Diagnostic Imaging Modalities of Temporomandibular Joint

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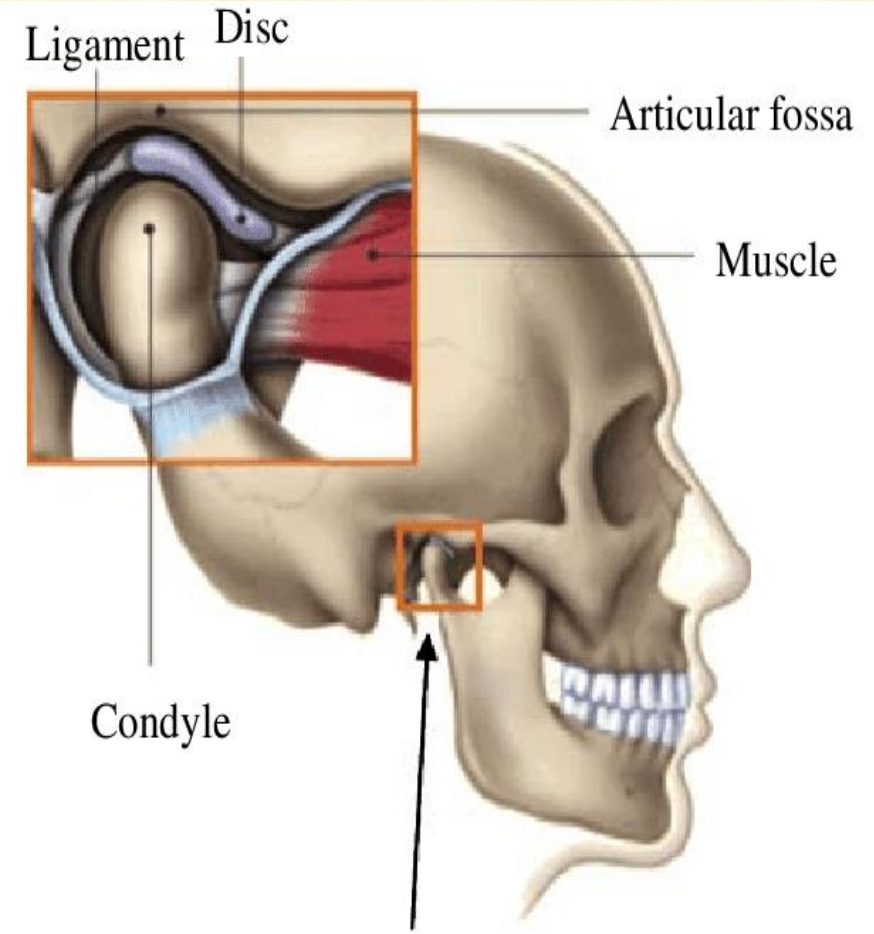
INTRODUCTION

- The temporomandibular joints (TMJ) are the two joints that connect the lower jaw to the skull.
- consist of the mandible (the lower jaw) and the temporal bone (the side and base of the skull).
- These joints works in synergy along with several muscles to allow the mandible to move up and down, side to side, and forward and back.



The temporomandibular joint

Introduction

- TMJ imaging may be necessary to supplement information obtained from the clinical examination, particularly when an osseous abnormality or infection is suspected, conservative treatment has failed, or symptoms are worsening.

- The purposes of TMJ imaging are to evaluate the **integrity and relationships of the hard and soft tissues, confirm the extent or stage of progression of known disease, and evaluate the effects of treatment.**

TMJ ANATOMY

1. Condyle:

- The condyle is a bony structure connected to the mandibular ramus by a narrow neck.
- The condyle presents an articular surface for articulation with the articular disk of the temporomandibular joint.
- The space between the mandibular condyle and the articular disc is considered inferior TMJ compartment.

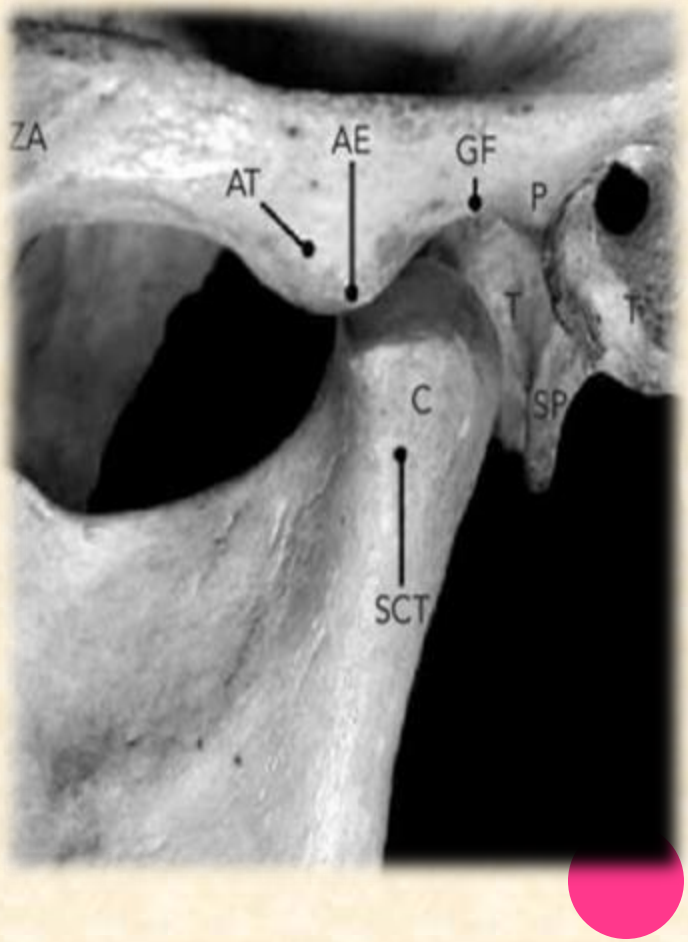
TMJ ANATOMY

- The shape of the condyle varies considerably; the superior aspect may be flattened, rounded, or markedly convex, whereas the mediolateral contour usually is slightly convex.
- These variations in shape may cause difficulty with radiographic interpretation.

TMJ ANATOMY

2. Glenoid fossa :

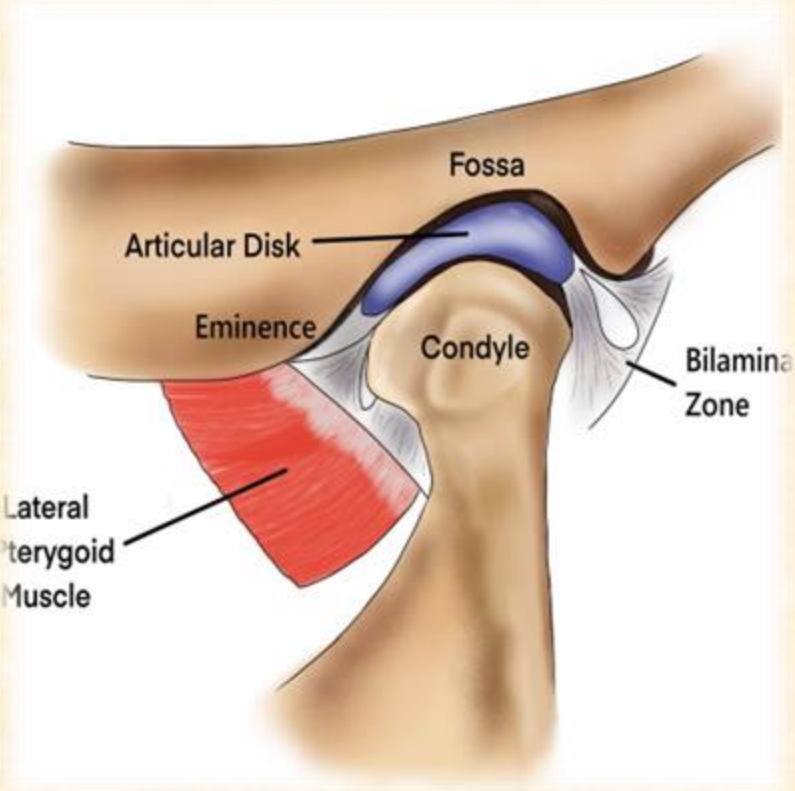
- Location, at the inferior aspect of the squamous part of the temporal bone.
- described as the temporal component of the TMJ.
- The anterior limit of the glenoid fossa of the temporal bone constitutes the articular eminence, which forms a medial bone prominence at the posterior border of the zygomatic bone.



TMJ ANATOMY

3. Articular disc:

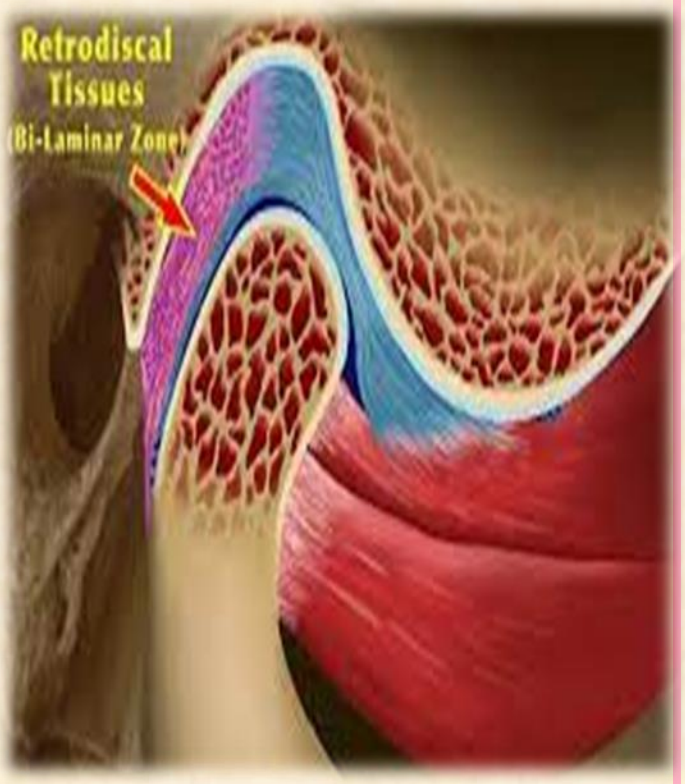
- is a fibrous extension of the capsule that runs between the two articular surfaces of the temporomandibular joint.
- The disc articulates with the mandibular fossa of the temporal bone above and the condyle of the mandible below. The disc divides the joint into two sections, each with its own synovial membrane.



