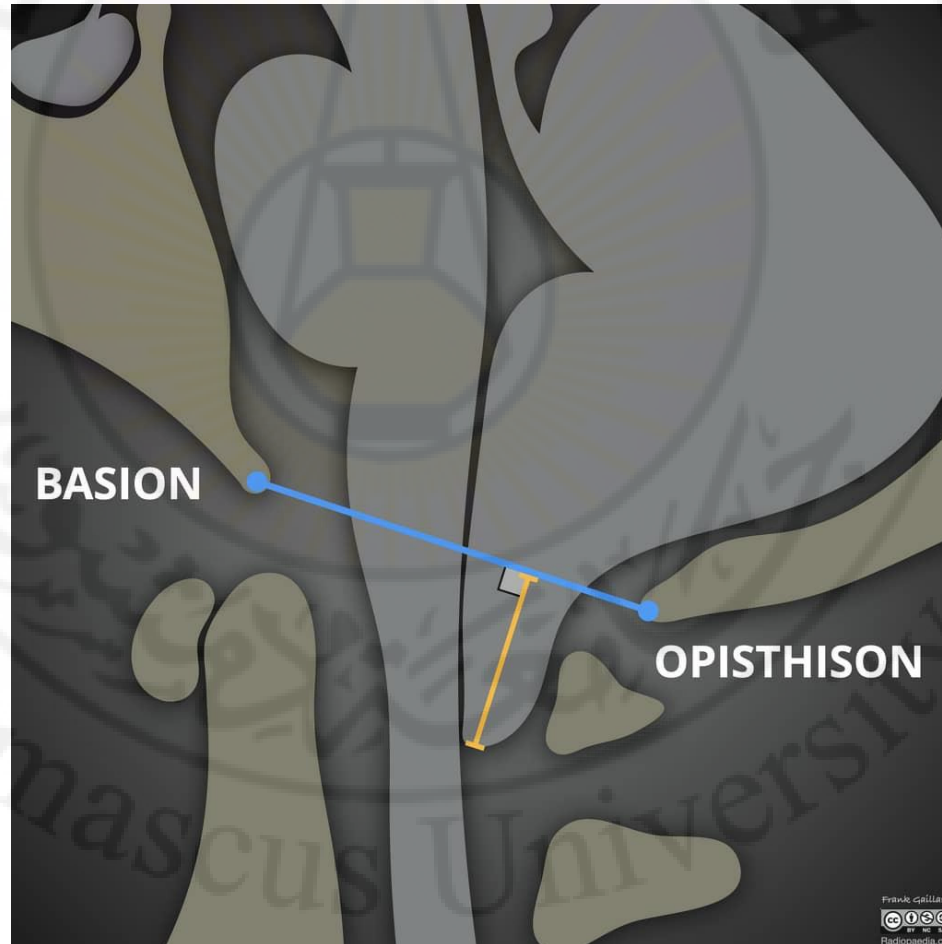
Sx are due to : compression of cerebellum/brainstem , interruption of CSF flow.

Chiari 0→5

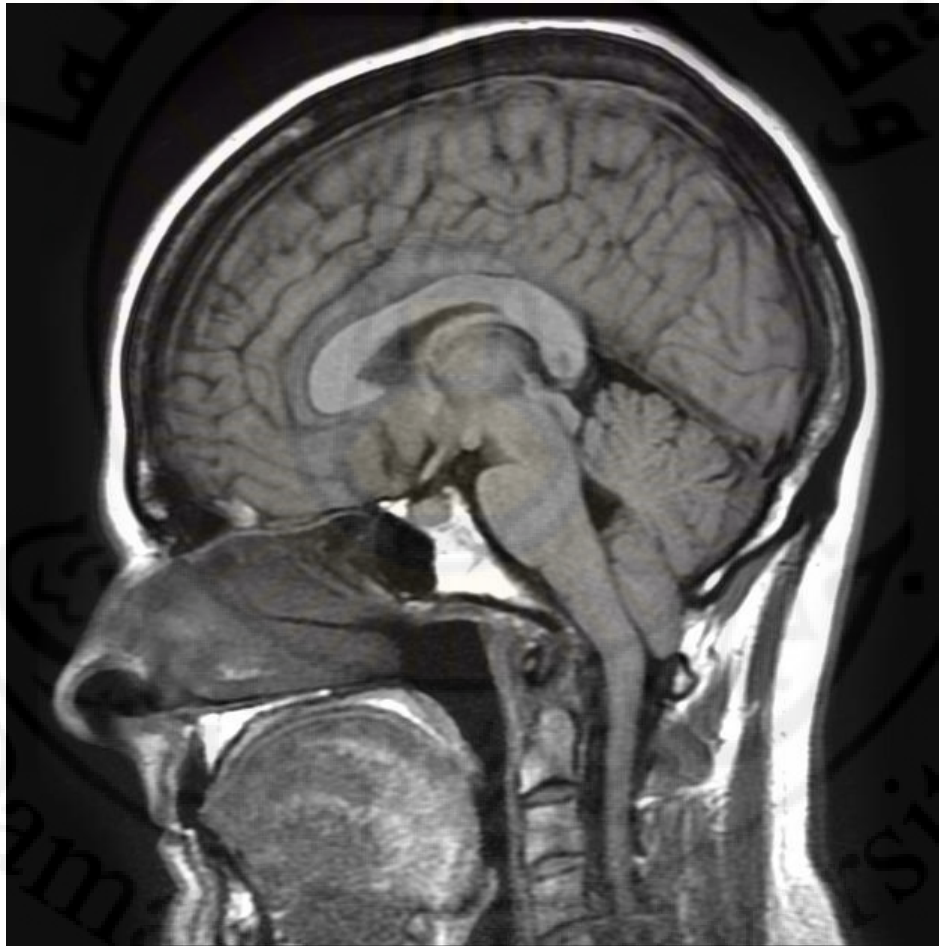
Chiari 1 : most common type presenting with herniation of cerebellar tonsils

Arnold chiari malformation

Cerebellar tonsils are first to herniate in Arnold chiari



Arnold chiari malformation



Arnold chiari malformation



Neonatal hypoxic ischemic encephalopathy

A result of global hypoxic ischemic brain injury in neonate usually after asphyxia.

