The Temporomandibular Joint (TMJ)

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5/21/09

Objectives

- Clinical significance
- Etiology of TMJ disorders
- Gross anatomy
- Normal CT, MRI anatomy
- Internal Derangement
- Trauma
- Rare disorders

Clinical Significance

- Approximately 10 million individuals in the United States are affected by temporomandibular joint (TMJ) abnormalities (National Institutes of Health data, National Institute of Dental and Craniofacial Research).
- There is a significant young female prevalence reported 5:1 to 10:1. (20s – 40s)
- Bilateral abnormalities have been reported in up to 60% of patients.

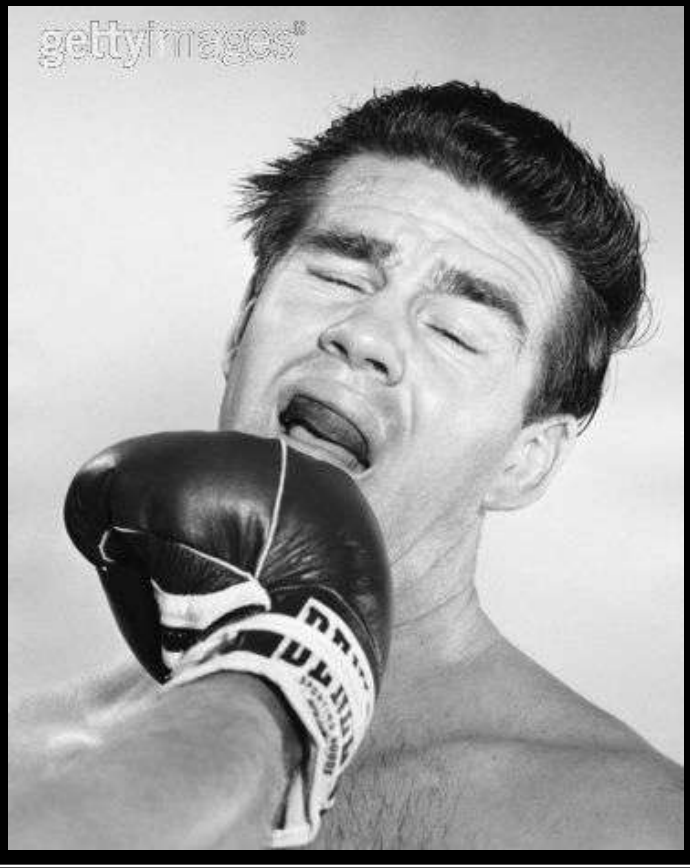
Clinical Significance

- Wetesson et al reported joint clicking or limitation of opening in up to 39% of the general population.
- Sommer et al reported the overall prevalence of TMJ internal derangement in the general population between 20% and 30%.
- Despite the high prevalence, only 5 – 10% with symptoms require treatment.
- Up to 40% of patients with symptoms have spontaneous resolution of symptoms.
- Asymptomatic volunteers have also shown internal derangement, however the prevalence of abnormalities is much higher in symptomatic patients (Schiffman et al).
- Currently MRI is the imaging technique of choice for the TMJ (excluding acute trauma).

Etiologies of TMJ abnormalities

- Post-traumatic
  - Thought to be underestimated.
  - May represent up to 43% of all TMJ abnormalities (Shellhas KP).

Mechanism of injury



Etiologies of TMJ abnormalities

- Post-traumatic
  - Thought to be underestimated
  - May represent up to 43% of all TMJ abnromalities (Shellhas KP)
- Why do females have a significantly increased prevalence of TMJ abnormalities???

Theory #1

Etiologies of TMJ abnormalities

- Post-traumatic
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- Why do females have a significantly increased prevalence???
  - Theory #2: Not well understood
  - Likely multifactorial

Etiologies of TMJ abnormalities

- Post-traumatic
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  - May represent up to 43% of all TMJ abnromalities (Shellhas KP)
- Idiopathic
- Ligamentous laxity
- Bruxism – teeth grinding
- Changes in composition of synovial fluid
- Improper activity of lateral pterygoid muscle

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- Overuse???

Etiologies of TMJ abnormalities

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- Idiopathic
- Ligamentous laxity
- Bruxism – teeth grinding
- Changes in composition
- Improper activity of later
- Overuse???
  - Too much gum???
  - Too much food???

- Imaging of the TMJ is not as “sexy” as…

Extremity Imaging of the elite athlete

TMJ imaging – elite athletes???

Takeru Kobayashi – Hot dog eating champion!

- 2008: First place tied (59 hot dogs)*
- 2007: Second place (63 hot dogs - new record)
- 2006: First place (53.75 hot dogs - new record)
- 2005: First place (49 hot dogs)
- 2004: First place (53.5 hot dogs - new record)
- 2003: First place (44.5 hot dogs)
- 2002: First place (50.5 hot dogs)
- 2001: First place (50 hot dogs)
- *Lost 5 hot dog eat-off. Match was also 10 minutes instead of 12 minutes.

Elite TMJ athletes

- Takeru Kobayashi and Joey Chestnut

Now that's an elite athlete

Before

After 60 hot dogs

- Wikipedia.com: Takeru Kobayashi developed jaw arthritis a week after he started training rigorously for the July 4th Nathan's Famous Hot Dog Eating contest.

Etiologies of TMJ abnormalities

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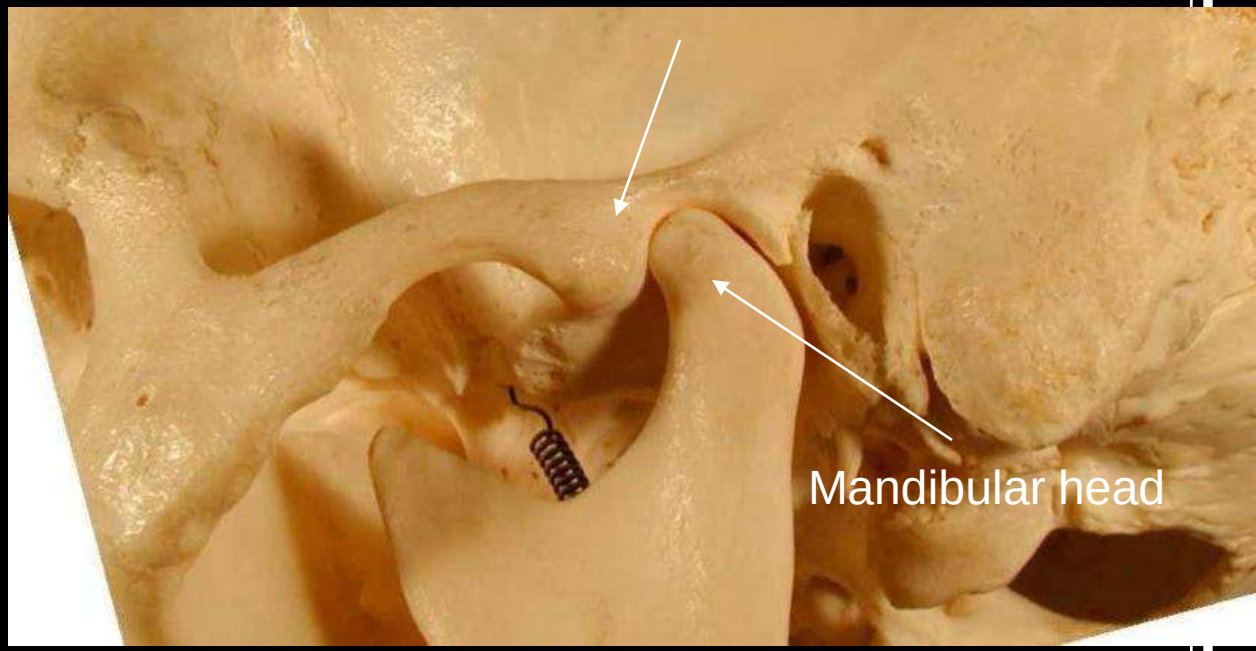
TMJ Gross Anatomy

Anatomy-Osseous components

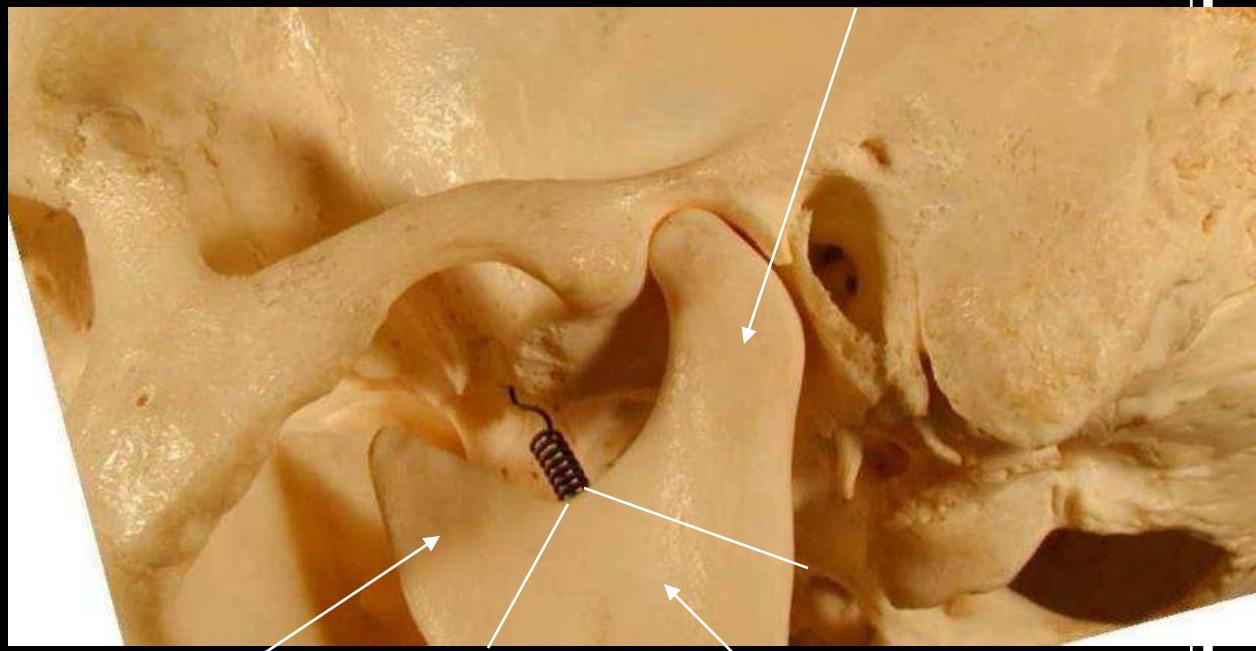
- The mandible and temporal bone are the osseus components of the TMJ
- The mandibular head is the inferior component of the joint



Picture courtesy of Rosalyn Cheng

Anatomy-Osseous components

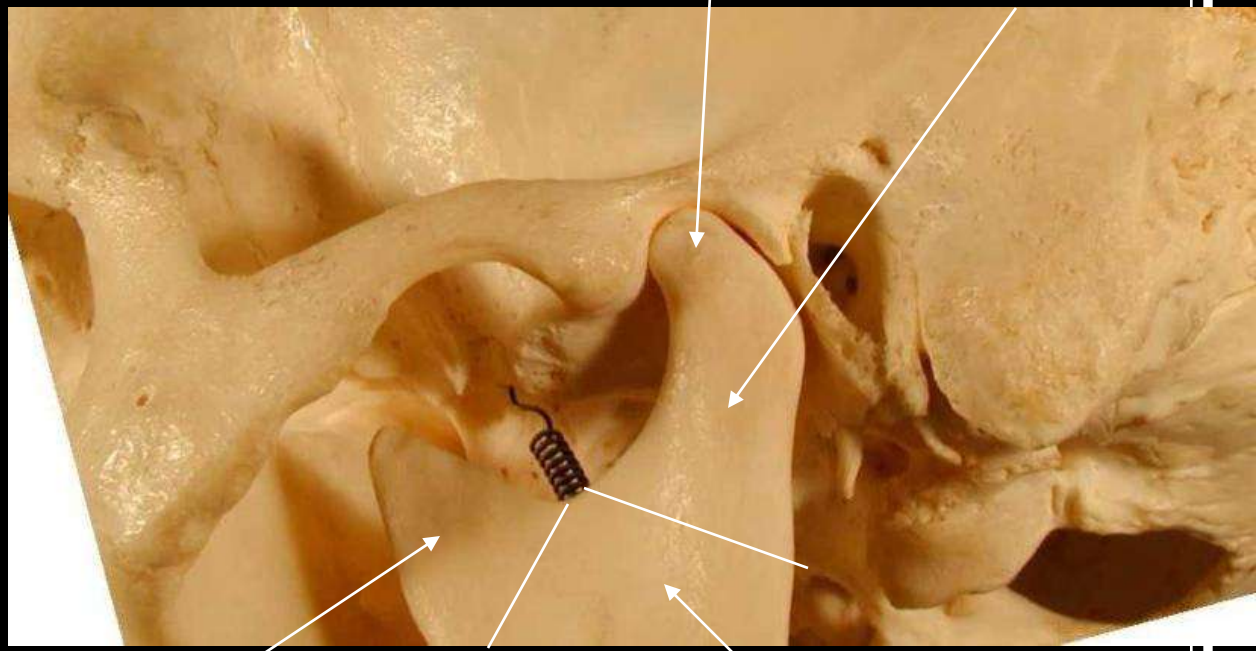
- Mandible anatomy



Picture courtesy of Rosalyn Cheng

Anatomy-Osseous components

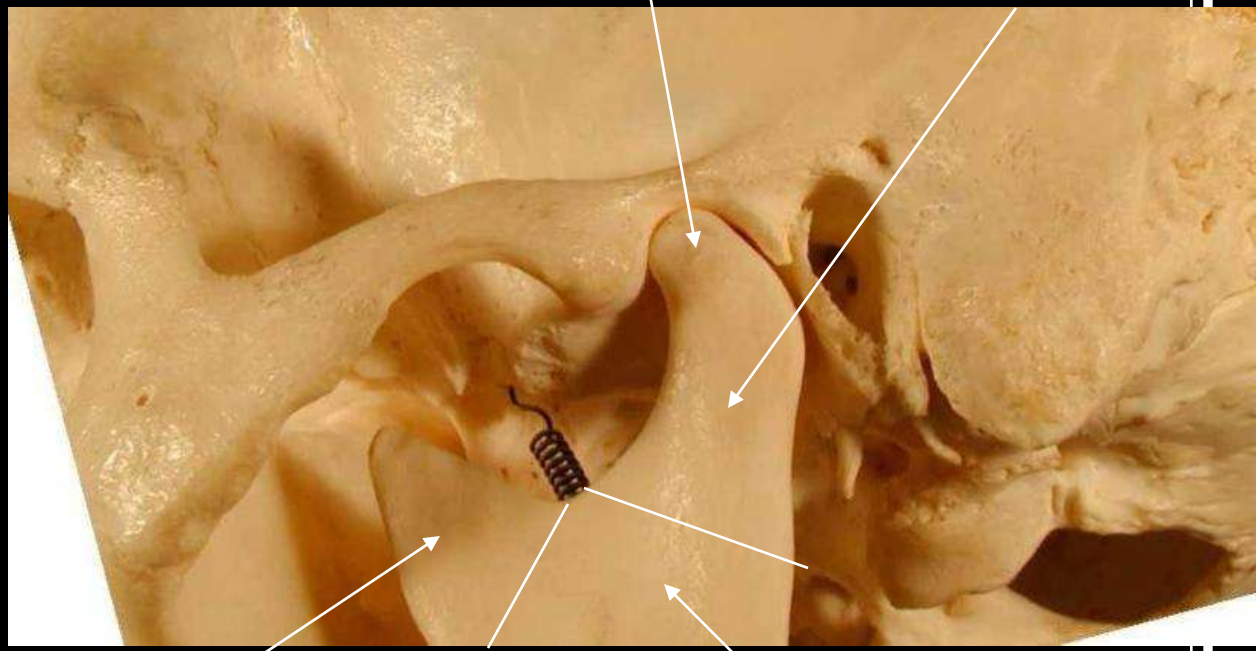
- Condyle anatomy



Picture courtesy of Rosalyn Cheng

Anatomy-Osseous components

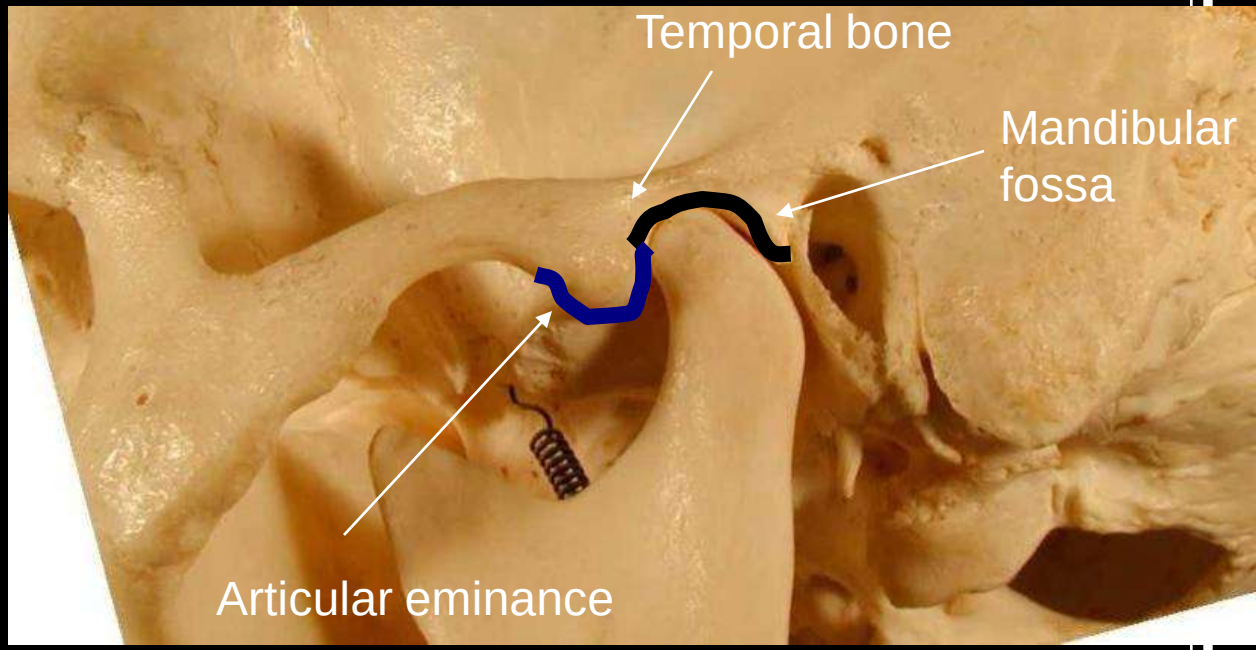
- Condyle anatomy



Picture courtesy of Rosalyn Cheng

Anatomy-Osseous components

- The mandibular fossa and articular eminance are derived from the temporal bone.



Mandibular fossa = Glenoid fossa

Picture courtesy of Rosalyn Cheng

TMJ disk

- The TMJ disk is the most critical structure of the TMJ.
- The disk prevents articular damage.
- Articular coverings are fibrous connective tissue instead of hyline cartilage.
- The disk is fibrocartilage, however mostly fibrous.

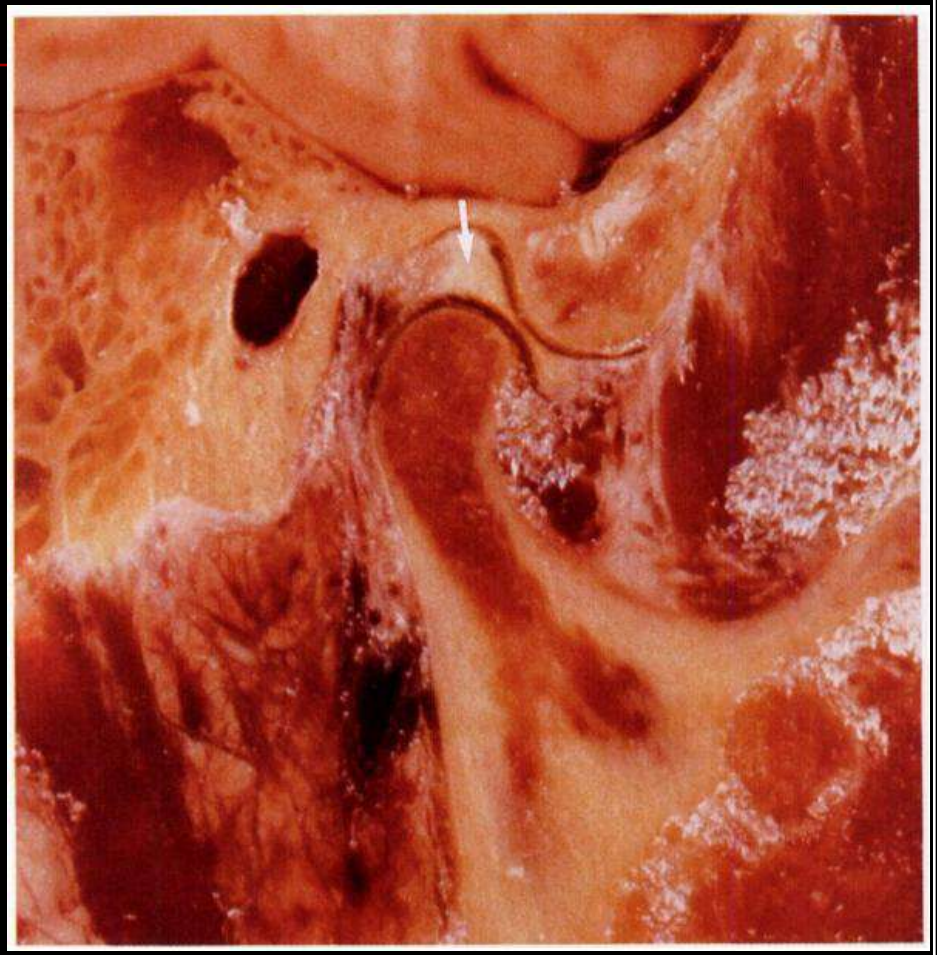
Sagittal

Christiansen EL et al. Correlative thin section temporomandibular joint anatomy and computed tomography. Radiographics. Vol 6, Num 4. July 1986.

TMJ disk

- Located between the mandibular condyle and the temporal component of the joint.
- Thick periphery
- Thin centrally
- Usually ~10mm anteroposterior and ~20mm mediolateral dimension

Sagittal



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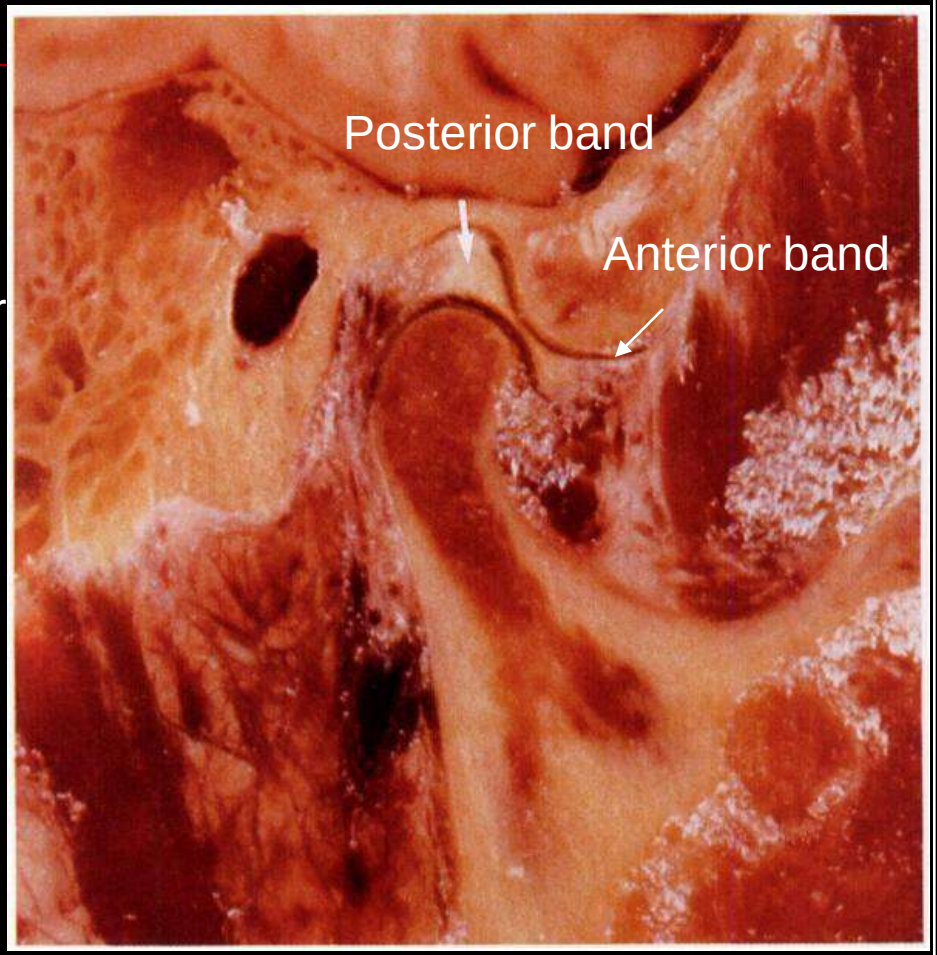
TMJ disk – closed mouth

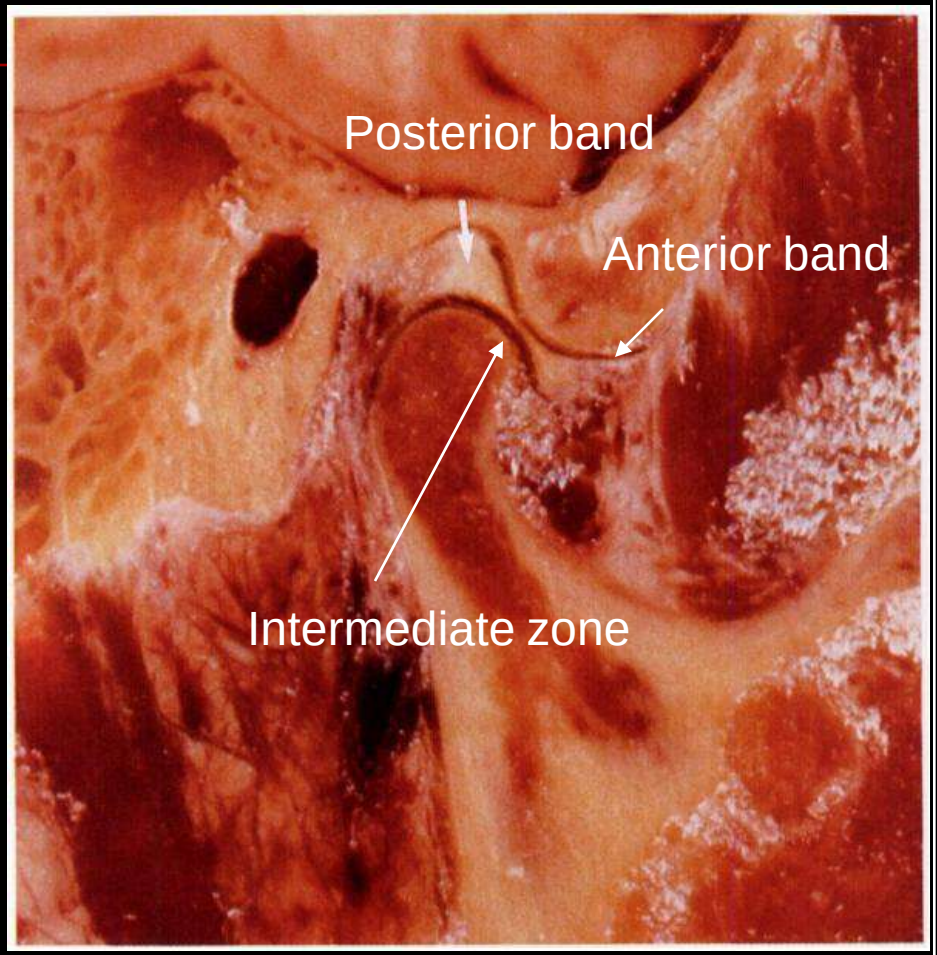
- The thicker anterior and posterior parts are referred to as the anterior band and the posterior band.
- The posterior band is located over the condyle, normally found in the 12 O'clock position. The Posterior band is larger than the anterior band.
- The central thin zone called the intermediate zone is located between the condlye and posterior part of the articular eminence
- The anterior band is located under the articular eminence.