TMJ ANATOMY

4. Posterior attachment (retrodiskal tissue):

- consists of a bilaminar zone of vascularized and innervated loose fibroelastic tissue.
- The superior lamina, which is rich in elastin, inserts into the posterior wall of the mandibular fossa.
- The inferior lamina attaches to the posterior surface of the condyle.



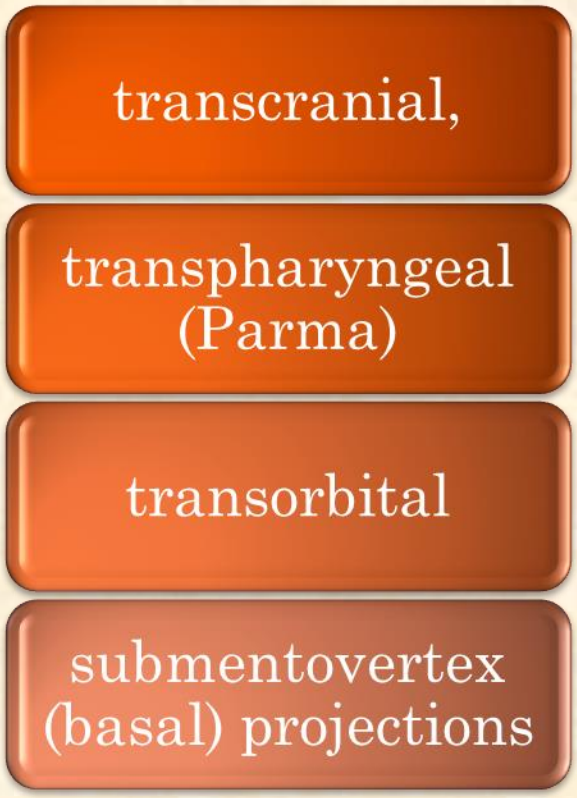
Imaging Modalities of Temporomandibular Joint

1. Plain Film Imaging Modalities

- used to evaluate only the bony elements of the TMJ.
- gradually being replaced with cone-beam computed tomography (CBCT)
- They do not give useful information when it comes to the non-bony elements.
- Has a problem of superimposition of adjacent structures.

Imaging Modalities of Temporomandibular Joint

- Plain film, usually consisting of a combination of:



Imaging Modalities of Temporomandibular Joint

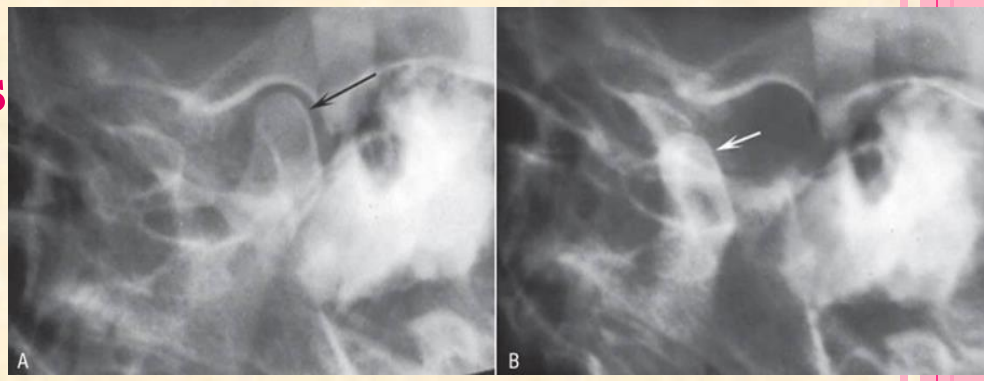
Transcranial projection	Transpharyngeal projection
1. taken in the closed and open mouth positions.	1. taken in the mouth open position only.
2. depicts the lateral aspect of the TMJ .	2. depicts the medial aspect of the condyle.

Imaging Modalities of Temporomandibular Joint

- *Transorbital projection*
  - taken in the open or protruded position
  - depicts the entire mediallateral aspect of the condyle in the frontal plane
  - useful in detecting condylar neck fracture

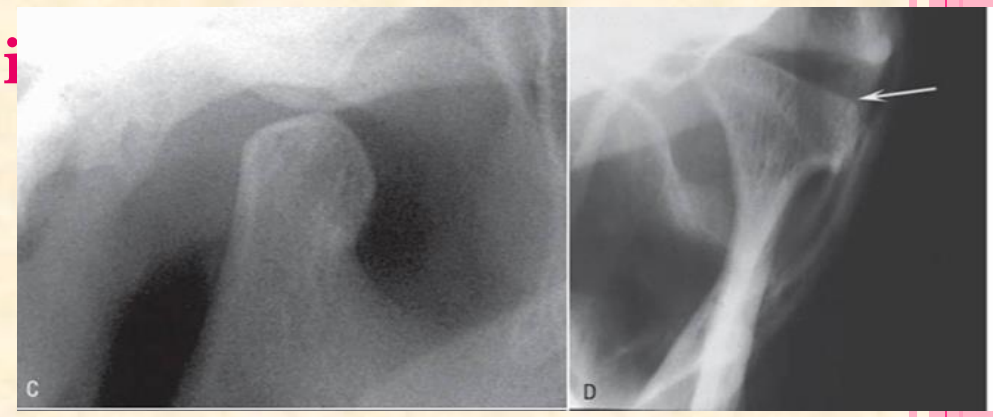
- *Submentovertex projection*
  - provides a view of skull base and condyles in the horizontal plane
  - used to determine the angulation of the long axes of the condylar heads for corrected tomography.

Transcranial projections

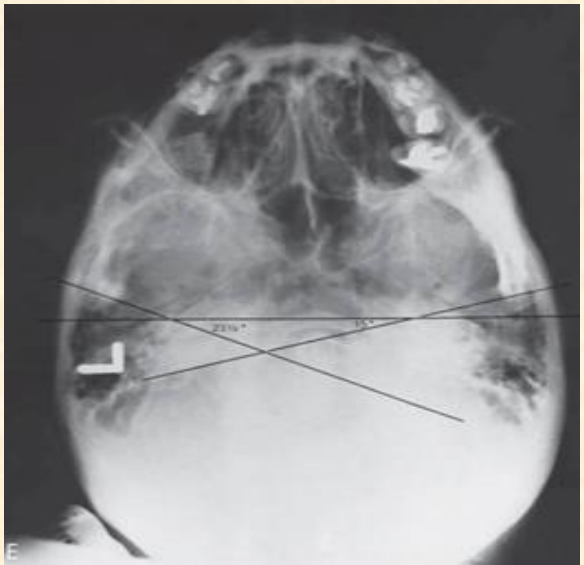


transpharyngeal projecti

transorbital projection



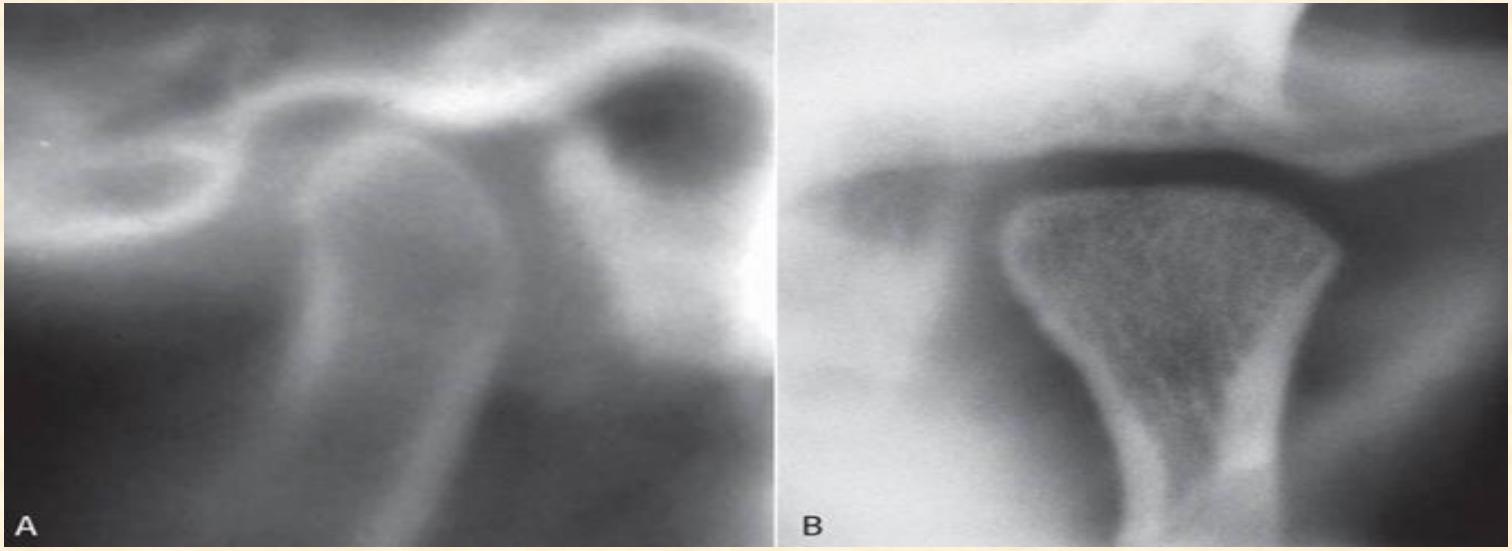
submentovertex projection



Imaging Modalities of Temporomandibular Joint

2. Conventional Tomography

- radiographic technique that produces multiple thin image slices, **permitting visualization of the osseous structures essentially free of superimpositions of overlapping structures.**