T1 : grey matter : hyperintense

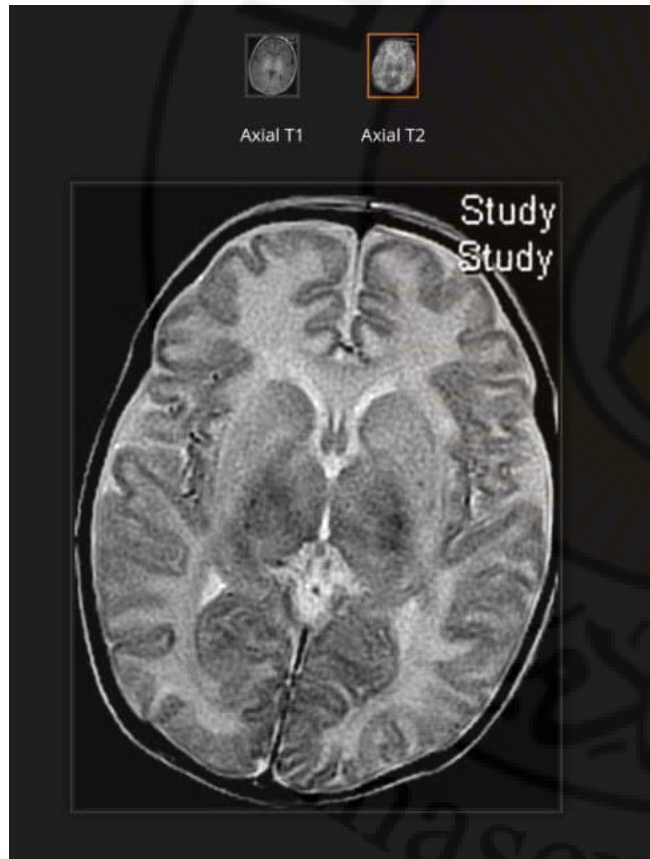
white matter : hypointense

T2 : grey matter : variable depending on time of imaging

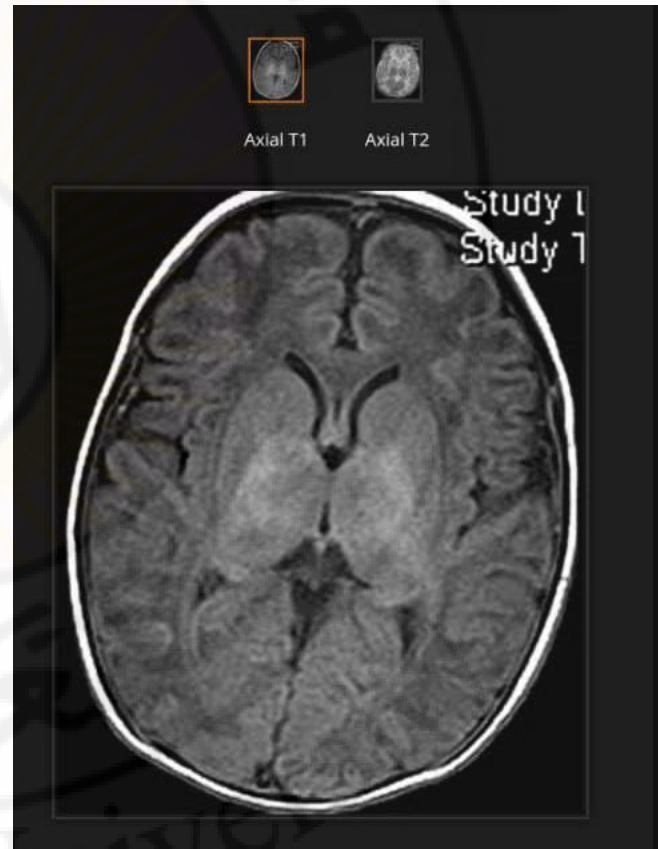
white matter : hyperintense

Leukomasia pattern.

Neonatal hypoxic ischemic encephalopathy



T2



T1

leukomalacia

- Usually occur in premature babies with hypoxic ischemic encephalopathy
- Two types : periventricular and subcortical.
- Both are a continuous disease spectrum.
- Presentation:

Cerebral palsy , Intellectual disability

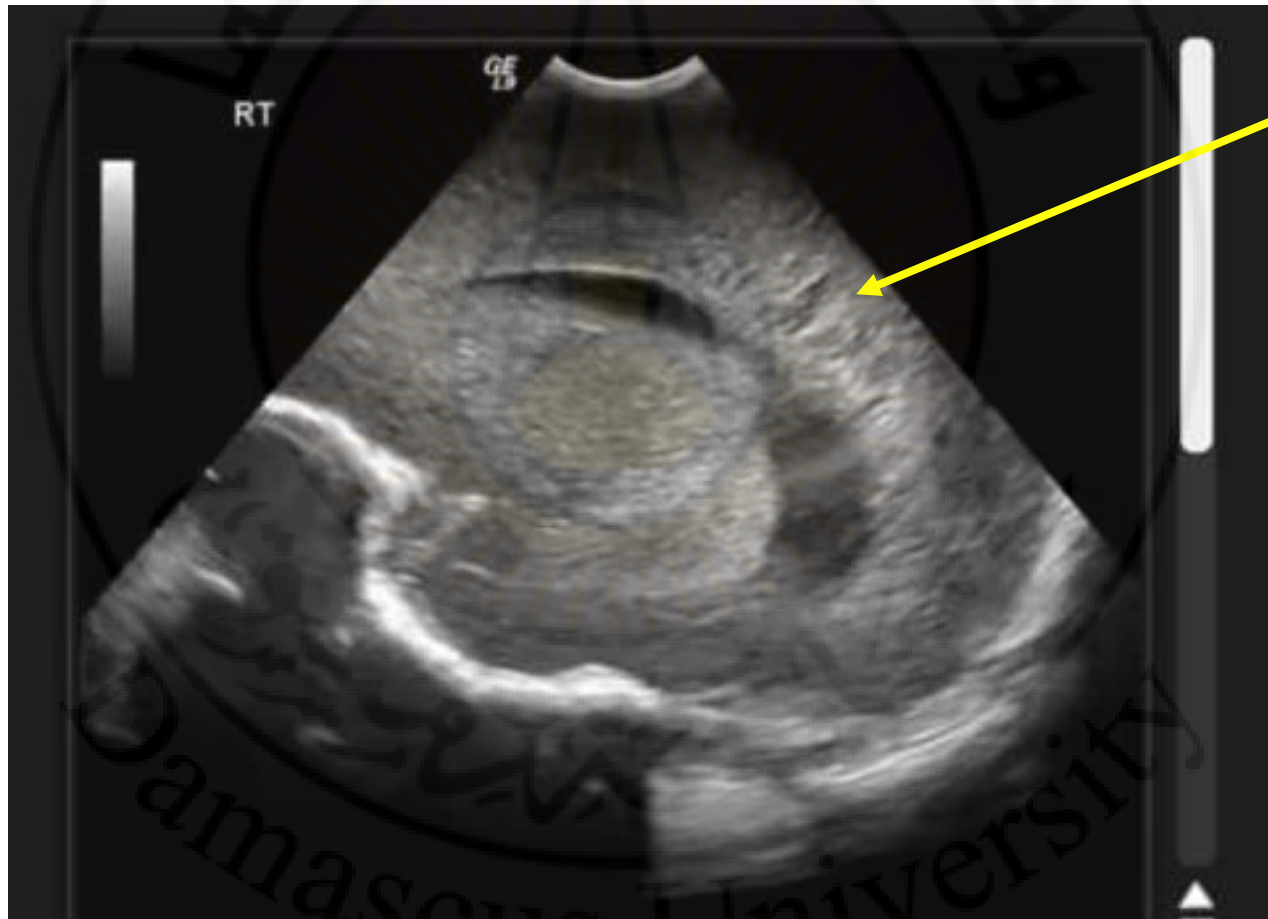
Stages :

- Early : white matter necrosis
- Subacute : cyst formation
- Late : parenchymal loss and enlargement of ventricles

