
بسم الله الرحمن الرحيم

TMJ Imaging

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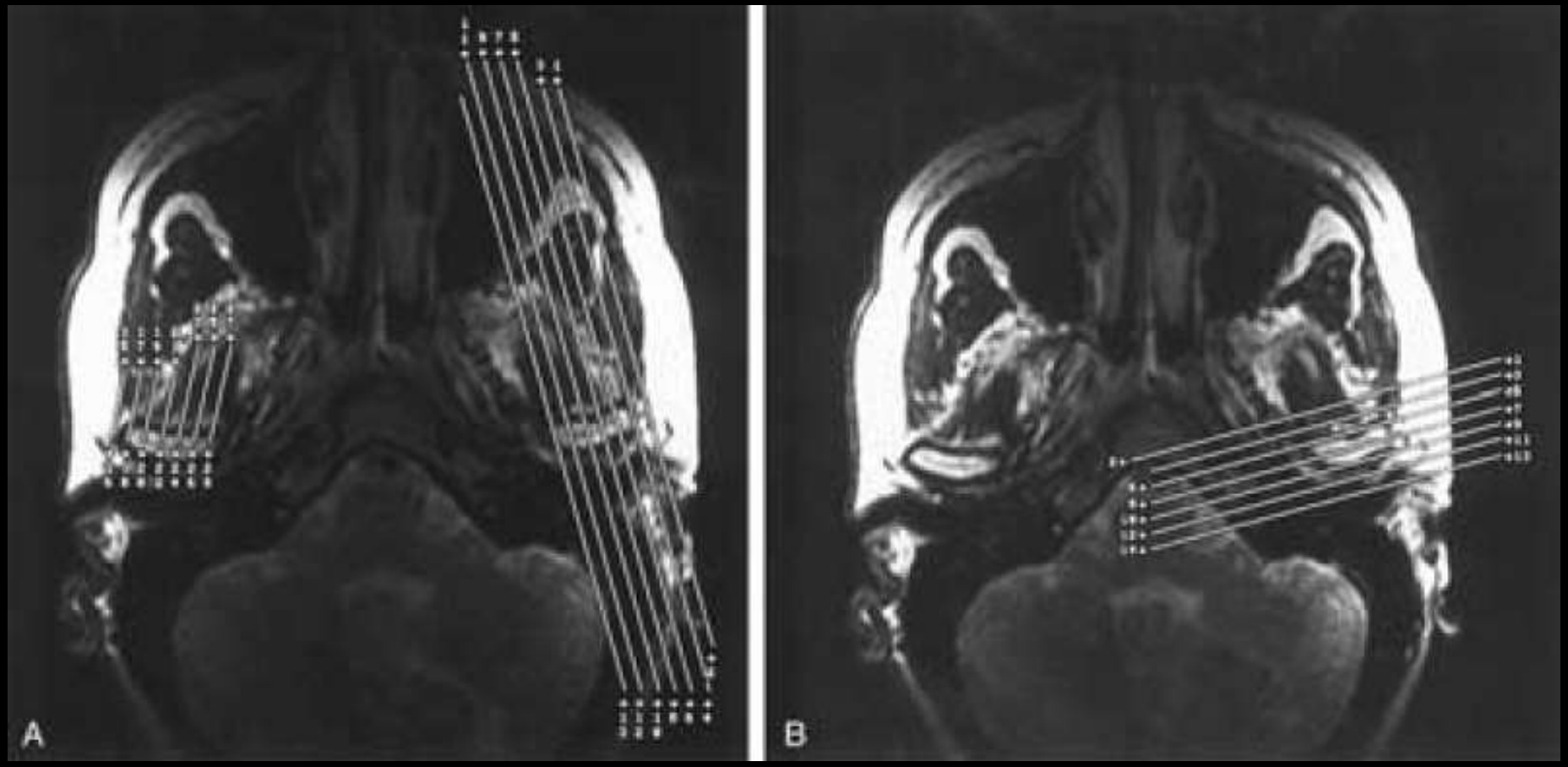
Image orientation

- An axial localizer image through the TMJ condyles.
- Using the axial scout image, a line is drawn between the anterior aspects of the two condyles.
- Then sagittal images are obtained perpendicular to this line.
- Images obtained first with the mouth closed, and then with the mouth open.
- Coronal oblique images are obtained to show medial or lateral disk displacement.
- Coronal images are obtained parallel to the long axis of the condyles based on the axial scout view.
- Coronal oblique images are done only with the mouth closed.

Pulse sequences and regions of interest

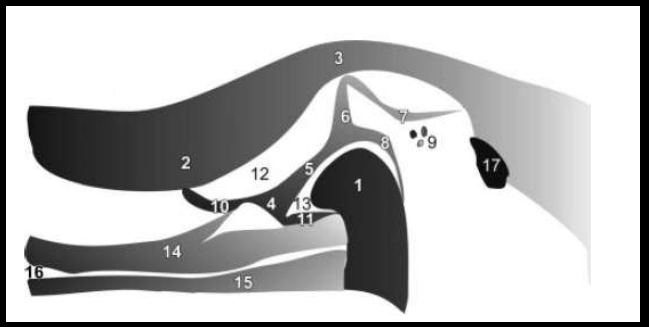
- Section thickness is 3 mm with no gap.
- FOV is 6 cm.
- T1 images show the anatomy well.
- T2 images may be valuable to assess the muscles surrounding the joint.


A
B

The osseous components of the TMJ are

1-The mandibular condyle.

2-Temporal bone at the base of the skull.



The portions of temporal bone that articulate with the condyle are

1-The glenoid fossa.

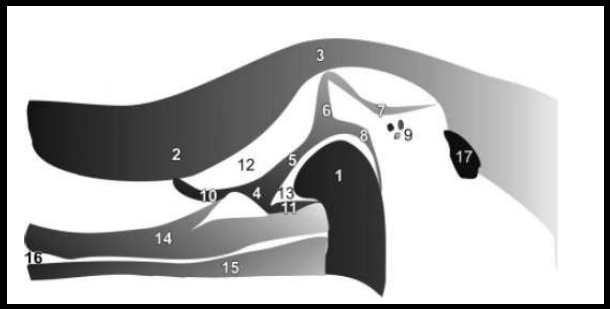
2-The articular eminence.

With closed mouth --- Condyle concentrically lies in glenoid fossa.

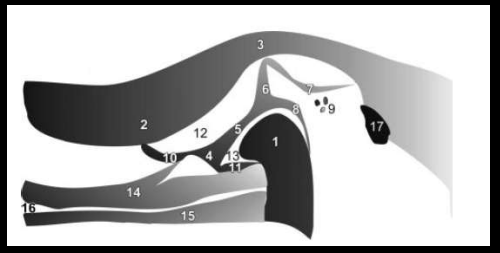
With open mouth --- Condyle translates anteriorly --- it lies directly underneath the apex of the articular eminence.

The articular surfaces of the TMJ are covered with a thin layer of fibrocartilage.

Normal articular meniscus or disk on sagittal MRI



- It is a biconcave fibrocartilaginous structure.
- Lies between the condyle and the temporal bone.
- It divides the synovial joint into superior and inferior compartments.
- Biconcave configuration (thicker peripherally than centrally - bow tie shape).
- Formed of anterior band, intermediate zone & posterior band.
- The disk has overall low signal on all pulse sequences.
- But may has intermediate signal centrally in the anterior or posterior bands.
- It attaches to the joint capsule, pterygoid muscle & bone.



Intermediate zone

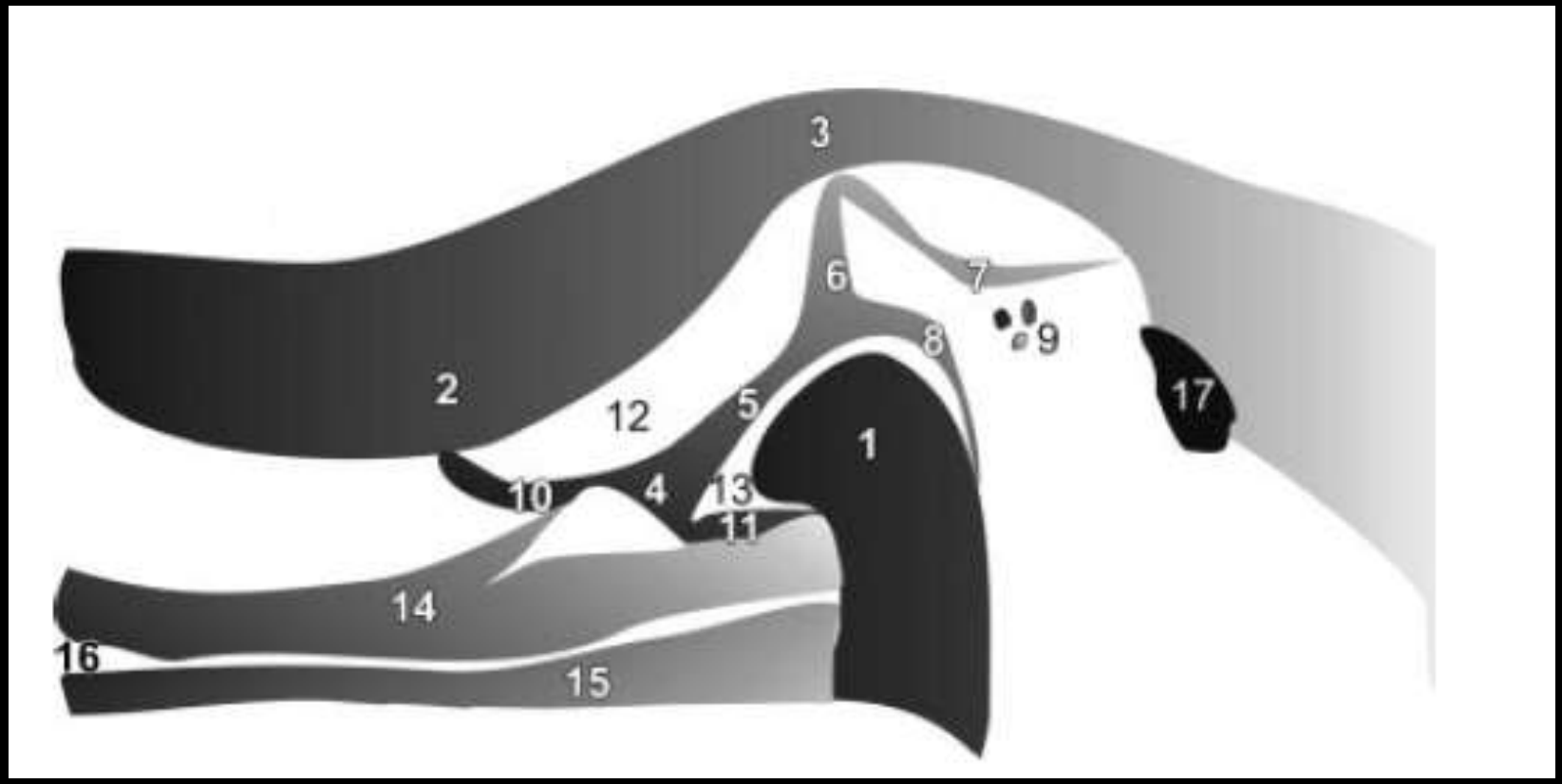
- Lies between the condyle and articular eminence with closed mouth and any degree of mouth opening.

The posterior band

- Normally, lies at 12-o'clock position, directly on top of the condyle, with the mouth closed.
- It may not clearly seen when the mouth is closed (as its signal blends with the adjacent low signal cortical bone of the condyle and glenoid fossa).
- It is more obvious with the mouth open.

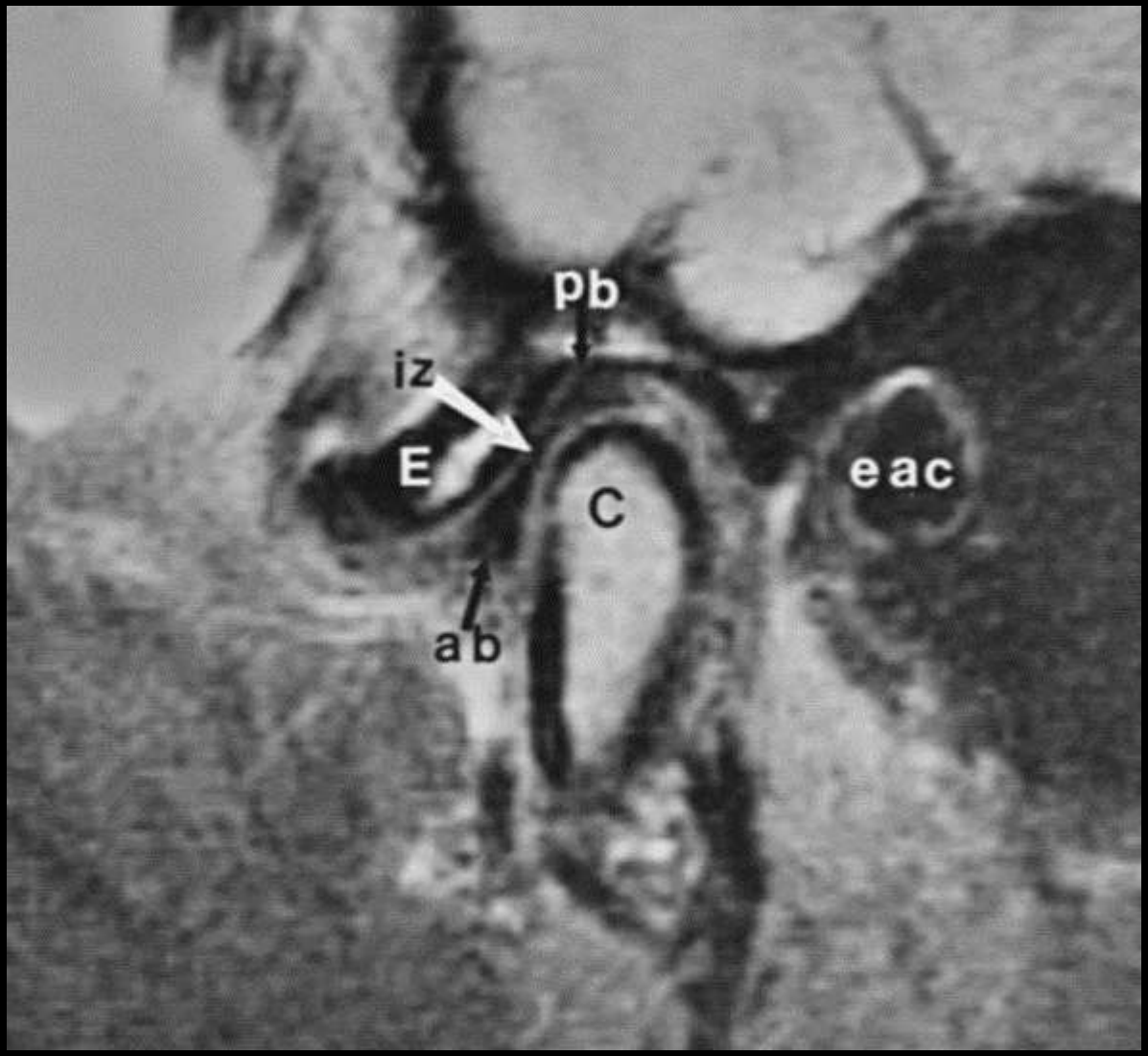
Bilaminar zone or posterior attachment

- The inferior retrodiskal (collagen fibers) and the superior retrodiskal layer (elastic fibers) are connected to posterior band of the disc.
- Retrodiskal layers + retrodiscal neurovascular structures form the bilaminar zone (medium signal).
- Functions as a rubber band.
- Allows the meniscus to move forward with the condyle during mouth opening, and then recoils back to its original position, bringing the disk with it, as the mouth closes).