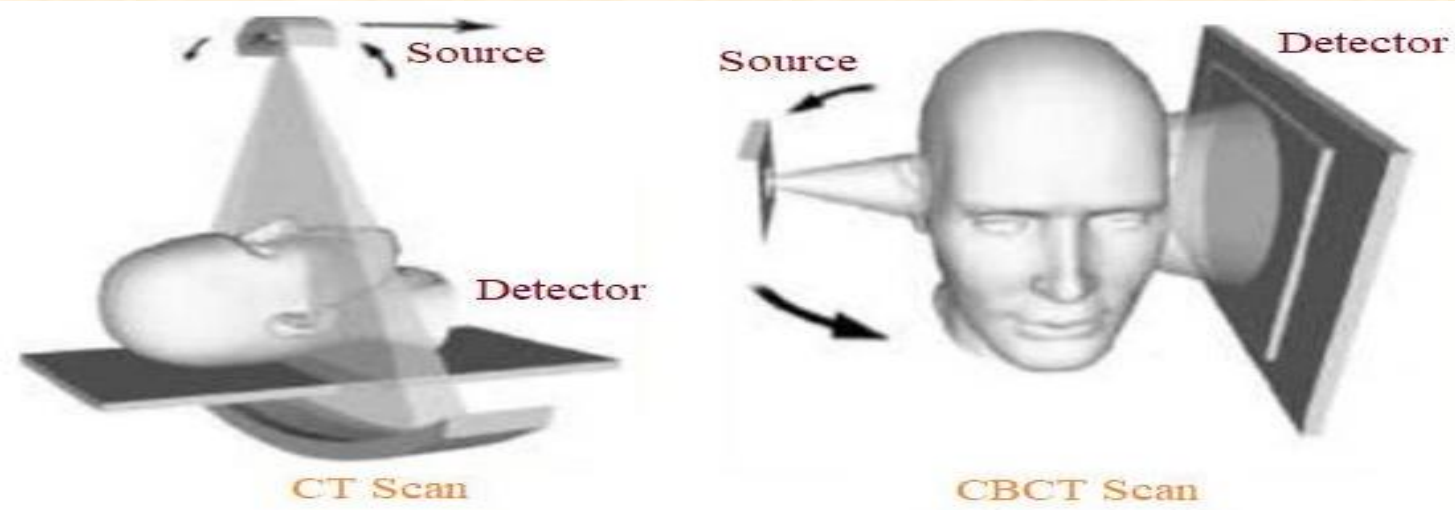
Imaging Modalities of Temporomandibular Joint

- Tomography typically are exposed in the sagittal (lateral) plane, corrected to the condylar long axis.
- The sagittal images could be supplemented with coronal (frontal) tomographs.
- several image slices in the closed (maximal intercuspation) position and usually only one image in the maximal open position.
- Used when morphologic abnormalities or erosive changes of the condylar head are suspected. The entire condylar head is visible in the mediolateral plane.

Imaging Modalities of Temporomandibular Joint

3. Computed Tomography (CT):

- best method for assessing osseous pathologic conditions of TMJ
- 3D (sagital, axial and coronal) images in closed and opened-mouth positions.
- There are two CT devices, conventional CT (sometimes referred to as medical CT and CBCT.



Imaging Modalities of Temporomandibular Joint

CT examination of the TMJ should focus on the following:

1- intactness of the cortex.

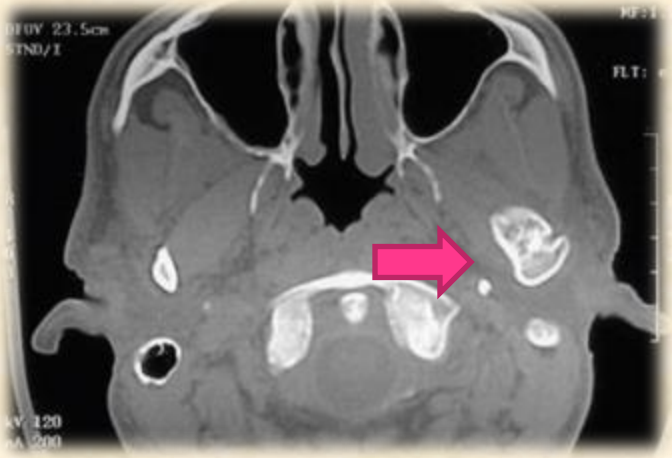
2- normal size and shape of the condyles and their centered position in the fossa.

3- the adequate joint spaces.

4- centric relation loading zone.

Imaging Modalities of Temporomandibular Joint

neoplasms

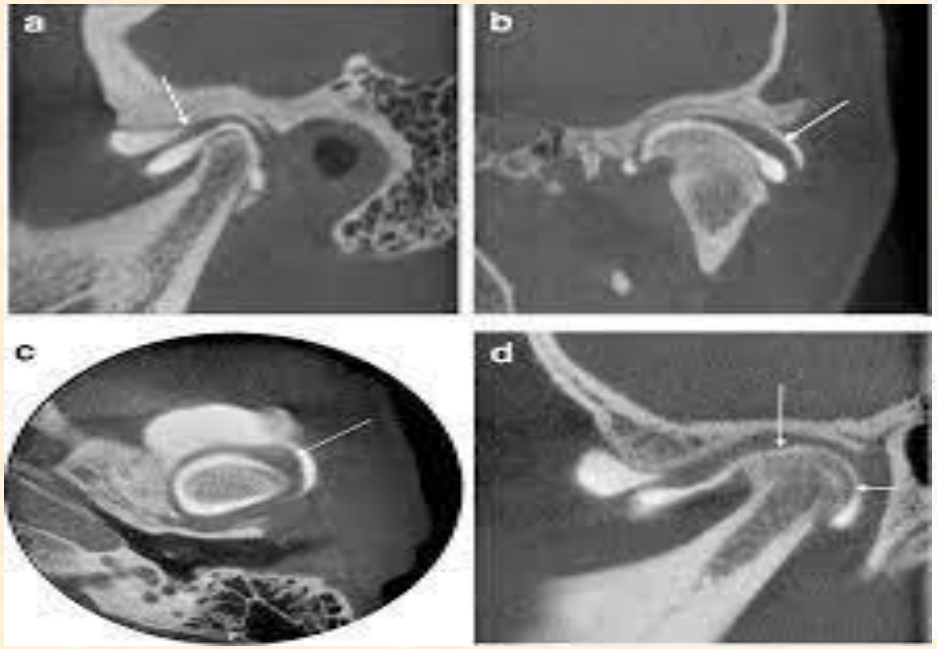


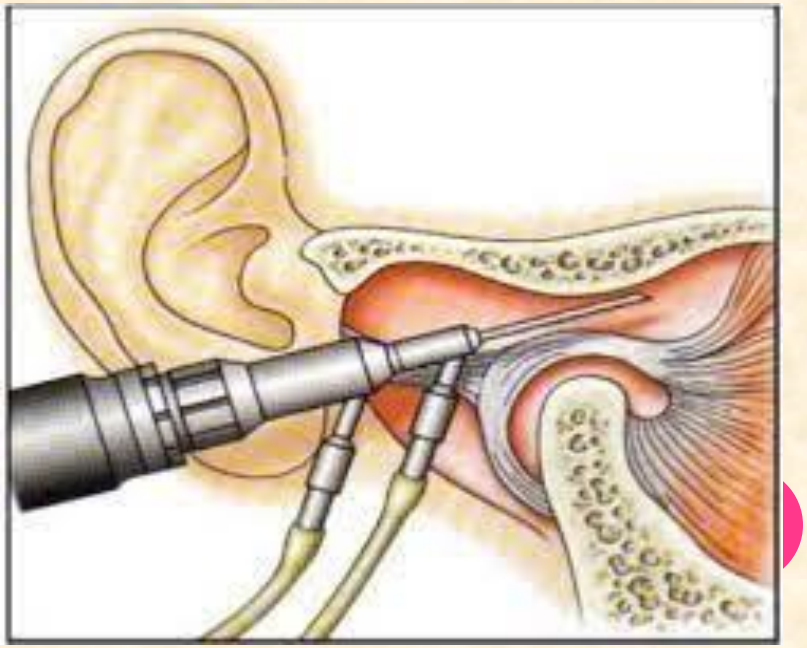
ankylosis

fractures

Imaging Modalities of Temporomandibular Joint

- . The disc could be visualized on CT scans only with injection of contrast media in the joint (arthrography).
- Arthrography is a dynamic investigation, but was never widely used, due to *its invasiveness, pain and allergic reactions*





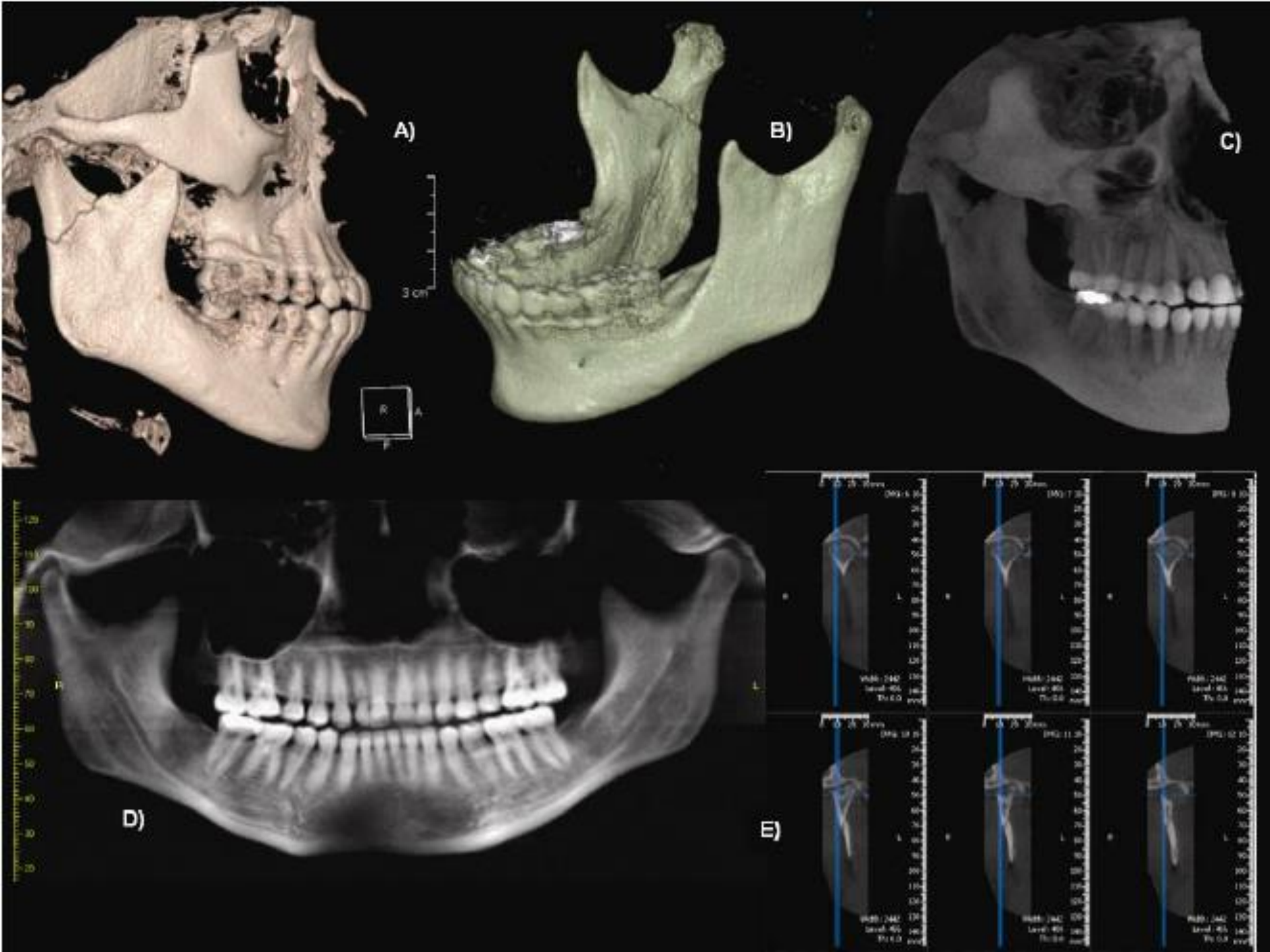
Imaging Modalities of Temporomandibular Joint

CBCT has the advantage of reduced patient dose compared with medical CT.