leukomalacia



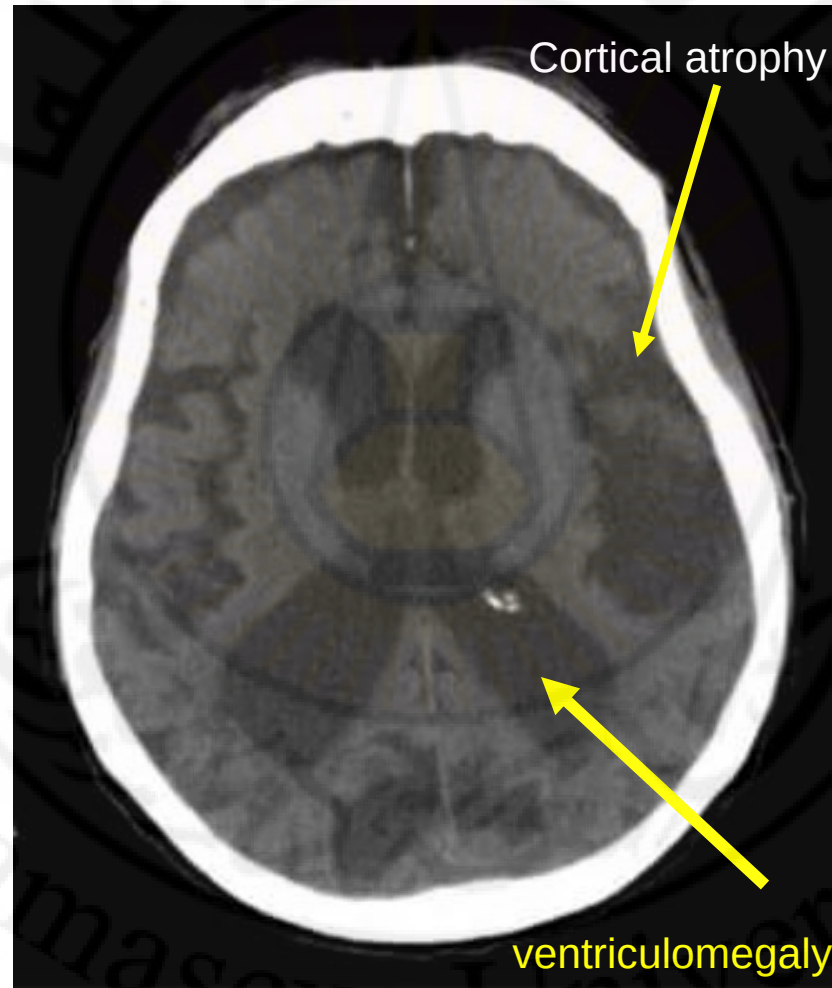
leukomalacia



Cerebral atrophy

- Parenchymal volume loss presenting as a common endpoint of many diseases affecting the central nervous system rather than being a primary diagnosis
- CT and MRI:
Cortical atrophy (prominent cerebral sulci)
ventriculomegaly