Christiansen EL et al. Correlative thin section temporomandibular joint anatomy and computed tomography. Radiographics. Vol 6, Num 4. July 1986.

TMJ disk – Names to memorize

- The thicker anterior and posterior parts are referred to as the anterior band and the posterior band.
- The posterior band is located over the condyle and is larger than the anterior band
- The central thin zone called the intermediate zone is located between the condlye and posterior part of the articular eminence
- The anterior band is located under the articular eminence.



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The Anterior Band

- **Anterior** is a five-piece melodic death medal band from Wales. They have released the critically acclaimed *This Age of Silence*.

TMJ disk

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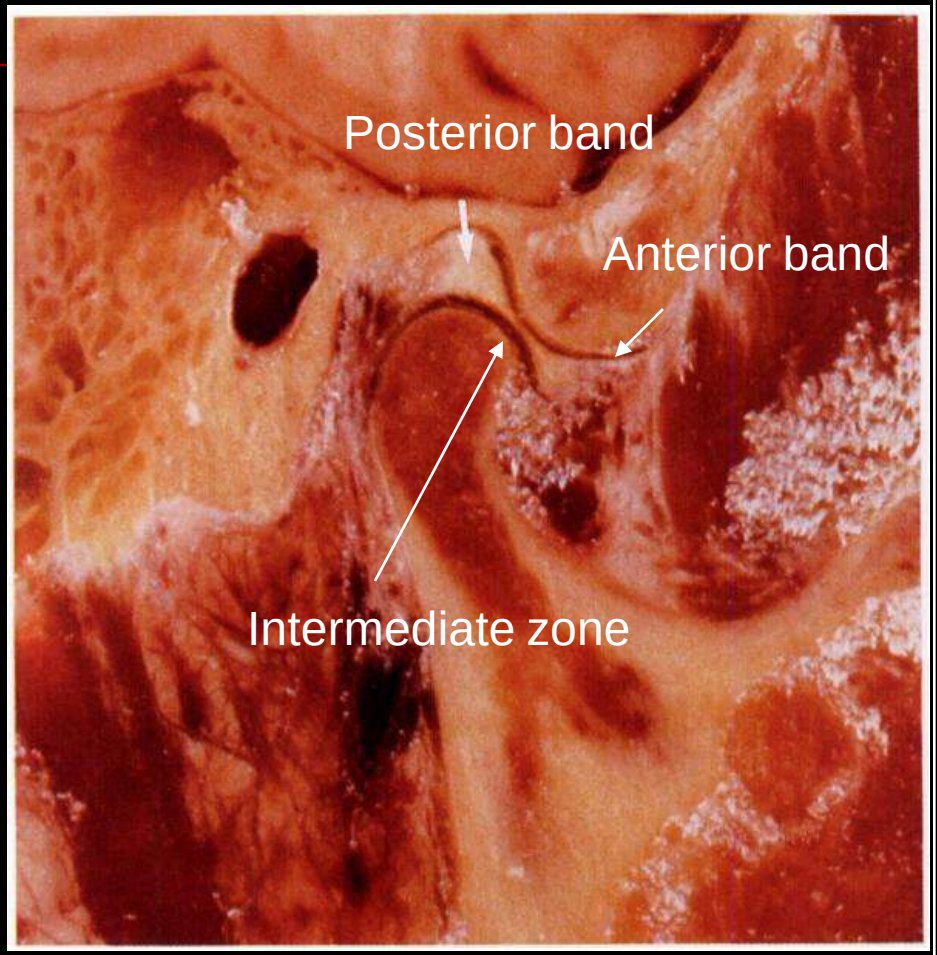

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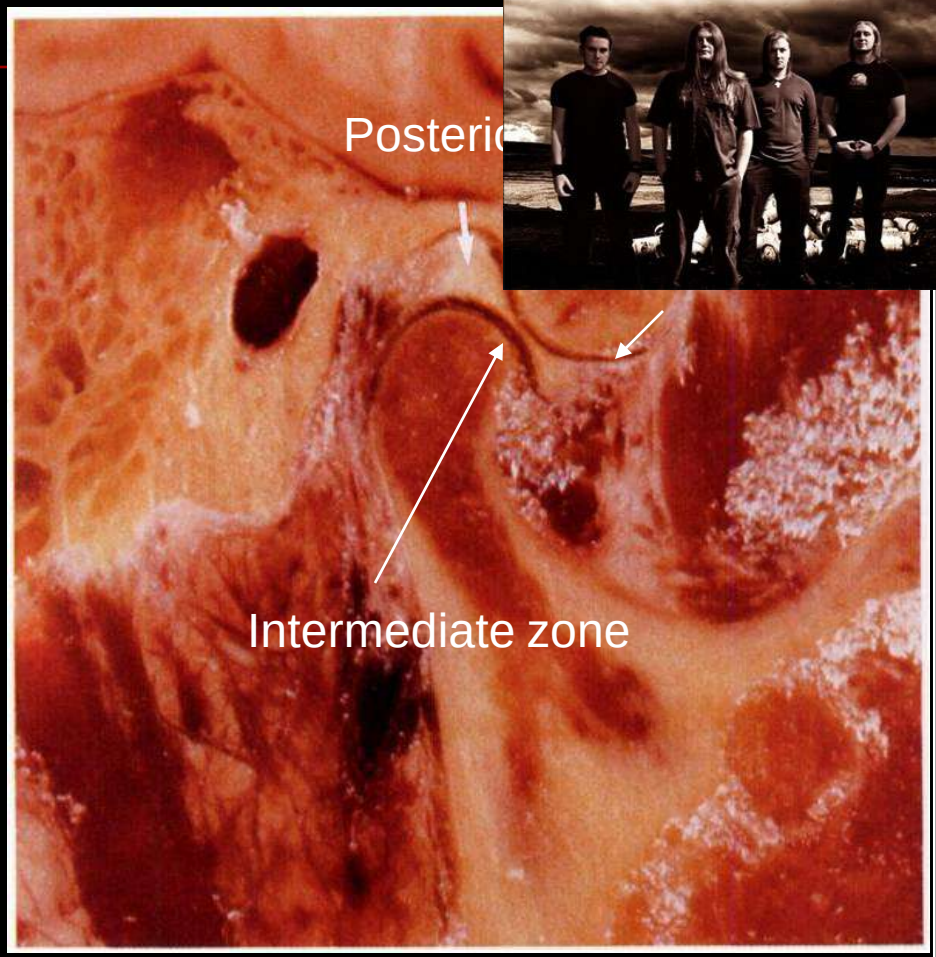
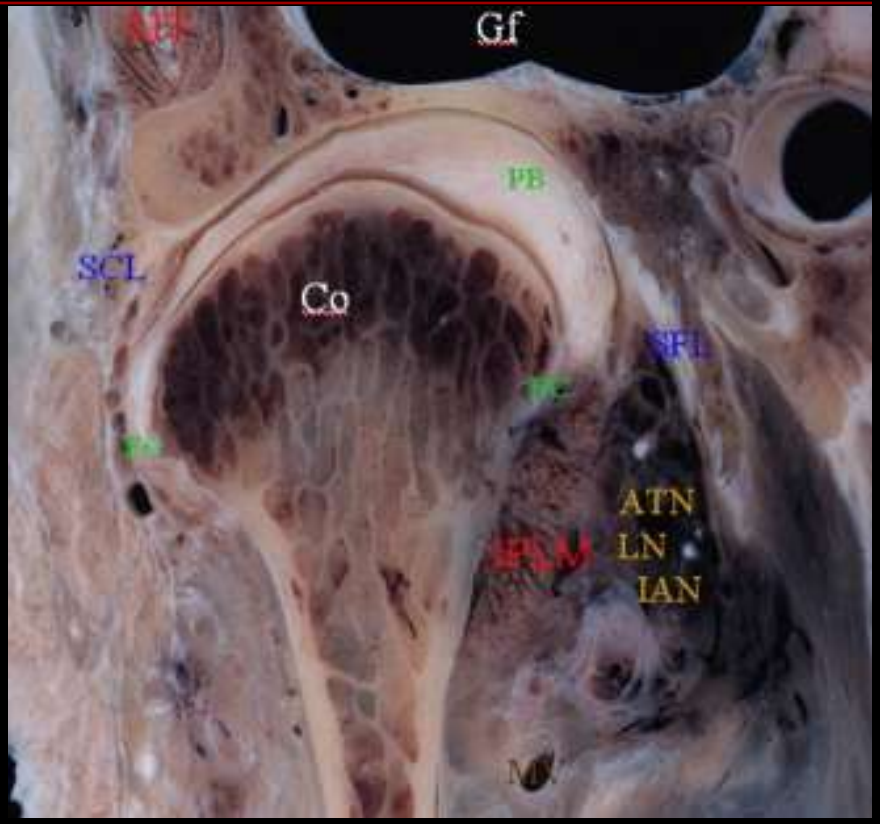


Christiansen EL et al. Correlative thin section temporomandibular joint anatomy and computed tomography. Radiographics. Vol 6, Num 4. July 1986.

TMJ disk

- Coronal section
- The disc is crescent-shaped.
- ~2x in length

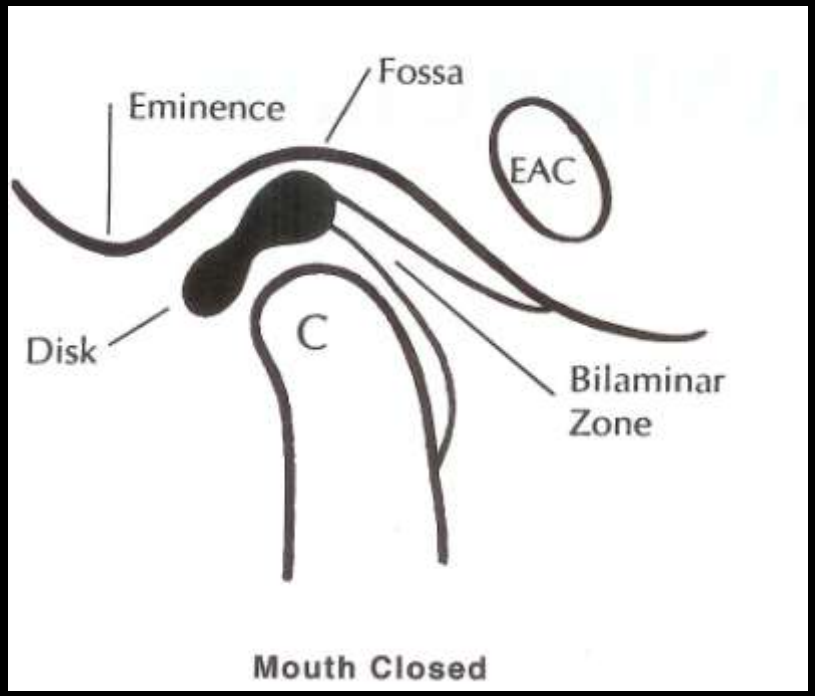
Coronal



Alomar X, et al. Sem Ultrasound, CT, MRI. 2007; 28(3):170-183.

Bilaminar zone

- The posterior disk is attached to the posterior temporal bone and the posterior condyle by the bilaminar zone or retrodiscal tissue.
- The superior fibers attach to the temporal bone and the inferior fibers attach to the posterior condyle.
- Initially histologic studies demonstrated an upper elastic component and a lower connective tissue component.
- Recent histologic studies have failed to confirm the bilaminar nature.
- Despite this, the name has persisted. Some instead use only retrodiscal tissue.
- The zone is highly vascular and well innervated.



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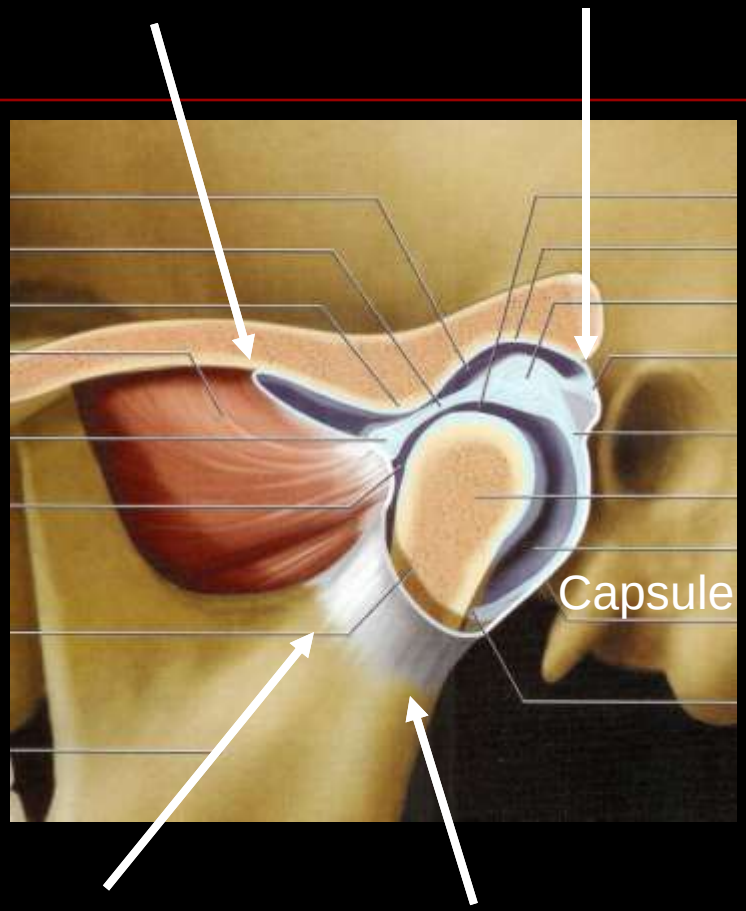
Joint capsule

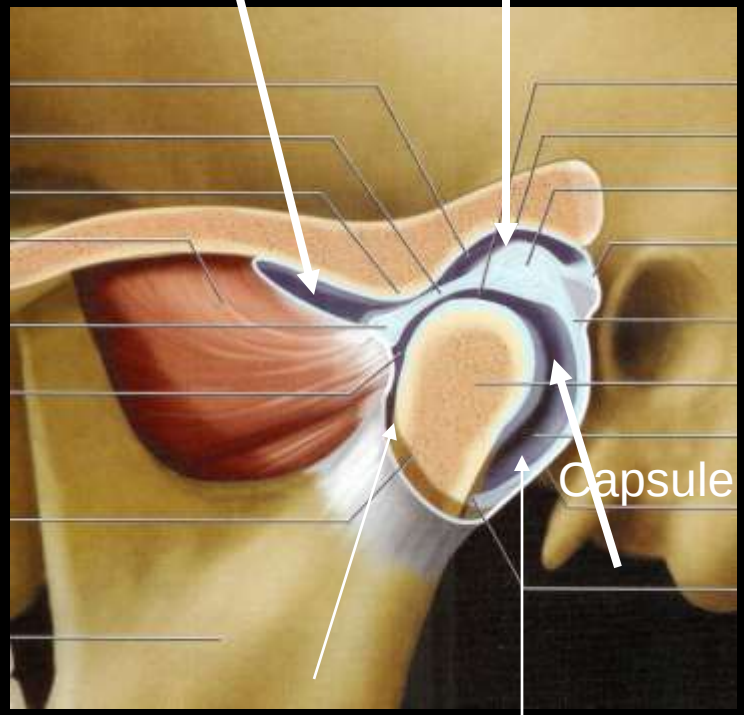
- A synovial articulation that encloses the entire articulating region of the TMJ.
  - Superiorly attached to the circumference of the mandibular fossa and anteriorly around the articular eminence
  - Inferiorly attached to the mandibular neck
- The disc is placed between the two articulating bones with circumferential peripherial attachments to the walls of the capsule, dividing the capsule into two non-communicating compartments.



Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII83.

Joint capsule

- Superior compartment
  - About 3 times larger than the inferior compartment
  - Anterior recess and posterior recess
- Inferior compartment
  - Encloses the entire neck of the mandible
  - Divided into anterior and posterior recesses.



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Anatomy

Superior compartment

Intermediate zone of disk

Articular eminence

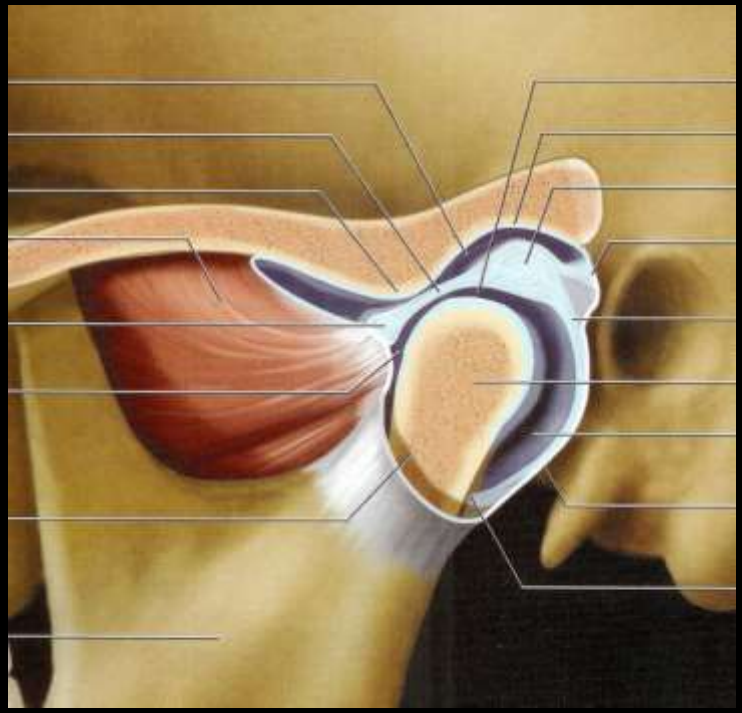
Lateral pterygoid muscle

Anterior band of disk

Anterior recess, inferior compartment

Condylar neck

Ramus of mandible



Inferior compartment

Mandibular fossa

Posterior band of disk

Superior portion, bilaminar zone

Inferior portion bilaminar zone

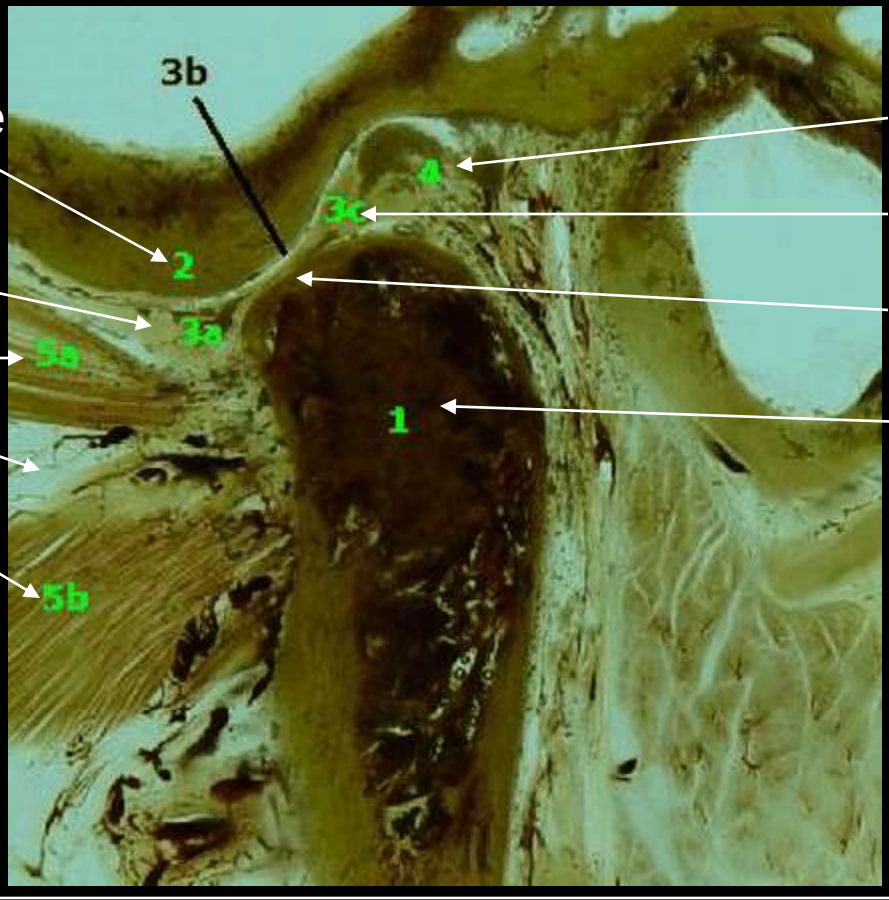
Condylar head

Posterior recess, inferior compartment

Inferior portion attaches to posterior mandible

Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII83.