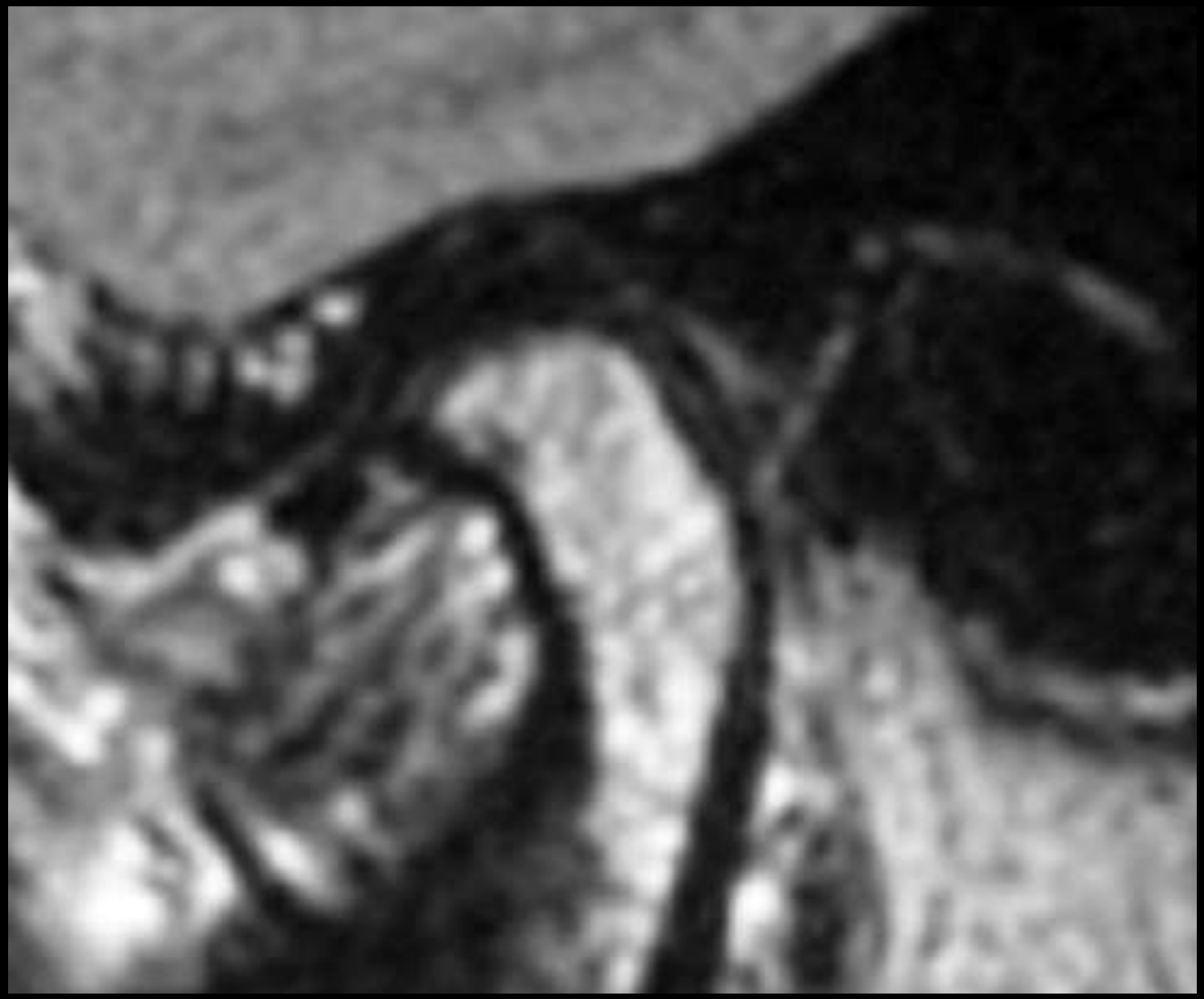


TMJ anatomy

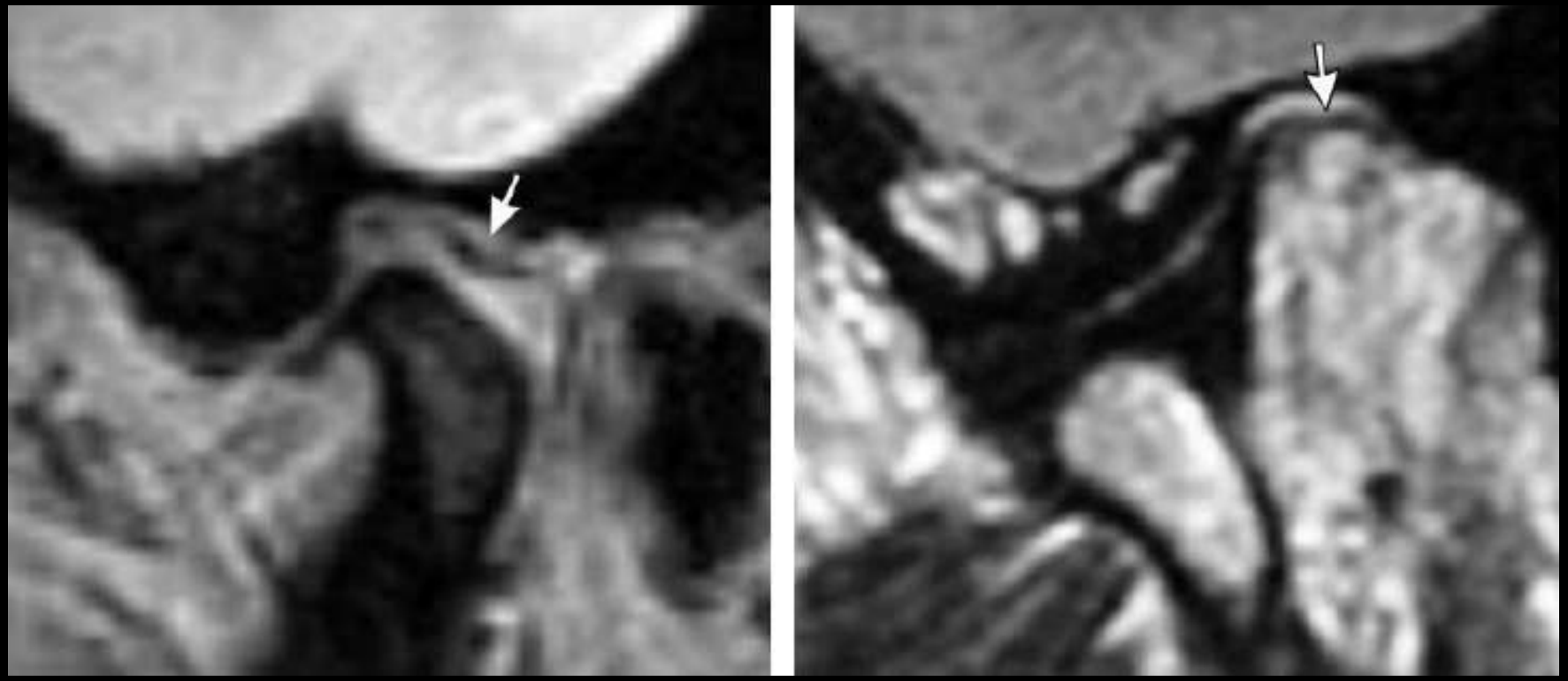
1 condyle; *2* temporal bone, articular eminence; *3* temporal bone, mandibular fossa; *4* disk, anterior band; *5* disk, intermediate zone; *6* disk, posterior band; *7* superior retrodiskal layer; *8* inferior retrodiskal layer; *9* vasculonervous structures; *10* capsular superior attachment; *11* capsular inferior attachment; *12* superior joint space; *13* inferior joint space; *14* superior head of the lateral pterygoid muscle (LPM); *15* inferior head of the LPM; *16* interpterygoid space; *17* external auditory canal.



Normal TMJ. Closed mouth - sagittal T1



Normal TMJ. Closed mouth - sagittal T1



Normal retrodiskal tissue

(a) Sagittal oblique GE T2 (closed-mouth) shows the retrodiskal layers (arrow).
(b) Sagittal oblique SE PD (open-mouth) shows the superior retrodiskal layer (arrow) between the posterior band and the mandibular fossa.

- LPM has two parts, bellies or heads (superior & inferior).

- It inserts in condyle (++) / disc / capsule.

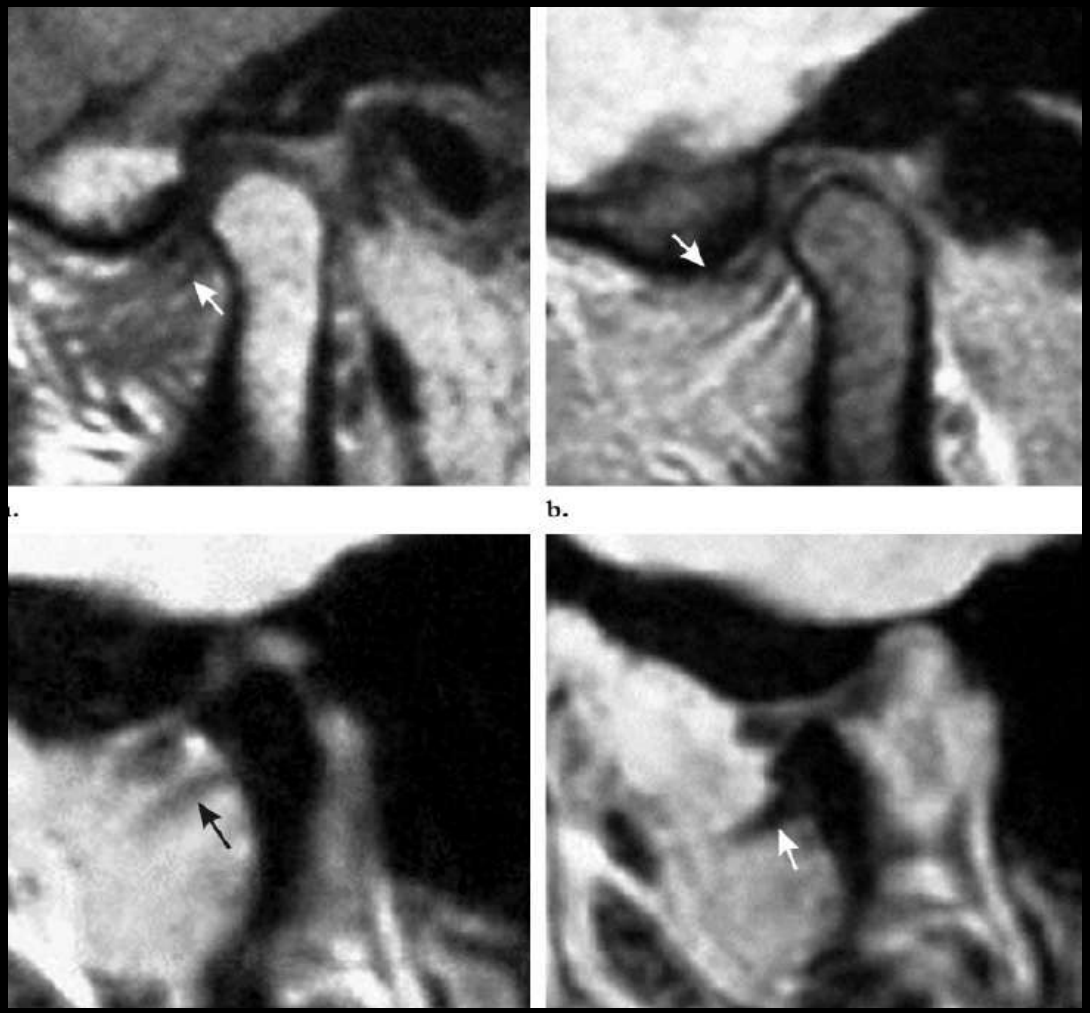
- LPM + digastric muscle + retrodiskal layers have an important function in mastication.

During jaw opening → two different motions occur at TMJ.

-1st motion is rotation around a horizontal axis through the condylar heads.

-2nd motion is translation → condyle & meniscus move together anteriorly beneath articular eminence, the central part of the disk lie between condyle & articular tubercle.

-Full open mouth → condyle may lie beneath the anterior band of the meniscus.