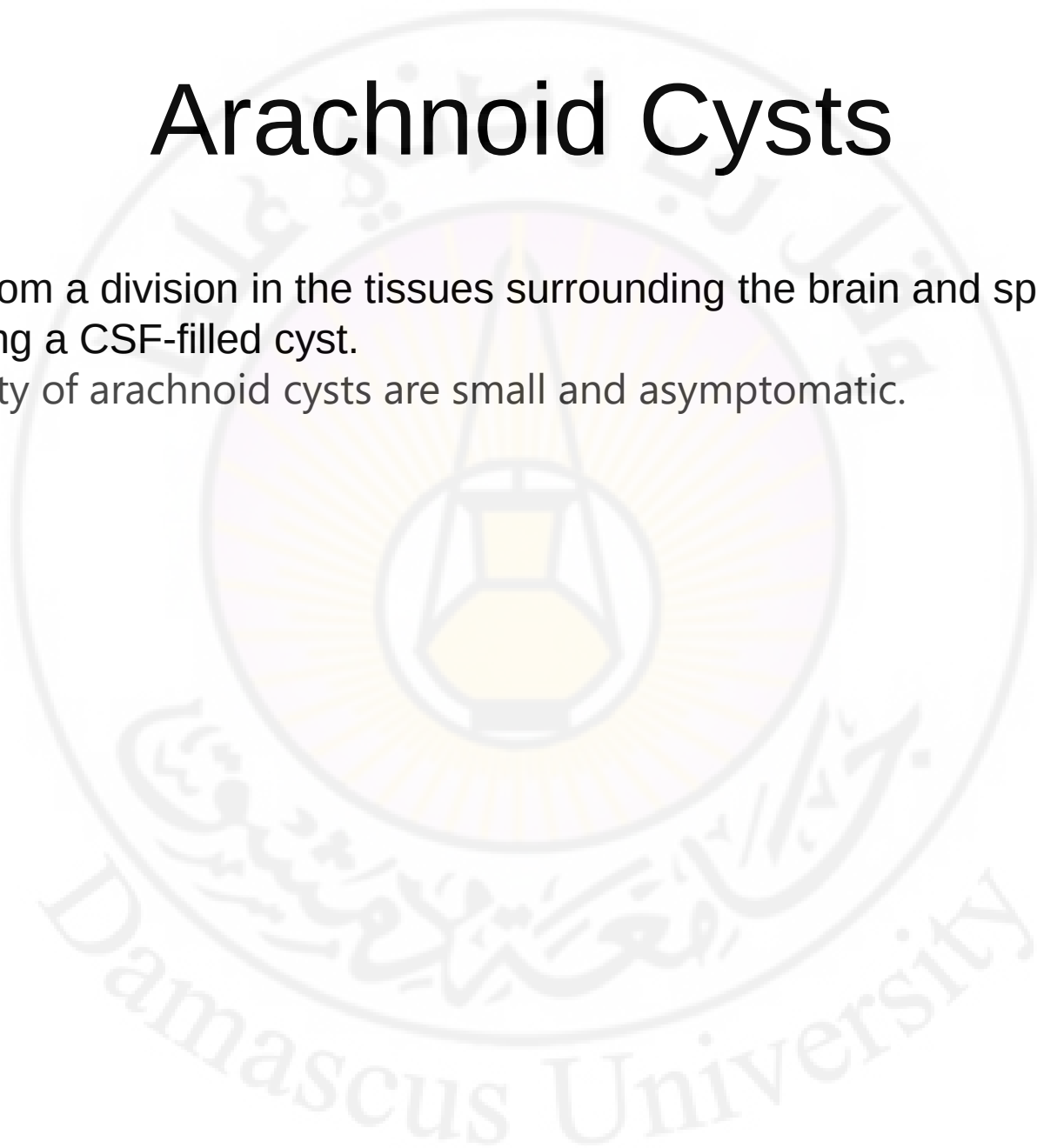
Cerebral atrophy



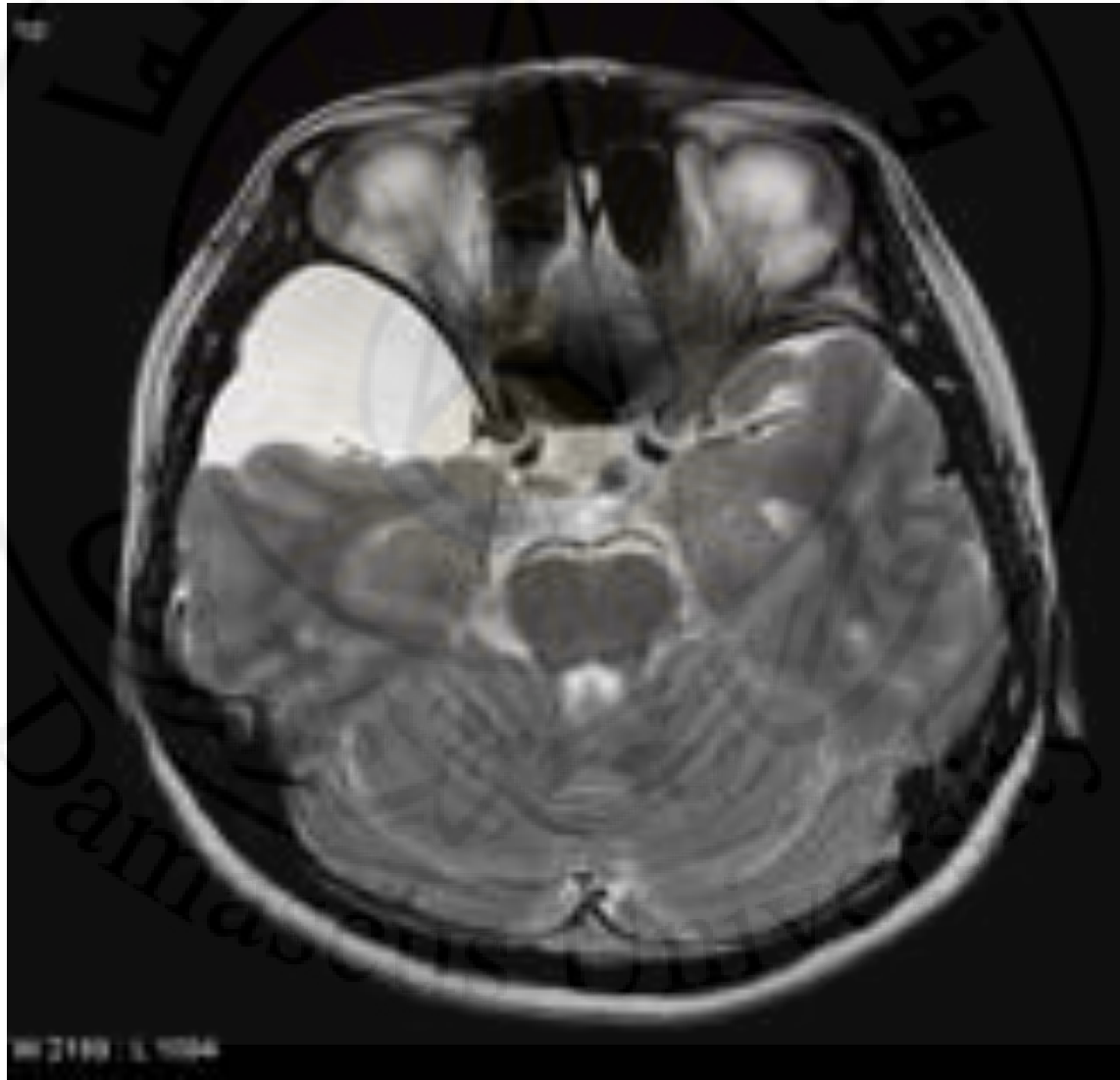
Arachnoid Cysts

It results from a division in the tissues surrounding the brain and spinal cord forming a CSF-filled cyst.

The majority of arachnoid cysts are small and asymptomatic.



Arachnoid Cysts



Synchronous PULSATILE TINNITUS

Synchronous pulsatile tinnitus may present as the direct result of **abnormal vascular anatomy** in the vicinity of the peripheral auditory system. Systemic aberrations of the circulation, such as a **hyperdynamic circulation**, have also been implicated in the development of synchronous pulsatile tinnitus.



Synchronous PULSATILE TINNITUS

Clinical examination:

Compression of internal jugular vein

If increased → arterial

If decreased → venous

Auscultaion : cranial , over a closed eye

TABLE 61.2 Pathological causes of pulsatile tinnitus

Type of pathology		Specific pathology
Vascular	Arterial	Atherosclerotic carotid artery disease ¹⁷⁴ Arteriovenous fistula ¹⁷⁵ Arteriovenous malformation ¹⁷⁶ Intracranial aneurysm ¹⁷⁵ Fibromuscular dysplasia of the carotid artery ¹⁷⁷ Dissection of the carotid artery ¹⁷⁸ Vascular anomalies of the ear ¹⁷⁹ Vascular compression of the VIIIth nerve ¹⁸⁰
	Venous	Jugular bulb abnormalities ¹⁸¹ Dural venous sinus stenosis ¹⁸² Abnormal condylar or mastoid emissary veins ¹⁸³ Idiopathic tinnitus, venous hum, essential tinnitus ^{184, 185}
Microvascular		Glomus tumour ¹⁸⁶ Paget's disease ¹⁸⁷ Cholesterol granuloma of middle ear ¹⁸⁸ Meningioma of middle ear ¹⁸⁹ Cavernous haemangioma ¹⁹⁰ Histiocytosis X ¹⁹¹
Circulatory		Increased cardiac output (anaemia, thyrotoxicosis, pregnancy) ¹⁹² Aortic murmurs ¹⁸⁸
Perceptual		Conductive hearing loss ¹⁹³ Cochlear trauma ¹⁹³
Other		Benign intracranial hypertension ^{194–197} Superior semicircular canal dehiscence syndrome ¹⁹⁸

Synchronous PULSATILE TINNITUS

INVESTIGATION:

- anaemia and thyrotoxicosis (CBC, TSH) .
 - In the absence of an obvious cause, synchronous pulsatile tinnitus requires imaging.
 1. duplex carotid ultrasonography
 2. contrast-enhanced CT
- If **negative** → may proceed to MRA-Angiography

The gold standard mode of imaging is angiographic imaging - risky - so this is often reserved for severe, recalcitrant cases where less invasive techniques have not revealed an obvious pathology.

If idiopathic intracranial hypertension is suspected, an ophthalmological assessment, lumbar puncture, measurement of intracranial pressure and diagnostic reduction of intracranial pressure by draining off some cerebrospinal fluid may be required.

treatment

Supportive:

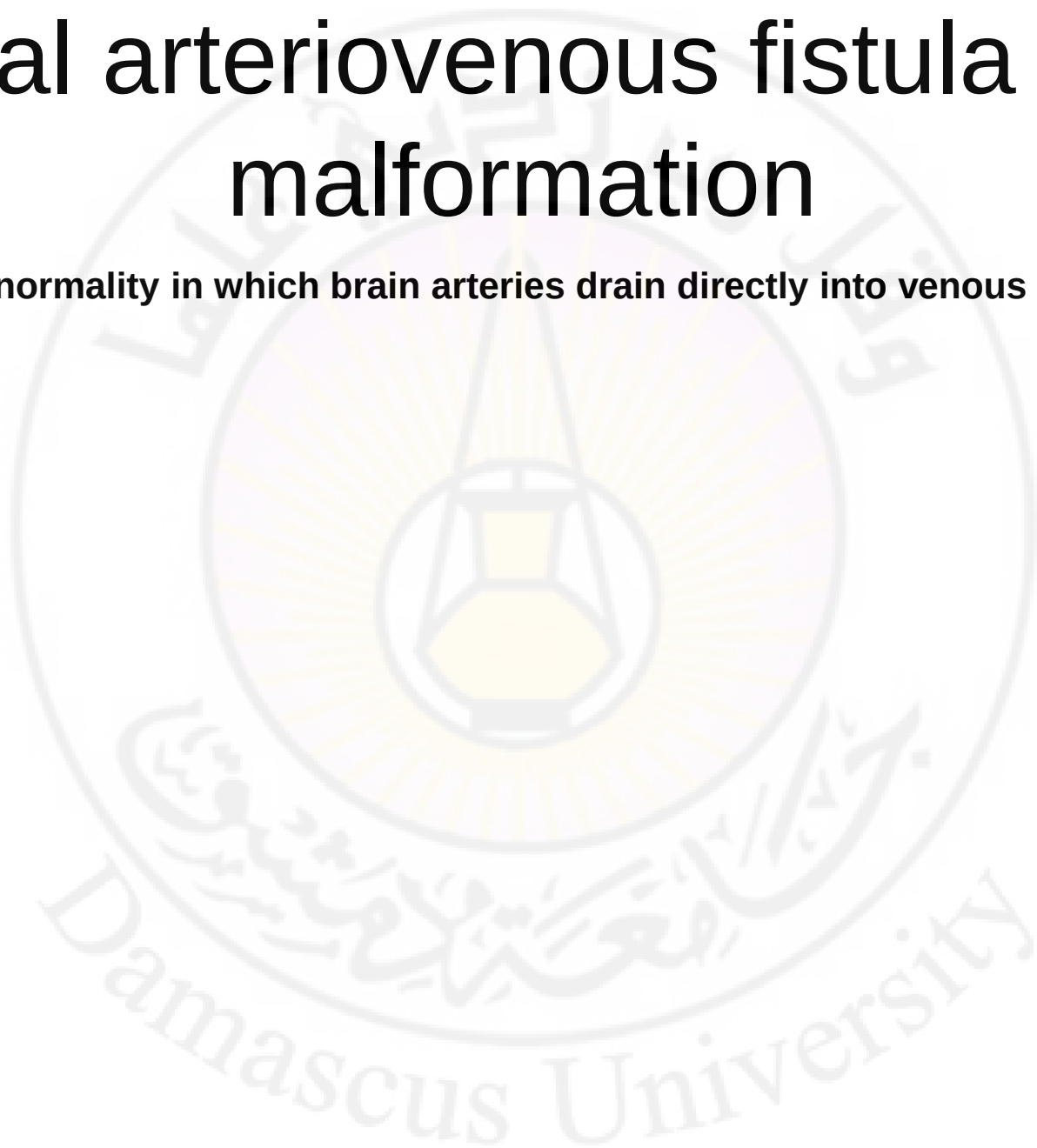
When no obvious cause is identified, providing reassurance that there is no untoward pathology present is often an important aspect of treatment.