Anatomy – Two heads of the LPM



Articular eminence

Anterior band

Superior head LPM

Fat

Inferior head LPM

Bilaminar zone

Posterior band

Intermediate zone

Mandibular head

Sommer OJ, Aigner F, Rudisch A, Gruber H, Fritsch H, Millesi W and Stiskal M. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

Coronal Anatomy - LPM

Superior joint space

Lateral pterygoid muscle (medial to the condyle)

Mandibular fossa

Disk

Inferior joint space

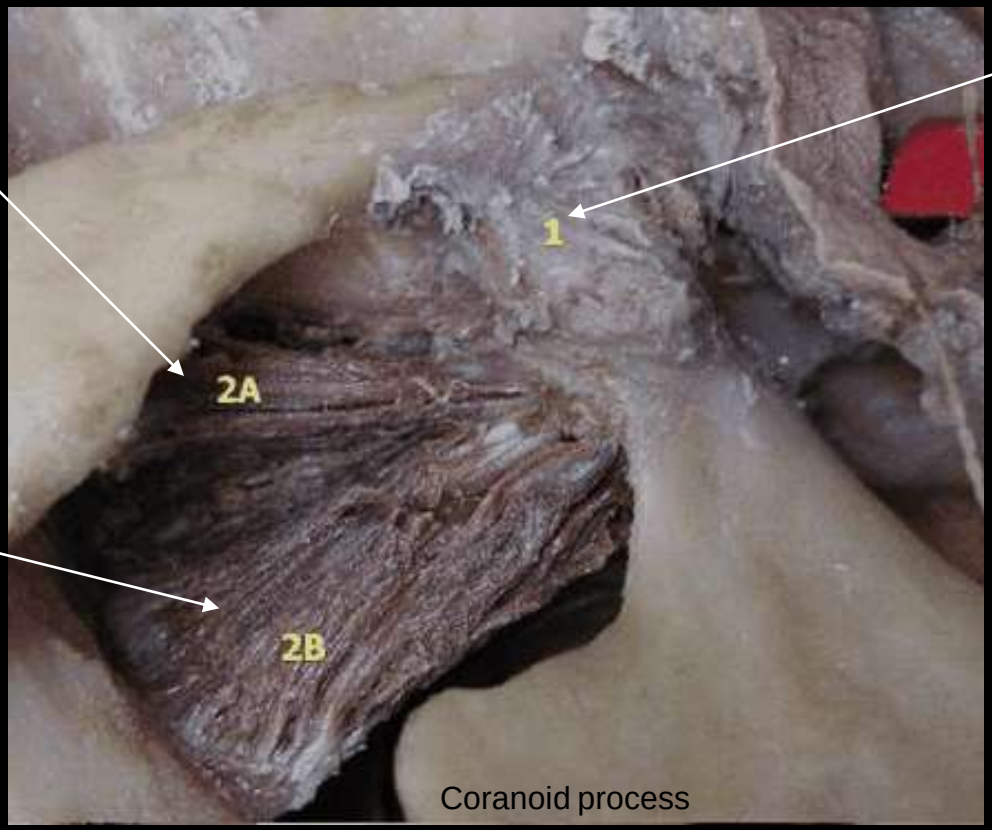
Mandibular head

Sommer OJ, Aigner F, Rudisch A, Gruber H, Fritsch H, Millesi W and Stiskal M. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

Anatomy – Lateral projection

Superior belly of Lateral ptygeroid Muscle (inserts on disk and capsule)

Inferior belly of Lateral ptygeroid Muscle (Inserts on anterior mandibular neck)



Joint capsule

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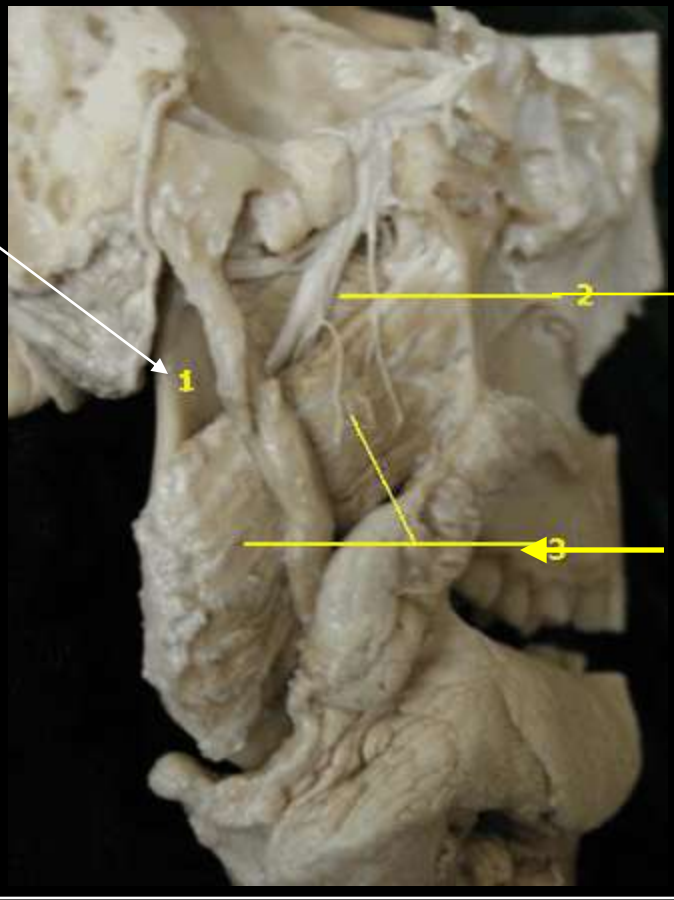
Anatomy – Medial projection

Mandibular ramus



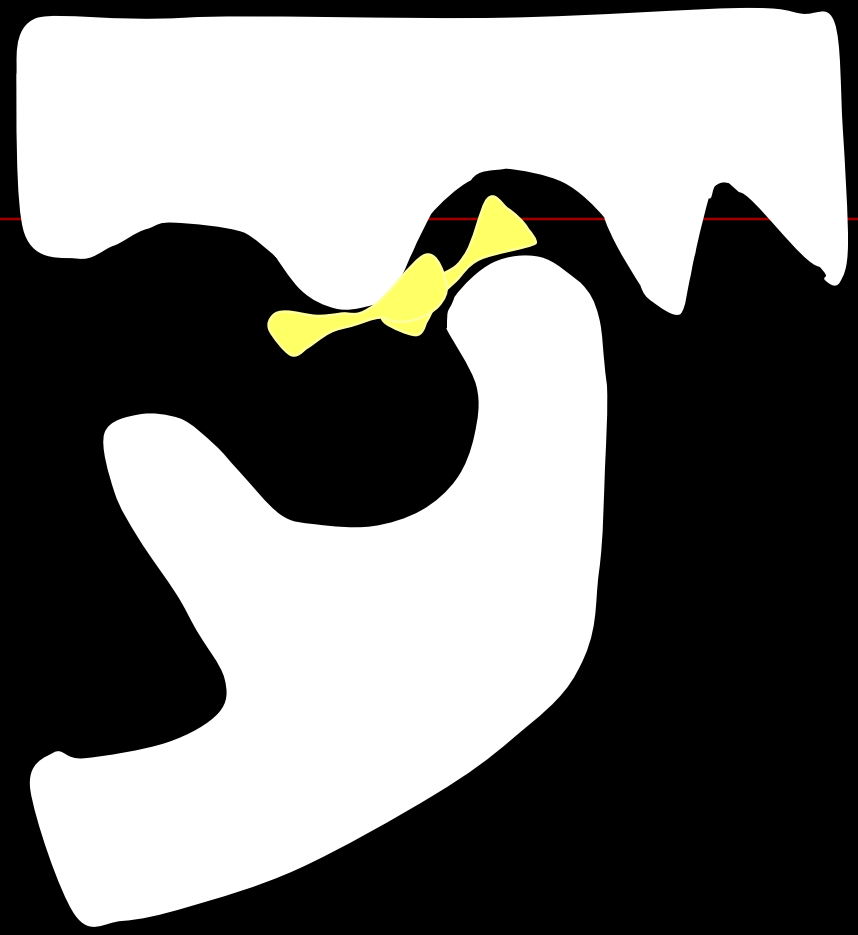
Lateral pterygoid muscle

Medial pterygoid muscle

Sommer OJ, Aigner F, Rudisch A, Gruber H, Fritsch H, Millesi W and Stiskal M. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

Translation

- Translation allows the TMJ complex significantly greater movement in relation to the actual size of the joint.

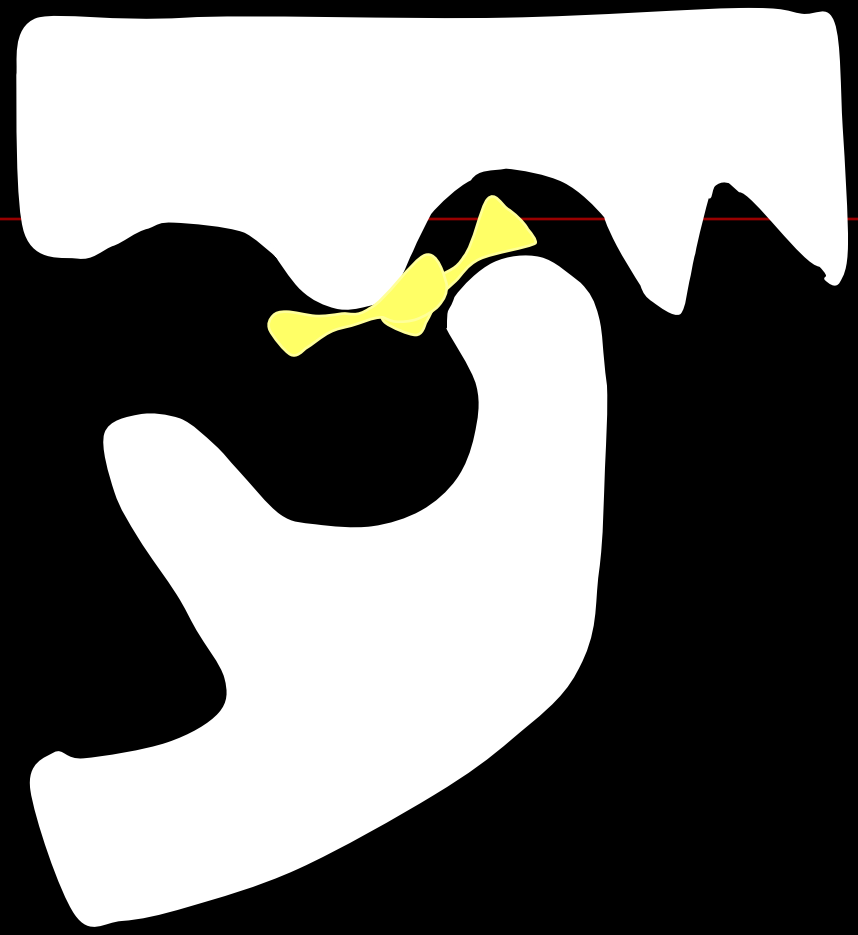


Translation

Courtsy of Rosalyn Cheng

TRANSLATION

- The principal function of the disk is to allow rotation and translation.
- Rotation is more evident in the lower joint space and occurs primarily before translation.
- Translation occurs more predominately in the superior joint space.
- During all mandibular movements, the intermediate zone of the disk remains located between the condyle and the temporal bone.



Translation

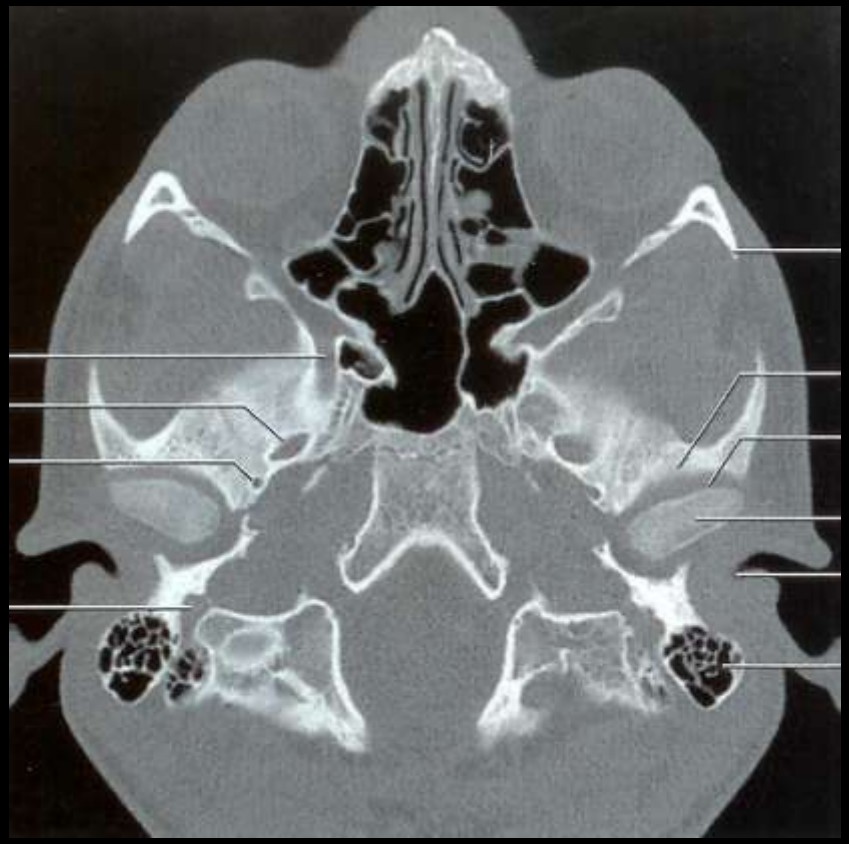
Courtsy of Rosalyn Cheng

IMAGING of the TMJ

CT – Direct sagittal scanning

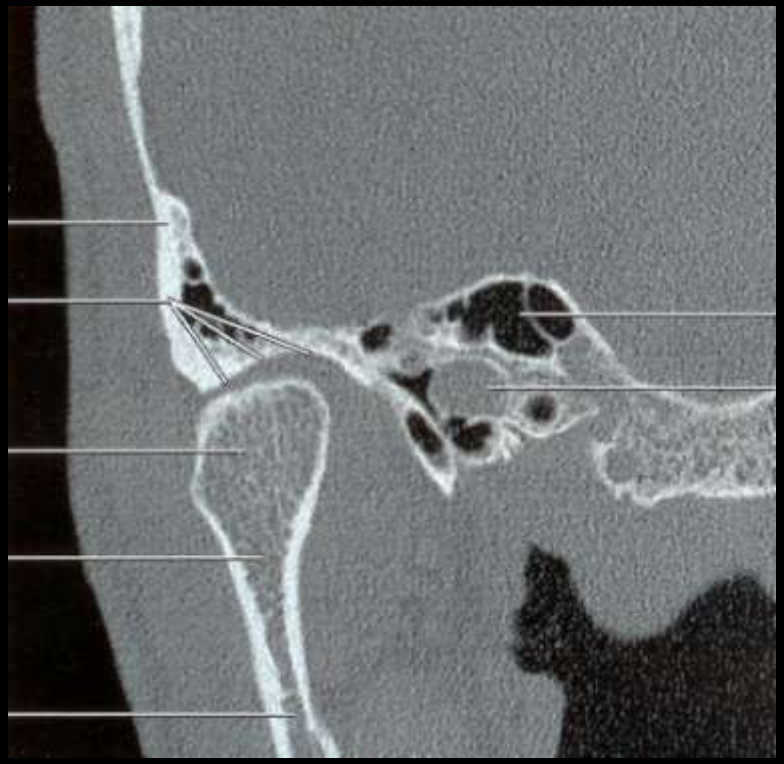
Sartoris et al. The Temporomandibular Joint: True Sagittal Computed Tomography with Meniscus Visualization. Radiology 1984;150

Anatomy - CT



Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII85.

Anatomy - CT



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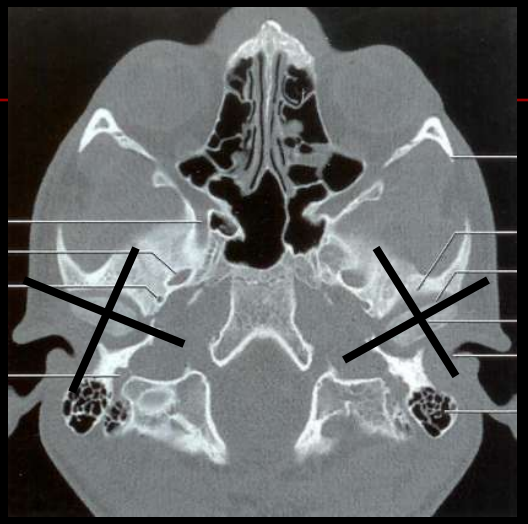
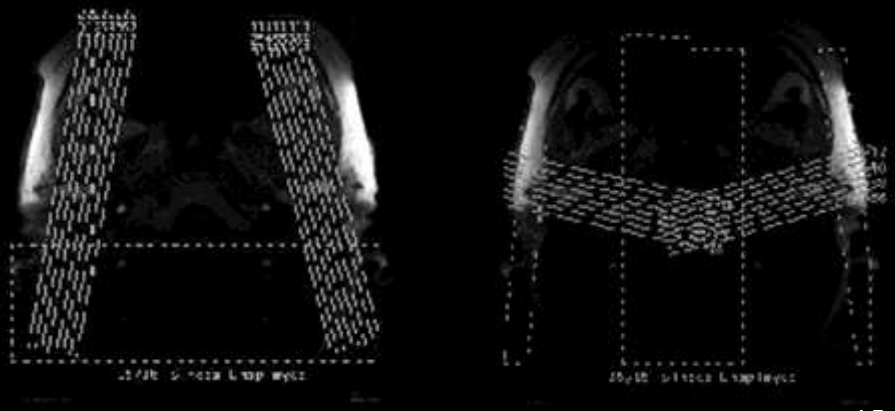
Anatomy - CT

Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII85.

IMAGING - MRI

- Correction for angulation of the mandibular head
- Oblique sagittal and oblique coronal images
- Dual surface coil technique to image the left and right TMJs simultaneously reduces imaging time.
- Body coil is used as the transmitter and the surface coils as the receivers





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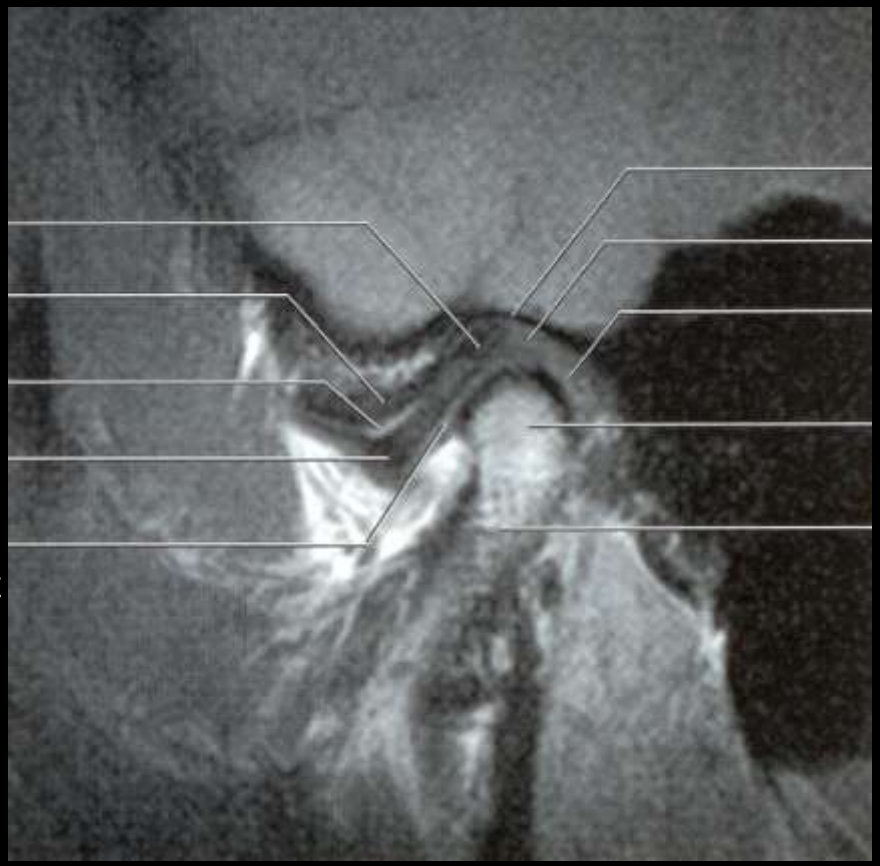
MRI imaging protocols

Coil	Circular polarized transmit-receive TMJ coil; dual-coil technique
Patient position	Supine
Sagittal PDW sequence (closed and open jaw)	TR msec/TE msec = 2,800/15, 210 x 256 matrix, FOV = 145 mm, section thickness = 3 mm
Sagittal STIR sequence (closed jaw)	4,240/30, TI = 150 msec, 224 x 256 matrix, FOV = 145 mm, section thickness = 3 mm
Coronal PDW sequence (closed and open jaw)	2,100/15, 182 x 256 matrix, FOV = 125 mm, section thickness = 3 mm
Coronal STIR sequence (closed jaw)	4,240/30, TI = 150 msec, 182 x 256 matrix, FOV = 145 mm, section thickness = 3 mm

- Alternatives
  - Substitute Coronal PD for T1
  - HASTE dynamic imaging
- Post-contrast imaging for a routine exam is not recommended
  - May be helpful in detecting synovitis, pannus.

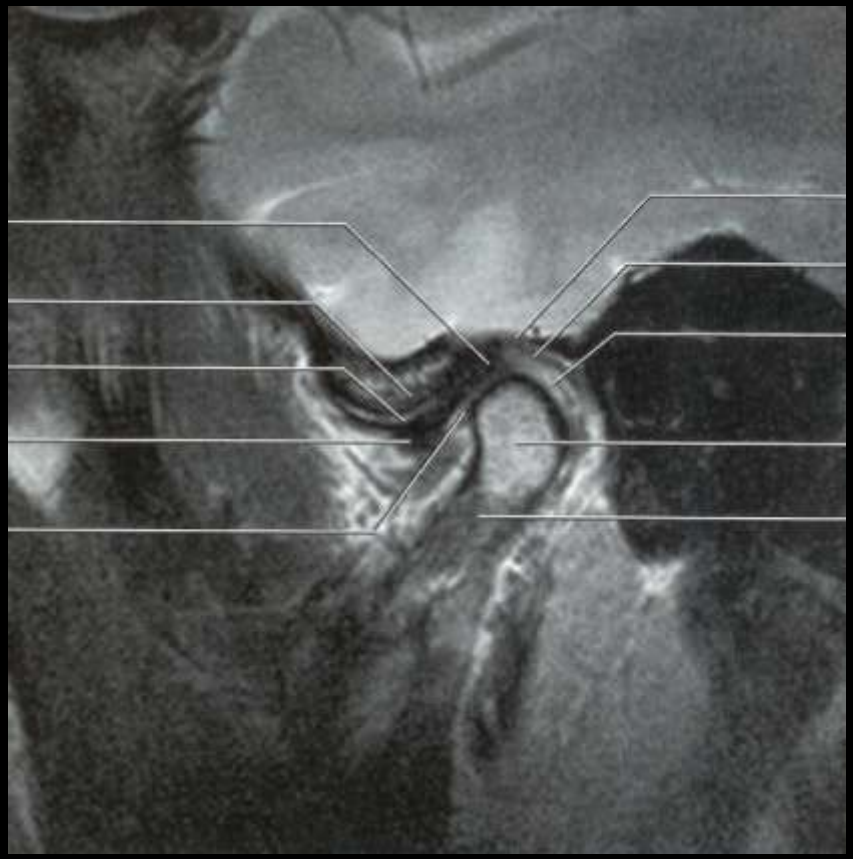
Sommer et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

T1 MRI Anatomy – Closed mouth



Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII86.

T2 MRI Anatomy – Closed mouth



Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII87.

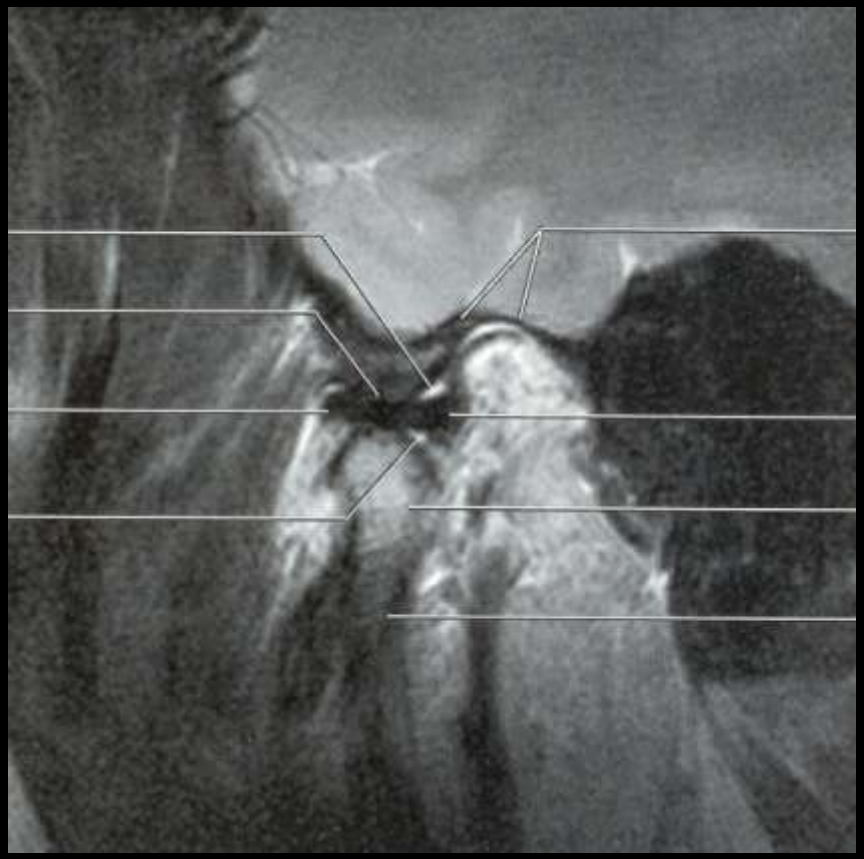
Open mouth

No, not my baby

T1 MRI Anatomy – Open mouth

Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII86.

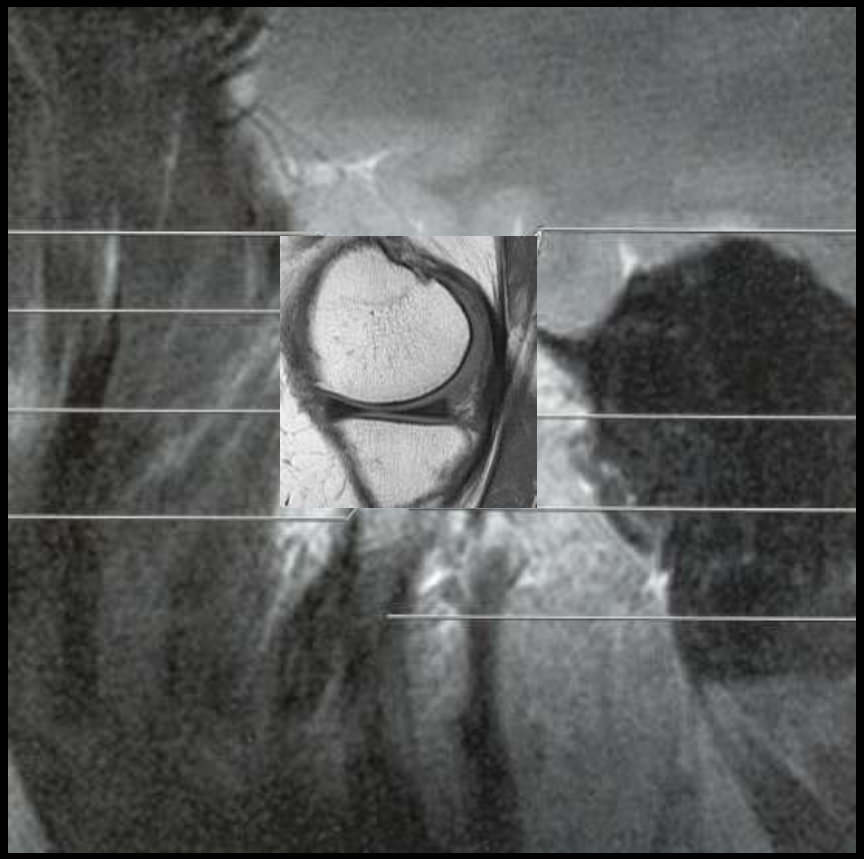
T2 MRI Anatomy – Open mouth



Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII87.

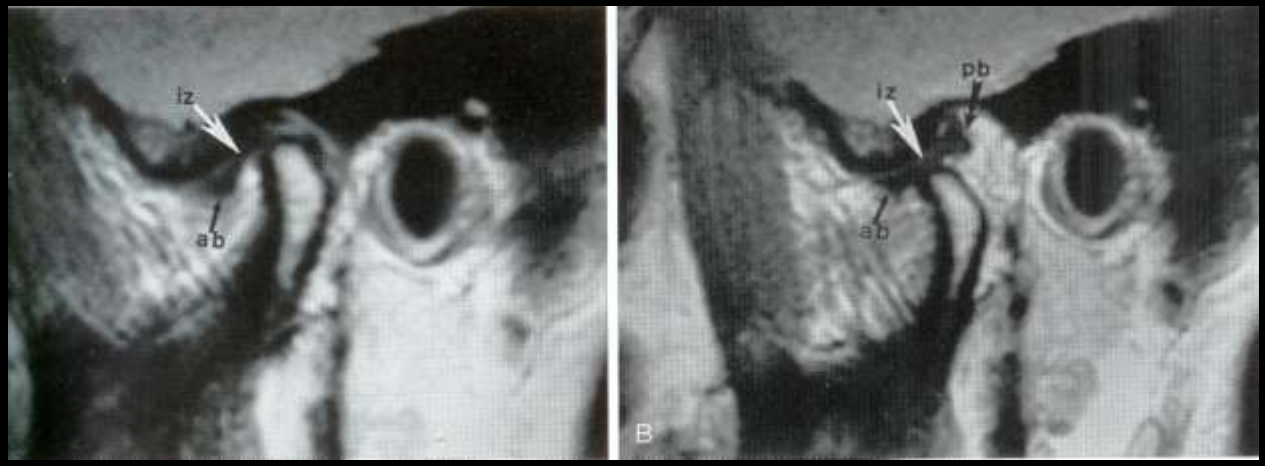
T2 MRI Anatomy – Open mouth

The “Knee joint”



Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII87.