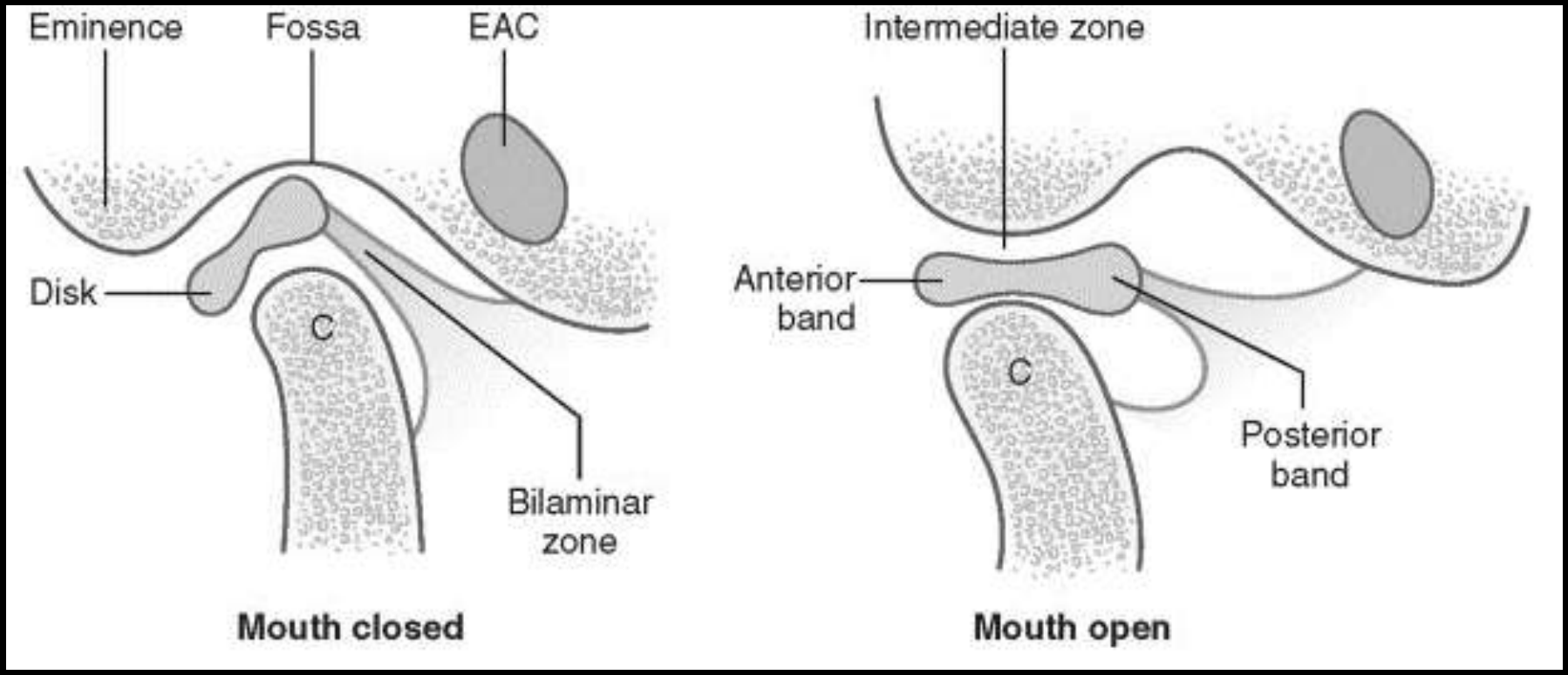
Normal LPM

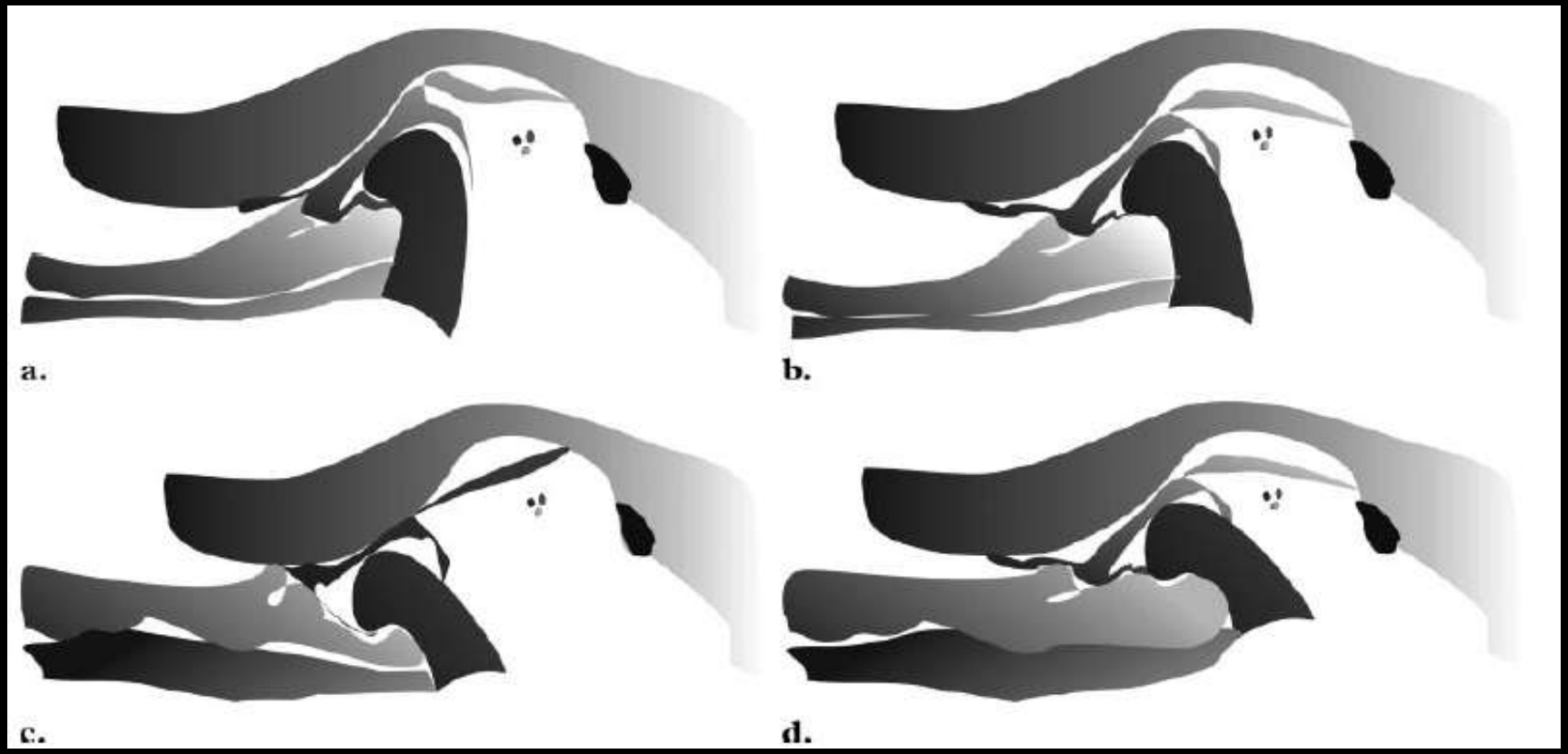
(a) Sagittal oblique SE PD (closed-mouth) shows a thin attachment of the inferior LPM (arrow) just below the disk..

(b) Sagittal oblique GE T2 (closed-mouth) shows a thin attachment of the superior LPM (arrow) just in front of the disk.

(c) Sagittal oblique GE T2 (closed-mouth) shows the thin insertional area of the inferior LPM (arrow).

(d) Sagittal oblique GE T2 (open-mouth) shows the insertional area of the inferior LPM (arrow) has increased due to contraction of the muscle during this phase.


Eminence
Fossa
EAC
Disk
C
Bilaminar zone
Mouth closed
Intermediate zone
Anterior band
C
Posterior band
Mouth open



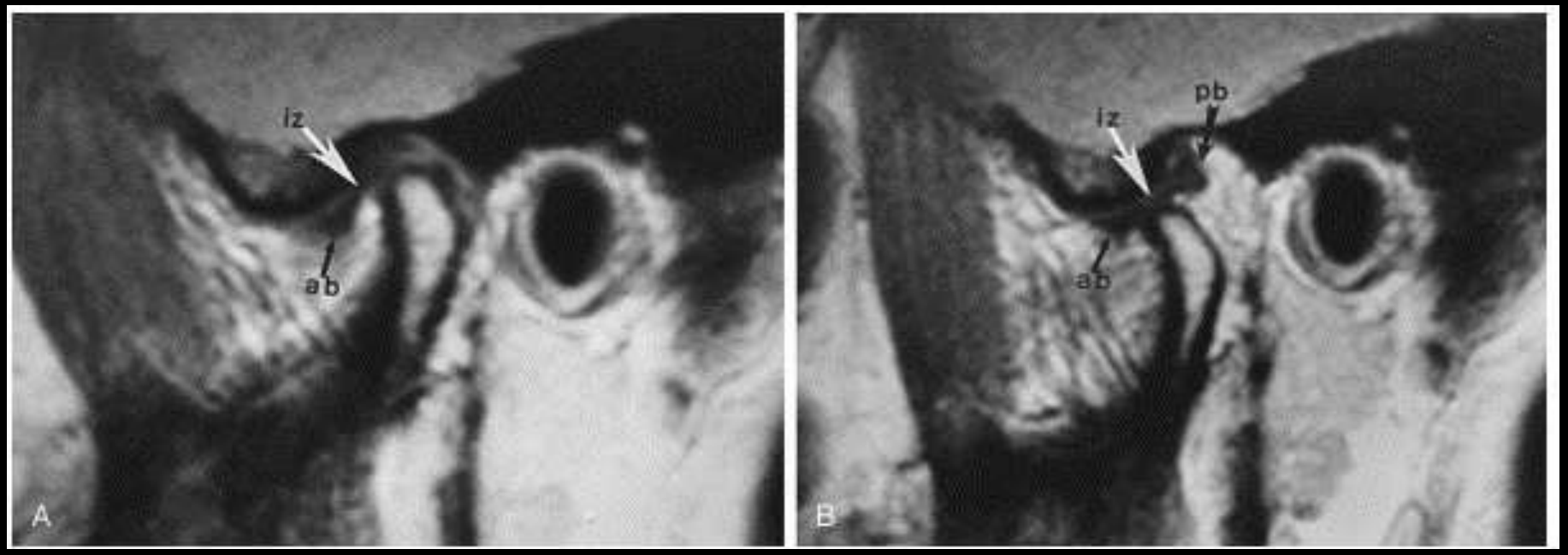
TMJ function

(a) Initial closed-mouth position.

(b) At the beginning of open-mouth position, digastric muscle forces the condyle downward. The condyle then rotates in the lower joint space, and condylar displacement begins when the jaw is opened beyond 20–25 mm. Retrodiskal ligaments stabilize the disk.

(c) Condylar protraction (maximum open-mouth position). Involvement of the inferior LPM is basic to this step, and the superior LPM can displace the disk, probably to maintain joint congruence. The superior retrodiskal layer prevents complete abnormal displacement.

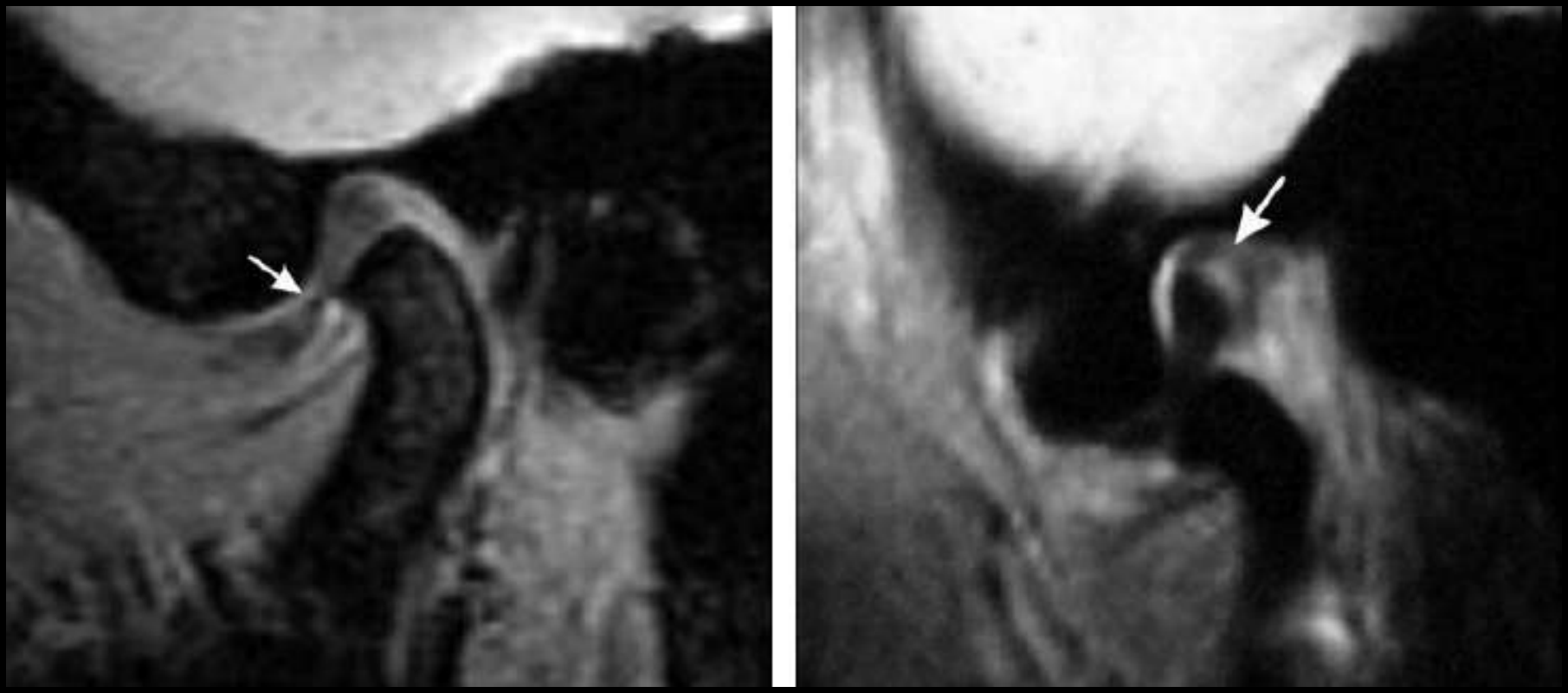
(d) Progression to the maximum clenching position. The inferior LPM is normally very active in this phase as well.



Normal TMJ (sagittal T1)

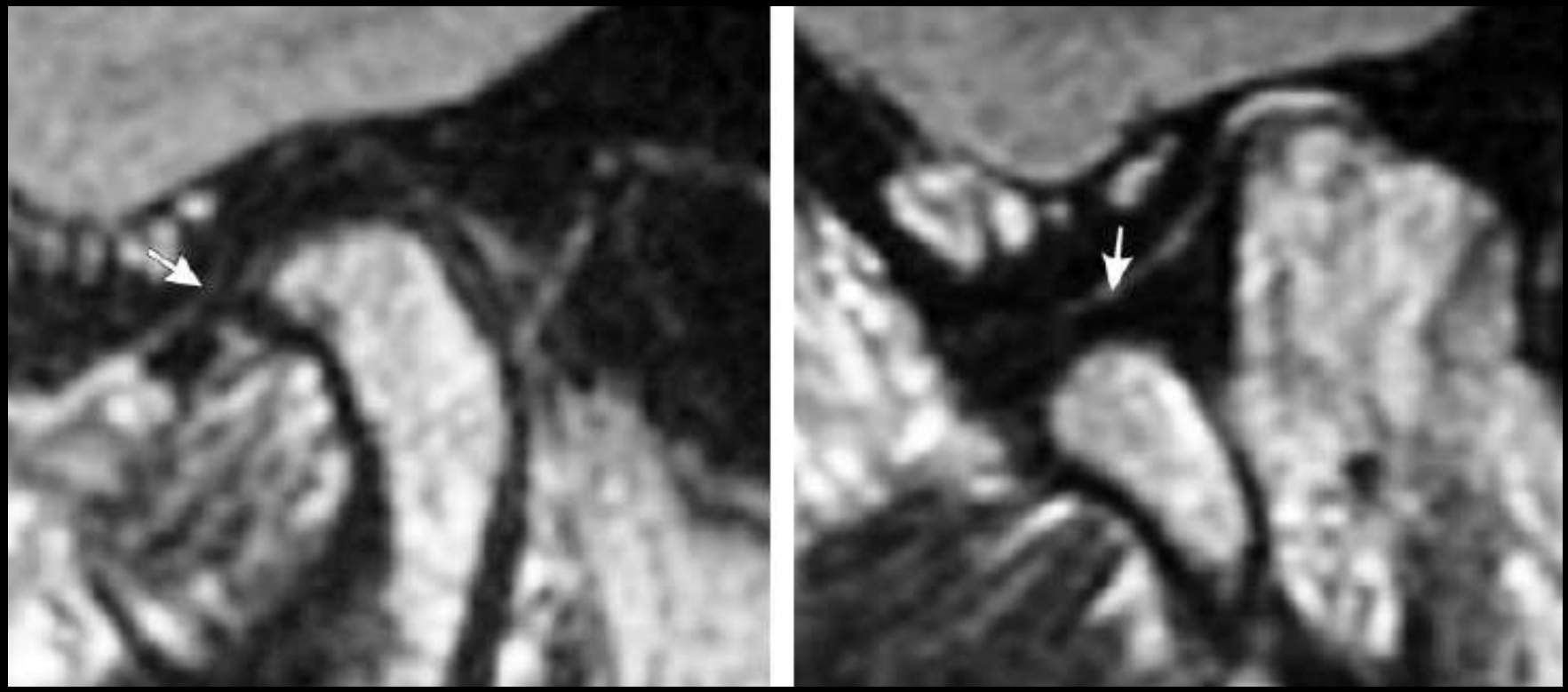
A, Mouth closed. Disk is in normal position, the posterior band is difficult to identify as it blends with adjacent cortical bone. The intermediate zone (iz) and anterior band (ab) are easy to see and confirm the normal disk position.