These patients may benefit from CBT or TRT to address the coexisting emotional effects of their tinnitus.

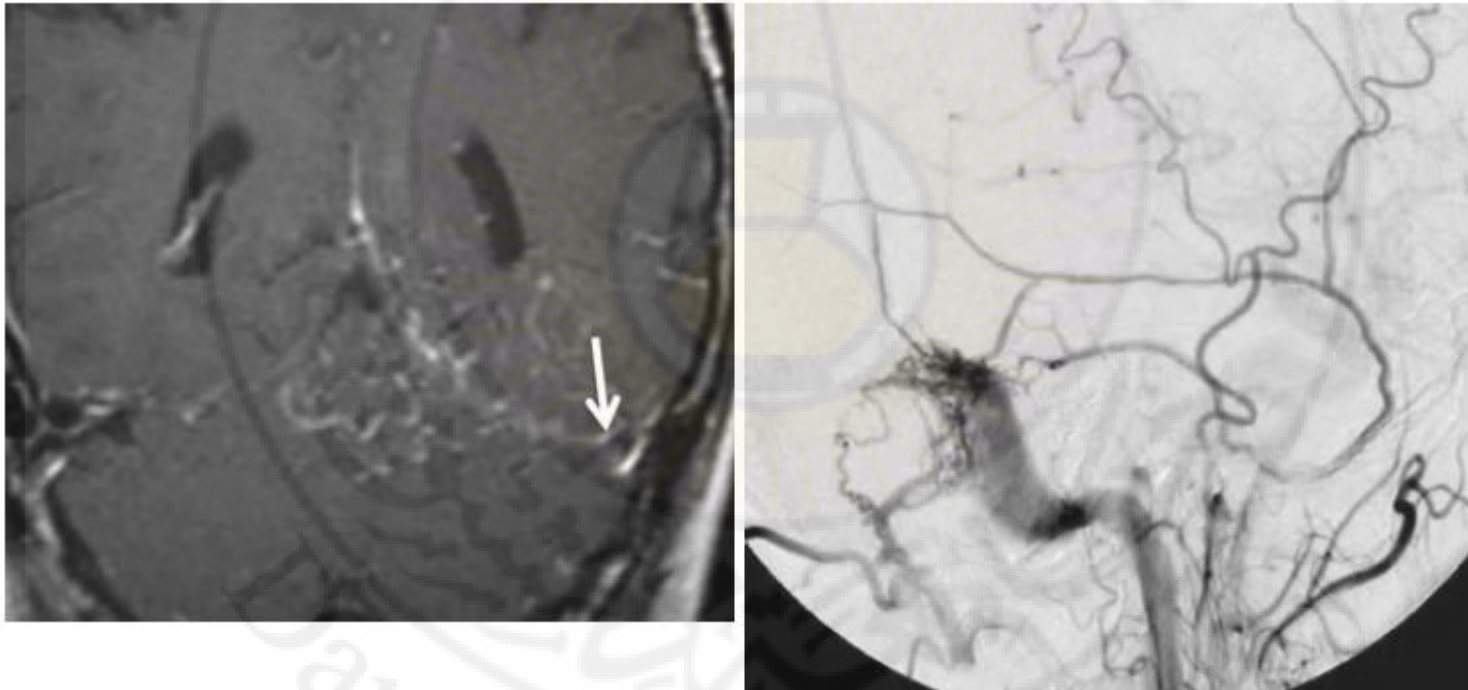
Anecdotally, sound therapies can be used as for subjective idiopathic tinnitus though there is no evidence base to support this management.