Normal MRI open and closed mouth

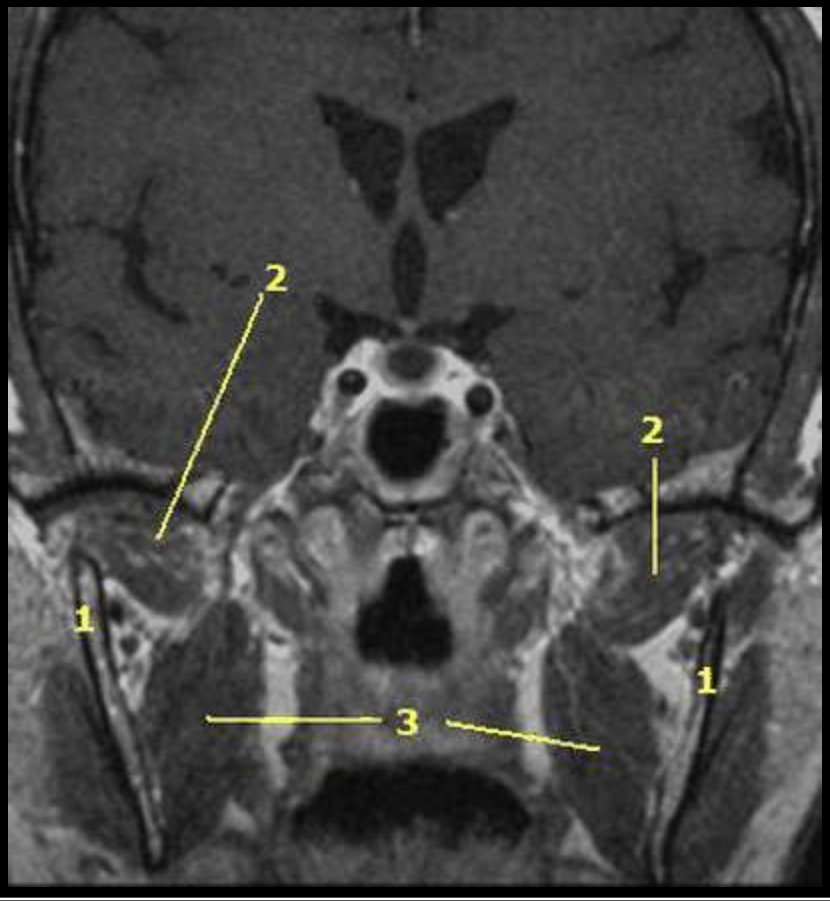


Coronal MRI T1

- Normal crescent-shaped disk

MRI Anatomy - Coronal

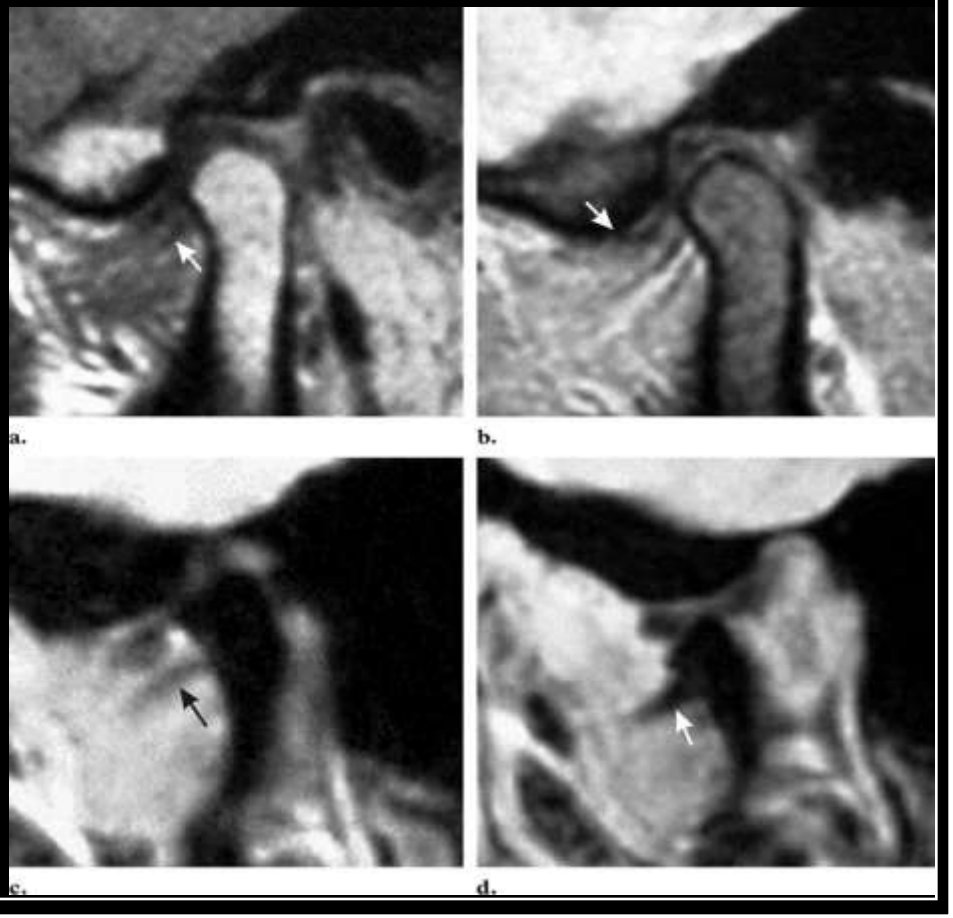
- 1 – Mandibular ramus
- 2 – Lateral pterygoid muscle
- 3 – Medial pterygoid muscle



Sommer OJ, Aigner F, Rudisch A, Gruber H, Fritsch H, Millesi W and Stiskal M. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

MRI Anatomy - Normal lateral ptygeroid attachments.

- Attachments of the LPM are normally thin.
  - A – Inferior LPM attachment.
  - B – Superior LPM attachement.
  - C - Inferior LPM attachment.
  - D - Inferior LPM attachment (open mouth). Thicker due to muscle contraction.



PATHOLOGY

- Disk location is extremely important because a displaced disk is a critical sign of TMJ dysfunction.
- The most frequent cause of TMJ dysfunction is Internal Derangement.

INTERNAL DERRANGEMENT

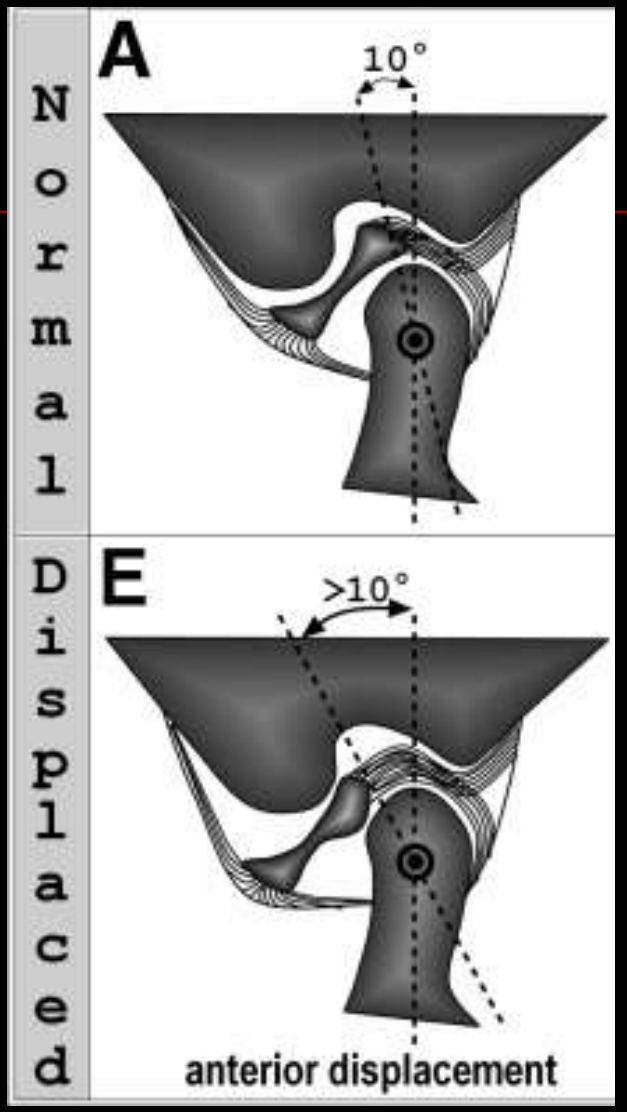
- Internal derangement of the TMJ is a specific term defined as the abnormal positional and functional relationship between the disk and the articulating surfaces.
- Displacement may be partial or complete
- Most common displacement is
  - Anterior
  - Anterolateral
  - Anteromedial
- Other displacement (10%)
  - Medial
  - Lateral
  - Posterior (rare)

Internal Derrangement

- The combination of two types of displacement (anterolateral) has been referred to as rotational displacement.
- Pure lateral or medial displacement has been referred to as sideways displacement
- In partial disk displacement, the lateral disk is displaced anteriorly and the more medial part is still in a normal superior position.

What is disk displacement???

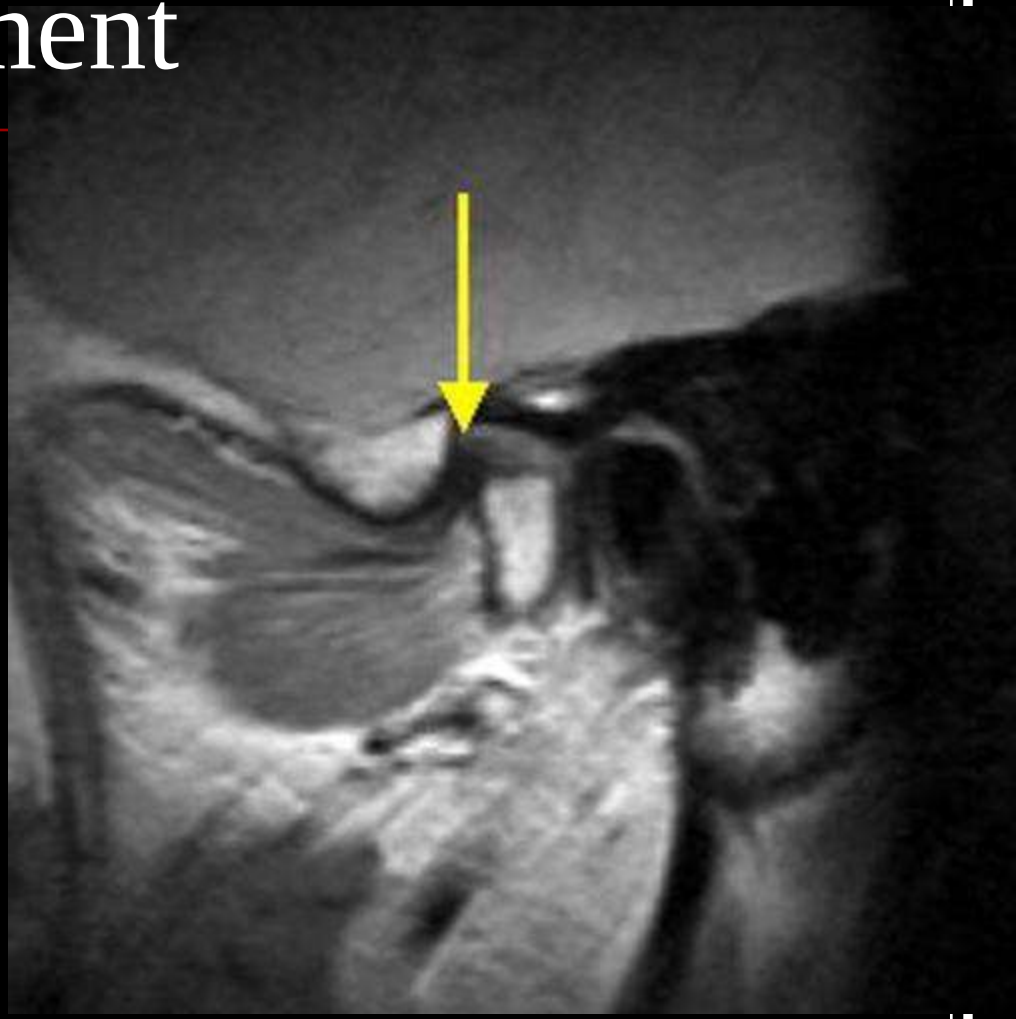
- The junction of the posterior band and the bilaminar zone should fall within 10 degrees of vertical to be within the 95th percentile of normal (closed mouth).
- Controversy
  - Tallents et al and Katzberg et al. demonstrated that a large number (~33%) of asymptomatic volunteers may exceed 10 degrees.
  - Rammelsberg et al suggested that disk displacement up to 30 degrees could be considered normal. Correlation with symptoms may be more useful.
  - Helms and Kaplan use the intermediate zone as reference (position between the condyle and temporal bone). This does not take in account the position of the posterior band.



Molinari et al. Sem Ultrasound, CT, and MRI. 2007; 28(3):192-204.

Partial displacement

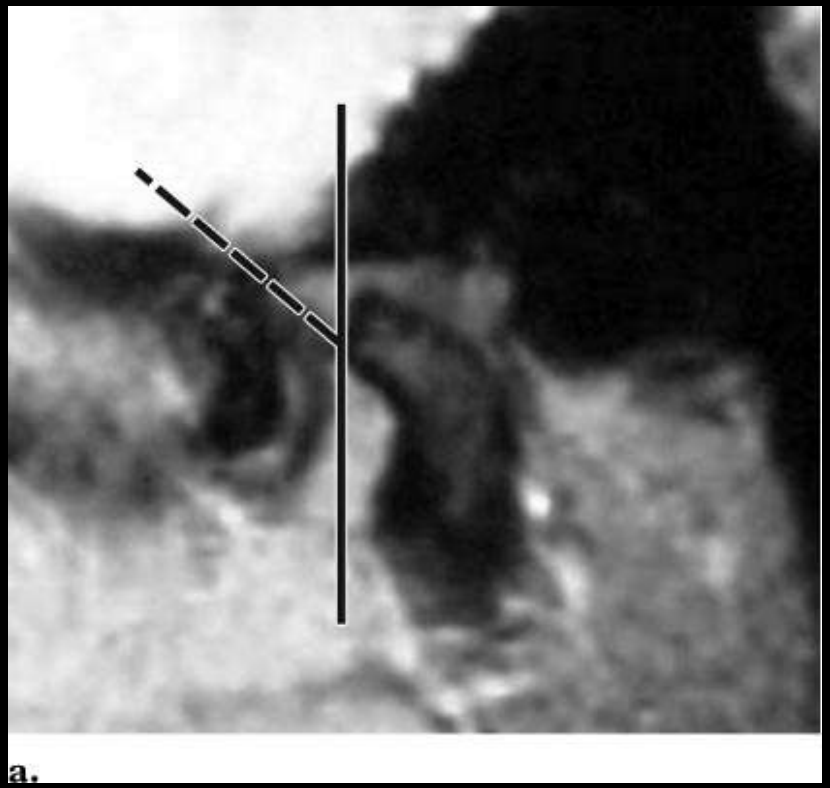
- Closed jaw
- Posterior band at the 10 O'clock position
- Partial disk anterior displacement.



Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

Complete anterior disk displacement – closed jaw

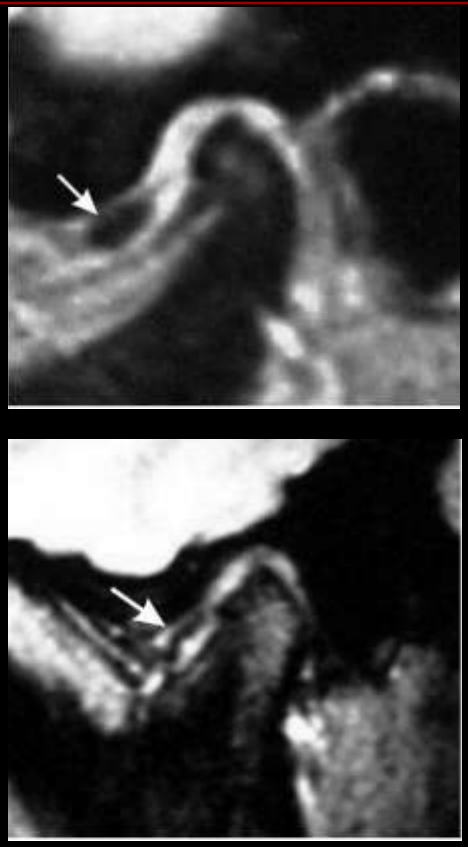
- Angle between the posterior band (dashed line) and the vertical solid line is 50 degrees



Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Complete anterior disk displacment with associated abnormal disk shape.

- Closed position
- Top – Complete anterior displacement with a rounded disk
- Bottom – Complete anterior displacement with irregularity and flattening of the disk. Condyle irregularity.



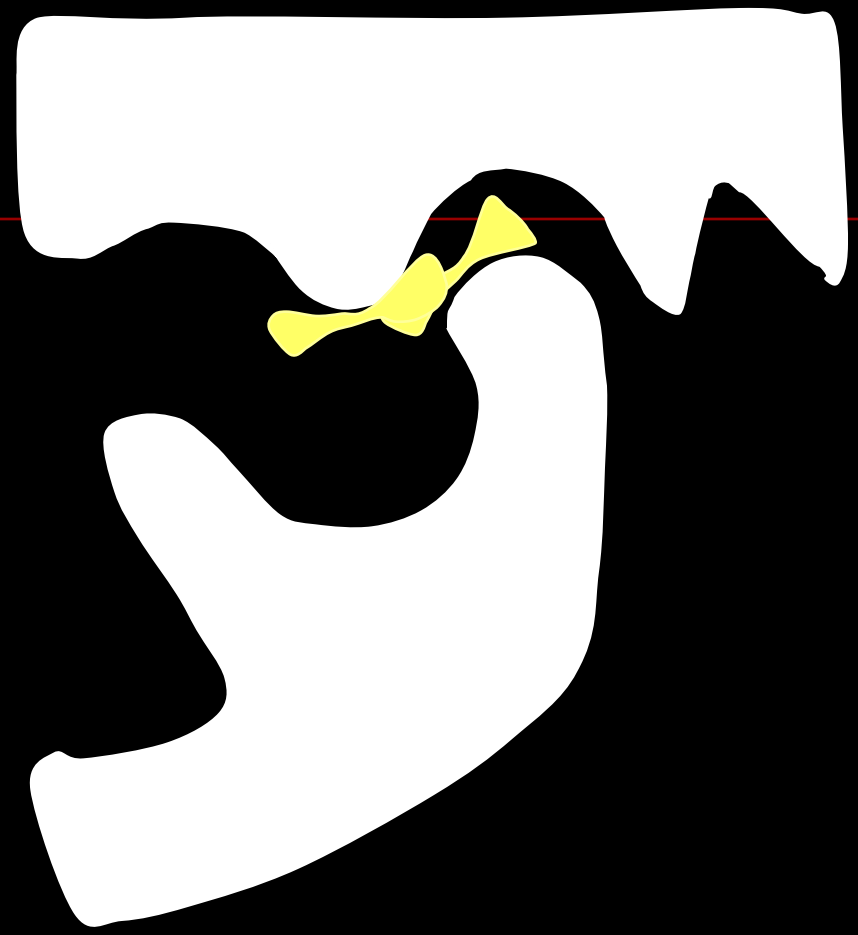
Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Functional aspects of displacement

- What happens to an anteriorly displaced disk during mouth opening?

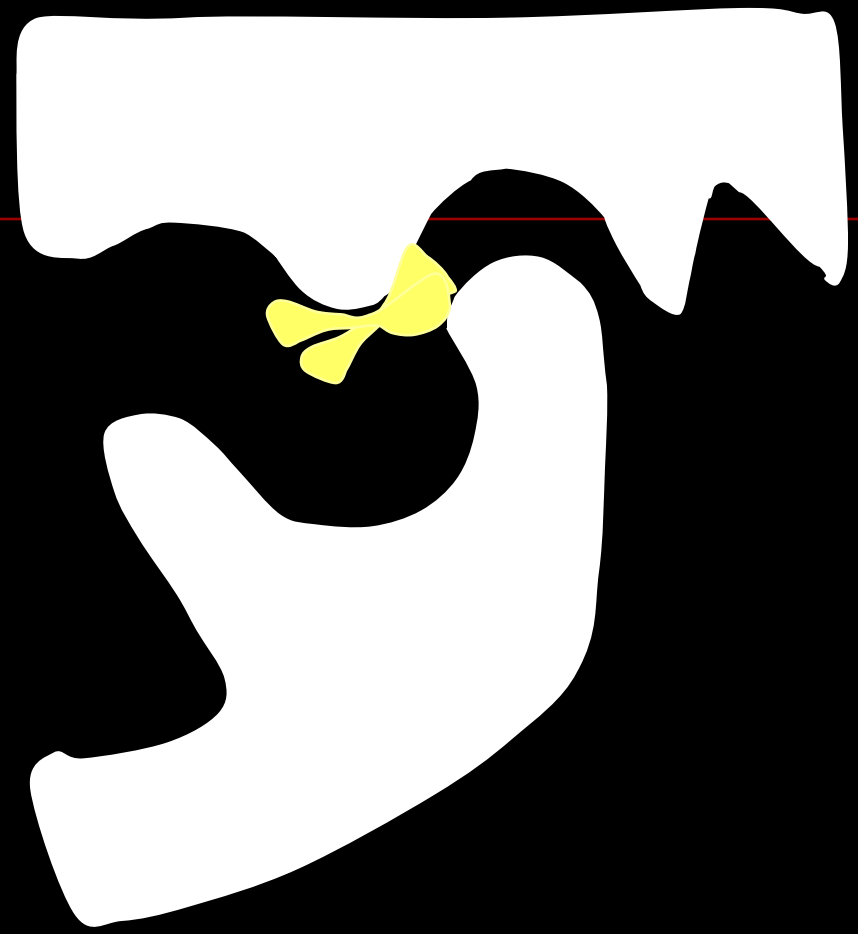
Functional aspects of displacement

- There are 2 different possibilities:
  - Disk displacement with reduction
  - Disk displacement without reduction



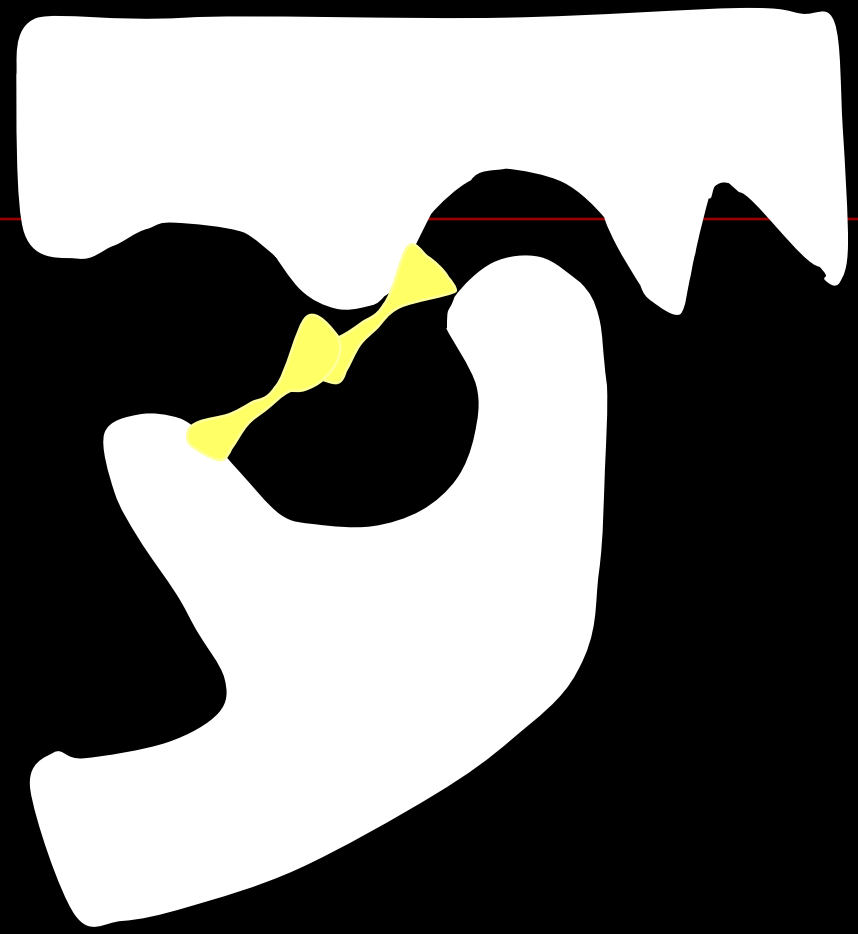
Normal Translation

Courtsy of Rosalyn Cheng



Anterior disk displacement with reduction

Courtsy of Rosalyn Cheng



Anterior disk displacement WITHOUT reduction

Courtsy of Rosalyn Cheng

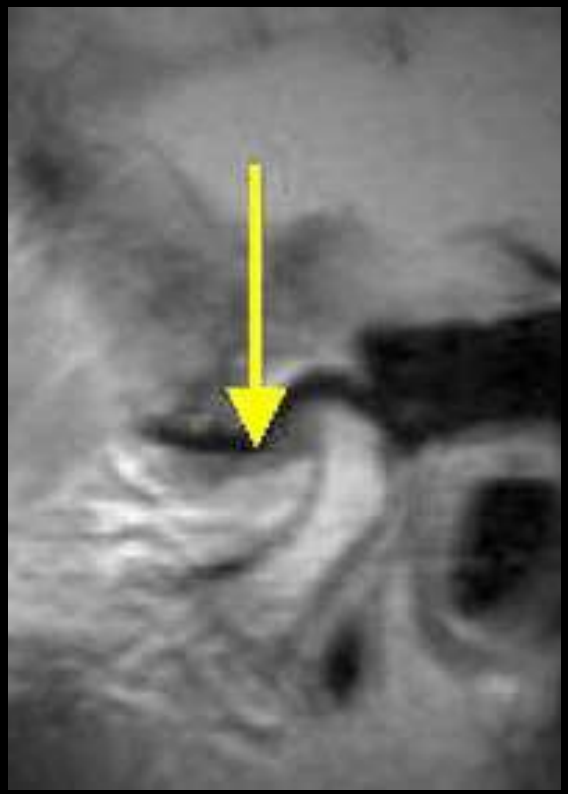
Functional aspects of displacement

- There are 2 different possibilities:
  - Disk displacement with reduction
  - Disk displacement without reduction
- Important because lack of reduction indicates progressive TMJ dysfunction.
- A displaced disk reduction usually causes a “Click” with opening and closing.
- A disk that does not reduce, jaw opening is typically limited. The jaw deviates to the affected side in the early stage.
- Later stage there is stretching of the posterior disk attachment.