B, Mouth partially open. The entire disk, including posterior band (pb), is obvious. The intermediate zone (iz) remains in its normal position between the condyle and eminence.



Morphologic features of the normal disk

(a) Sagittal oblique GE T2 (closed-mouth), the anterior and posterior bands are thick and the intermediate zone (arrow) is thin, creating a biconcave disk shape.
(b) Sagittal oblique GE T2 (open-mouth) more clearly depicts the posterior band and retrodiskal tissue (arrow).



Normal disk mobility

(a) Sagittal oblique SE PD (closed-mouth) shows a disk (arrow) in its normal position between the condyle and temporal bone and centered in the intermediate zone.
(b) Sagittal oblique SE PD (open-mouth) shows that the disk (arrow) maintained its normal position during condylar movement.

Normal Disk

•Biconcave structure with thin intermediate zone between the condyle and the eminence wherever they are most closely apposed on sagittal images.

Abnormal Disk

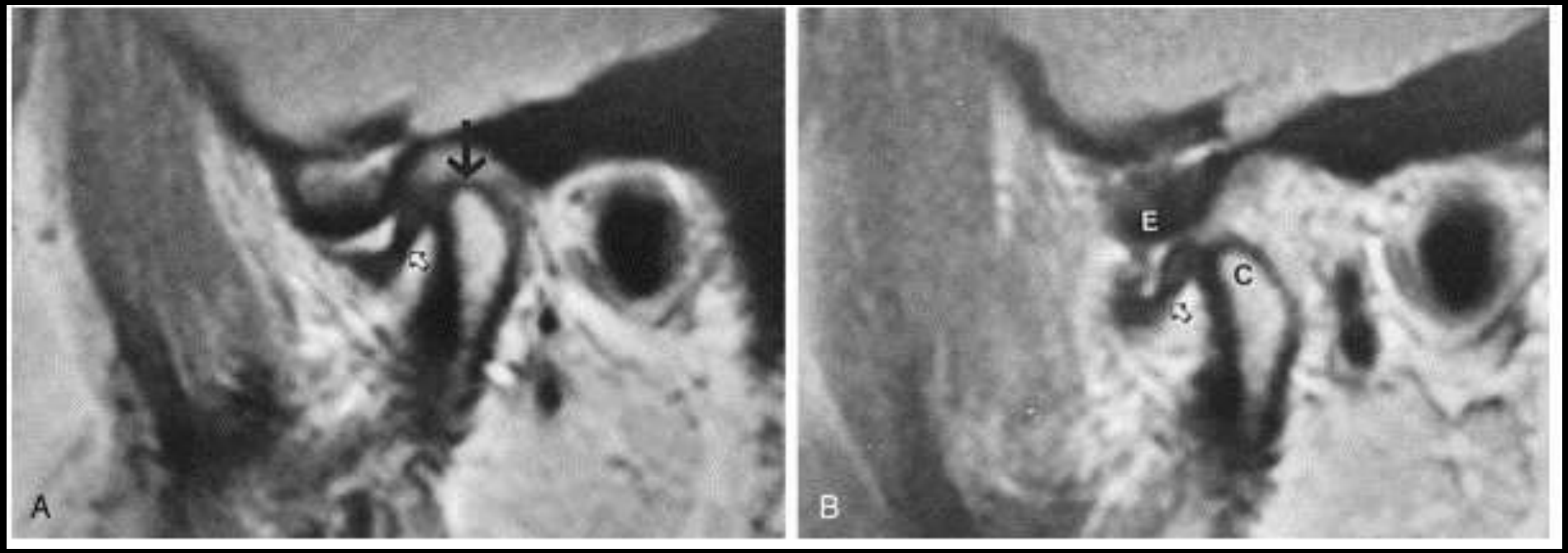
•Disk displaced anteriorly from normal closed-mouth position (intermediate zone no longer interposed between the closest contact point of condyle and eminence.

•Disk reduce to normal position with mouth opening (anterior displacement with reduction).

•Disk remain displaced with mouth opening (anterior displacement without reduction).

•Disk degenerates with loss of internal intermediate signal and biconcave shape.

•Joint degenerates -- Subchondral cyst, subchondral sclerosis, osteophytes of condyle.
-- Osteonecrosis.



Anterior disk displacement without reduction

A, Closed mouth. The posterior band is located anterior to the 12-o'clock position (*solid arrow*) of the condyle. The intermediate zone (*open arrow*) is not positioned between the condyle and eminence.

B, Open mouth. Limited anterior translation, with the condyle (C) not reaching the apex of the articular eminence (E). The disk remains anteriorly displaced and folded at the intermediate zone (*open arrow*).

Check for

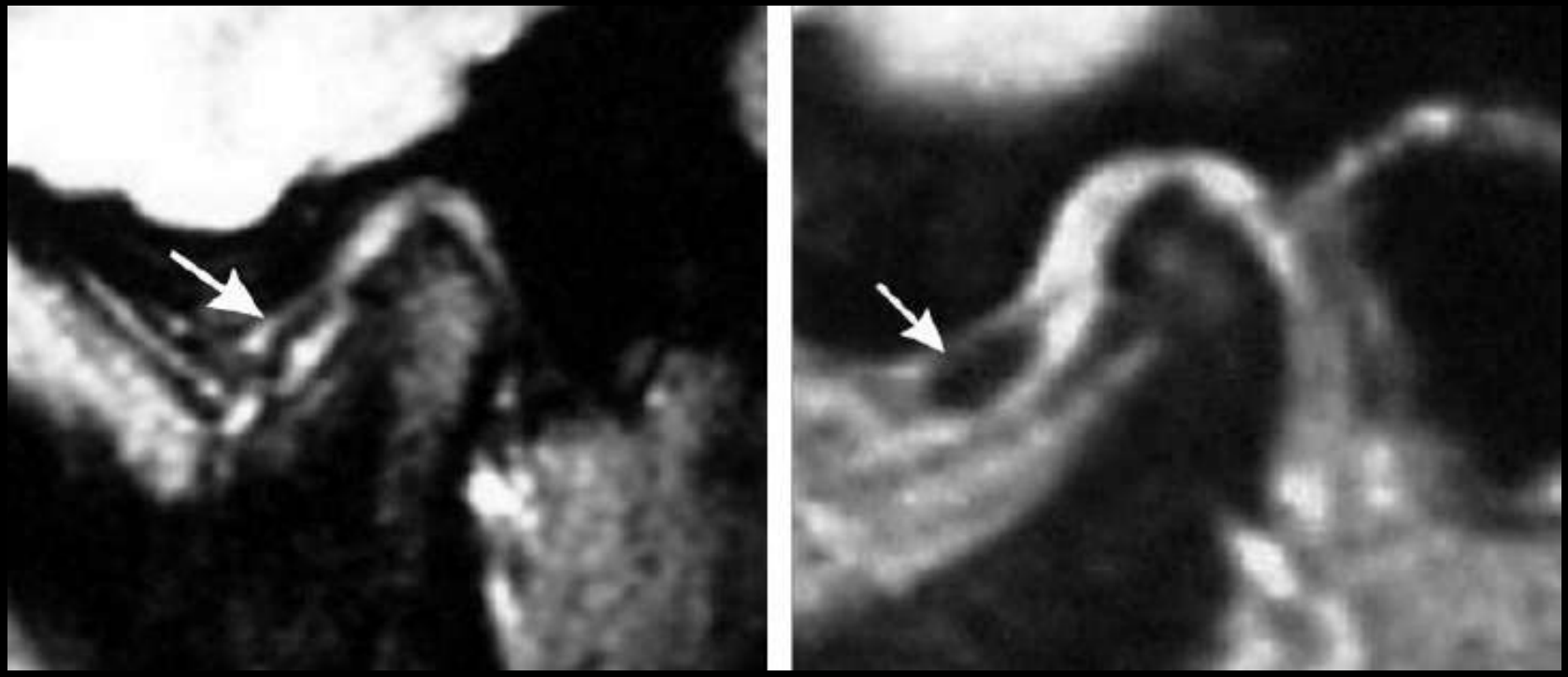
- Limited anterior translation (if the apex of the condyle does not move as far anterior as the apex of the articular eminence).
- Evaluate articular disk (meniscus) → morphology, location relative to the condyle in both closed & open mouth positions.
- Disk morphology changes → flat / biconvex / crumpled / folded.
- Disk displacement → ant. (++), anteromedial, anterolateral, lateral, medial, posterior.
- Disk signal changes.
- Stuck disk → posterior band is fixed at condylar fossa in open & closed mouth.
- Rupture of retrodiscal layer.
- Thickening of lateral pterygoid muscle attachment.
- Joint effusion (high T2, do not enhance).
- Synovial hypertrophy (high T2 & enhance).
- Osteoarthritic changes (condylar flattening, osteophytes, erosions, sclerosis). .

Degenerative erosion of the TMJ

Closed mouth sagittal T1 shows erosion of the condyle (*arrowhead*) 2ry to ch. displaced disk (*arrow*).

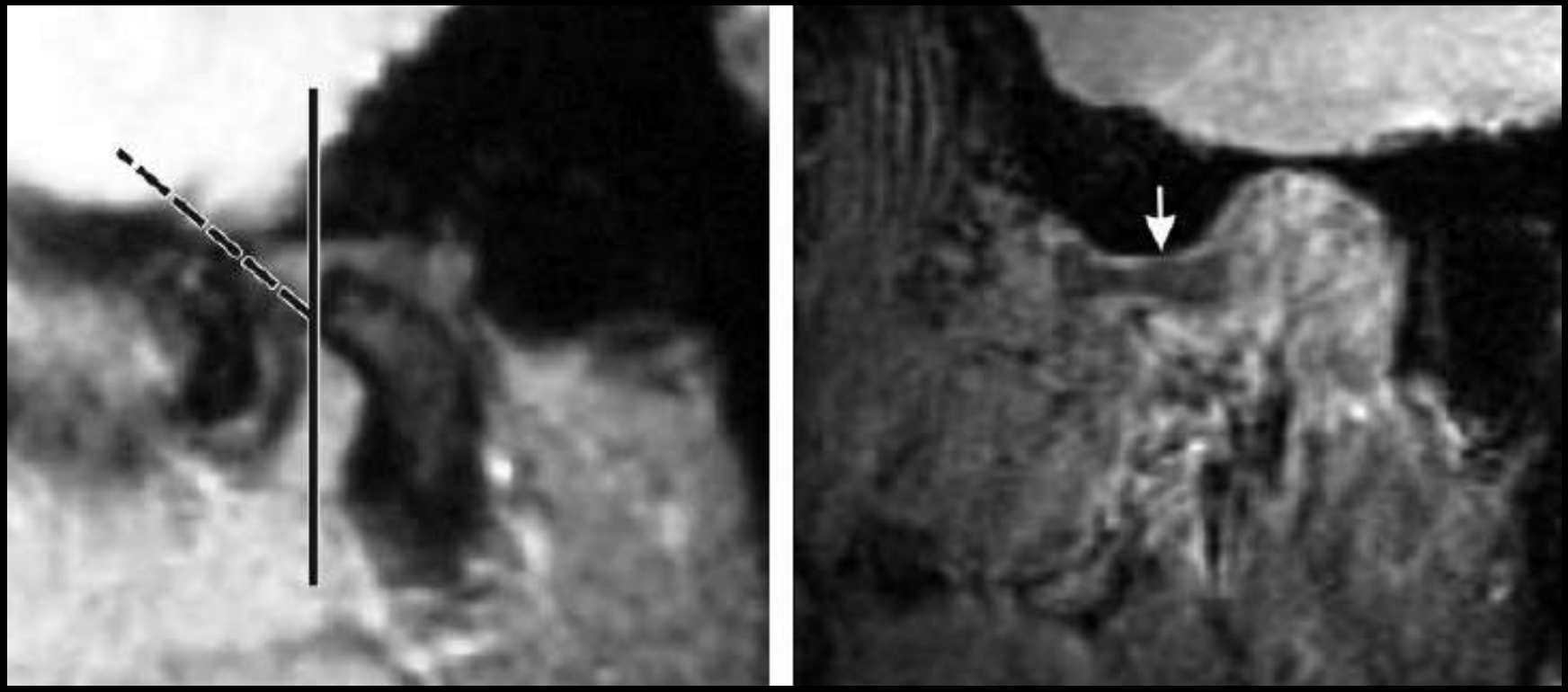
Degenerative sclerosis and osteophytes of condyle

Open mouth sagittal T1 shows sclerosis of the condyle and an anterior osteophyte (*arrow*), limited anterior translation of the condyle, disk displacement.