Dural arteriovenous fistula and malformation

Vascular abnormality in which brain arteries drain directly into venous sinuses



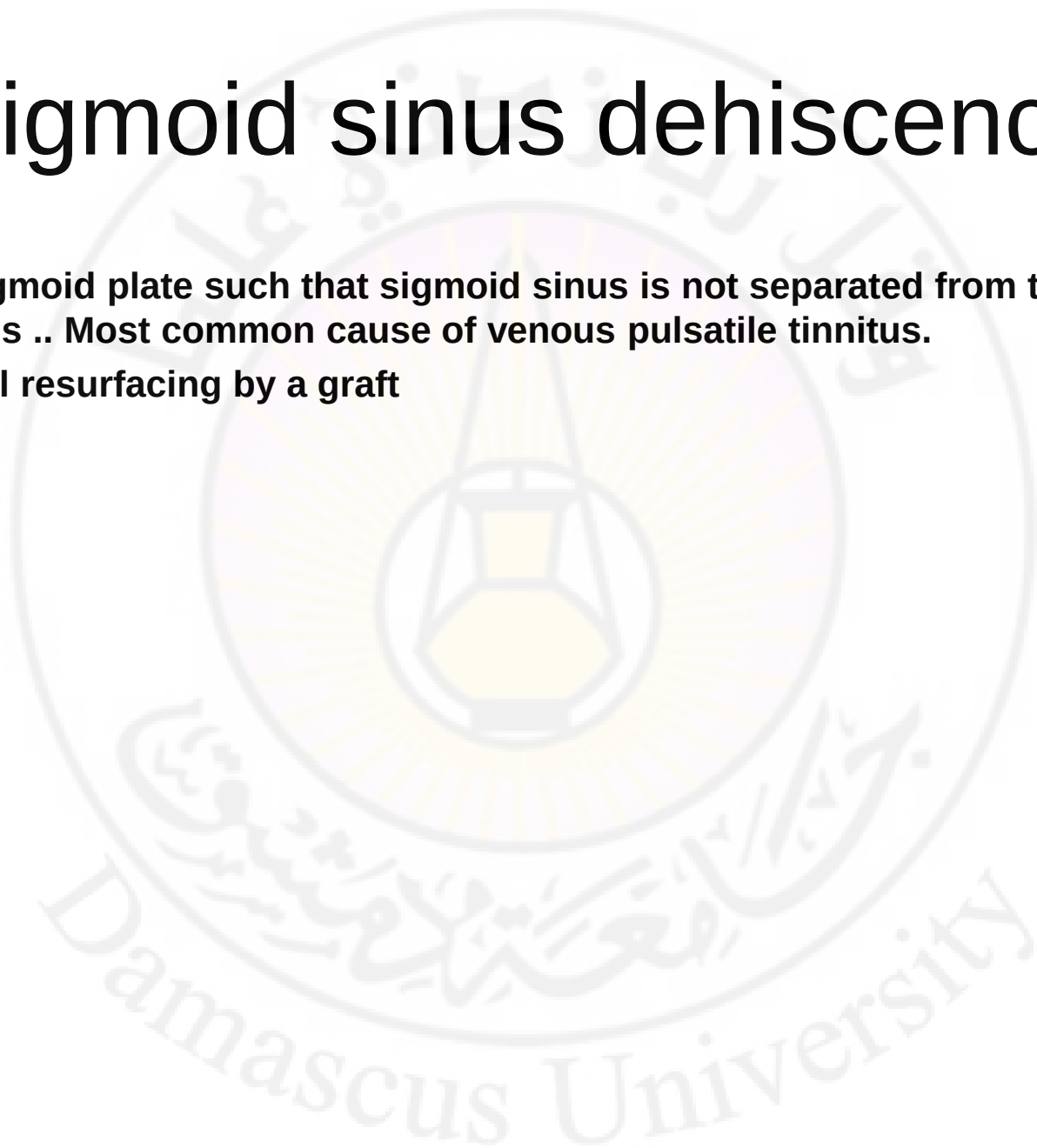
Dural arteriovenous fistula



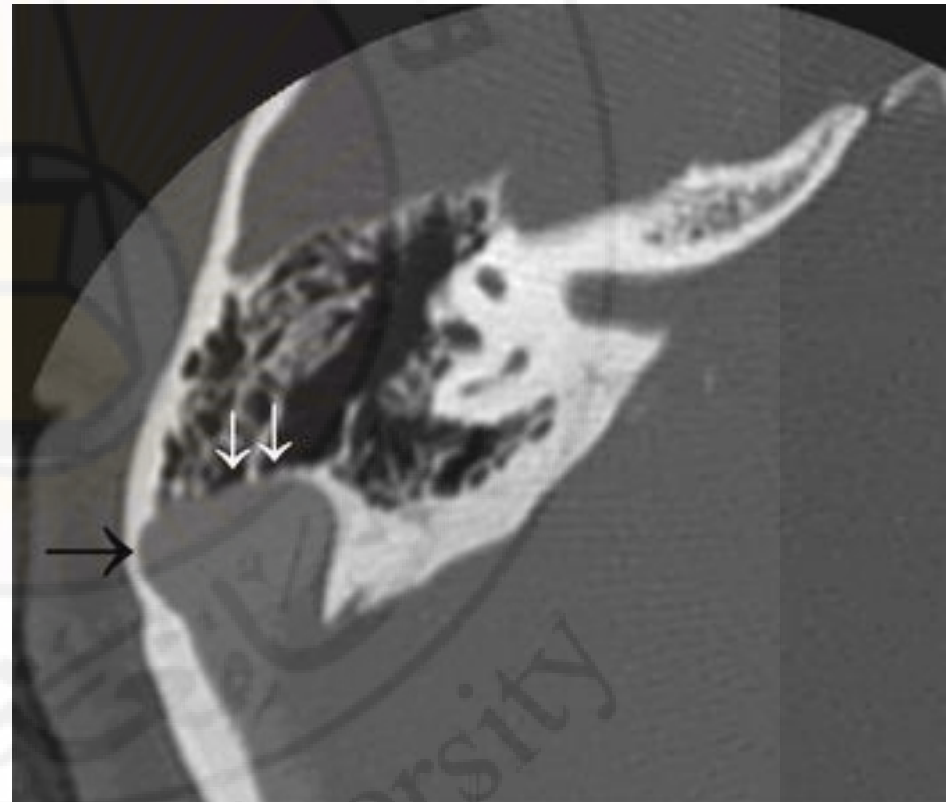
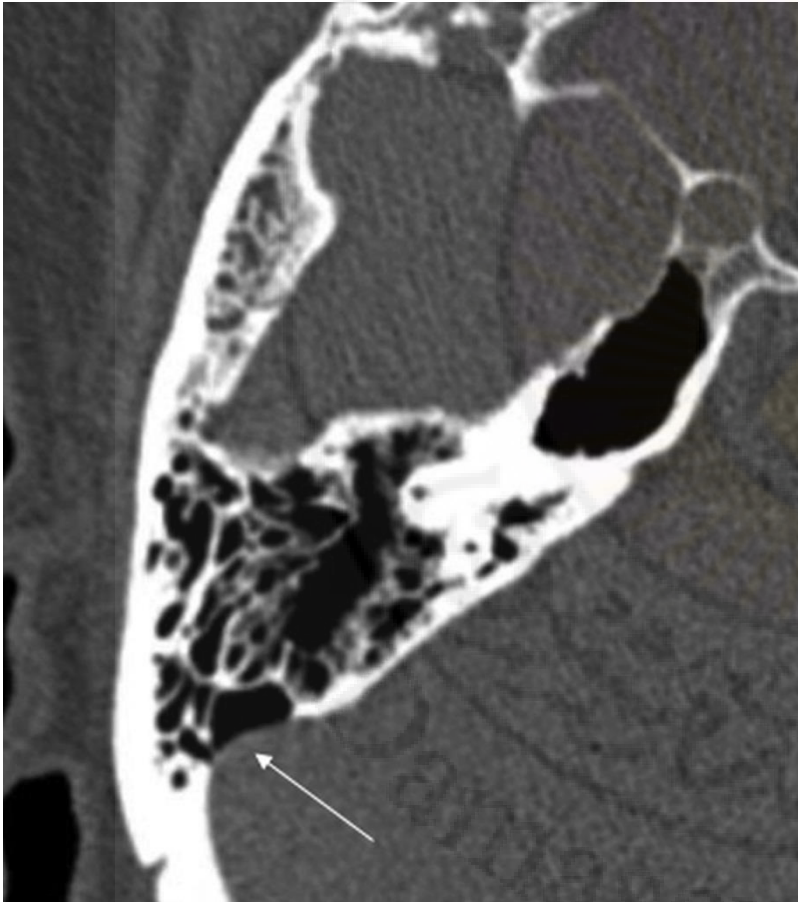
Sigmoid sinus dehiscence

Defect in sigmoid plate such that sigmoid sinus is not separated from the air in mastoid cells .. Most common cause of venous pulsatile tinnitus.