Recapture (reduction) of disk displacement

- Seen in early TMJ disease
- Usually seen with normal morphology of the disk

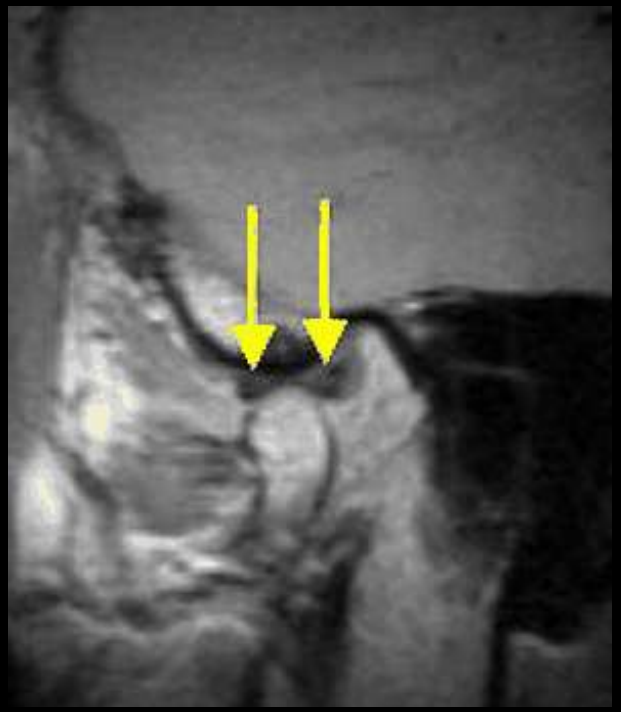
Closed jaw – Anterior disk displacement.



Normal disk morphology

Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

Open jaw - Recapture

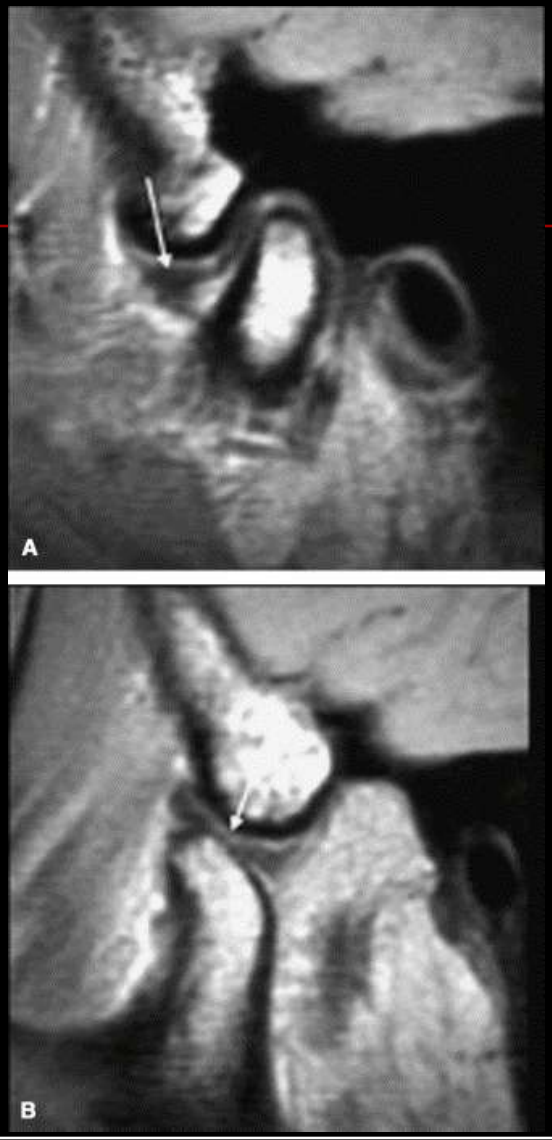


Normal open mouth exam

Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

Additional example

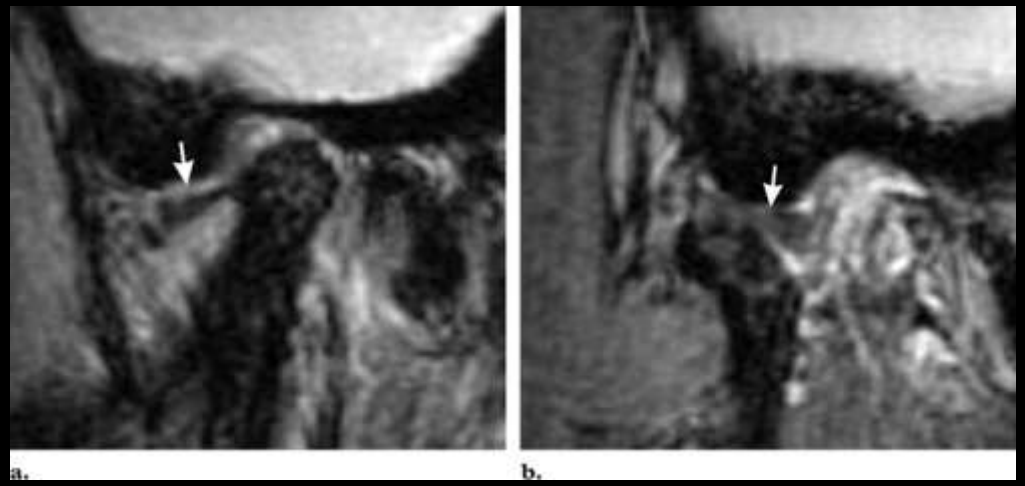
- Anterior disk displacement with recapture



Sano et al. Current problems in Diagnostic Radiology 2004; 33(1): 16-24.

Additional example. Anterior disk displacement with reduction

- Reduction commonly produces an audible click.



Click

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Anterior disk displacement without reduction

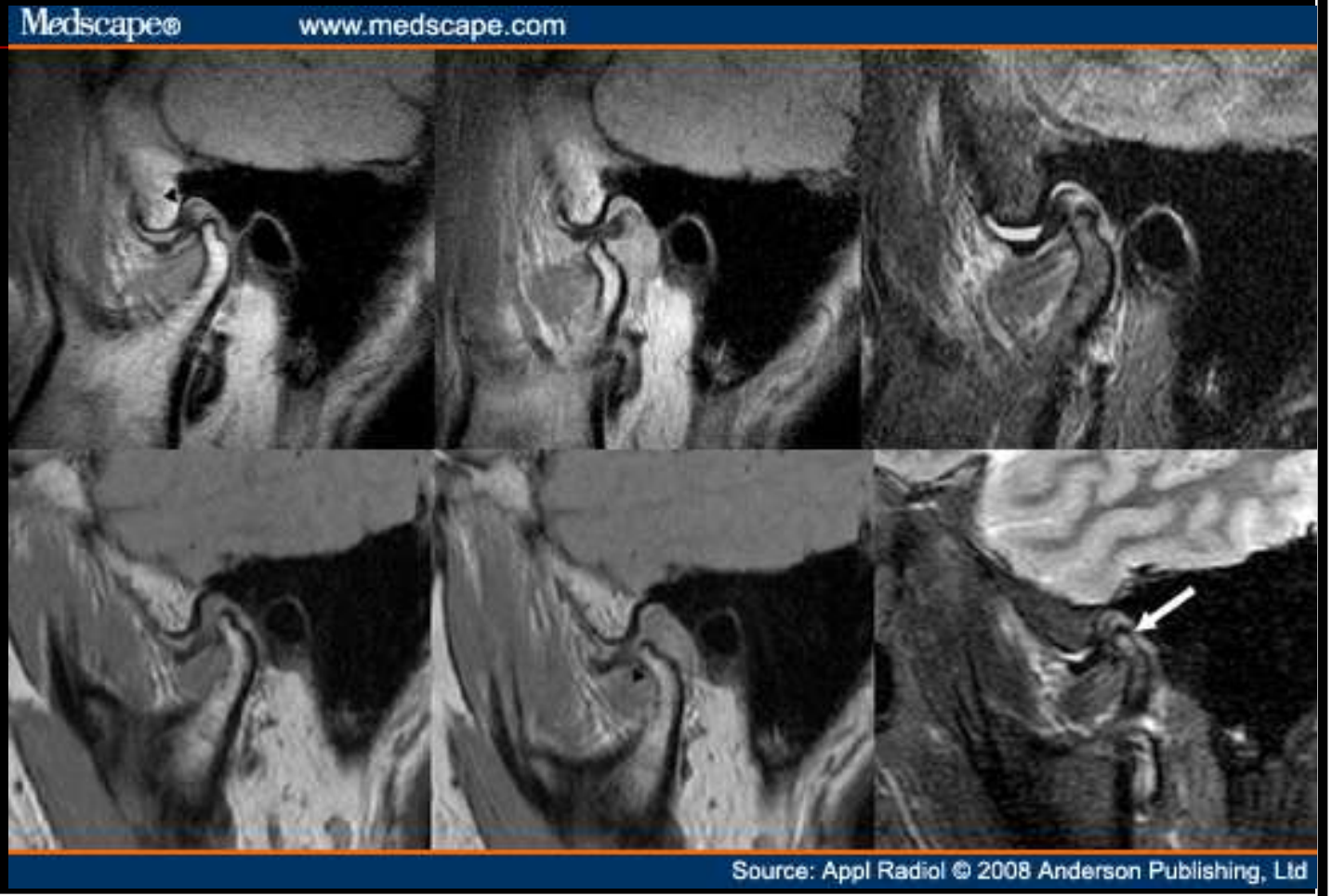
- Progressive disease leads to disk displacement WITHOUT reduction.

Harms SE, Wilk RM. Magnetic Resonance Imaging of the Temporomandibular Joint. *Radiographics*. Vol 7, Num 3, May 1987 pp 512 – 542.

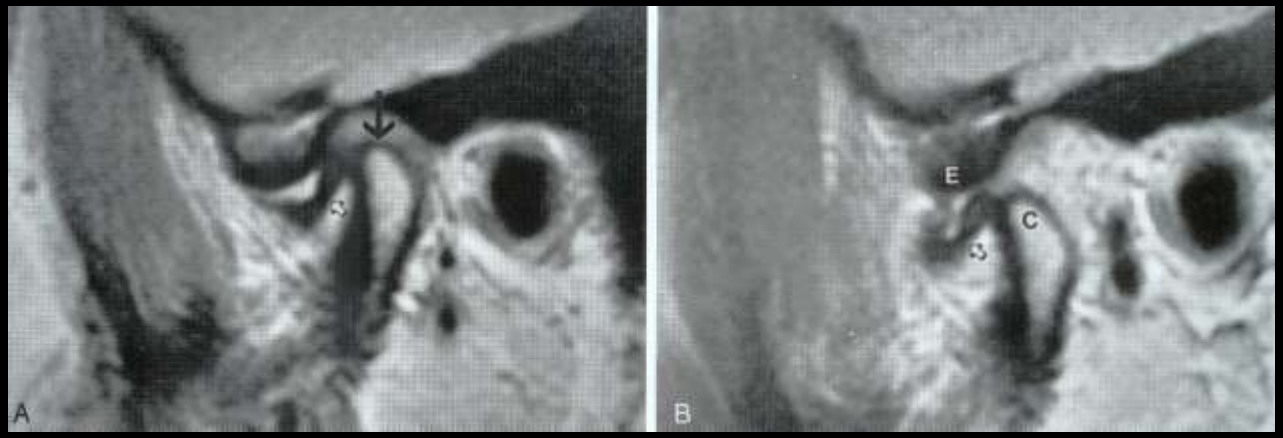
Progression of TMJ disease

Recapture

No Recapture

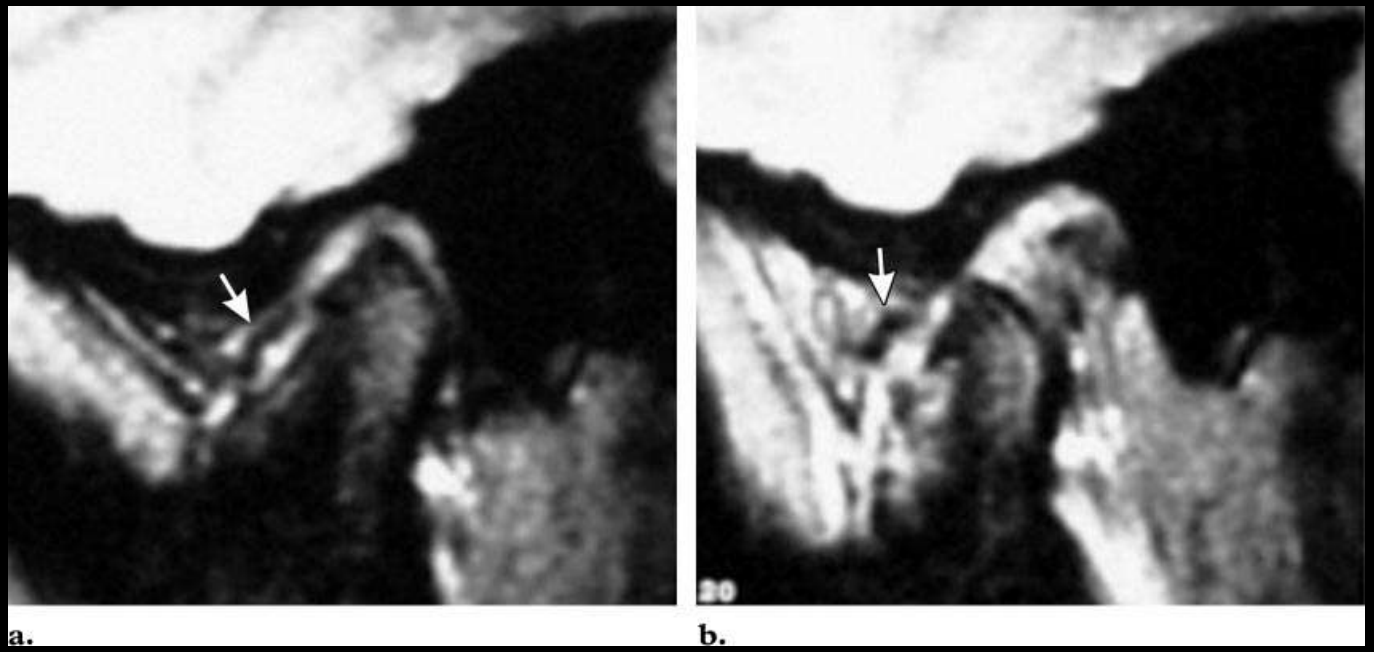


Anterior disk displacement without recapture – Early disease



- Early disease has a normal disk shape

Anterior displacement without recapture – Late disease



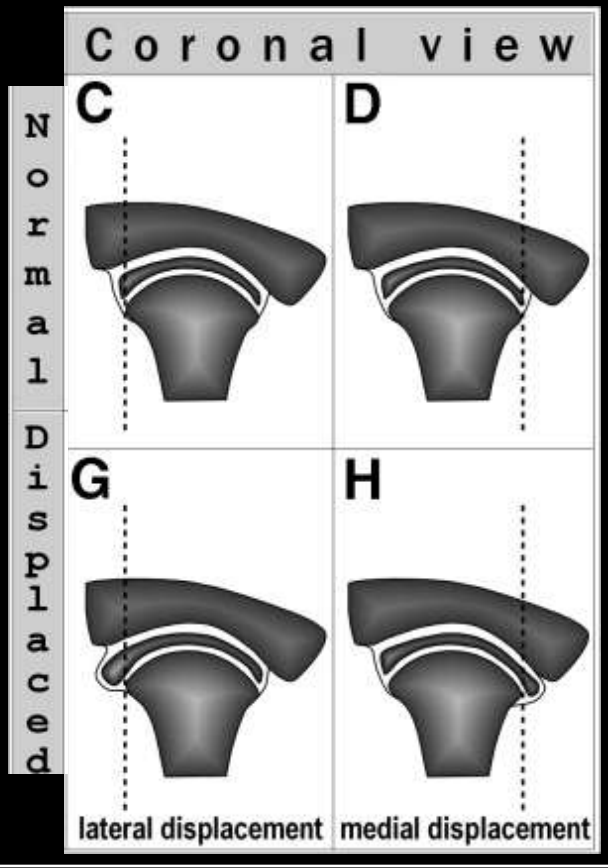
- More typical case of displacement with a morphologically deformed disk and evidence for osteoarthrosis of the condyle.
- Usually not associated with noise.

Tomas X, Pomes J. Articulacion temporomandibular. In: Mercader JM, Vinuela F, eds. Neurorradiologıa diagnostica y terapeutica. Barcelona, Spain: Masson, 2004; 403–408.

Other types of displacement

Medial and lateral disk displacement

- Disk projecting outside of the condyle margin is abnormal.

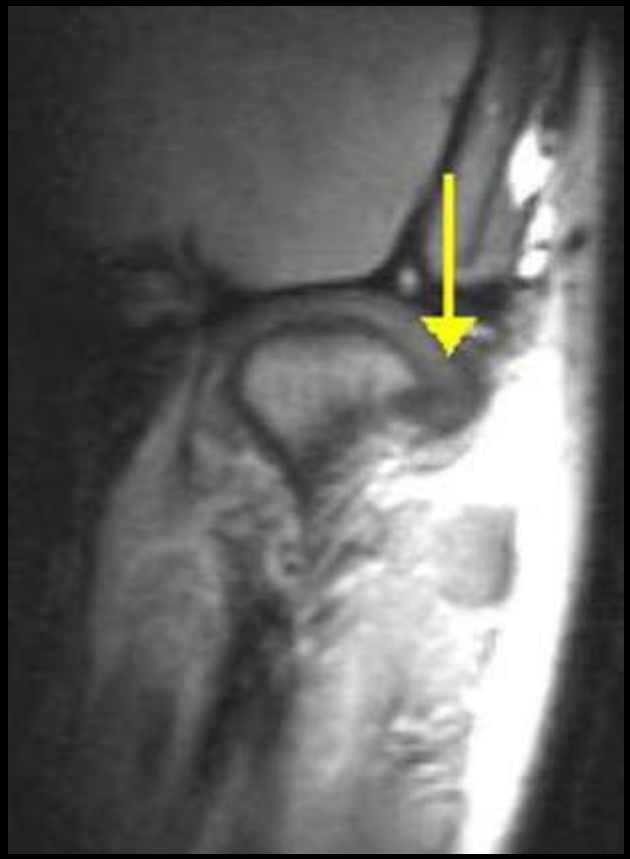


Molinari et al. Sem Ultrasound, CT, and MRI. 2007; 28(3):192-204.

Slight medial disc displacement

Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

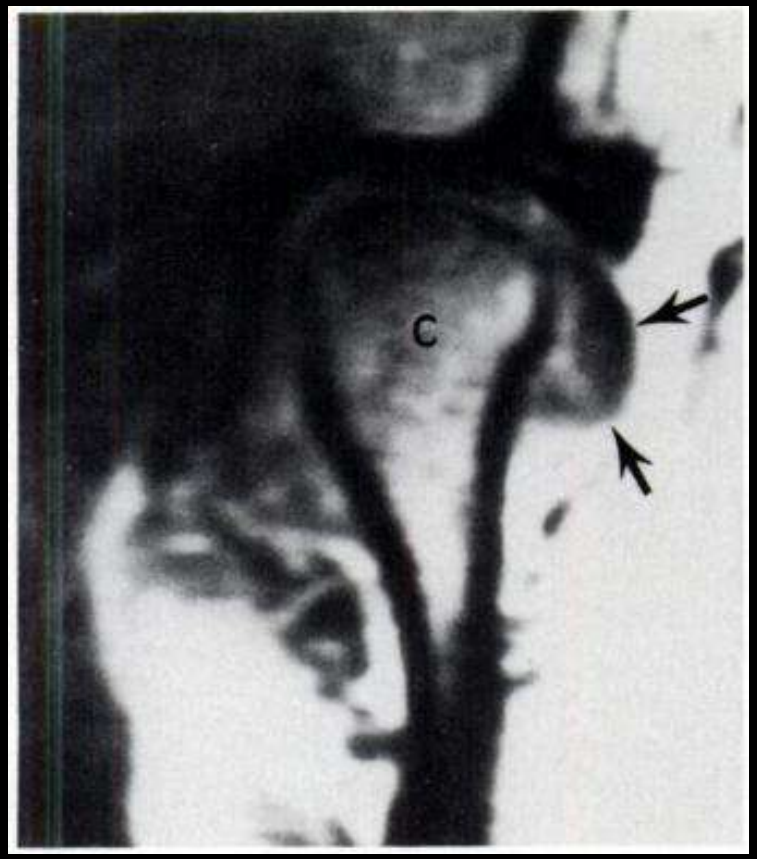
Slight lateral disk displacement



Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

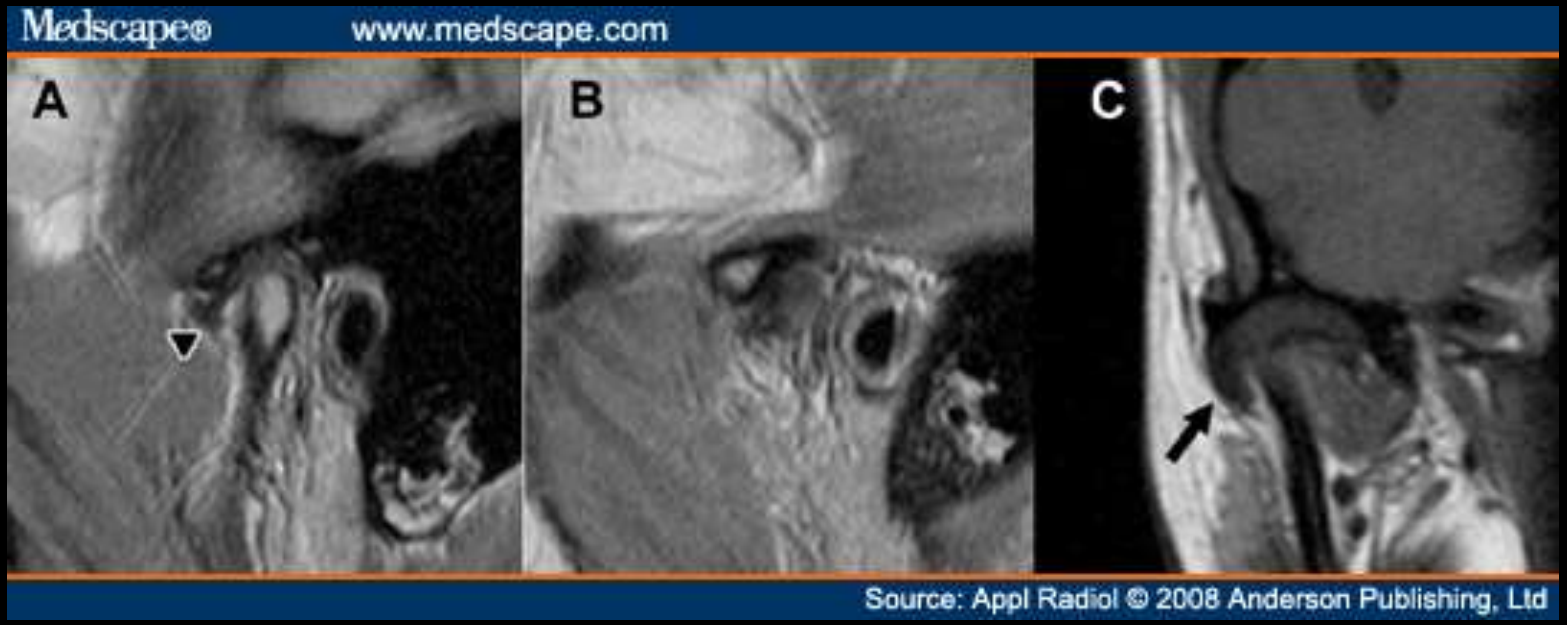
Lateral disk displacement

Lateral Disk displacement



Katzberg et al. Temporomandibular Joint: MR Assessment of Rotational and Sideways Disk Displacements. Radiology 1988; 169:741-748.