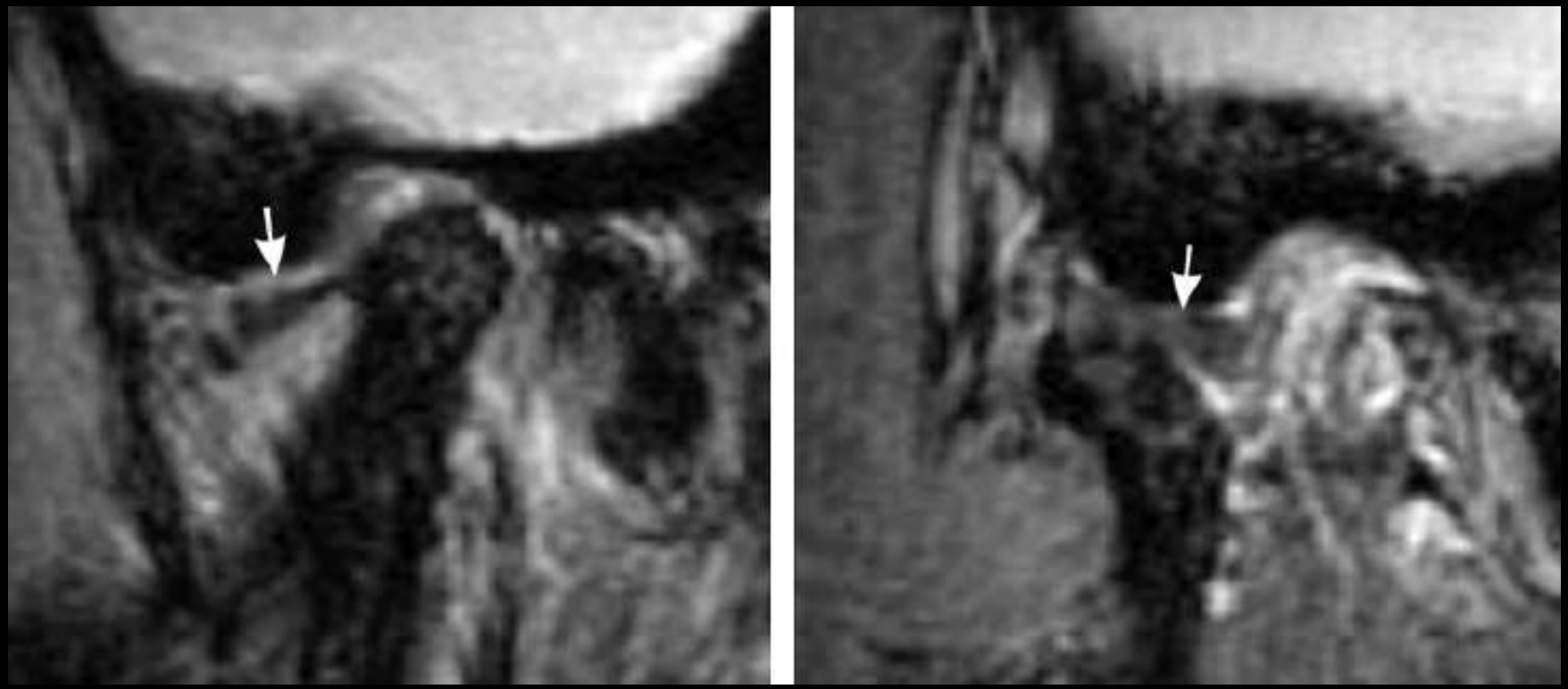
(a) Sagittal oblique GE T2 (closed-mouth) shows a displaced disk (arrow) that has lost its typical biconcavity and become crumpled and irregular.
(b) Sagittal oblique GE T2 (closed-mouth position) in a different patient shows a displaced disk with a rounded shape (arrow).

(a) Sagittal oblique SE PD (closed-mouth) shows a flattened displaced disk (arrow).
(b) Sagittal oblique GE T2 (closed-mouth) shows perforation of the intermediate zone (arrow).



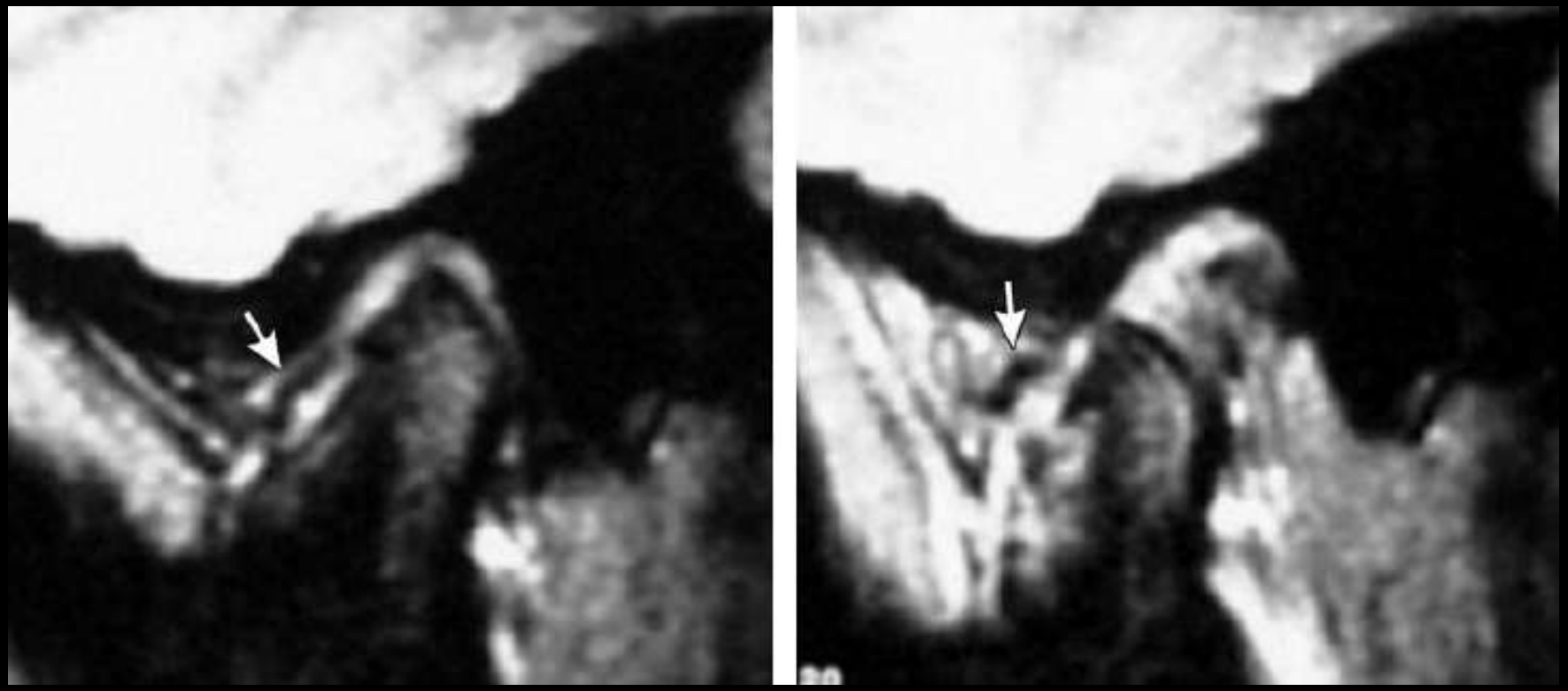
Abnormal disk displacement

(a) Sagittal oblique GE T2 (closed-mouth) shows significant disk displacement. The intermediate zone is clearly beyond the condyle, and the angle between the posterior band (dashed line) and vertical (solid line) is close to 50°.
(b) Sagittal oblique GE T2 (closed-mouth) in a different patient shows antero-medial disk displacement. The disk (arrow) appears to be “floating” by itself, and the condyle is no longer visualized.



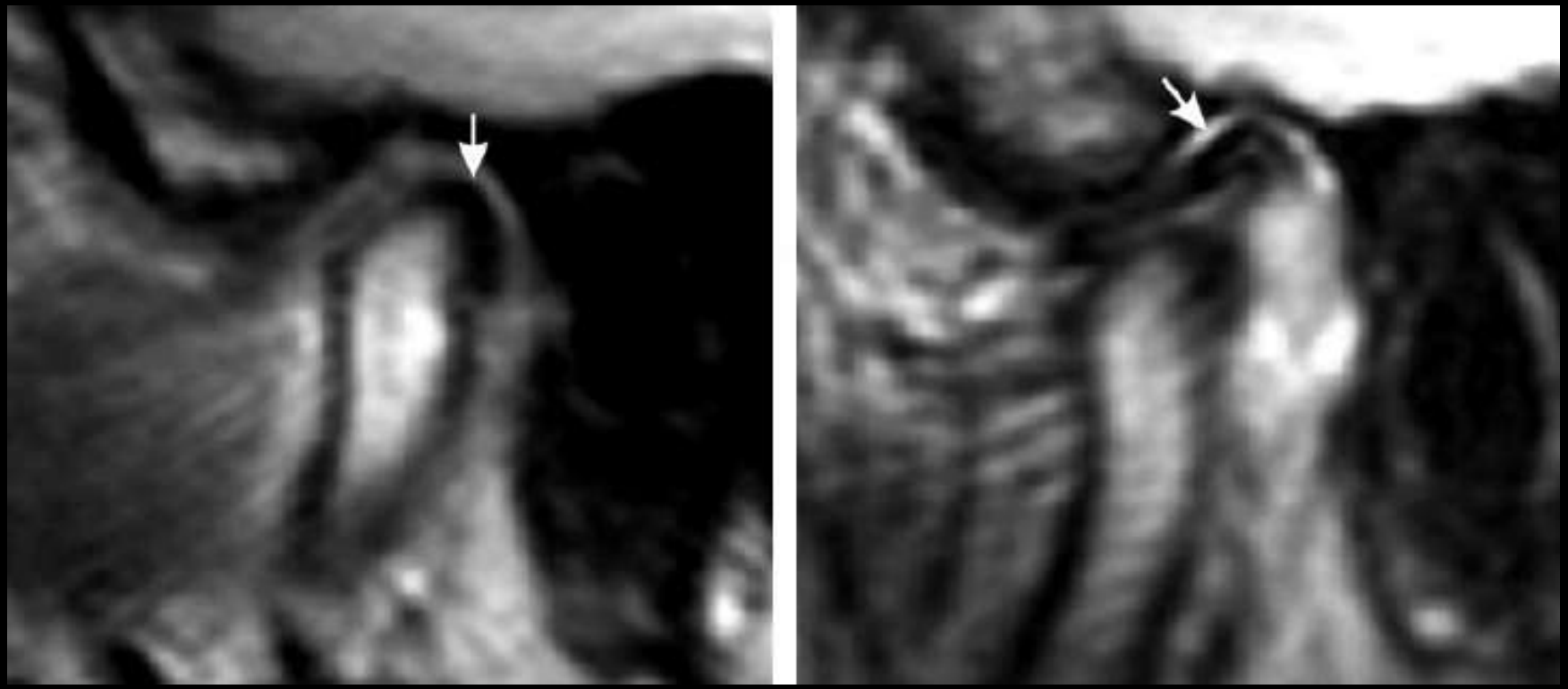
Anterior disk displacement with reduction

(a) Sagittal oblique GE T2 (closed-mouth) shows an anteriorly displaced disk (arrow). **(b)** Sagittal oblique GE T2 (open-mouth) shows that the disk (arrow) has returned to its normal position between the condyle and the temporal bone.



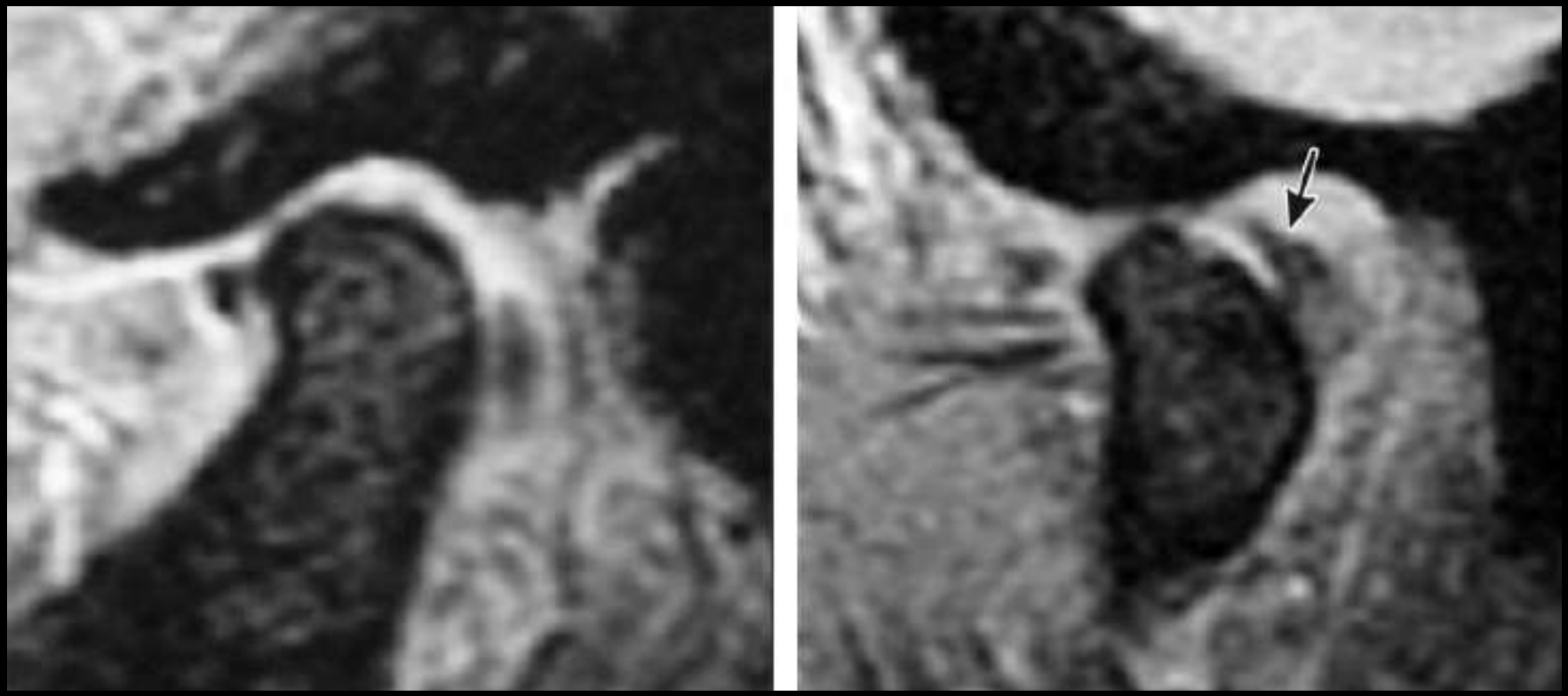
Anterior disk displacement without reduction

(a) Sagittal oblique GE T2 (closed-mouth) shows a disk (arrow) displaced from its normal location.
(b) Sagittal oblique GE T2 (open-mouth) shows that the disk (arrow) remains displaced from its normal location.



Stuck disk

Sagittal oblique SE PD (closed-mouth) **(a)** & (open-mouth) **(b)** shows that the posterior band (arrow) remains close to the mandibular fossa.