In CBCT the patient is usually scanned in the closed position and low-resolution scans can be done in the open or other positions.

These are useful for assessing osseous deformities of the jaws or surrounding structures.

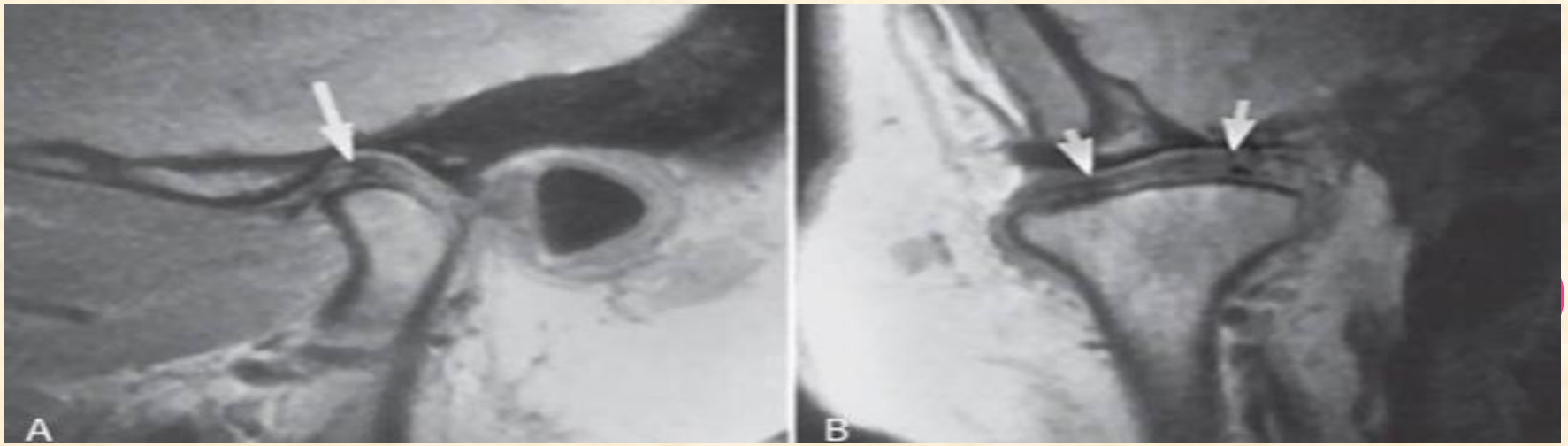
Conventional and CBCT cannot produce accurate images of the articular disk.


A)
B)
C)
D)
E)
3 cm

Imaging Modalities of Temporomandibular Joint

4. Magnetic Resonance Imaging (MRI):

- uses a magnetic field and radiofrequency pulses rather than ionizing radiation to produce multiple digital image slices.
- used for imaging the articular disk.
- images in the sagittal and coronal planes without repositioning the patient
- open and closed mandibular positions



Abnormalities of Temporomandibular Joint

1. Developmental Abnormalities

Condylar Hyperplasia

Definition

- enlargement and occasionally deformity of the condylar head.
- etiologic factors include hormonal influences, trauma, infection, heredity, intrauterine factors, and hypervascularity.
- usually unilateral and may be accompanied by varying degrees of hyperplasia of the ipsilateral mandible .

Radiographic Features

- The condyle may appear relatively normal but symmetrically enlarged
- It may be more radiopaque .
- condylar neck may be elongated and thickened.
- The cortical thickness and trabecular pattern of the enlarged condyle usually are normal.
- The glenoid fossa may be enlarged.
- The ramus and mandibular body on the affected side also may be enlarged.

Condylar Hypoplasia

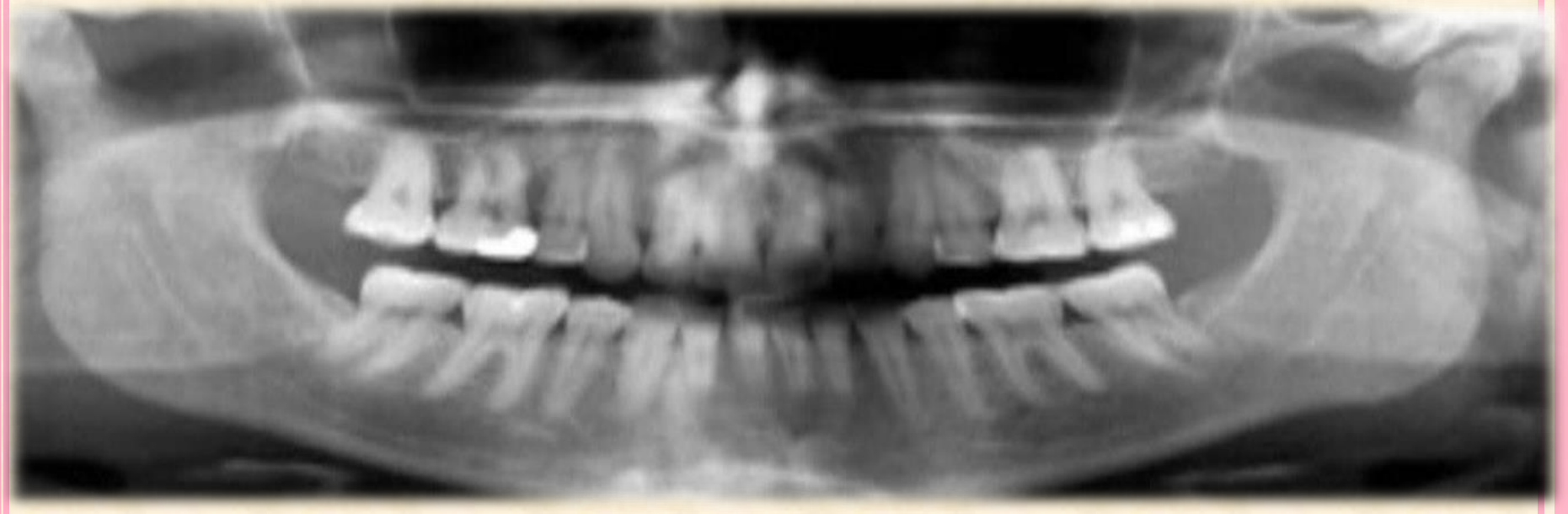
Definition

- failure of the condyle to attain normal size because of congenital and developmental abnormalities or acquired diseases that affect condylar growth.

- The acquired causes :traumatic injuries sustained during the growth and development of the mandible, therapeutic radiation and arthritis.

Radiographic Features

- The condyle is normal in shape and structure but is diminished in size.
- mandibular fossa is small.
- The condylar neck is thinner ,short or elongated.
- The coronoid process is slender.
- Occasional dental crowding may also result.
- Degenerative changes in the affected joint may be detected .



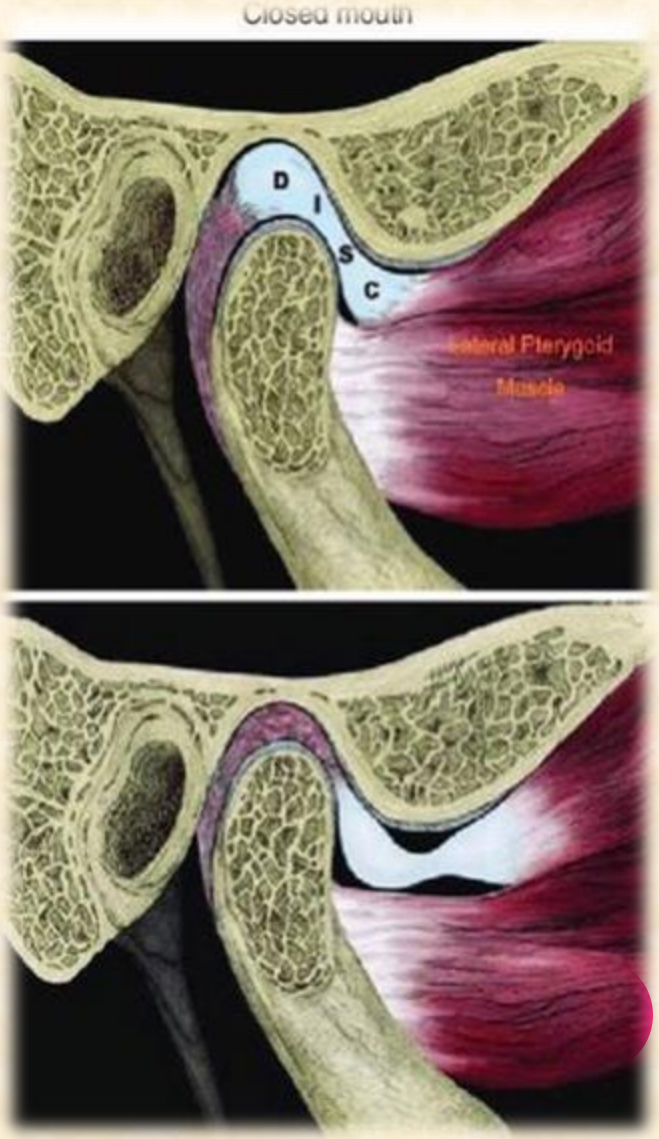
Abnormalities of Temporomandibular joint