Rx : surgical resurfacing by a graft



Sigmoid sinus dehiscence

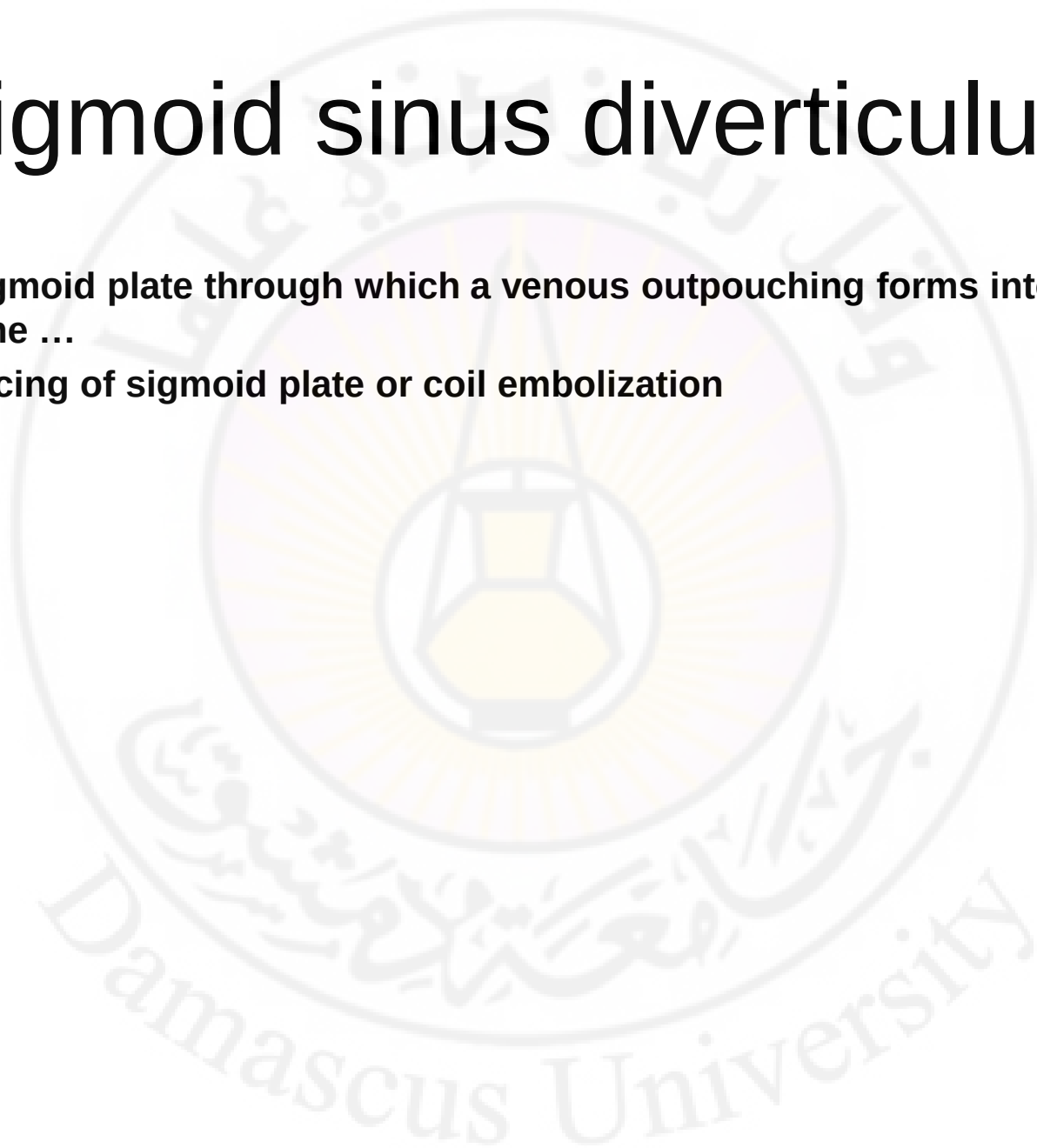


dehiscence

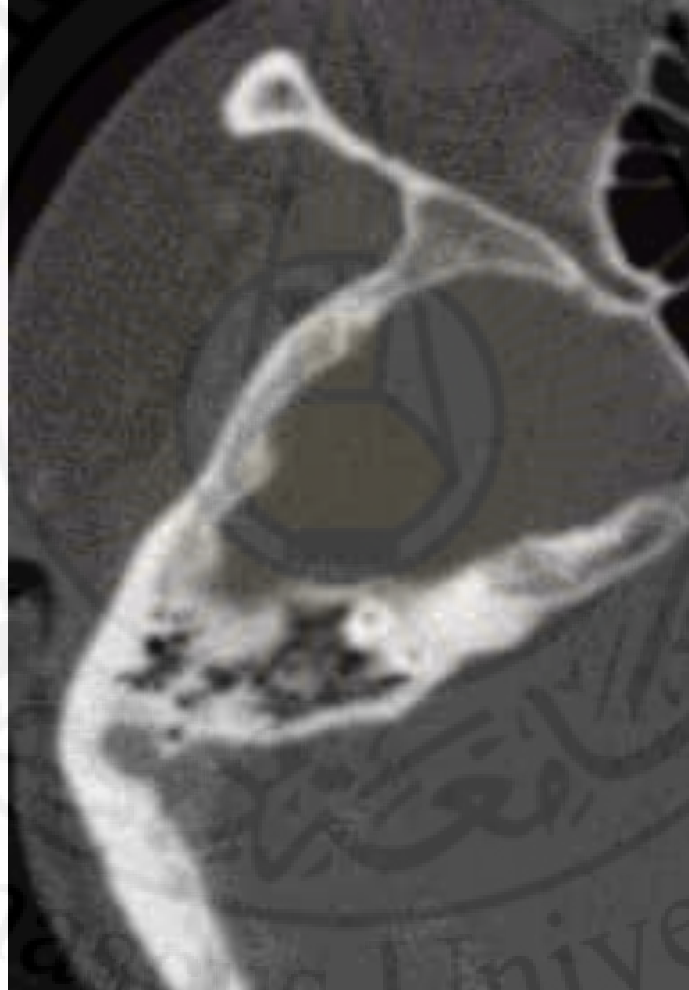
Sigmoid sinus diverticulum

Defect in sigmoid plate through which a venous outpouching forms into the mastoid bone ...