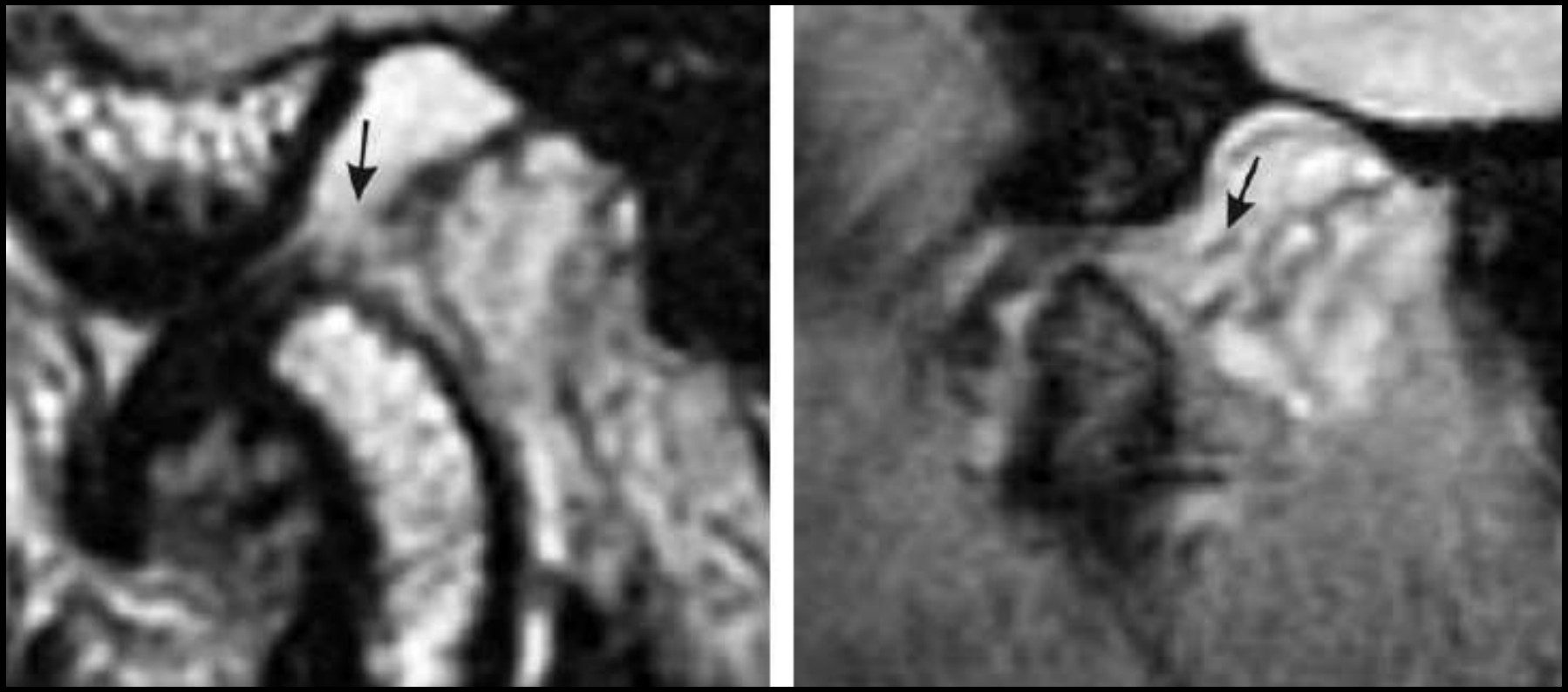


Posterior disk displacement

(a) Sagittal oblique GE T2 (closed-mouth) shows a posterior band displaced posteriorly. **(b)** Sagittal oblique GE T2 (open-mouth) shows that the posterior band (arrow) remains displaced.

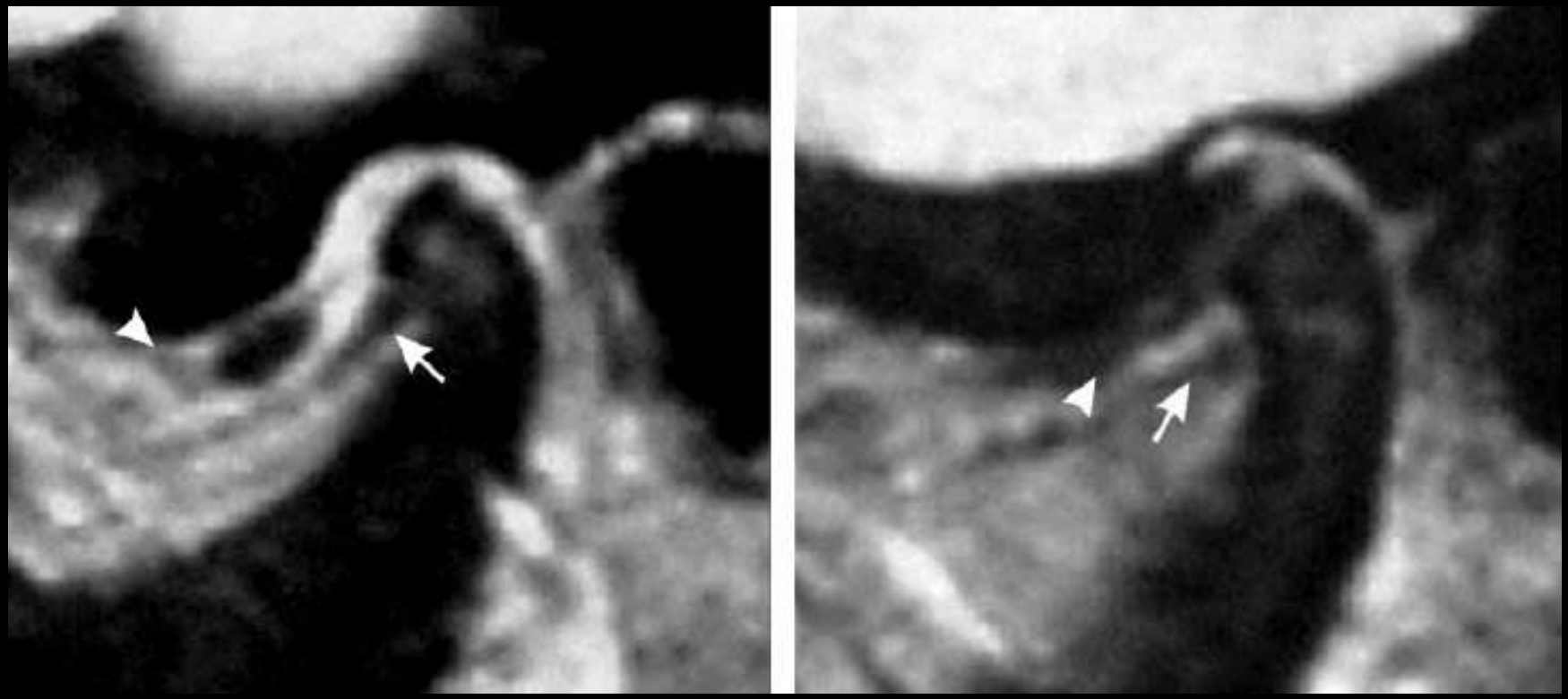
Joint effusion

Sagittal oblique GE T2 (closed-mouth) shows joint fluid (arrow) clearly delineates the shape of the disk between the upper and lower joint spaces.



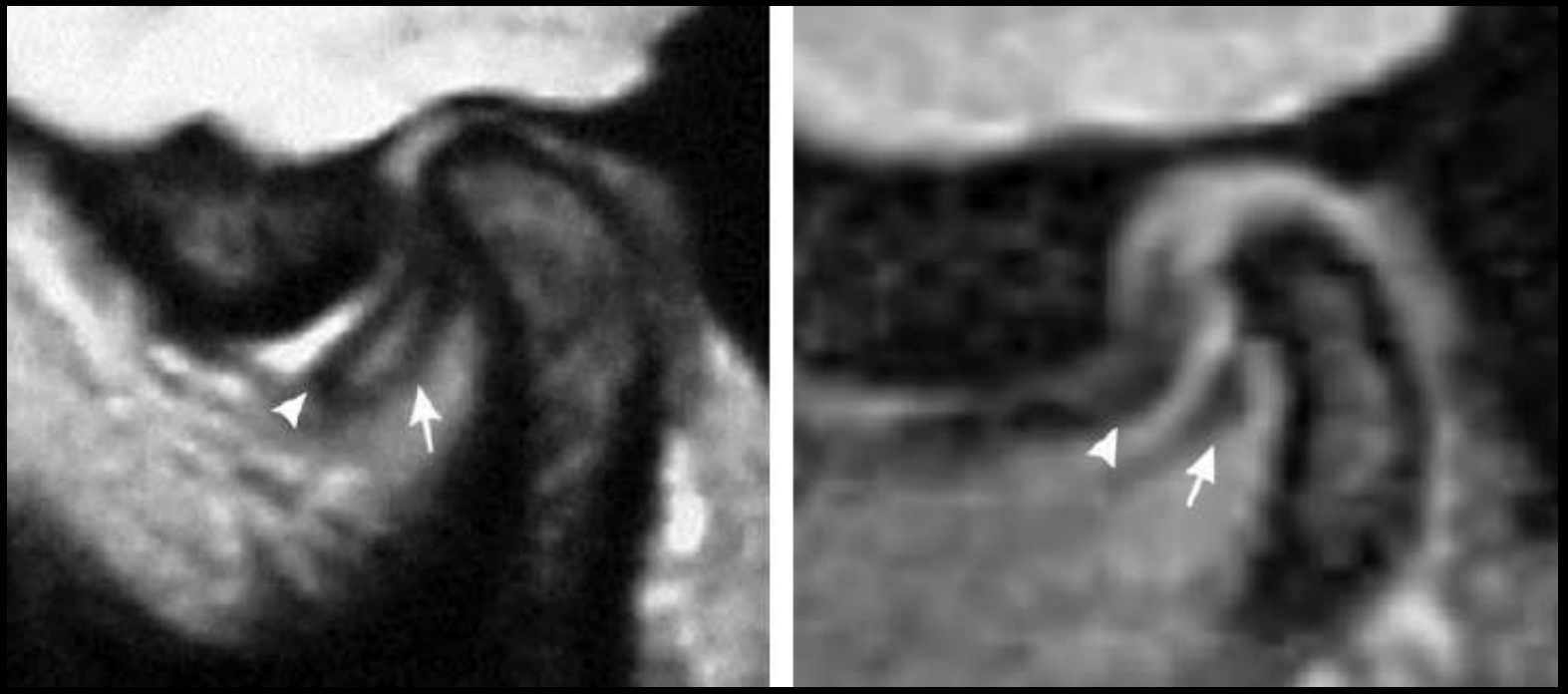
Abnormal retrodiskal tissue

(a) Sagittal oblique SE PD (open-mouth) shows rupture of the fibers of the superior retrodiskal layer (arrow) resulting in loss of union with the posterior band.
(b) Sagittal oblique GE T2 (closed-mouth) in a different patient shows rupture of the fibers of the superior retrodiskal layer (arrow).



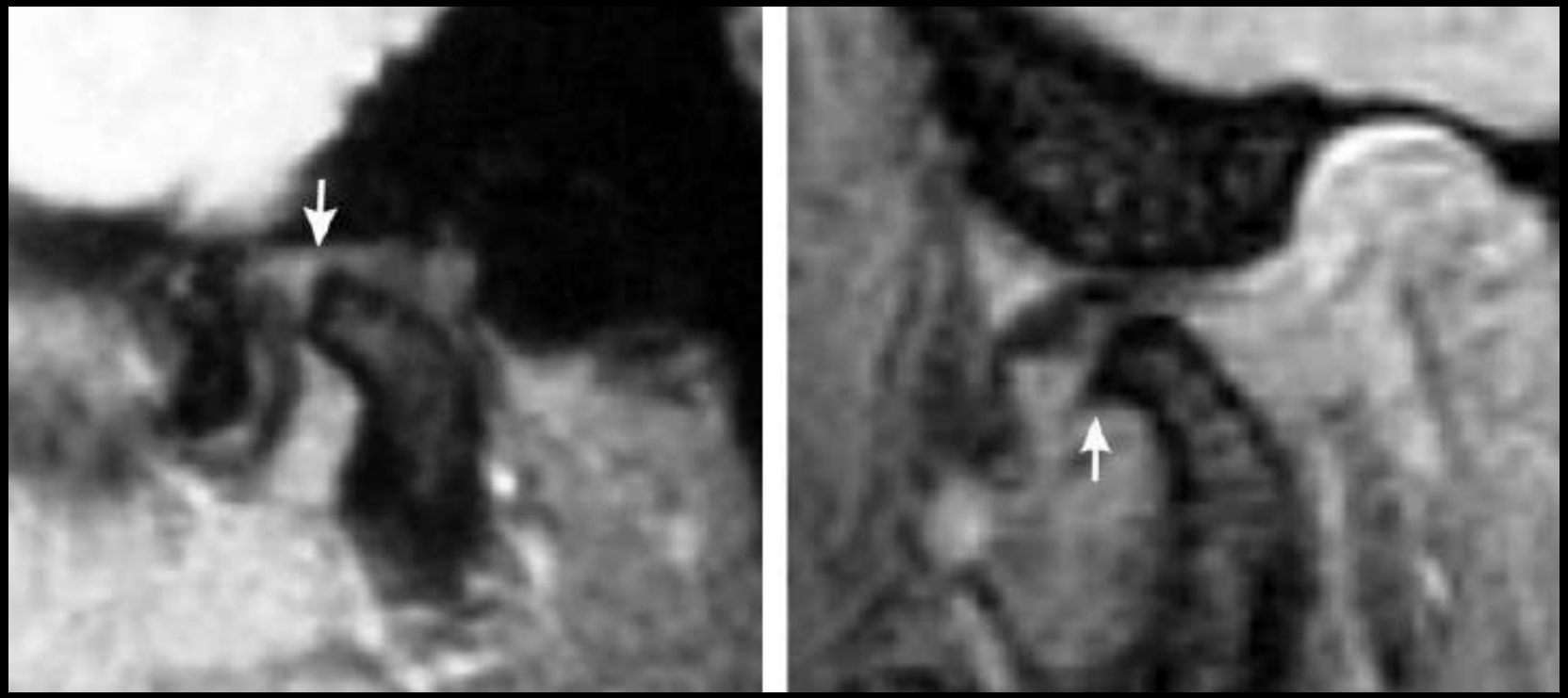
Abnormal LPM

(a) Sagittal oblique GE T2 (closed-mouth) shows complete disk displacement.
(b) Sagittal oblique GE T2 (closed-mouth) shows subtle disk displacement. The insertional areas of the superior (arrowhead) and inferior (arrow) LPMs are markedly thin.