2. Soft Tissue Abnormalities

-Internal Derangement

Definition

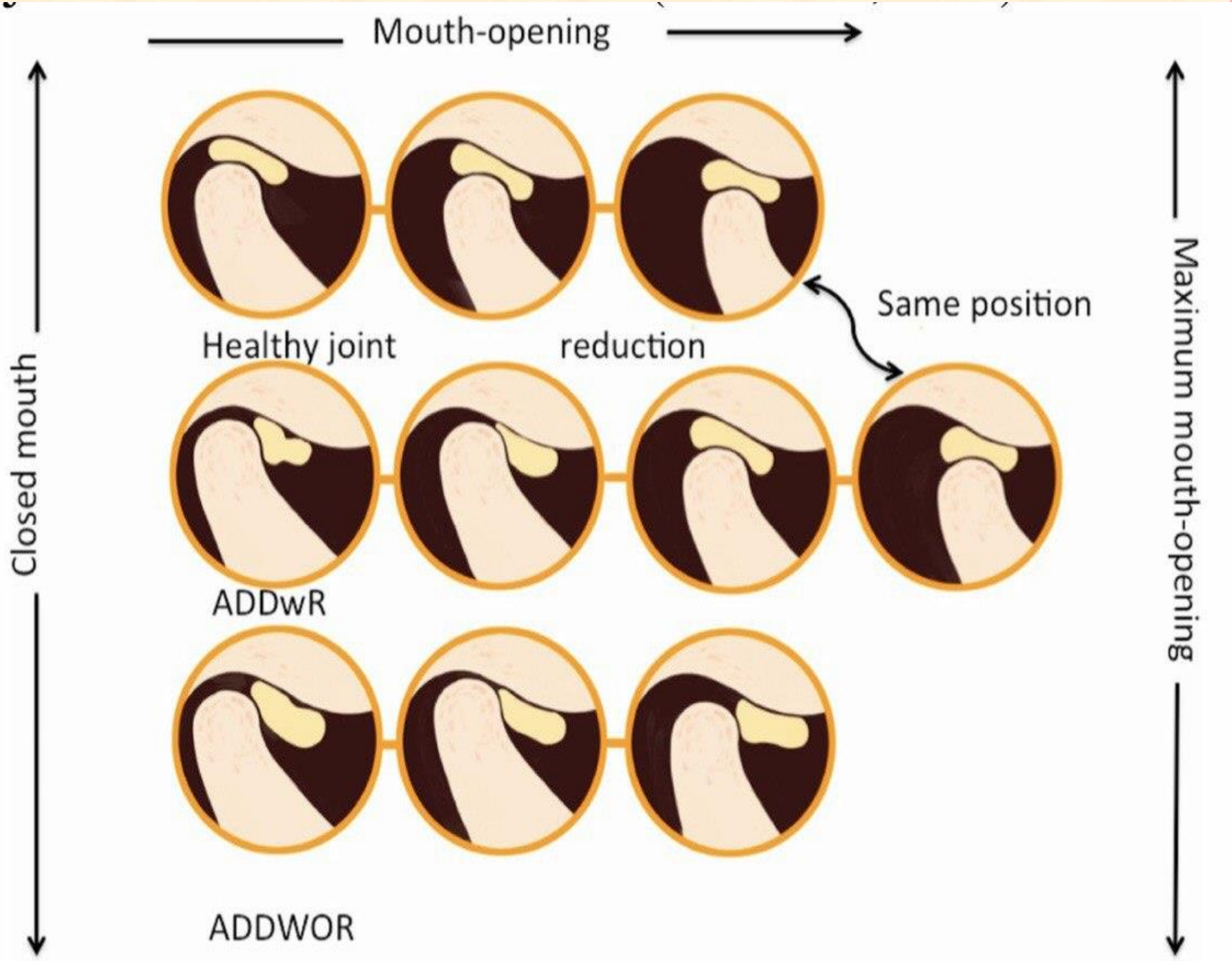
Internal derangement of TMJ is defined as an abnormal positional relationship of the disc relative to the mandibular condyle and the articular eminence **OR** is defined as a disruption within the internal aspects of the TMJ in which there is a displacement of the disc from its normal functional relationship with the mandibular condyle and the articular portion of the temporal bone.



- The disk most often is displaced in an anterior direction.
- Lateral and posterior displacements are extremely rare.
- The cause of internal derangements is unknown.
- **internal derangements can be diagnosed by MRI.**

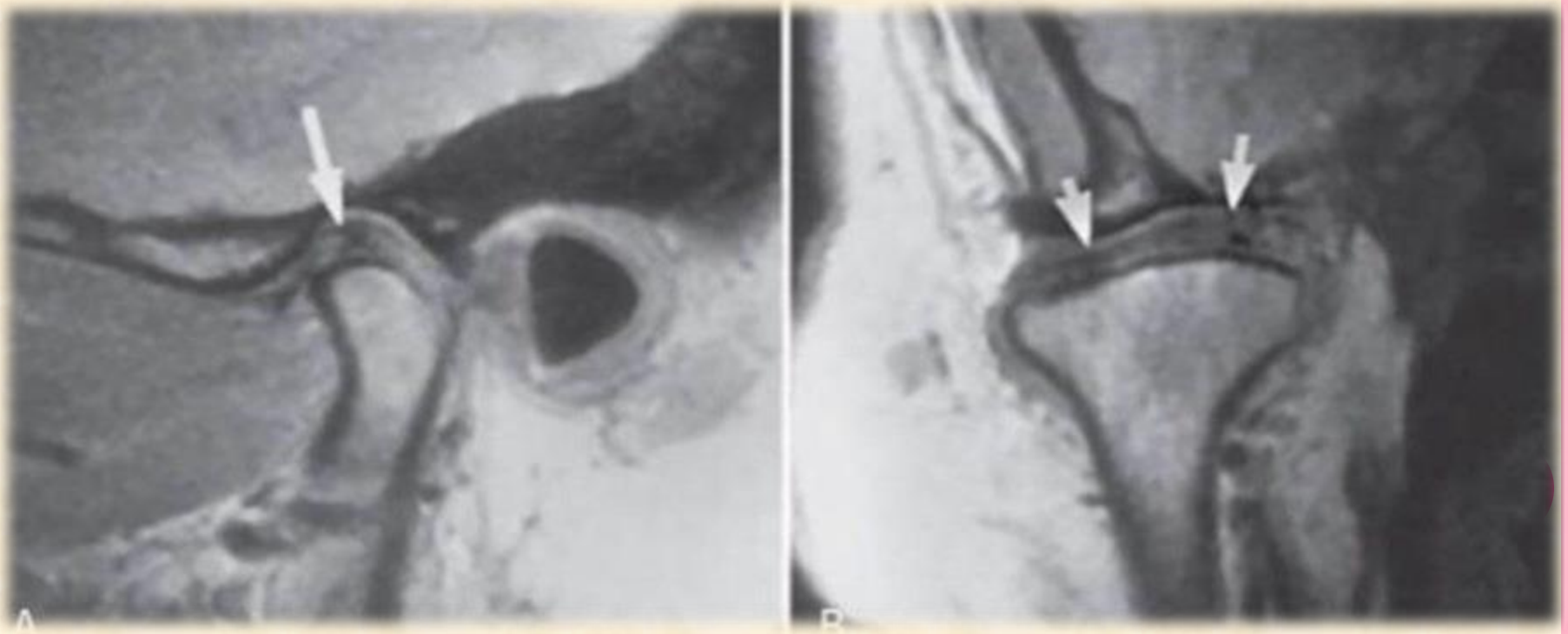
- **Disk displacement with reduction** when The disk is displaced from its position between the condyle and eminence to an anterior and medial or lateral position but is reduced in full mouth opening usually resulting in a noise. Click occurs on both vertical opening and closing. Pain may be present when chewing hard foods.

- **Disk displacement without reduction** when Disc displacement does not assume the normal position.


Mouth-opening
Closed mouth
Maximum mouth-opening
Same position
Healthy joint
reduction
ADDwR
ADDWOR

Radiographic Features

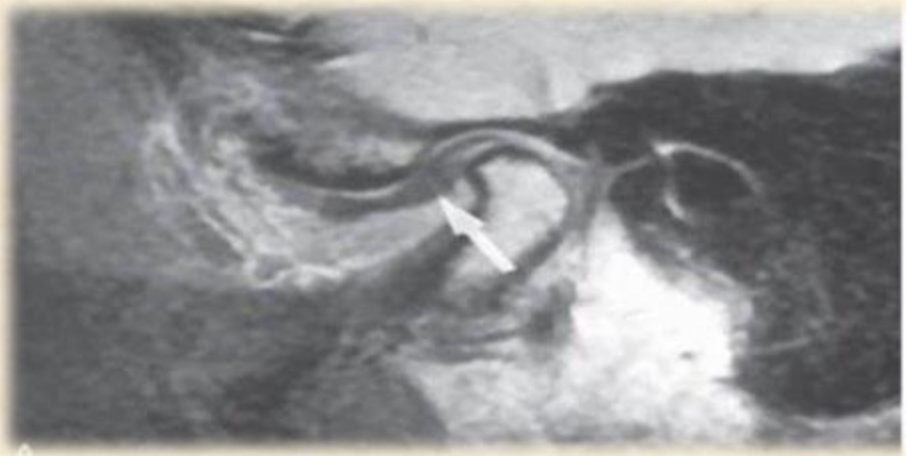
- **Normal Disc Position**. **MRI is the technique of choice.**
- On MRI, the normal disc has a low signal intensity and the signal intensity of the posterior attachment is usually higher
- In a sagittal image slice, the normal biconcave disc appears as a "bow tie" shape.