Rx : resurfacing of sigmoid plate or coil embolization

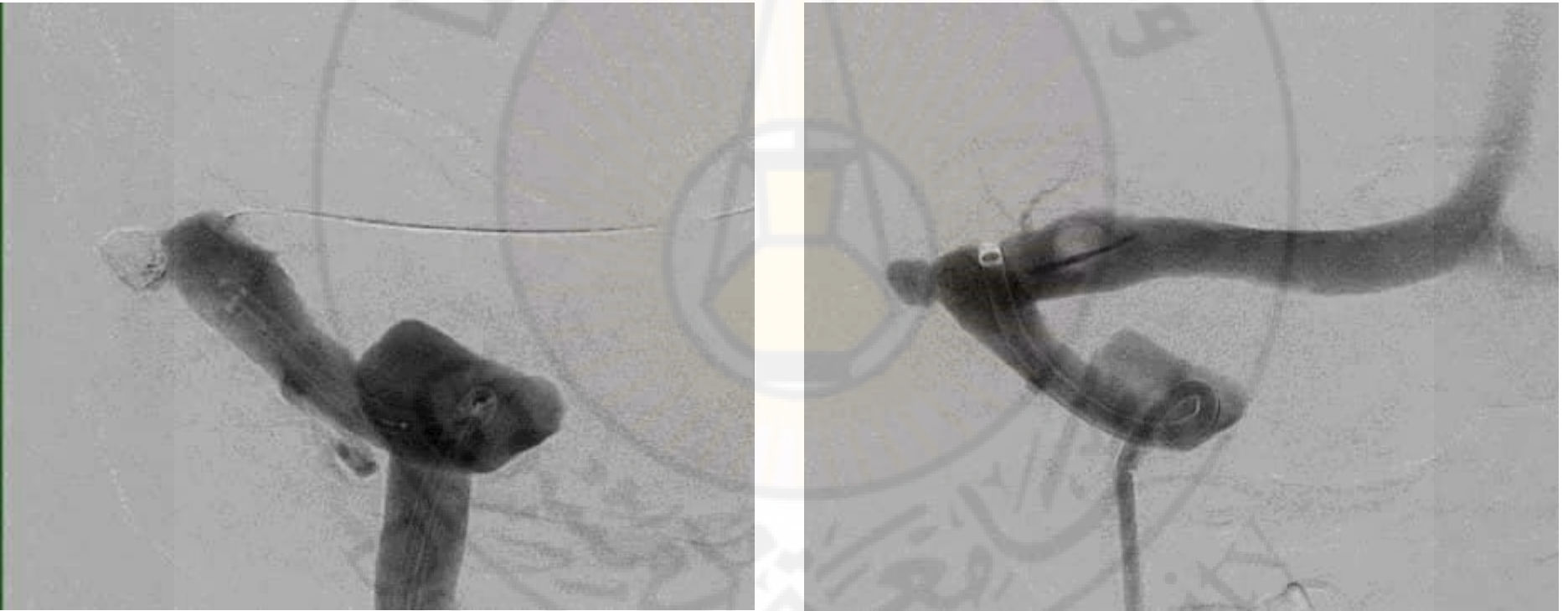


Sigmoid sinus diverticulum



diverticulum

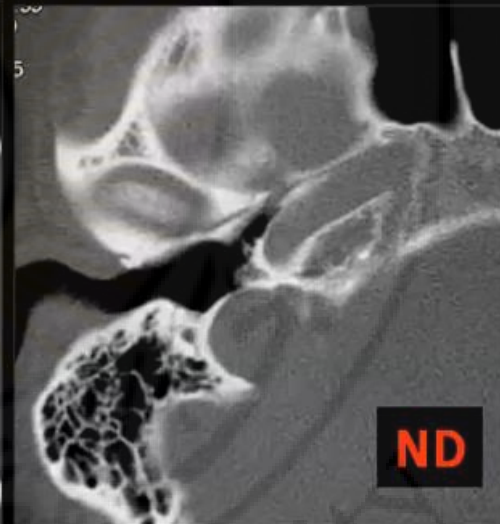
Sigmoid sinus diverticulum



Coiling of diverticulum

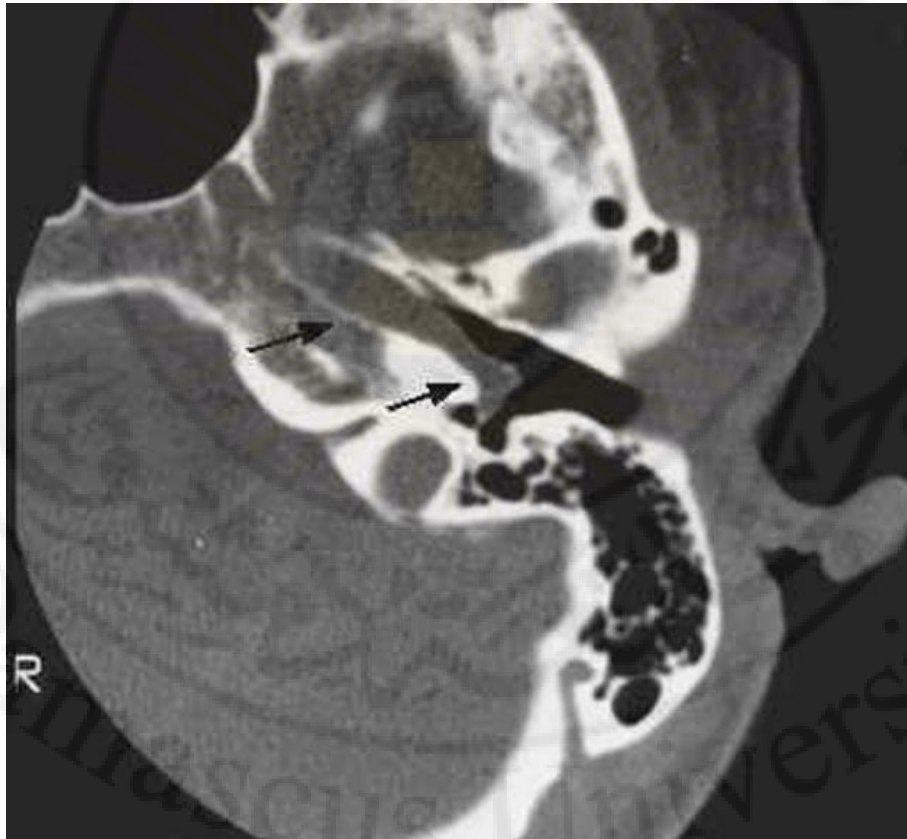
High riding jugular bulb and jugular bulb dehiscence

Jugular bulb



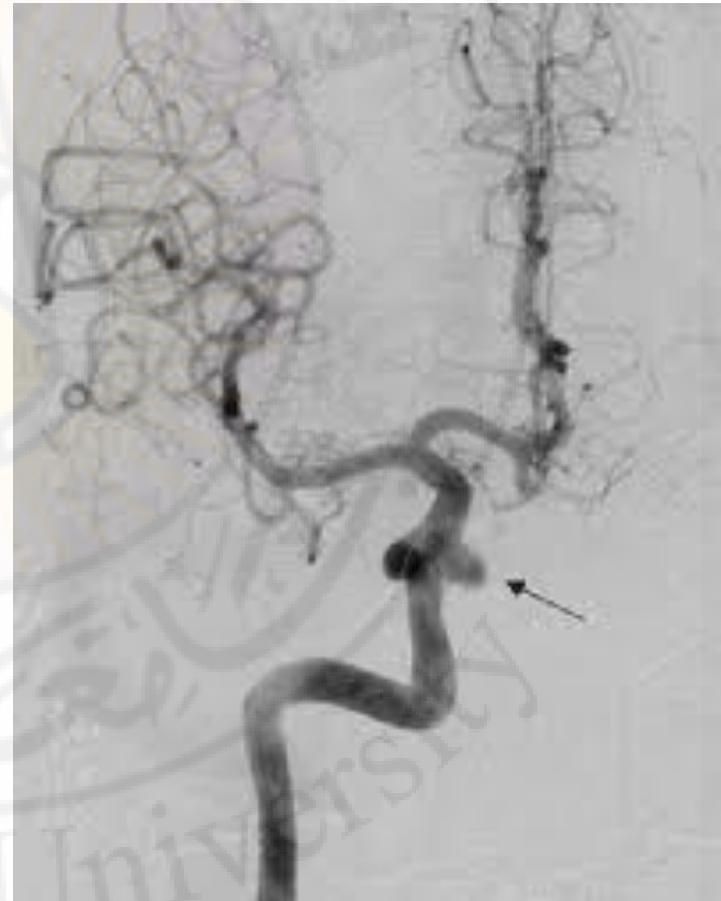
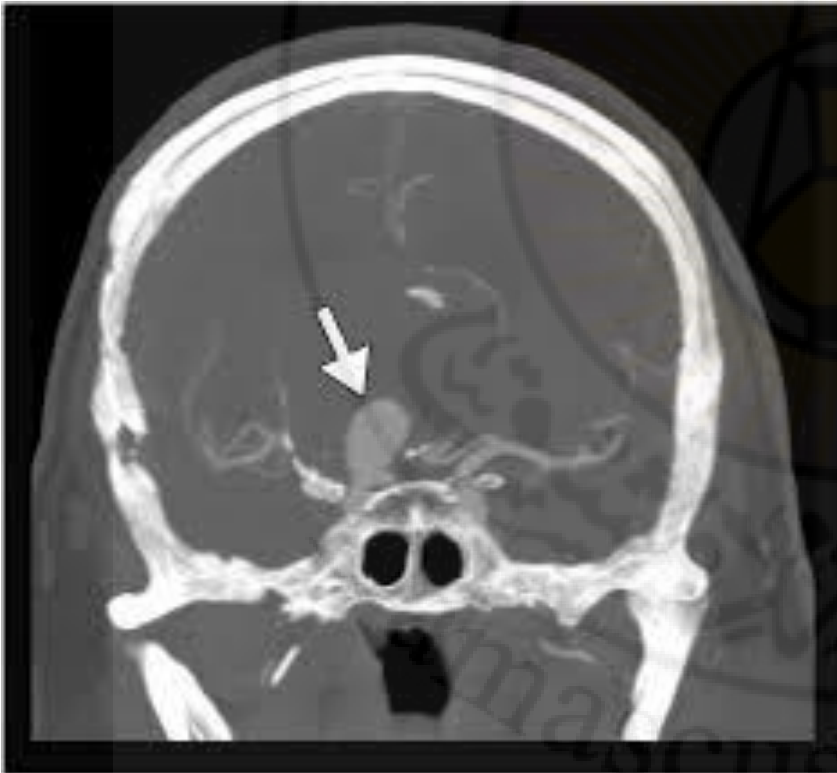
Aberrant carotid artery

Enlargement of usually small collaterals which course through the middle ear, appearing as an artery that passes lateral to the cochlear promontory.



Internal carotid artery aneurysm

Dilatation along the course of internal carotid artery
May rupture leading to hemorrhage



paraganglioma

Highly vascularized tumour that might present with pulsatile tinnitus.