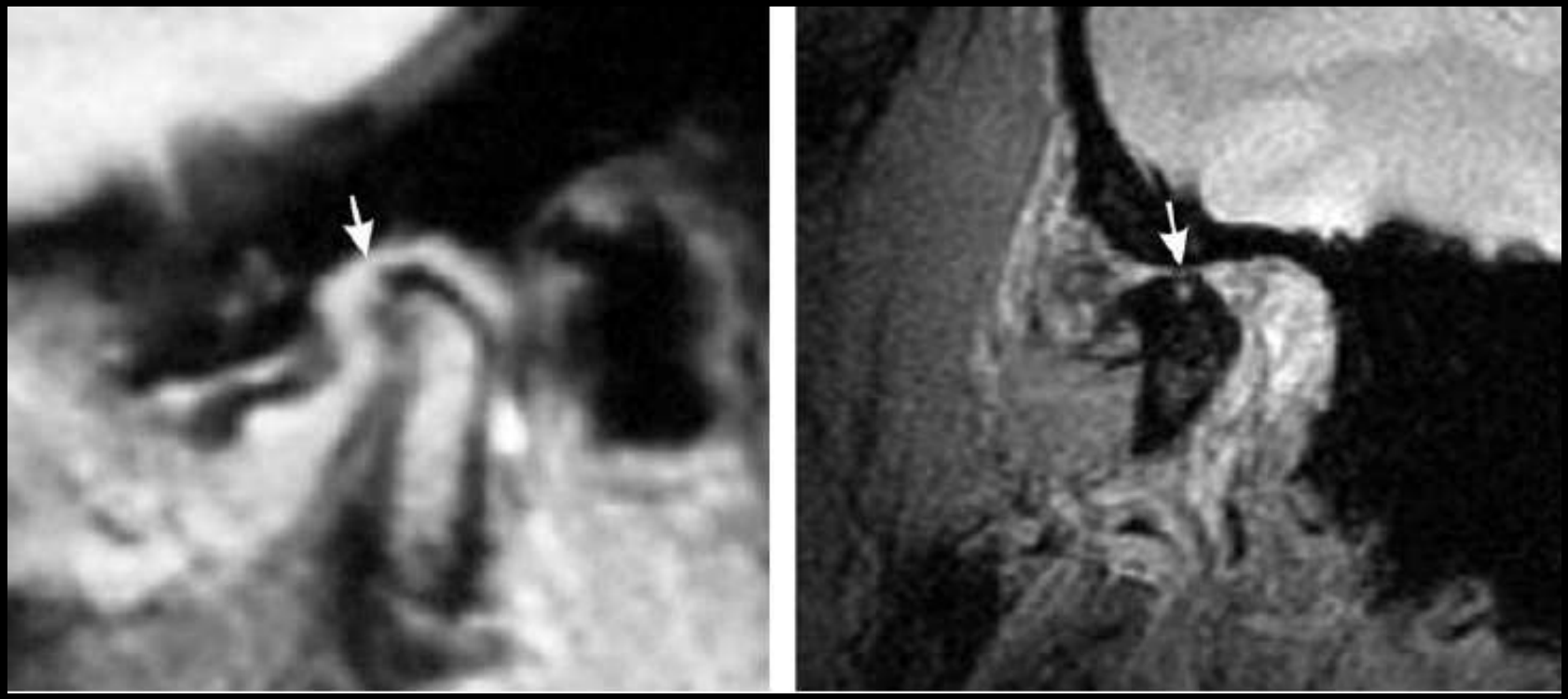
Thick inferior LPM (double disk sign)

(a) Sagittal oblique GE T2 (closed mouth) shows complete disk displacement. The thick insertional area of inferior LPM (arrow) is parallel to the disk (arrowhead), creating the double disk sign.
(b) Sagittal oblique GE T2 (closed mouth) in a different patient shows severe internal derangement (arrowhead). A thick inferior LPM attachment (arrow) is again seen. The double disk sign must be recognized to ddt between disk and muscle attachment.



Osteoarthritic changes in different patients

(a) Sagittal oblique GE T2 (closed-mouth) shows condylar flattening (arrow).
(b) Sagittal oblique GE T2 (open-mouth) shows an osteophyte (arrow).



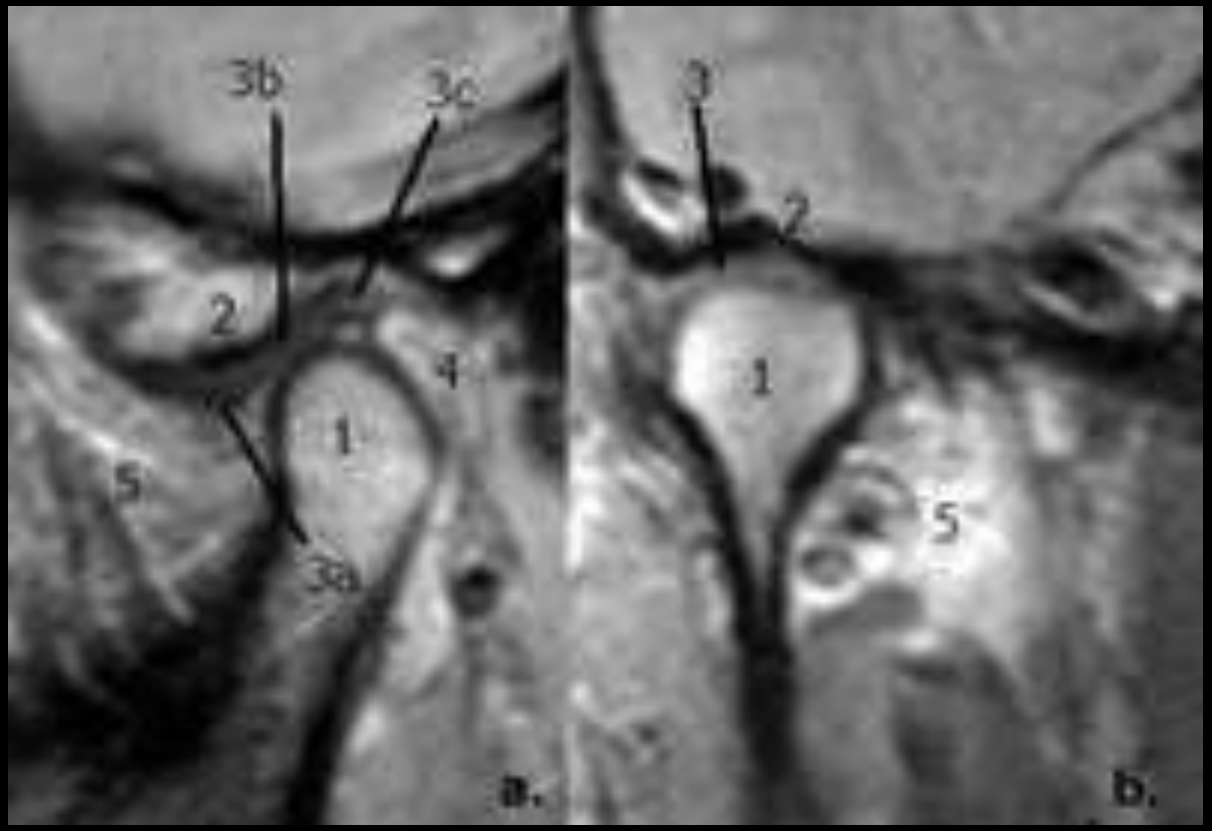
Osteoarthritic changes in different patients

(a) Sagittal oblique SE T2 (closed-mouth) shows condylar erosion (arrow).
(b) Sagittal oblique GE T2 (open-mouth) shows displaced non reduced disc with condylar osteophyte, flattening, sclerosis, and erosion (arrow).

Table 1
Direct and Indirect MR Imaging Signs of TMJ Dysfunction

- Direct signs
  - Abnormal disk morphologic features
    - Crumpled
    - Rounded
    - Flat
    - Perforated
  - Abnormal disk displacement in closed-mouth position
    - Anterior displacement
      - More frequently observed
      - Posterior band exceeds 10° (9,18,19) or 30° (20) from vertical
    - Posterior displacement
      - Rare
      - Posterior band exceeds −10° (9,18,19) or −30° (20) from vertical
    - Lateral or medial displacement
  - Abnormal disk movement in open-mouth position
    - Anterior disk displacement with reduction
    - Anterior disk displacement without reduction
    - Stuck disk (disk remains fixed)
  - Osteoarthritic changes of the condyle
    - Flattening
    - Osteophytes
    - Erosion
    - Sclerosis
- Indirect signs
  - Large amount of joint fluid (joint effusion)
  - Increased thickness of LPM attachments
  - Rupture of retrodiskal layers

Open mouth sagittal T1



<u>Normal TMJ - Closed mouth</u> (*a*, Sagittal & *b*, coronal)

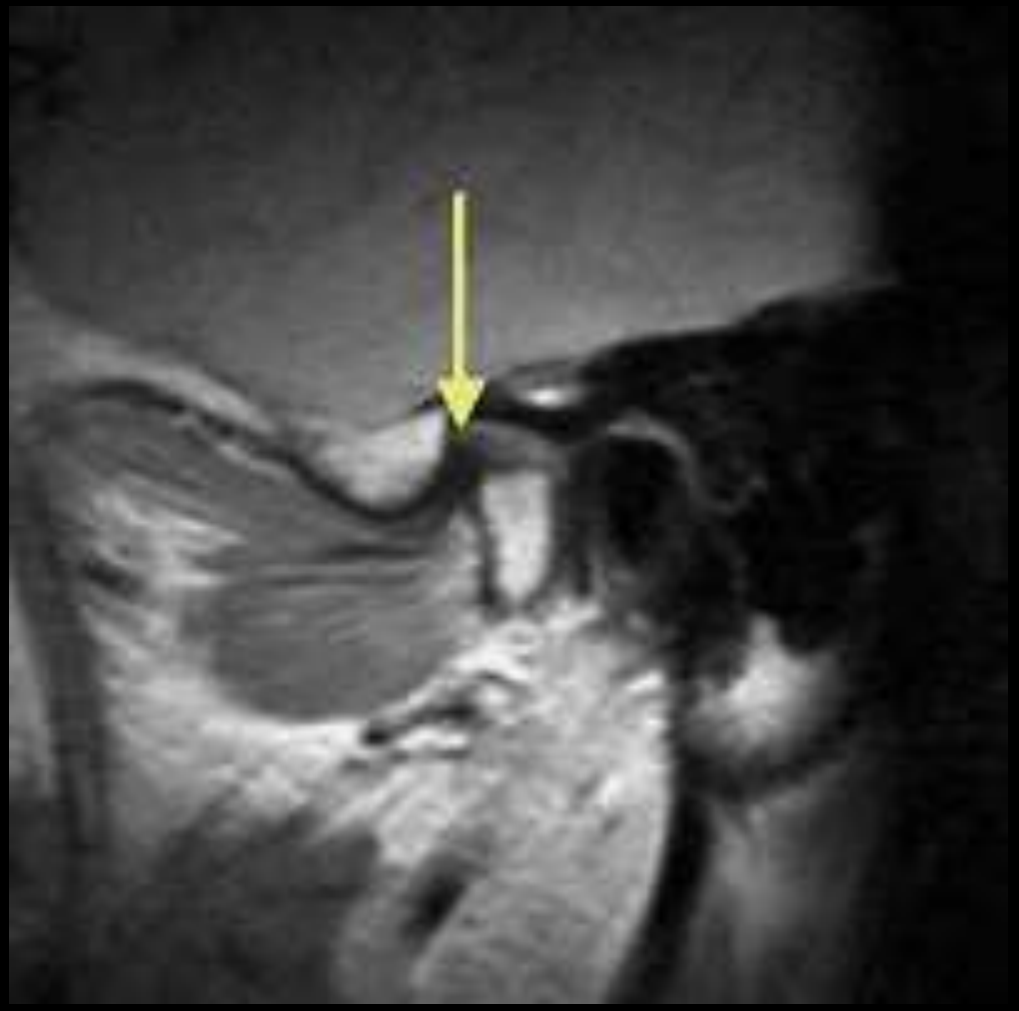
1, Mandibular head; *2*, articular fossa; *3*, disk (*3a*, anterior band; *3b*, intermediate zone; *3c*, posterior band); *4*, bilaminar zone; *5*, lateral pterygoid muscle.

Normal TMJ - Open mouth (*a*, Sagittal & *b*, coronal)

Note the bow-tie shape of the disk in the sagittal projection. *1*, Mandibular head; *2*, articular eminence; *3*, disk (*3a*, anterior band; *3b*, intermediate zone; *3c*, posterior band) ; *4*, bilaminar zone; *5*, lateral pterygoid muscle.

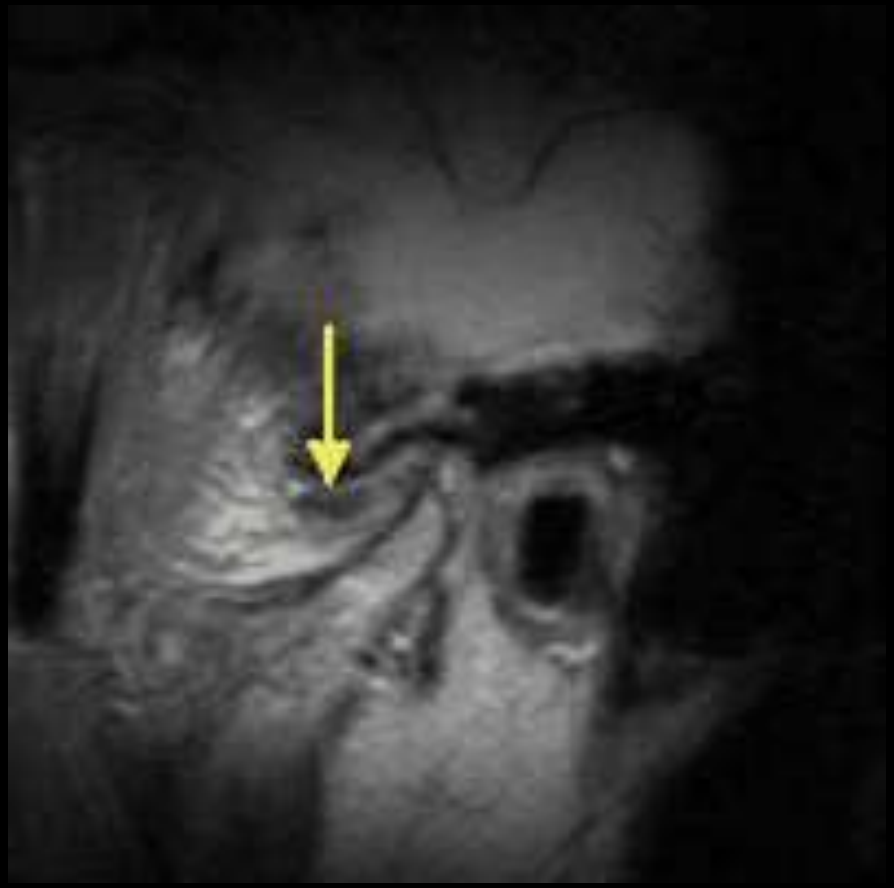
Pterygoid muscles

Mandibular ramus *(1)*, lateral pterygoid muscle *(2)*, medial pterygoid muscle *(3)*.