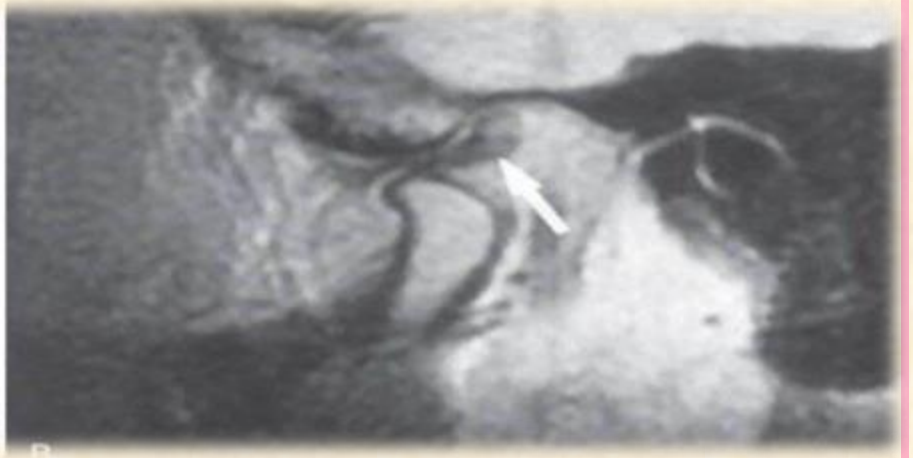


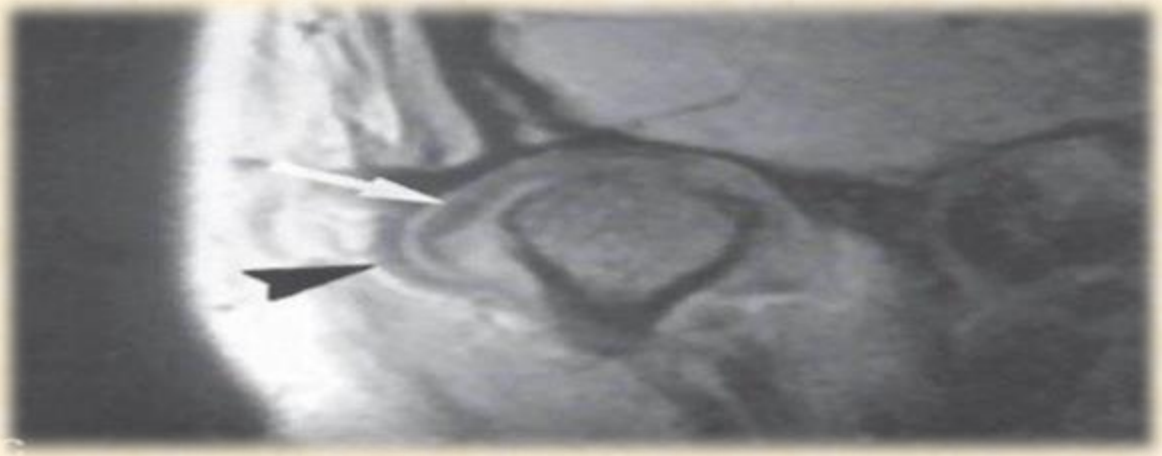
Disk Displacement Position

- **MRI imaging is required for identification of a displaced disc.**
- A disc is considered anteriorly displaced when its posterior band sits anterior to its normal position and the thin intermediate zone is no longer positioned between the condyle and articular eminence.
- Also, when the disc is chronically anteriorly positioned, the posterior attachment is pulled between the articulating surfaces of the condyle and temporal bone, and owing to resulting fibrosis.

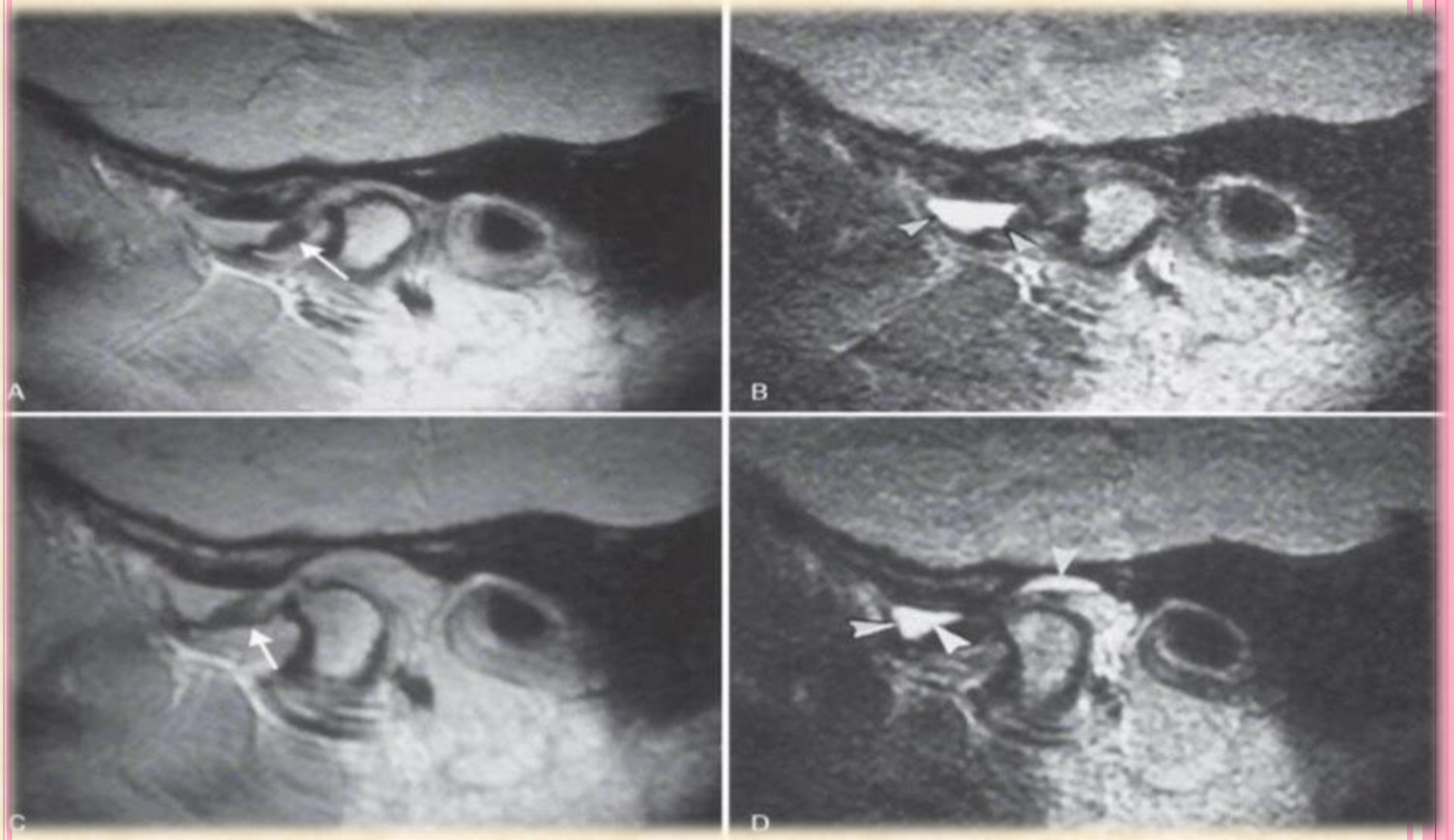
- **Anteromedial displacement is indicated in sagittal image slices.**
- **Medial or lateral displacement is indicated on coronal MRI .**
- Posterior disc displacement is rare.







MRI of Disk Displacement without Reduction in The Presence of The Joint Effusion



Abnormalities of Temporomandibular Joint

3. Remodeling and Arthritic Conditions

Remodeling

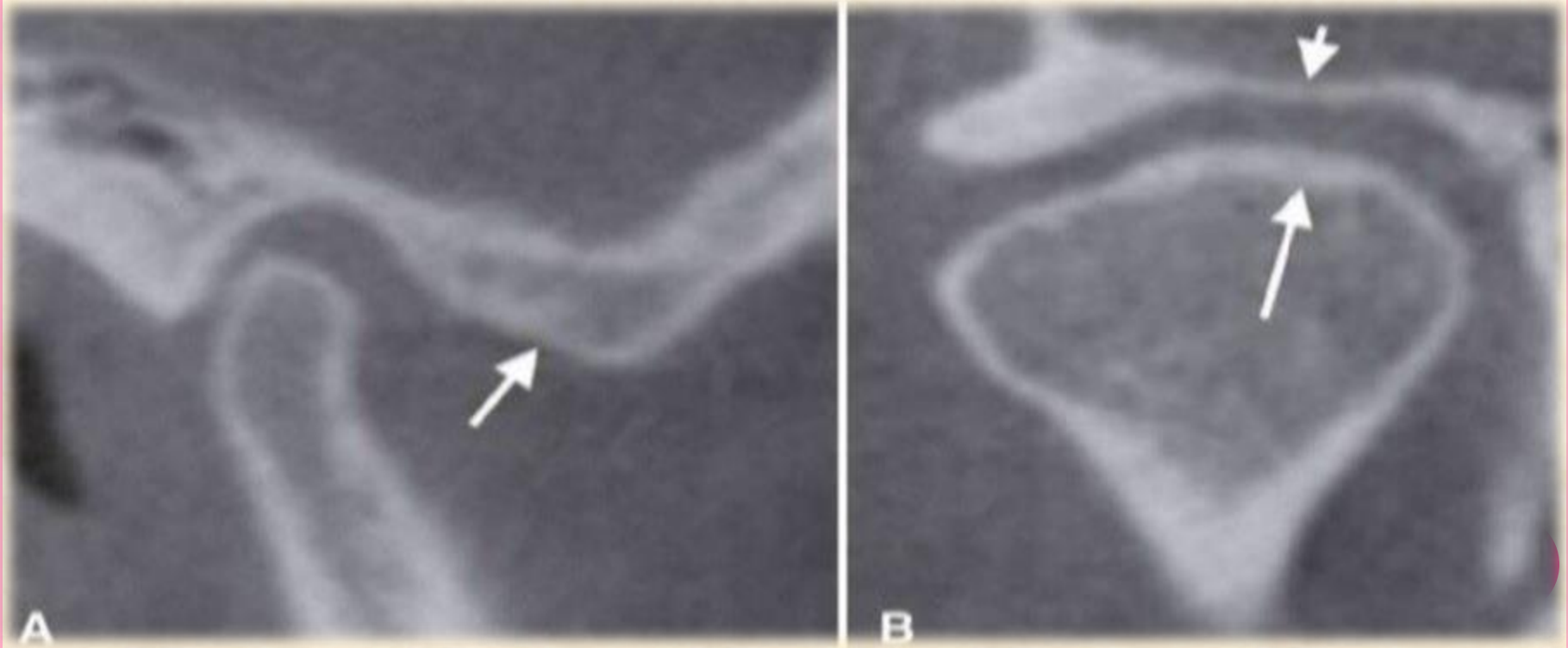
Definition

- an adaptive response of cartilage and osseous tissue to forces applied to the joint that may be excessive.

- may result **in flattening of curved joint surfaces. The number of trabeculae also increases, increasing the density of subchondral cancellous bone (sclerosis).**
- **No destruction or degeneration of articular soft tissues occurs.**

Radiographic Features

- changes noted in the diagnostic images may affect the condyle, temporal component, or both.
- The lateral aspect of the joint is affected in early stages, and the central and medial aspects become involved as remodelling progresses.



Abnormalities of Temporomandibular Joint

4. Degenerative Joint Disease

Osteoarthritis

Definition

- Osteoarthritis (OA) is defined as a degenerative condition of the joint characterized by deterioration of articular tissue and concomitant remodelling of underlying subchondral bone .

- OA is caused primarily by the degeneration of collagens and proteoglycans in cartilage.