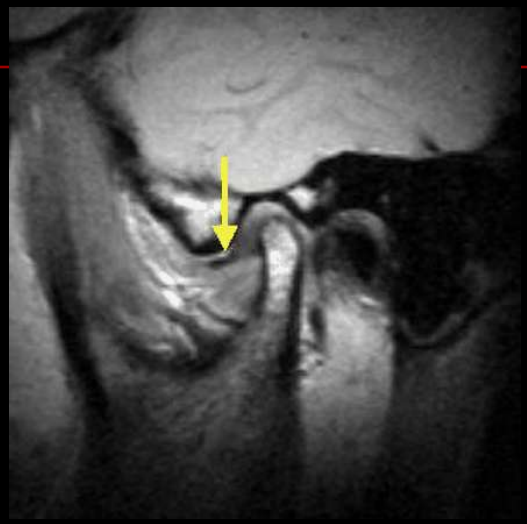
Multidirectional disk displacement - Anterolateral dislocation



- A – Sag T1 anterior disk dislocation with abnormal bulging of the anterior band and ill-definition of the posterior band
- B – More lateral image demonstrates ill-defined hypointense tissue
- C – Demonstrates lateral disk dislocation

Anterolateral diaplacement

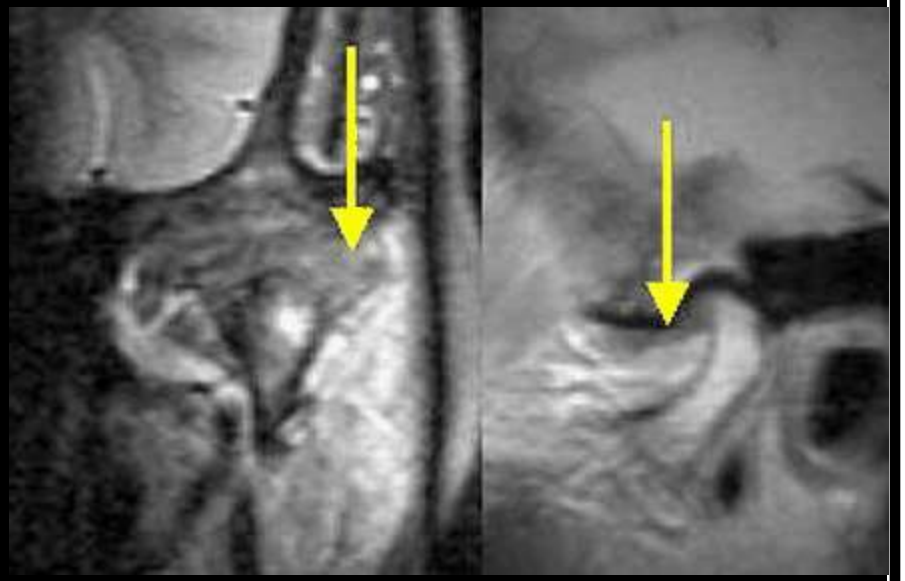
- Closed jaw position
- Top image: anterior disk displacement
  - Deformed disk
- Bottom image: Lateral component of disk displacement
  - Line = lateral condylar contour



Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

Anterolateral disk displacement

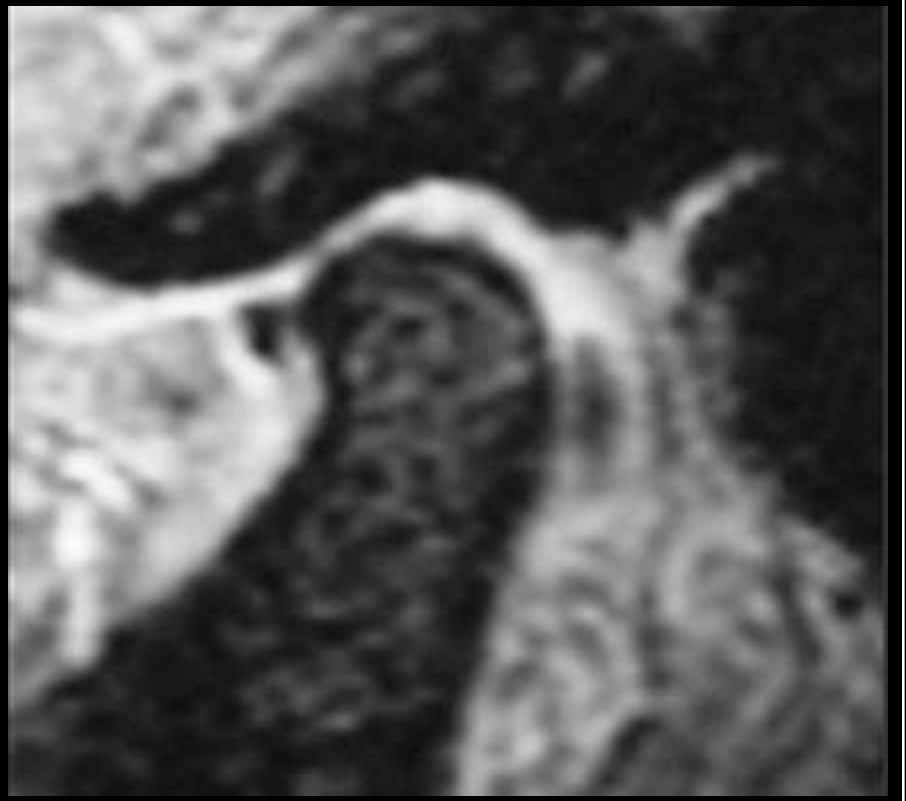
- Jaw closed position
- Coronal: Lateral bulging of the disk
- Sagittal: Anterior displacement



Sommer, OJ et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics 2003;23:14

Posterior disk displacment

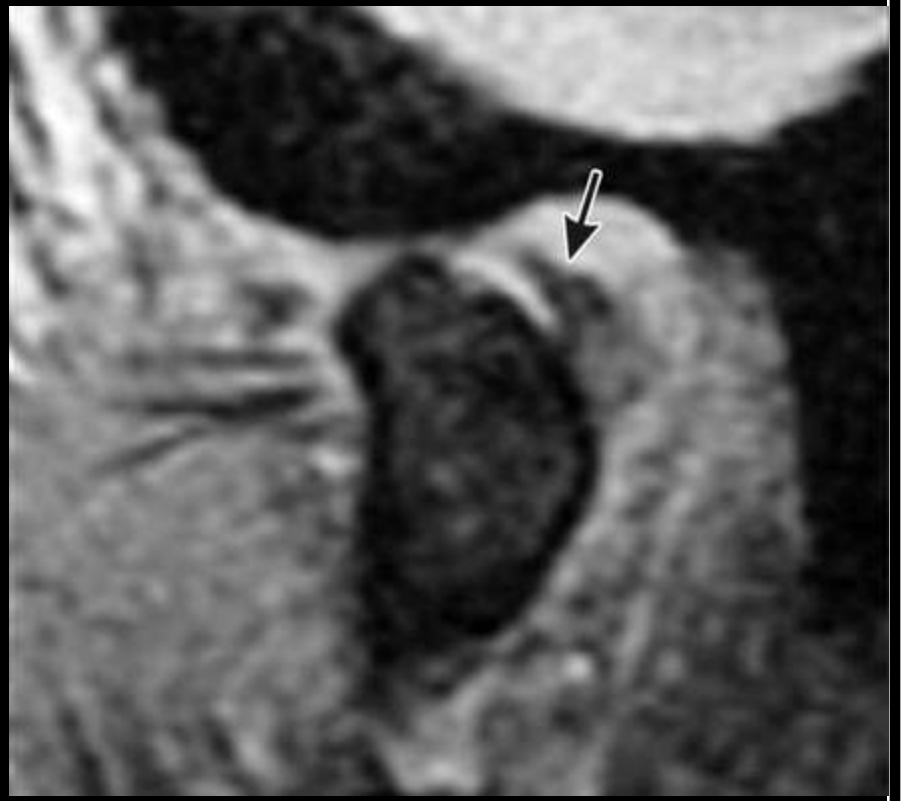
- Rare
- Accounts for 0.01 – 0.001% of all TMJ disorders.
- Clinically may present as a jaw locked open
- Closed mouth



Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Posterior disk displacement

- Persistent posterior dislocation in open mouth position.
- Locking of the jaw open in this case.



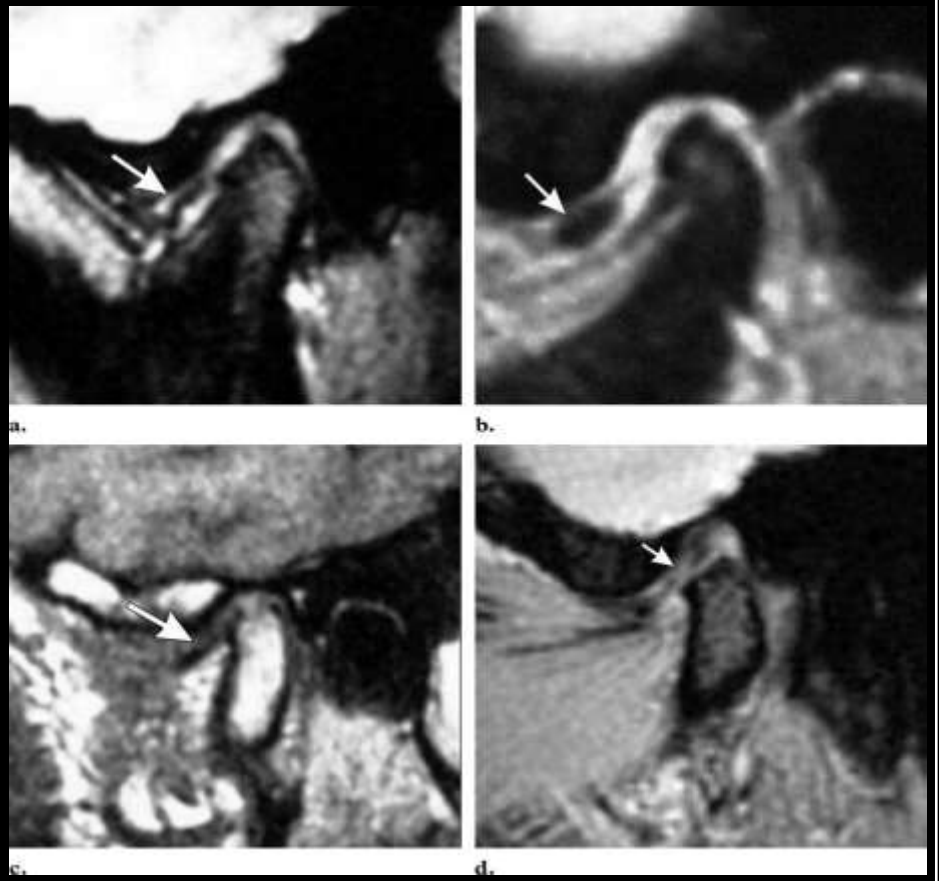
Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Disk deformity

- Early stages of disk displacement the disk remains normal shape
- A displaced disk begins to deform
  - Thickening of the posterior band
  - Shortening of the AP dimension
  - Decreased size of the anterior band and intermediate zone
  - Resulting biconvex disk
  - Elongated and thinned posterior disk attachment.

Abnormal morphologic features of the disk – Late stage disk disease

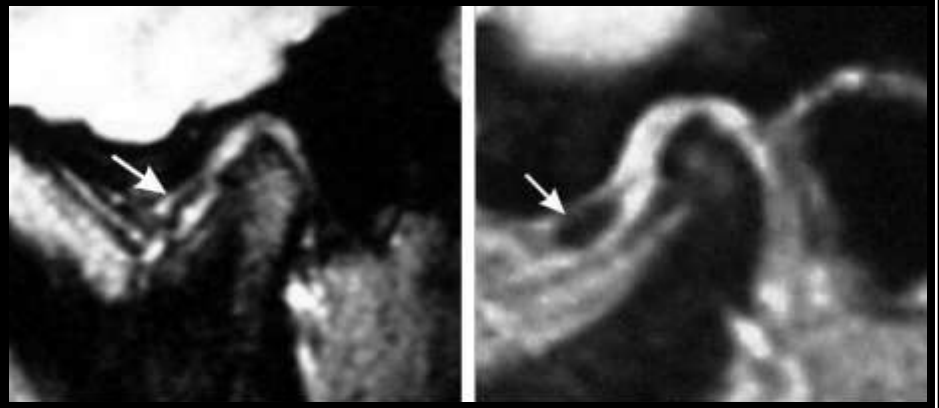
- A – Crumpled irregular
- B – Rounded
- C – Flattened
- D – Intermediate zone perforation



Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

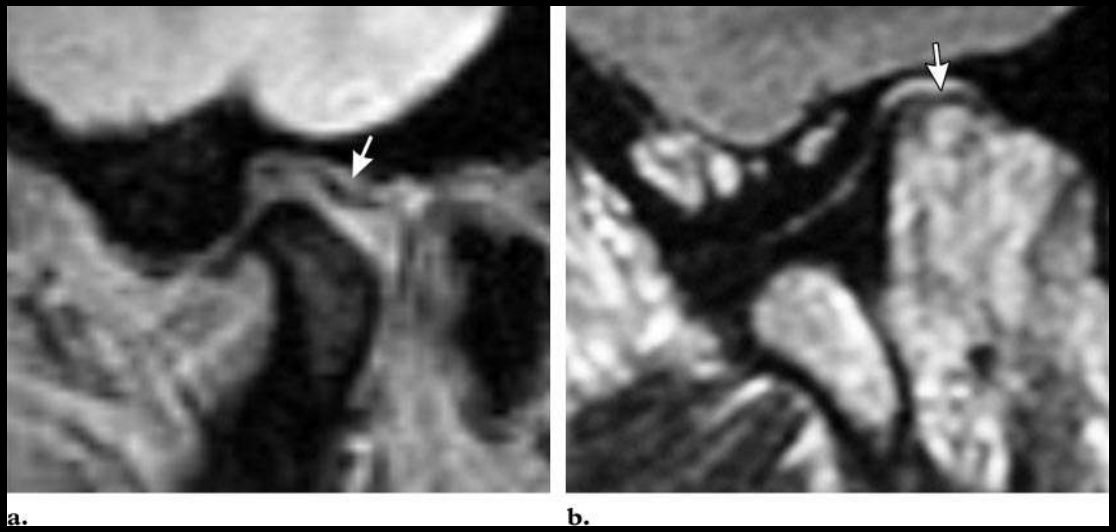
Importance of an abnormal disk morphology

- Disk deformation is significant since it usually cannot be repositioned surgically
- Diskectomy may be necessary



Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

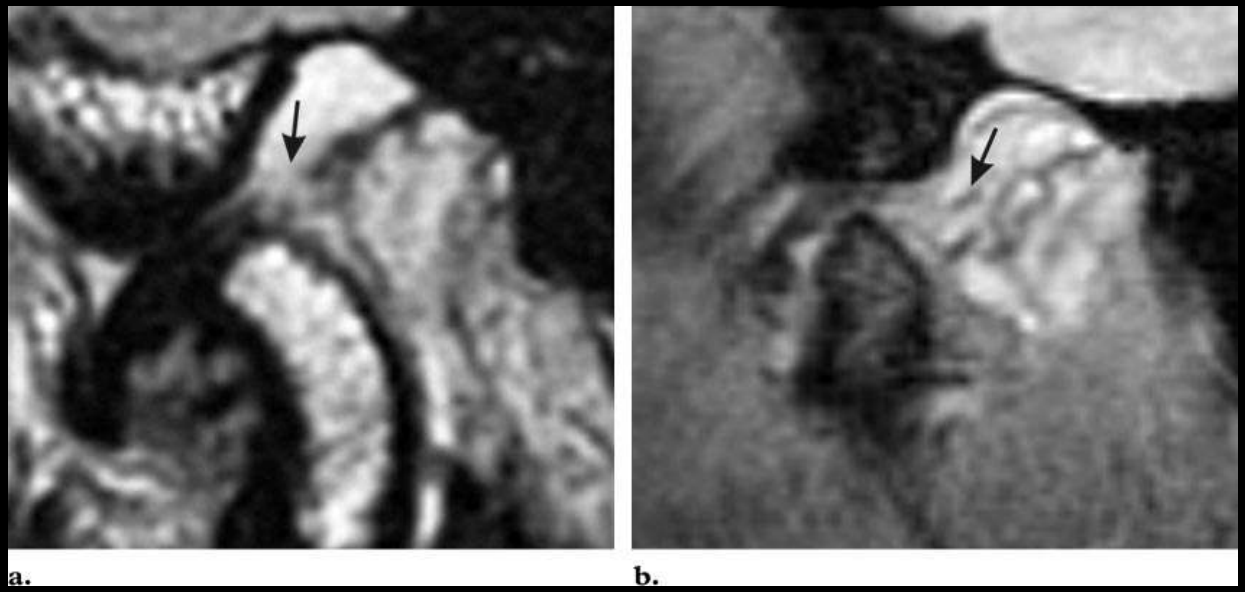
Normal retrodiskal tissue



- A – Closed mouth, Normal retrodiskal tissue
- B – Open mouth, Normal superior retrodiskal tissue

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Superior retrodiskal tissue rupture



- Rupture of the superior retrodiskal layer. Two different patients.

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Wilks grading system

Stage	Description
I	Slight anterior disk displacement, normal disk morphology
II	Slight anterior disk displacement, change in disk configuration, thickening of posterior band
III	Anterior disk displacement, disk deformity and thinning
IV	Progressive disk degeneration, incipient remodeling of the joint
V	Severely deformed disk ± perforation, osteoarthritis (subchondral cysts, osteophytes, flattening of the condylar head)

Wilkes CH. Internal derangements of the temporomandibular joint: pathologic variations. Northwest Dent 1990; 69:25-32.

Vogl and Abolmaali

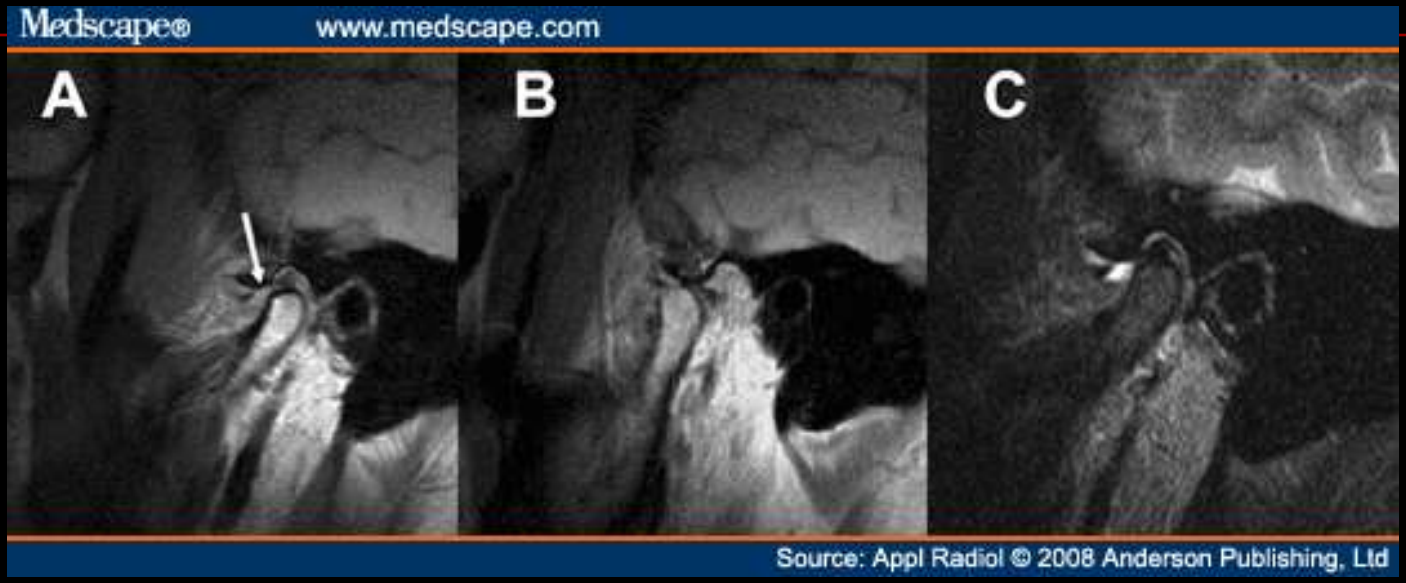
Stage	Description
I	Slight partial disk displacement with recapture
II	Disk displacement with recapture, disk deformity, hyperintensity of the posterior band
III	Disk displacement without recapture, disk deformity and signal intensity change, pterygoid fascia thickening, adhesions
IV	Progressive morphologic and structural changes, osteophytosis
V	Disk rupture and perforation; severe osteoarthritis
VI	Destruction of the mandibular condyle

Vogl TJ, Abolmaali N. MRI of the temporomandibular joint: technique, results, indications. Rofo Fortschr Geb Roentgenstr Neuen Bildgeb Verfahr 2001; 173:969-979

Last day in the bone pit

Additional disk abnormalities

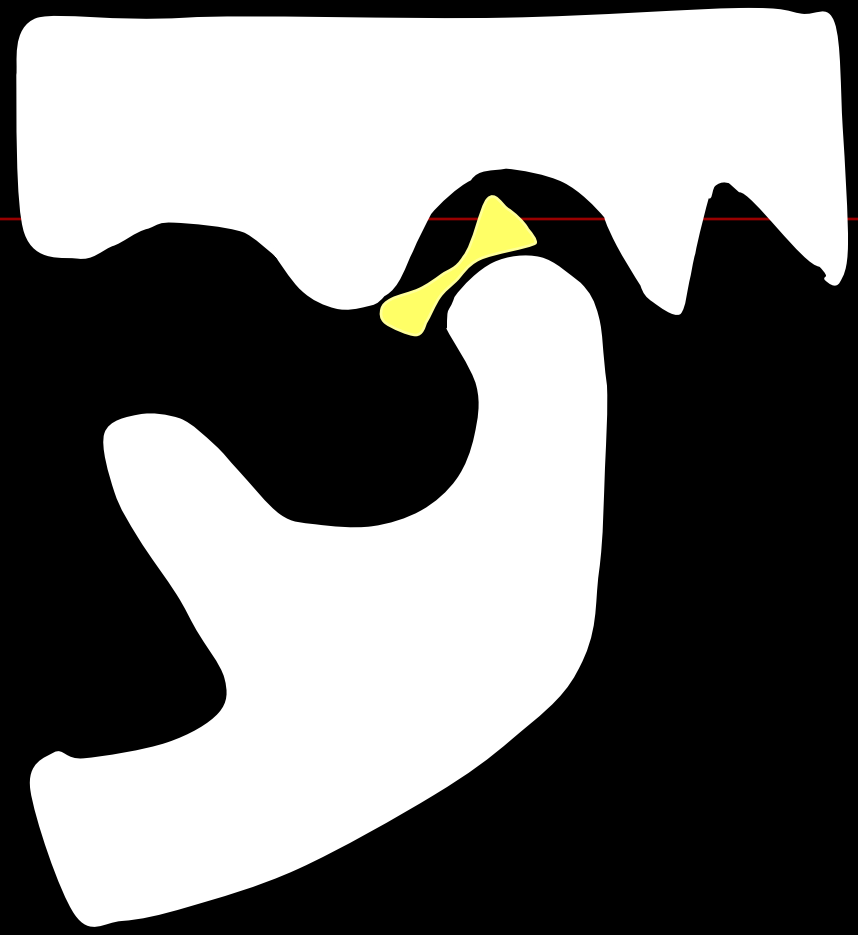
Intermediate zone Disk perforation



- A – Closed mouth
  - Large defect in the expected intermediate zone
- B – Open mouth
  - Condyle filling the defect with direct contact on the articular eminence
- C – STIR
  - Joint effusion and communication of the superior and inferior joint spaces

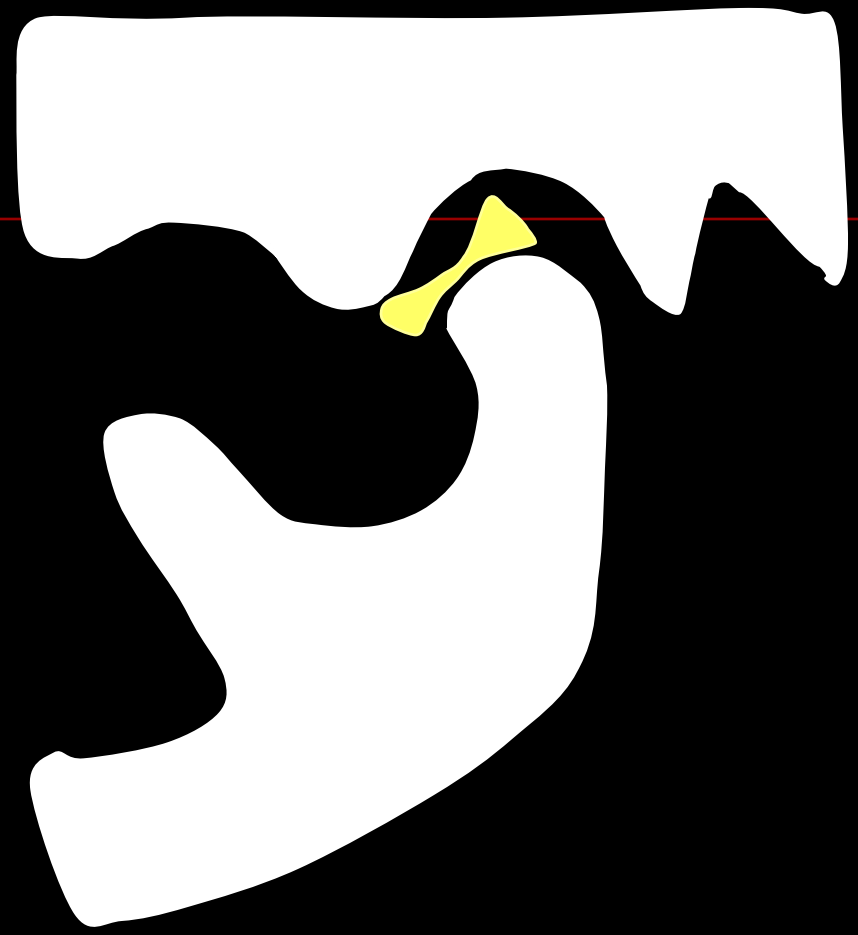
Stuck disk

- Translation of the disk does not occur. Thought to be due to adhesions.
- Significant translation of the condyle in relation to the disk (normally minimal).