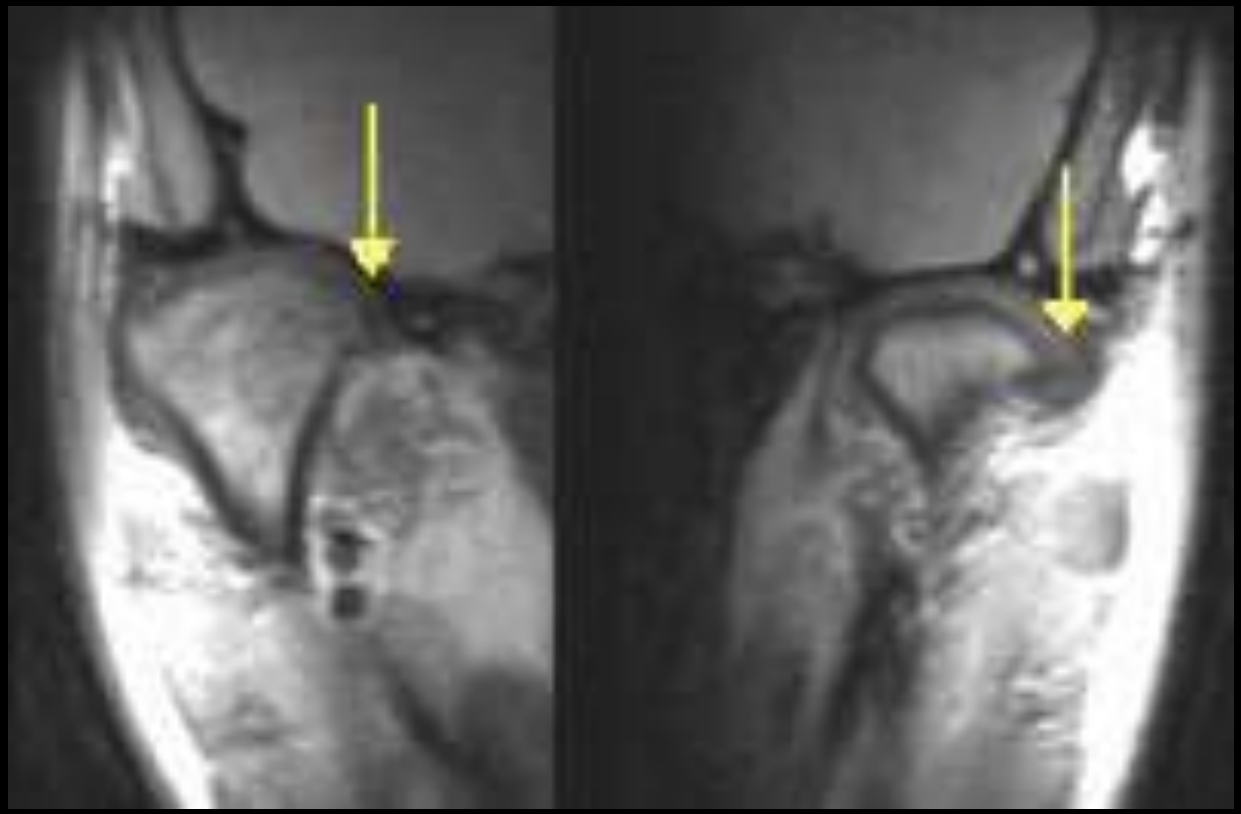
Partial anterior disk displacement

Sagittal MR (closed-mouth) shows the posterior band (arrow) at the 10 o'clock position.



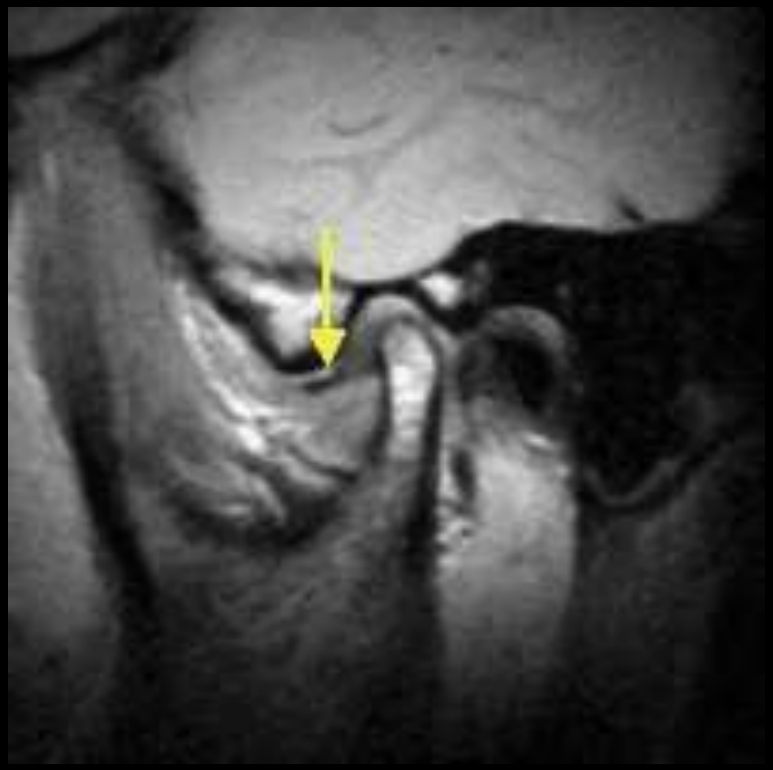
Complete anterior disk displacement

Sagittal MR (closed-mouth) shows disk deformity (arrow). Deformity of the condyle is also noted due to osteoarthritic changes.



Medial & lateral disk displacement

Coronal MR (closed-mouth) shows mild medial displacement of Rt disc (arrow) with a slight lateral displacement of Lt disc (arrow).



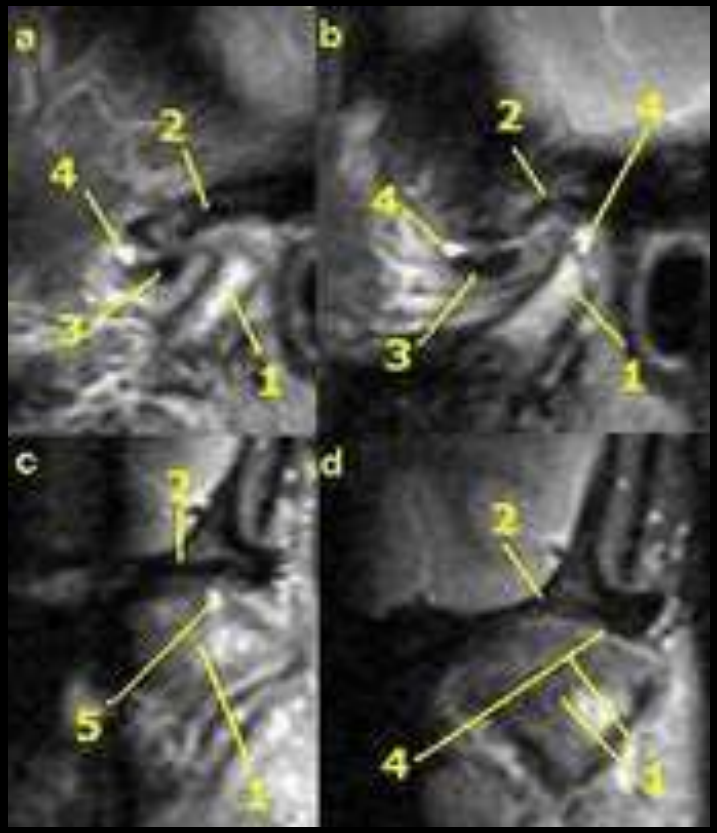
<u>Anterolateral disk displacement</u> **(a)** Sagittal & **(b)** coronal MR (closed-mouth).

In **a,** anterior displacement and deformity of the disk are noted. The arrow indicates the completely dislocated and deformed disk.

In **b,** the lateral component of the antero-lateral disk displacement can be easily identified. The disk (arrow) bulges laterally beyond lateral condylar contour (indicated by the line).

Anterior disk displacement without reduction

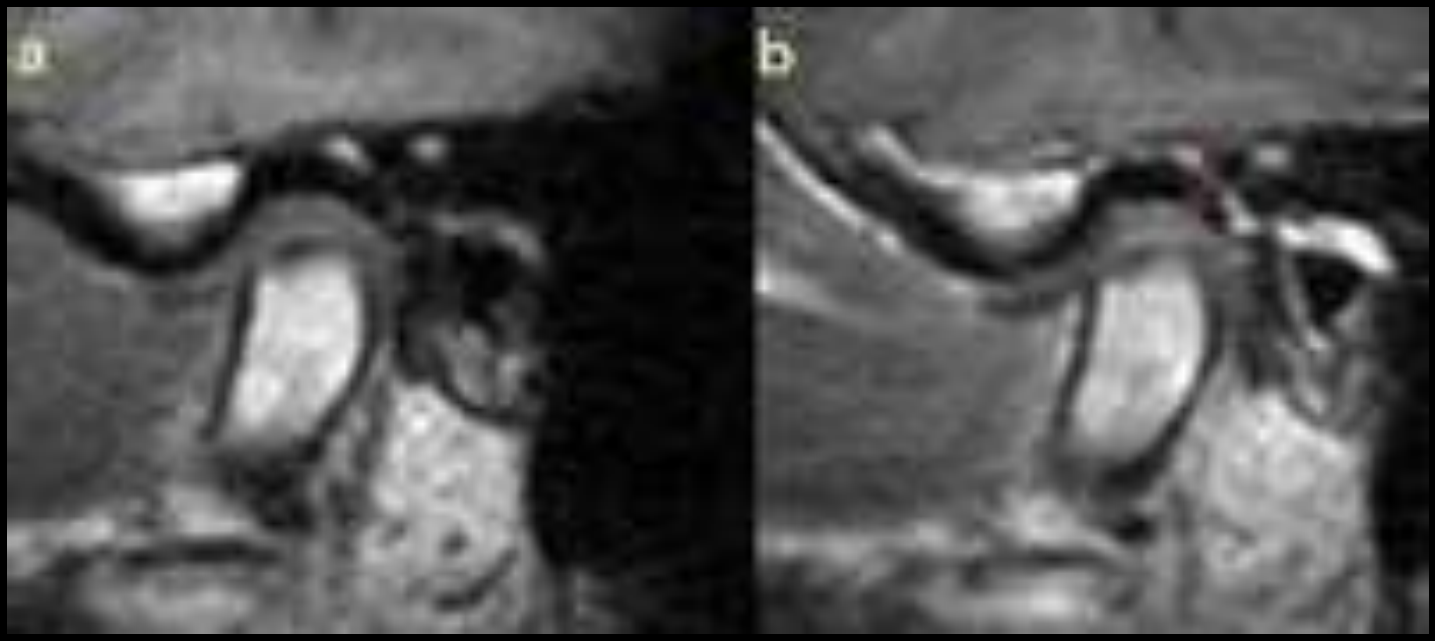
Sagittal MR (open-mouth) shows anteriorly displaced disk (arrow) that does not relocate.



Anterior disk displacement with osteoarthritis

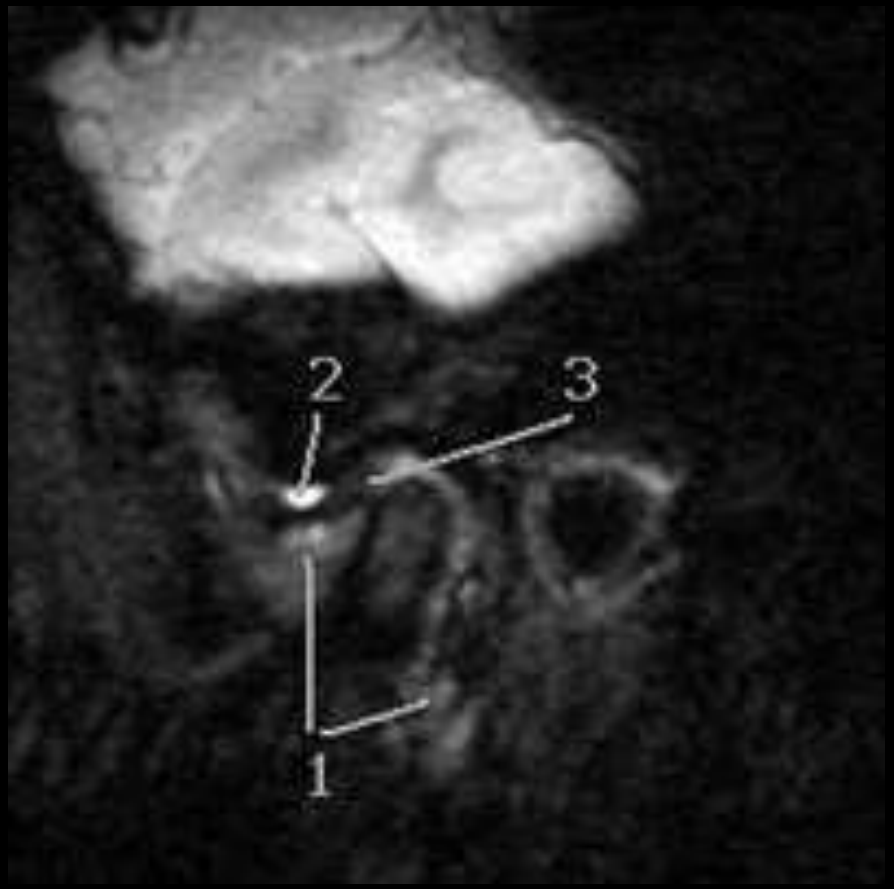
(a, b) Sagittal & *(c, d)* coronal STIR images (closed-mouth) in 2 different positions in the respective plane.

Joint space narrowing, contour irregularity and subchondral cyst are best seen in the coronal images; BM edema and synovial fluid are best seen in sagittal images. *1*, Condyle with areas of bone edema; *2*, articular fossa; *3*, displaced disk; *4*, effusion; *5*, cyst.



Inflamed TMJ Rht arthritis

Sagittal SE T1, *a*, before & *b*, after IV contrast show slight enhancement of the bilaminar zone (arrow).



Inflamed TMJ in Rht arthritis

Sagittal STIR shows (1) synovitis and inflammation of the surrounding tissue, (2) small volume of intracapsular fluid in superior joint space, (3) partial anterior disk displacement.


Thank You