Radiographic Features

- **Osseous changes in DJD are more accurately depicted on CT images, although osseous changes may also be detected on MRI, particularly T1-weighted images.**

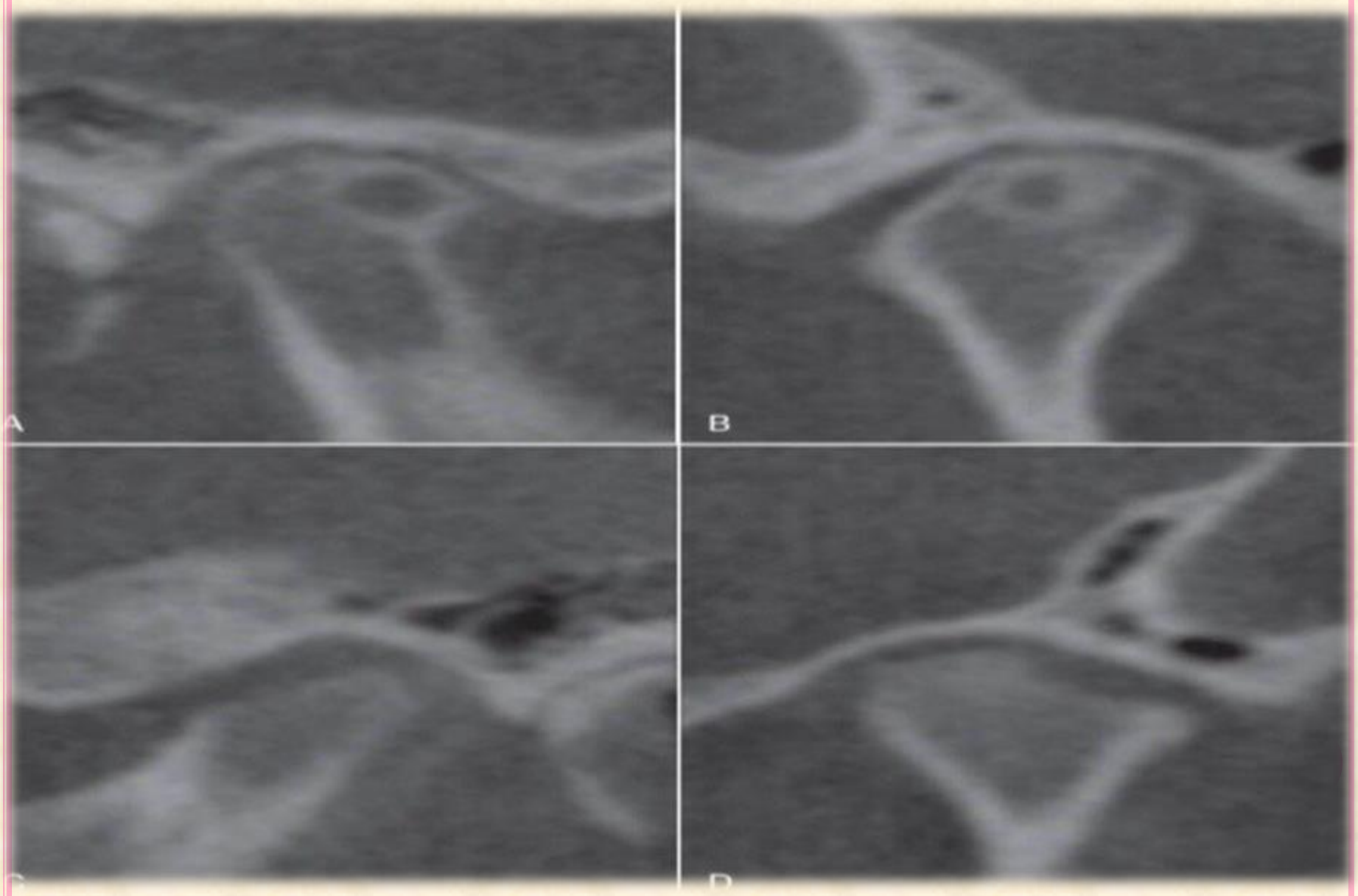
- Erosions are a sign of the deteriorating component of DJD

- In severe DJD, the glenoid fossa may appear grossly enlarged. This erosion may allow the condylar head to move forward and superiorly into an abnormal anterior position that may result in an anterior open bite.

- The condyle may also be markedly diminished in size and altered in shape

- In some cases, there are lesions called **Ely cyst or subchondral bone cyst** , but they are not true cysts.

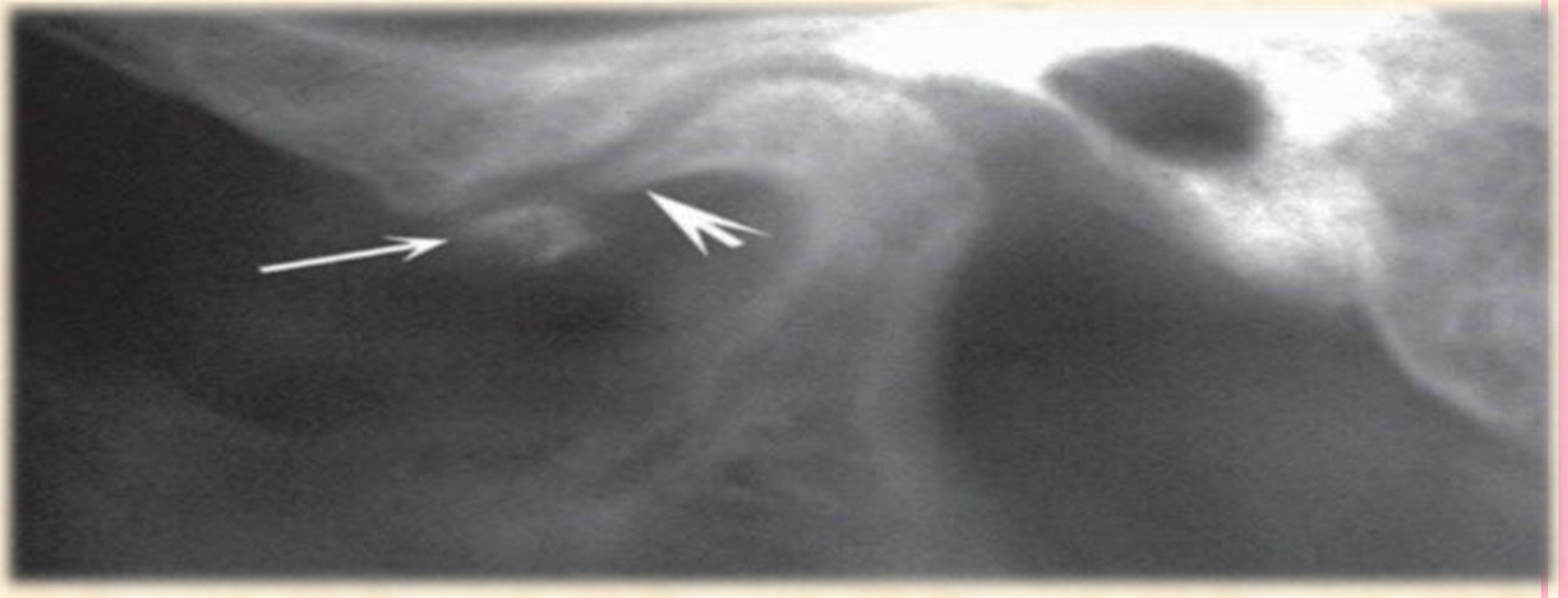
CBCT, CLOSED POSITION DEPICTING VARIOUS EROSIONS IN DEGENERATIVE JOINT DISEASE



- In the proliferative phase of the disease, bone formation occurs at the periphery of the articulating surfaces. These projections of new bone are called **osteophytes**

- These fragments are known as **joint mice**

- Variable degrees of sclerosis of the subchondral bone may accompany any of the changes described .



Abnormalities of Temporomandibular joint

5. Trauma

Fracture

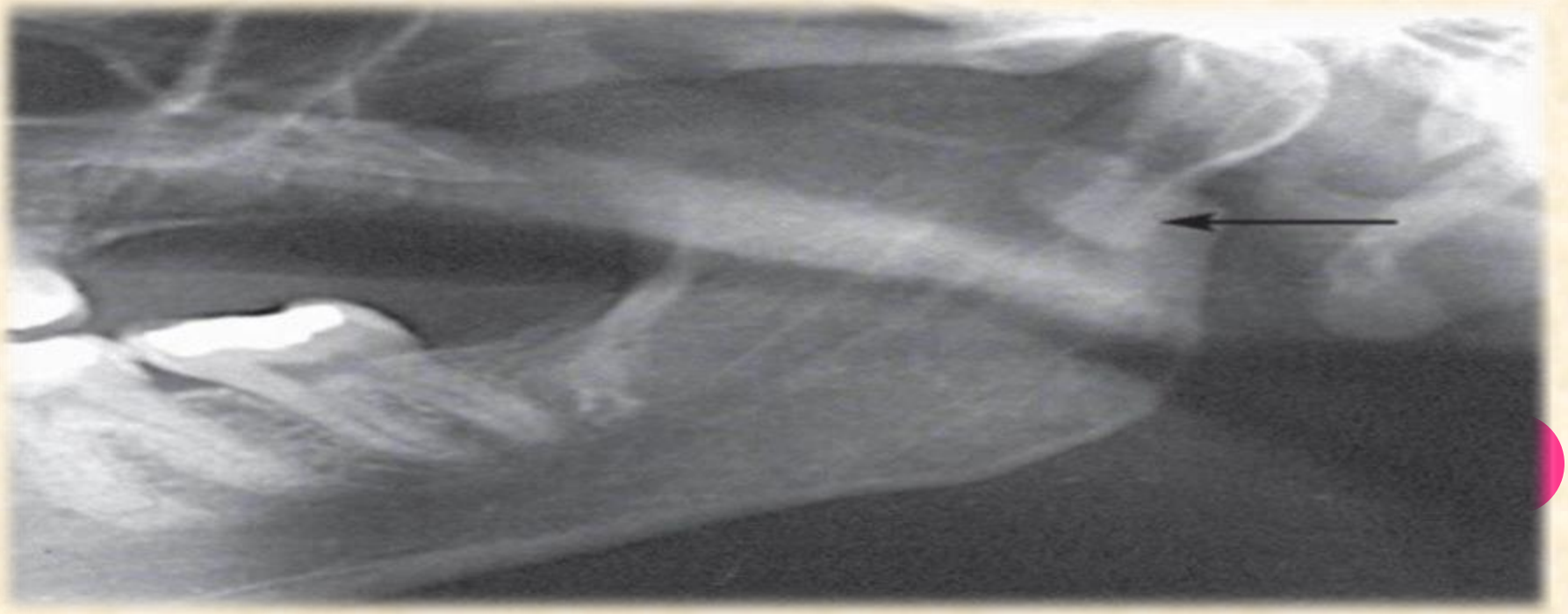
Definition

Fractures of the TMJ usually occur at the condylar neck and often are accompanied by dislocation of the condylar head. Fractures may be classified according to the anatomic location of the fracture: condylar head, condylar neck, and subchondral region.