Stuck Disk

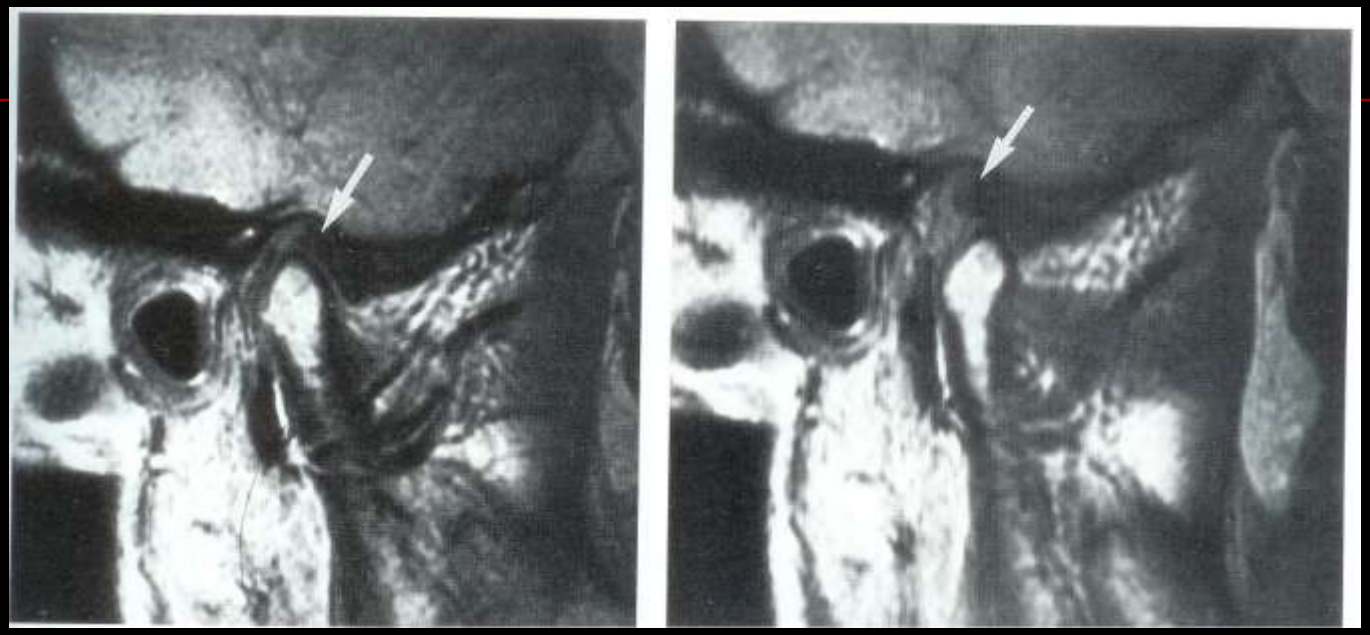
Courtsy of Rosalyn Cheng



Stuck Disk – typically limited opening

Courtsy of Rosalyn Cheng

Stuck disk



- Minimal disk movement
- Limited jaw opening
- Associated with pain and dysfunction

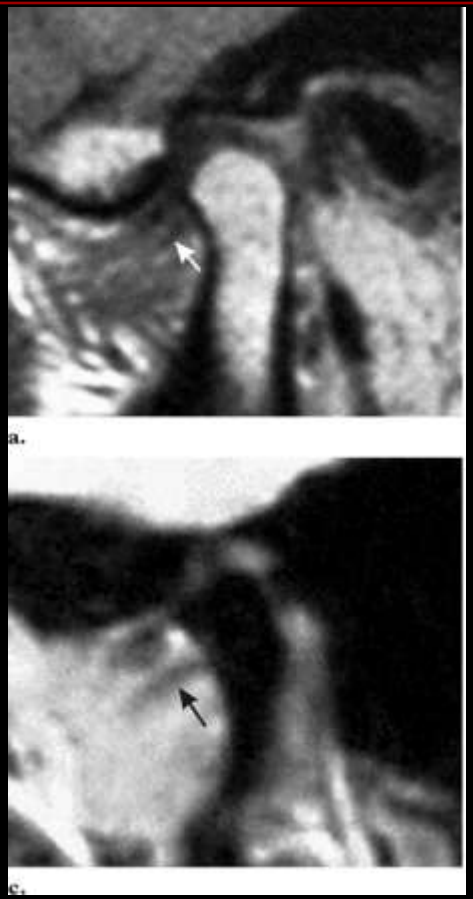
Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Lateral Ptergygoid Muscle (LPM)

- Recent work has stressed the importance of the LPM
- Hypertrophy, atrophy and fibrosis of the LPM have been seen in TMJ dysfunction

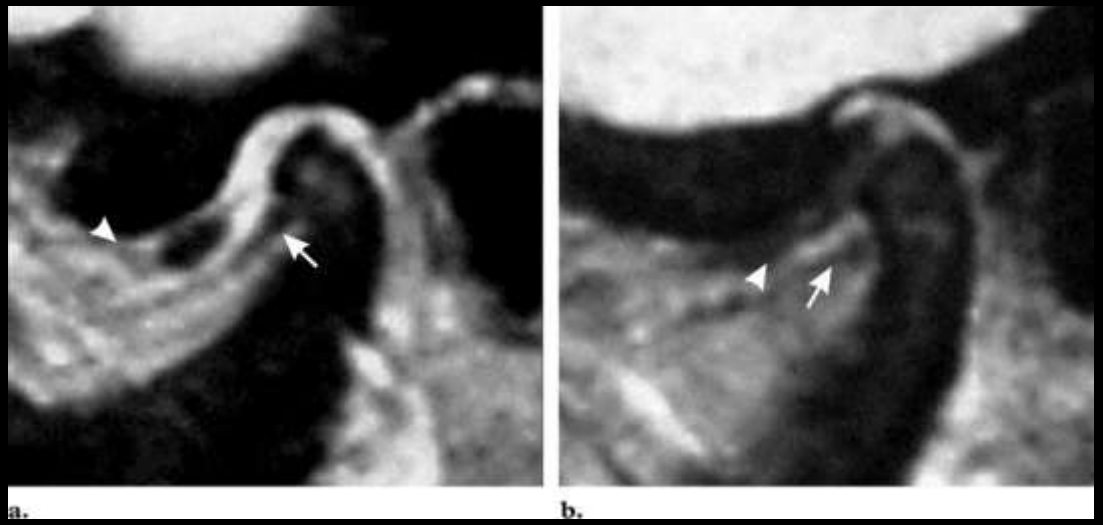
REVIEW Normal lateral ptygeroid attachments.

- Attachments of the LPM are normally thin.



Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

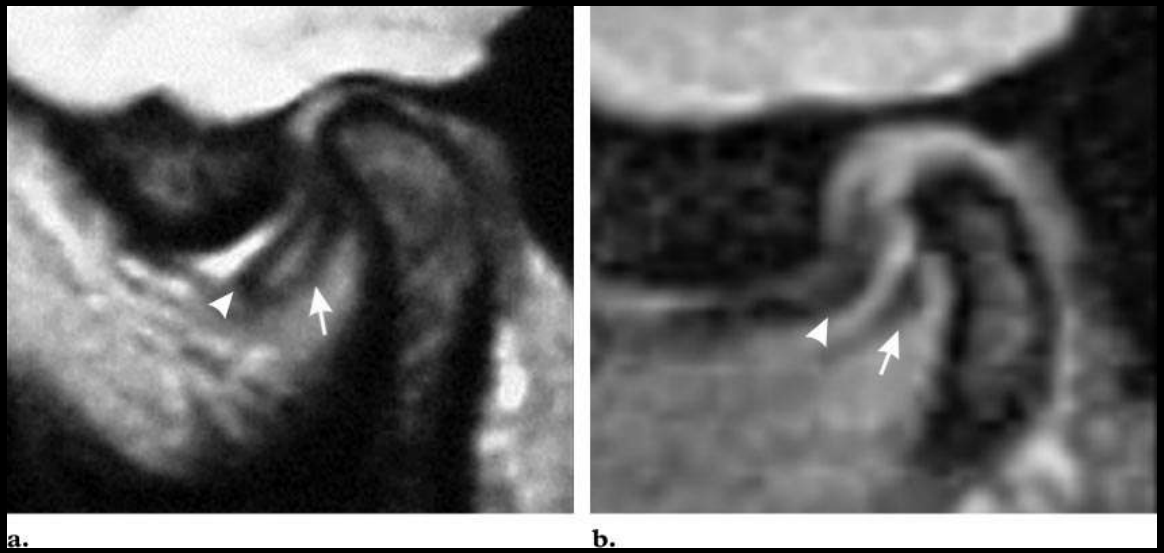
LPM insertion thickening



- A – Symptomatic side: Complete disk displacement with a thickened LPM insertion.
- B – Asymptomatic side: Subtle disk displacement with thinner LPM insertion.
- Progressive thickening of the LPM has been shown to be associated with degree of disk displacement.

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Double disk sign



- A – Complete disk displacement. Thick LPM insertion parallel to the disk simulates a double disk.
- B – Disk displacement and deformity. Thick LPM insertion simulates a double disk.

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Pseudodisk

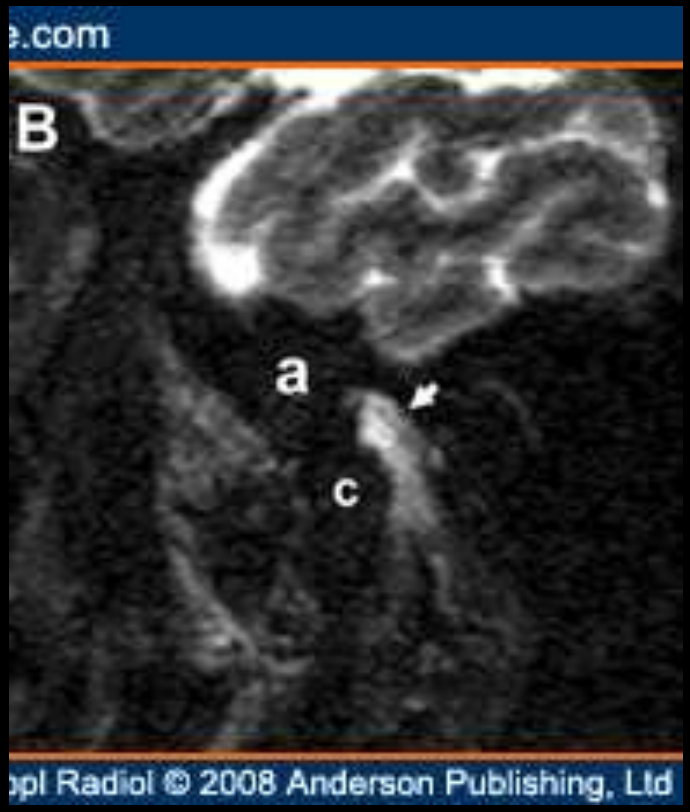
- Histologically thought to represent fibrosis.

Pseudodisk

- Fibrosis of the LPM insertion on to the anterior disk (arrows)
- Low signal intensity replaces the normally bright posterior disk attachment (arrowheads)
  - Posterior fibrosis of the retrodiscal tissue = pseudodisk.

Edema in the retrodiscal soft tissue

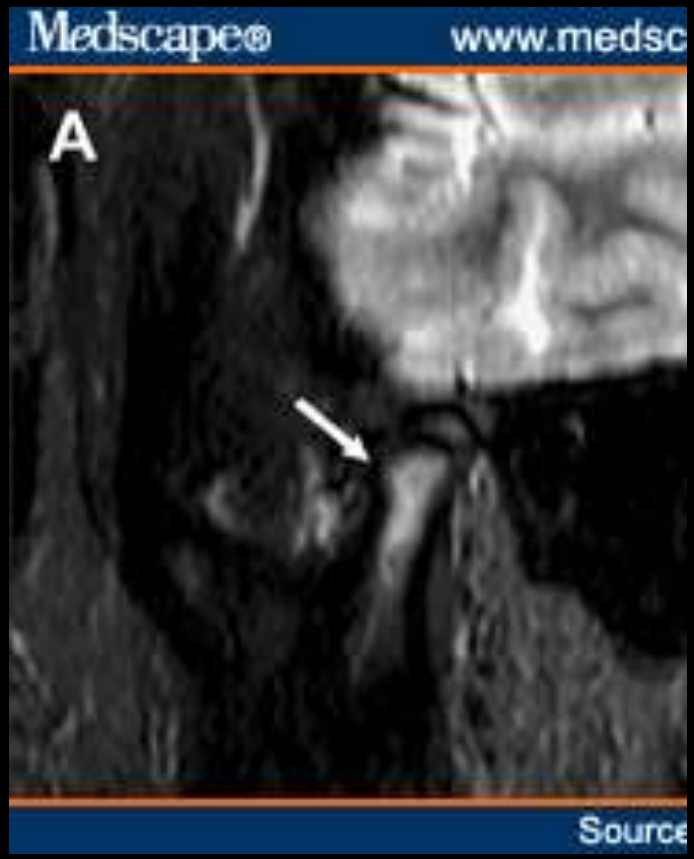
- Sag STIR
  - Increased signal in the retrodiscal tissue
  - a – articular eminence
  - b – condyle
- Often painful.
- Sano et al. describe increased retrodiscal soft tissue in painful joints is likely a function of hyperermia and perivascular inflammation.



www.medscape.com

Bone Marrow Edema

- BME in the mandibular condyle
- What does it mean?
  - Sano et al. theorize that BME may simply reflect edema, osteonecrosis or osteoarthritis.
  - Westesson et al. state that BME is non-specific and may represent osteonecrosis, a precursor to osteonecrosis, sclerosis or fibrosis.
- Osteonecrosis of the condyle has not been shown to be associated with systematic disease like sickle cell disease, alcoholism and steroid like in the hip.



www.medscape.com

Joint effusions

- Trace joint fluid is normal

Osborn AG, Harnsberger HR, et al. Diagnostic and Surgical Imaging Anatomy. Amirsys. 2006. ppII87.

Normal trace fluid

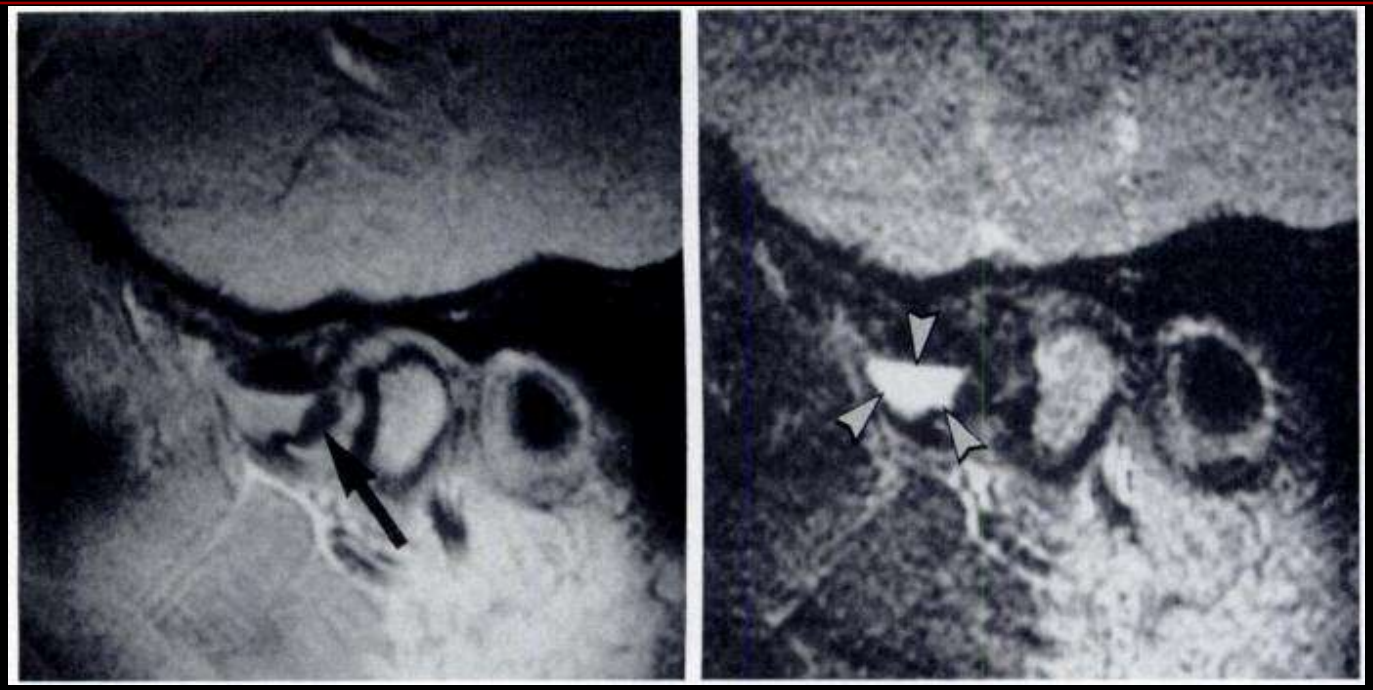
Wetesson et al. Temporomandibular Joint: Relationship Between MR Evidence of Effusion and the Presence of Pain and Disk Displacement. AJR: 159. September 1992. 559-563.

Joint effusions

- Moderate joint fluid in the superior compartment.
- Effusions are seen usually on seen in symptomatic patients.
- Large effusions are not seen in asymptomatic patients.
- Effusions may represent early change that precedes osteoarthritic changes.

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

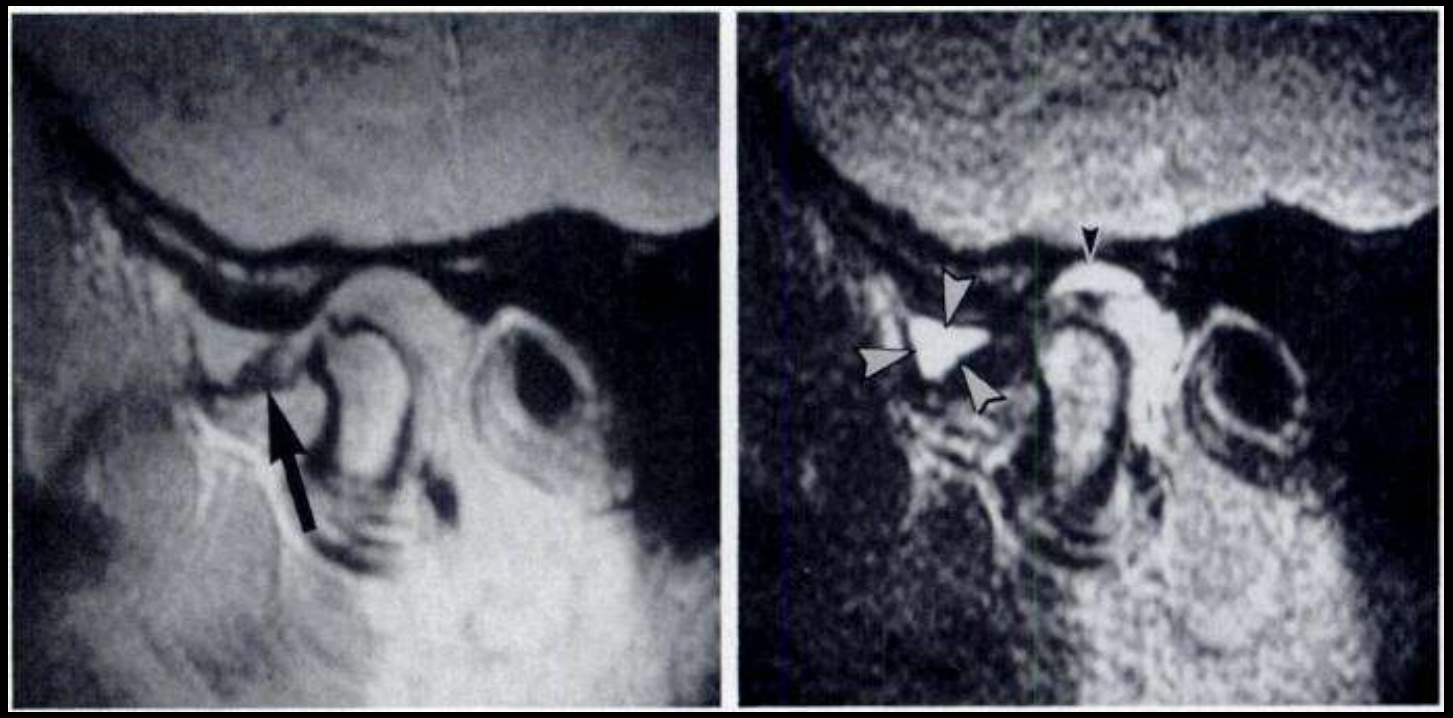
Joint effusion – PD and T2



Joint effusion in the anterior recess of the superior compartment.
Associated anterior disk displacement.

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Joint effusion - PD and T2



Joint effusion in the Anterior recess and posterior recess
of the superior compartment. Anterior disk displacement without reduction

Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

So what does a displaced disk mean???

- Schiffman et al. showed that disk displacement can occur in 20 – 25% of the population.
- Disk displacement has been found in 80% of patients with symptoms.
- Larheim et al. showed that volunteers have early stage disk displacement whereas symptomatic patients have more severe disk displacement.
- Because of the overlap, imaging findings should always be interpreted in light of clinical findings.

Treatment for disk displacement

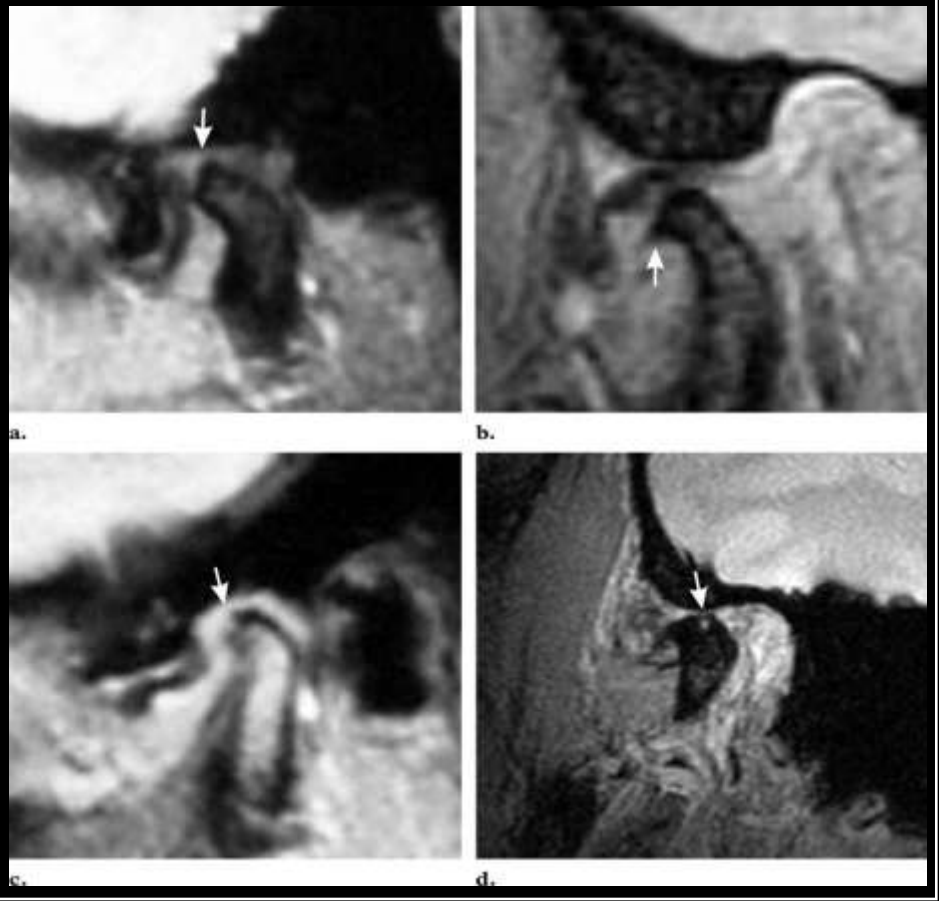
- Symptoms may resolve spontaneously
- Medical therapy for persistent pain (NSAIDS)
- Intraoral splints
- Asymptomatic disk displacement requires no treatment
- Severe internal derangement:
  - Arthroscopic adhesioectomy
  - Disk plication
  - Surgical partial resection of the posterior band and reattachment of the disk. Only for displacement without recapture and no disk deformity
  - Total diskectomy for severe OA and deformed discs without recapture. This has many complications and is not favored recently
  - Joint replacement – not favored due to high failure rates.

Osteoarthrosis

- Most often seen in joints with longstanding disk displacement without reduction
- Disk displacement is thought to be a precursor of osteoarthritis. OA is rarely seen in the absence of disk displacement.
- OA is present in a large proportion of older individuals and is usually asymptomatic.
- Westesson et al state that OA can be diagnosed with the presence of condylar flattening, osteophytes, erosions or sclerosis.

Osteoarthrosis

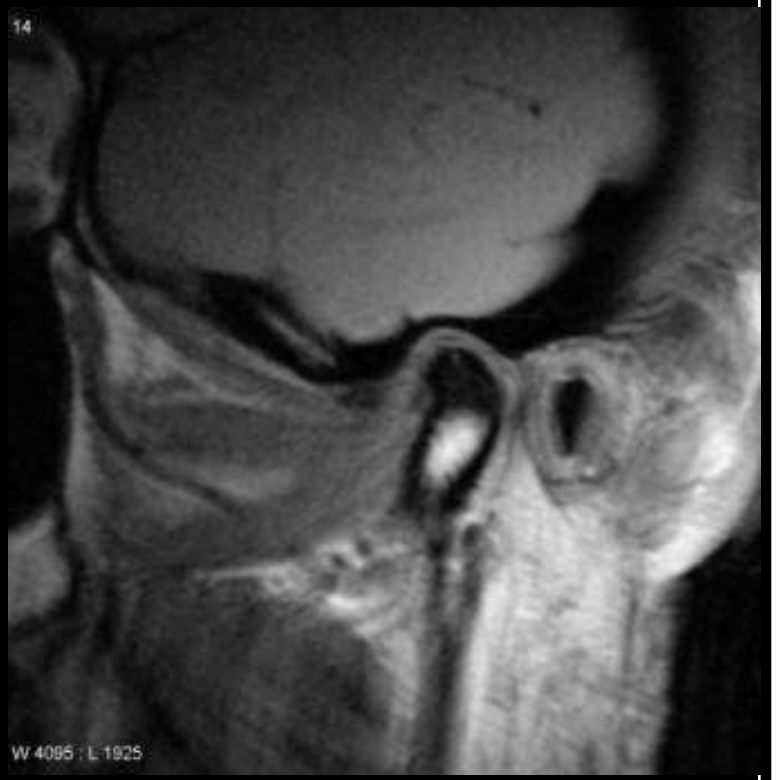
- OA in 4 different patients
- A – condylar flattening
- B – osteophyte
- C – Condylar erosion
- D – condylar osteophyte, flattening, decreased signal intensity (sclerosis), and erosion



Thomas et al. MR Imaging of the Temporomandibular Joint Disfunction: A Pictorial Review. Radiographics 2006; 26:765-781.