Radiographic Features

- In relatively recent condylar neck fractures, a radiolucent line limited to the outline of the neck is visible. This line may vary in width.

- If the bone fragments overlap, an area of apparent increase in radiopacity may be seen instead of a radiolucent line.



- **CT is the preferred imaging modality to evaluate condylar fractures.**
- **Two- and three-dimensional reformatted images are useful to accurately locate a fractured fragment.**
- **Alternatively, if CT is not available, multiple right-angle radiographic projections from the lateral, frontal, and basilar aspects may be used to detect a fracture**

Abnormalities of Temporomandibular Joint

6. Tumors

Benign Tumors

Definition

The most common benign tumor to affect the TMJ is **osteoma** followed by **osteochondroma**.

Osteomas may occur as single isolated lesion or as a part of Gardner's syndrome These benign tumors often produce a tender swelling and patients usually give a history of trauma.

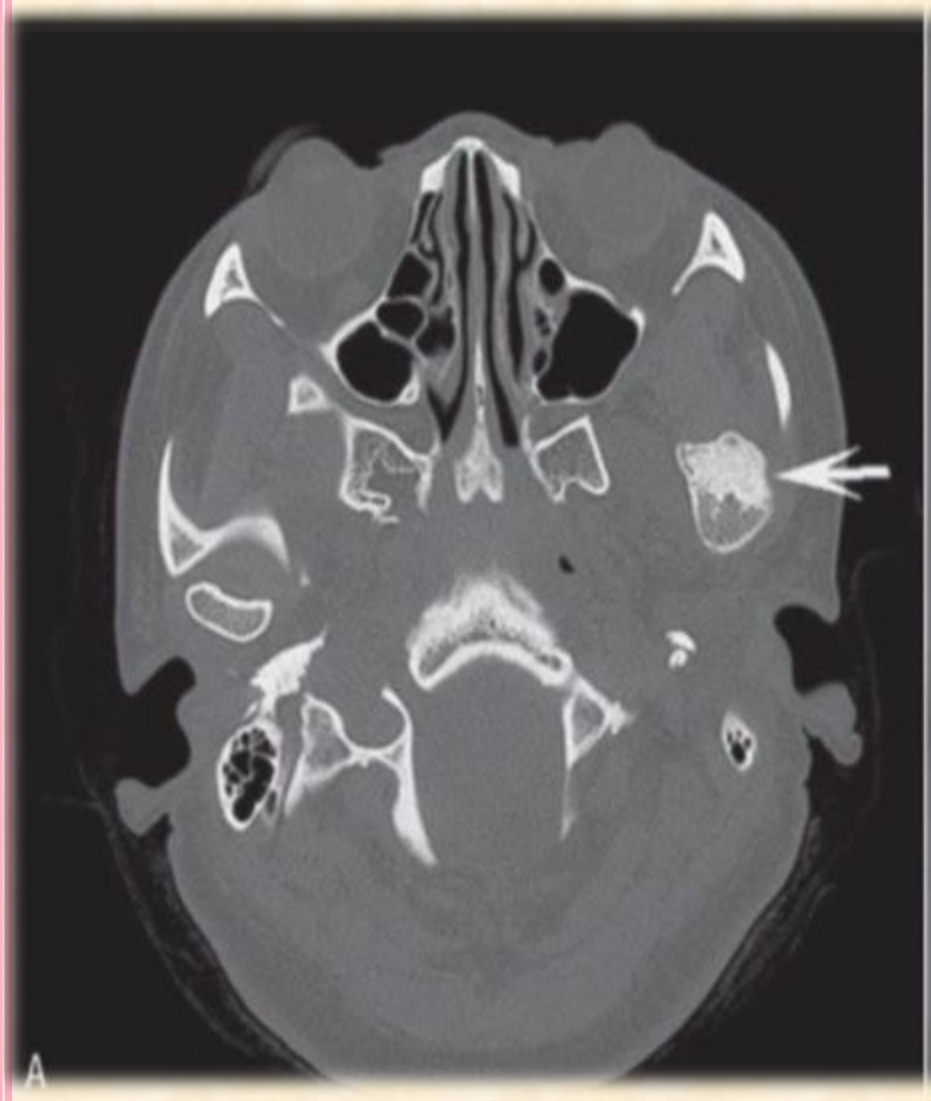
Radiographic Features

- Condylar tumors cause condylar enlargement that often is irregular in outline. They may radiographically present as **a well- defined radiopaque nodular mass extending from the condylar head, unlike hyperplasia where there is uniform enlargement of the condylar head.**

- There may be decreased trabecular density or increased density

- **Osteochondromas** are benign tumors that most often extend from the anterior surface of the condyle near the attachment of the lateral pterygoid muscle. These bony growths usually have a cartilaginous cap.

To differentiate osteochondroma from osteomas



Malignant Tumors

- **Chondrosarcomas** account for about 1–3% of the sarcomas affecting the facial bones and jaws.

- Low-grade tumors have excellent prognosis, whereas high-grade tumors may metastasize through the lymphatics

- Many of the patients complain of a rapidly growing swelling and pain, diminished hearing and restricted mouth opening.

- **Synovial chondrosarcoma** may usually originate as a primary from the synovium or secondarily in an already existing synovial chondromatosis.

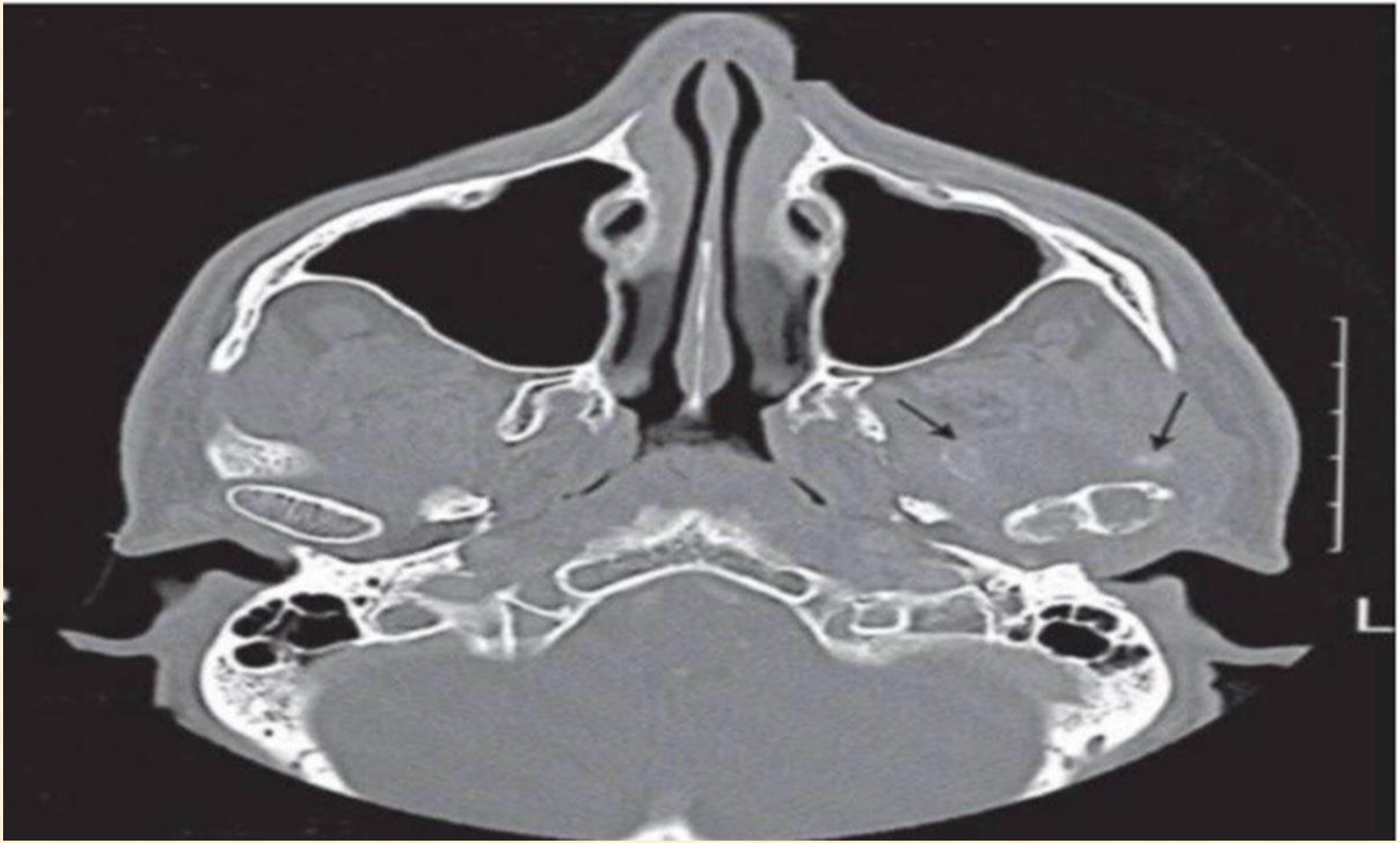
Radiographic Features

- **CT is the imaging modality of choice to view bone involvement and MRI is useful for displaying the extent of involvement into the surrounding soft tissues.**

- Malignant primary and metastatic TMJ tumors appear as a **variable degree of bone destruction with ill-defined, irregular margins.**

- **Chondrosarcoma** may appear as **an indistinct, radiolucent destructive lesion of the condyle with surrounding discrete soft tissue calcifications**.

Chondrosarcoma (CT, axial section)



Conclusion

Although the clinical examination is the most important step in the diagnosis of TMJ pathology, special imaging techniques are needed due to the complex anatomy and pathology. It is very common to take an image of the joint when there is locking, pain and articular sounds.

The clinician should properly decide which patients would need special imaging techniques depending on the clinical examination, the amount of diagnostic information available from a particular imaging modality, the cost of the examination, and the radiation dose.

One important thing to consider when imaging the TMJ is the interpretation of the joint function, which can be accomplished by comparing the condyle in the closed and opened mouth position.


Thank
you