Mild OA

- Decreased signal in the condyle consistent with sclerosis



Gillard F. Osteoarthritis of the TMJ. http://radiopaedia.org/articles/osteoarthritis-of-the-tmj Jan-09

Moderate-Severe OA

- Flattening of the condyle
- Osteophytes
- Joint space loss
- No visualized disk

Gillard F. Osteoarthritis of the TMJ. http://radiopaedia.org/articles/osteoarthritis-of-the-tmj Jan-09

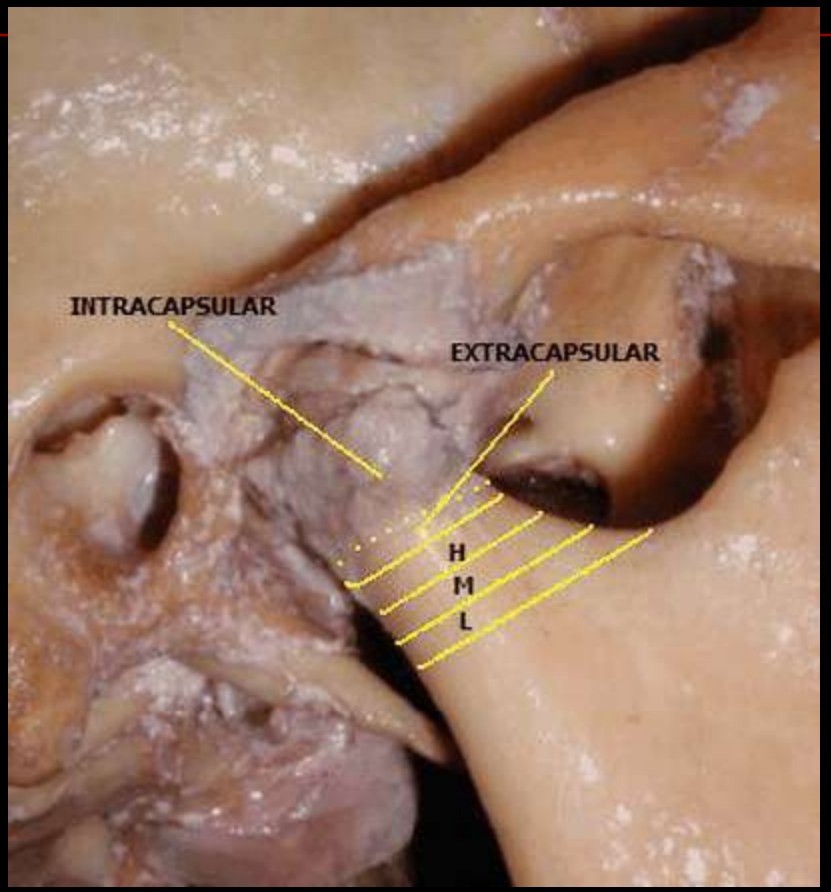
TRAUMA

- The condylar process of the mandible is involved in approximately 30% (25 – 50%) of fractures of the mandible.
- MVA and assaults account for 75% of all cases
- Falls, sporting accidents, iatrogenic ~25%
  - Tonsillectomy, tooth extractions, endoscopy

Gaillard F, http://radiopaedia.org/articles/tmj-trauma 2009.

Condylar process fracture classification

- Fracture location:
  - Condylar head
    - Intracapsular
    - Extracapsular
  - Neck
    - High
    - Mid
    - Low
- Overlap between Extracapsular condylar head fracture and high condylar neck fracture
- Fractures are typically displaced medially due to traction from the lateral pterygoid muscle



Sommer OJ, et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

Trauma - Imaging

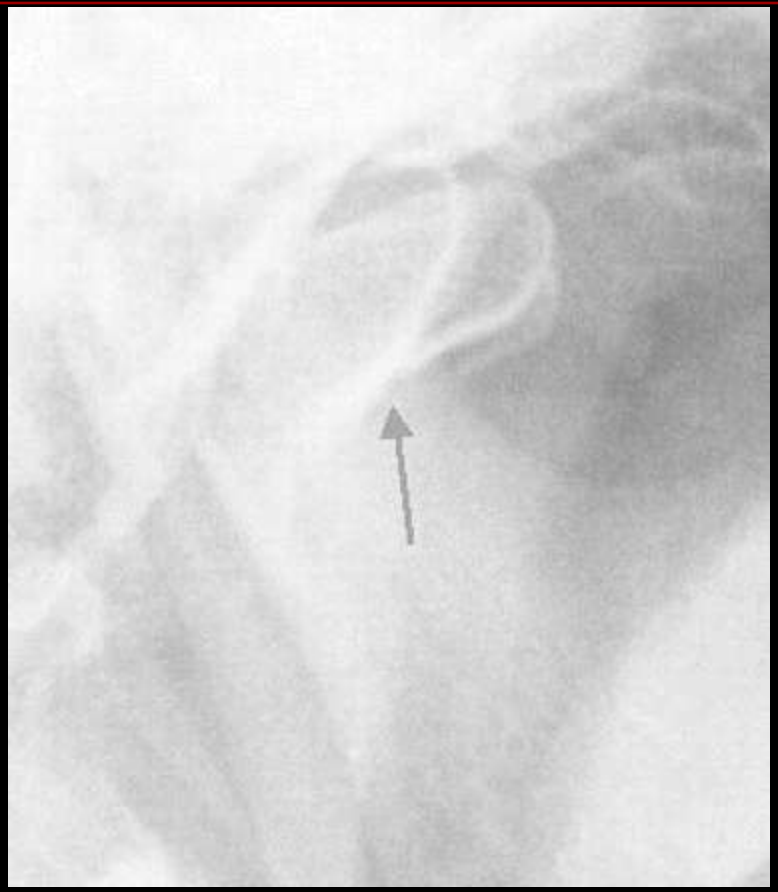
- Radiographs traditionally used.
- Facial CT in increasingly utilized
- Various grading systems have been established
- Unclear role of MRI imaging.

MRI Imaging for trauma

- Evaluation of the disk, its attachments and the articular capsule may influence the therapeutic approach
- The disk remains attached to the condylar head in most non-dislocated fractures

Bilateral condylar fractures

- Lateral view



Sommer OJ, et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

- Bilateral medially displaced high condylar fractures

Sommer OJ, et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

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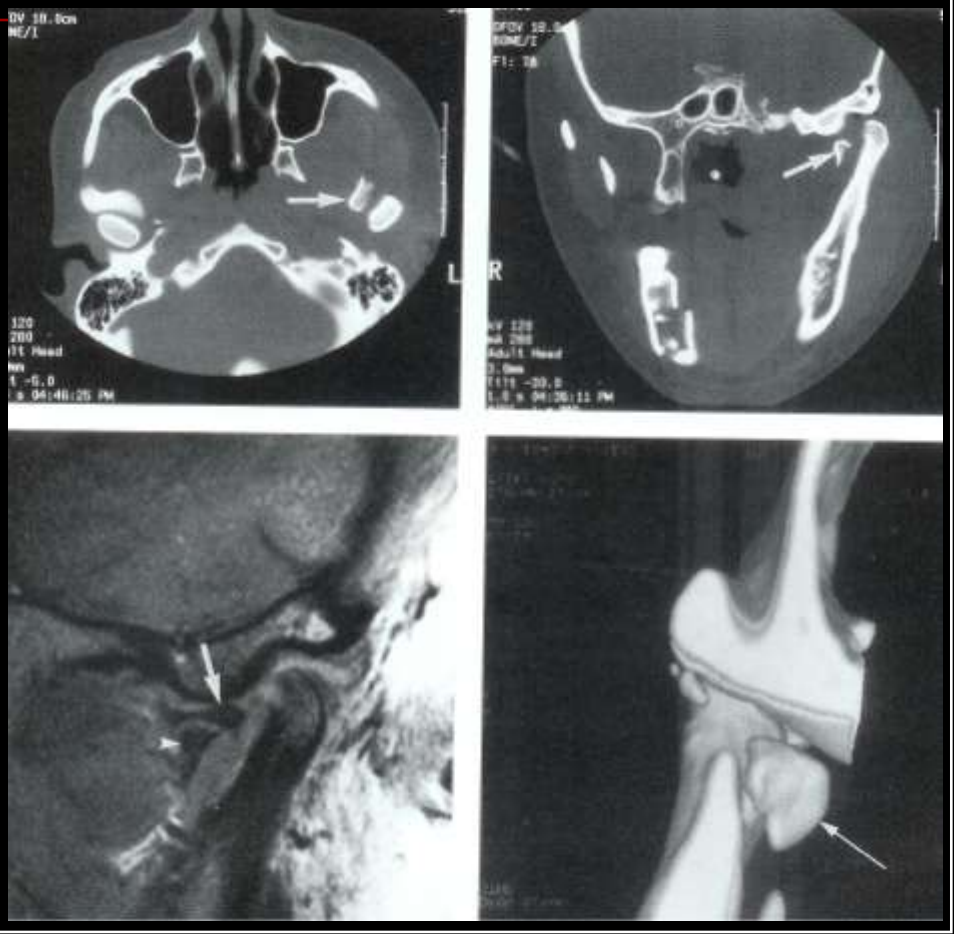
- High neck condylar fracture

Gaillard F, http://radiopaedia.org/articles/tmj-trauma 2009.

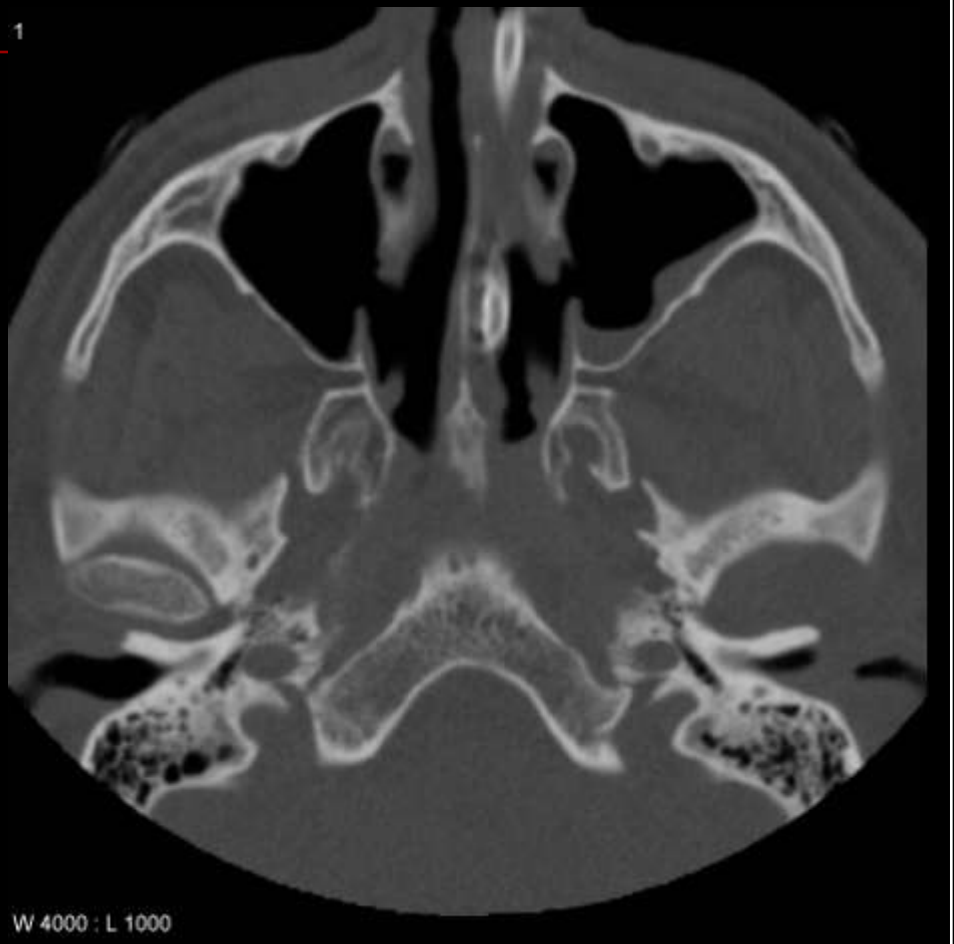
Value of MRI???

- TOP: Intracapsular fracture with medial displacement of the condlye.
- BOTTOM: Anteriorly and inferiorly displaced disk adjacent to displaced fragment.



Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

- TMJ dislocation



Gaillard F, http://radiopaedia.org/articles/tmj-trauma 2009.

Arthrography

- Almost completely replaced by MRI
- May be useful to determine the mandibular position that reestablishes a normal condyle-disk relationship in displacement with reduction. Used to optimize protrusive splint therapy (conservative therapy)
- Used to delineate loose bodies
  - Synovial chondromatosis, osteoarthrosis or osteochondritis dissecans are principal causes
- Diagnostic aspiration of joint fluid
- Intra-articular injection of steroids
- Contraindication:
  - Infection in the preauricular area

INFLAMMATORY DISORDERS

Inflammatory diseases

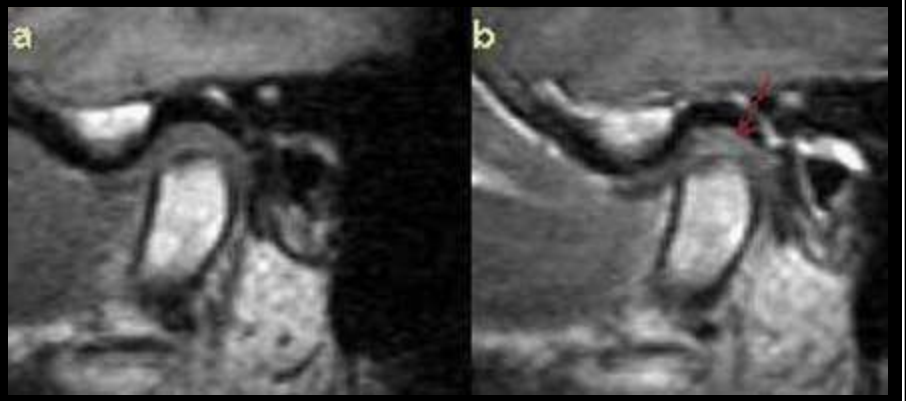
- The TMJ is a synovial lined joint, therefore affected by synovial arthropathies.
- Rheumatoid arthritis is the most common.
- Less likely are gout, psoriatic arthritis, ankylosing spondylitis, systemic lupus erythematosus, juvenile chronic arthritis, and CPPD.

Inflammatory diseases

- All inflammatory diseases have a similar appearance
- Radiologic findings:
  - Swelling
  - Edema
  - Effusion
  - Joint space narrowing
  - Cartilage destruction
  - Erosions
  - Marrow edema

Non-specific inflammation/enhancement

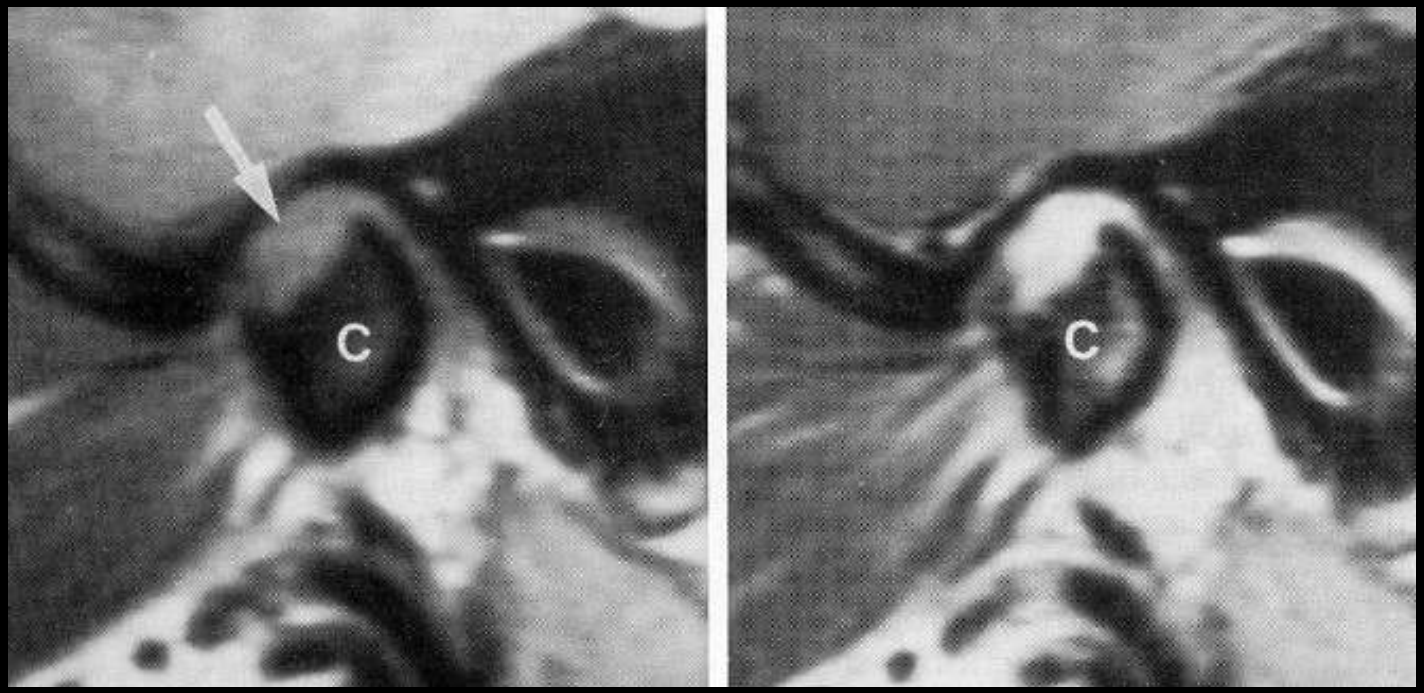
- High vascularity and loose tissue structure in the bilaminar zone allow edema and joint inflammation to be detected first in this area.
- Enhancement is non-specific and found in synovitis and synovitis secondary to osteoarthritis



Precontrast Postcontrast

Sommer et al. Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics. 2003. http://radiographics.rsnajnls.org/cgi/content/full/e14v1

Rheumatoid Arthritis



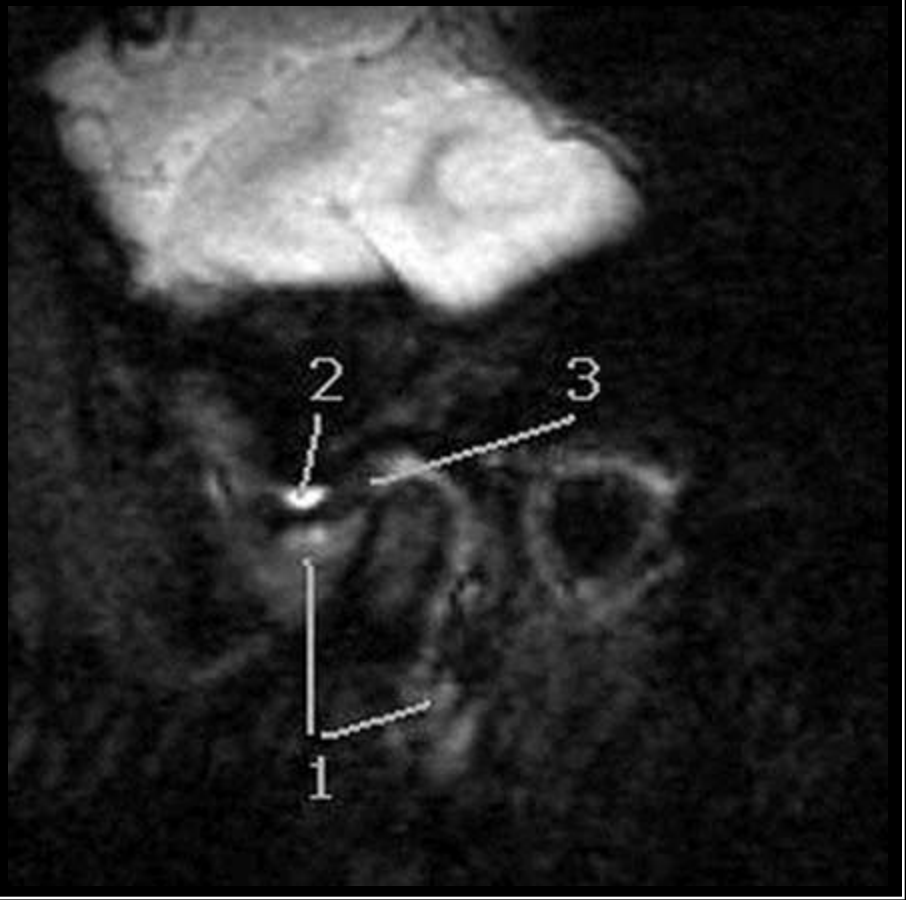
Pre-Contrast

Post-Contrast

Courtesy of Tudor Hughes, M.D.

Rheumatoid Arthritis - Synovitis

- 1 – Synovitis and inflammation
  - 2 – Small effusion in the superior joint space
  - 3 – Partial anterior disk displacement



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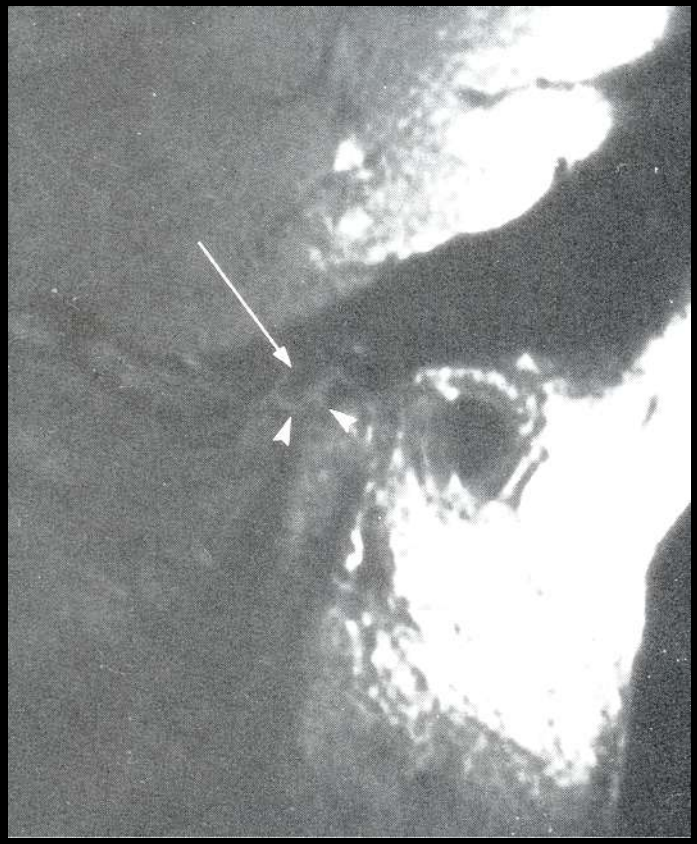
RARE DISORDERS

Osteochrondritis dissecans

- Loose bodies are rare in the TMJ
- A lose body with an associated defect in the condyle can be characterized as osteochondritis dissecans.



Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

CPPD

Courtesy of Tudor Hughes, M.D.

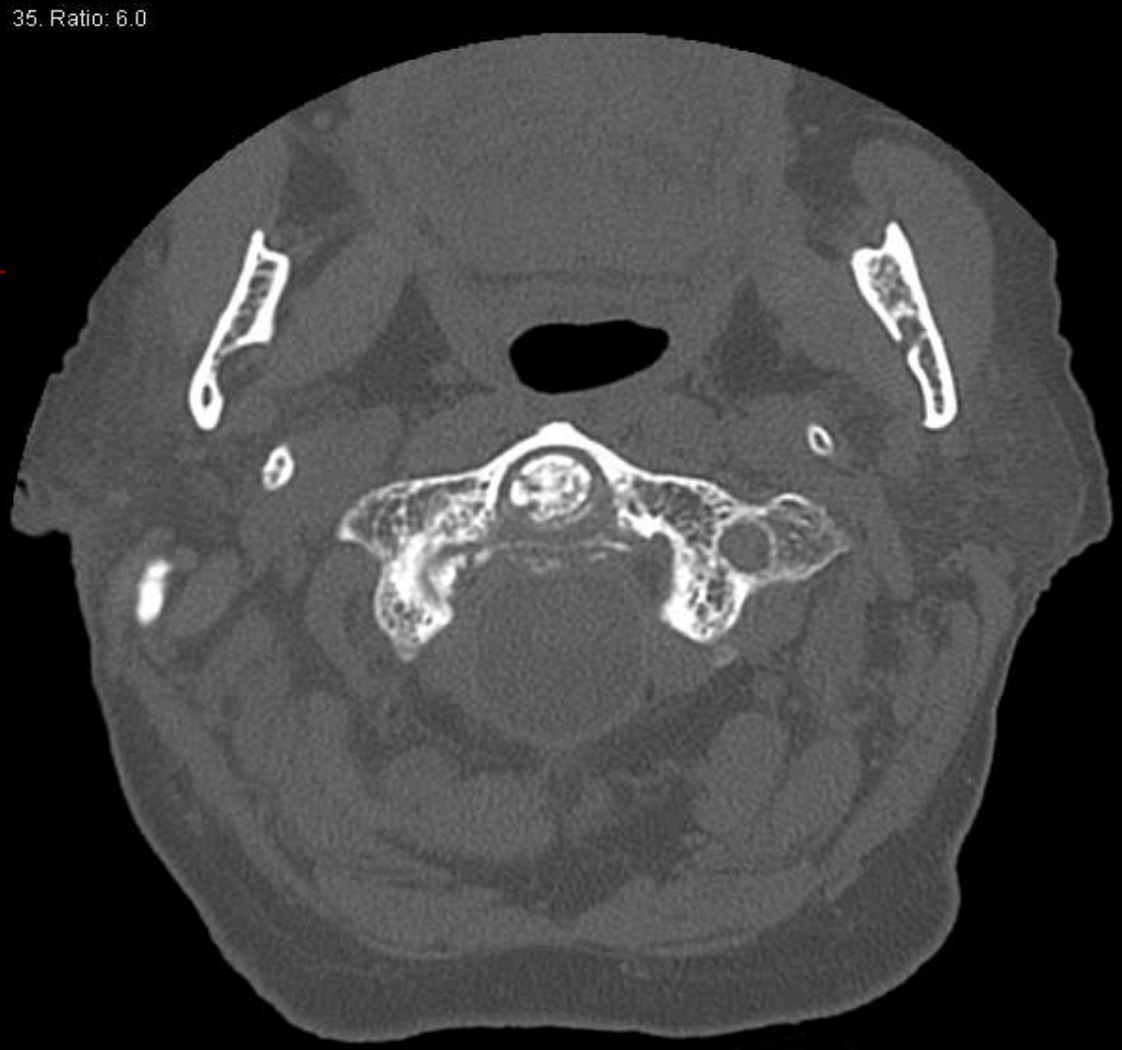
CPPD

Courtesy of Tudor Hughes, M.D.

CPPD

Courtesy of Tudor Hughes, M.D.

CPPD



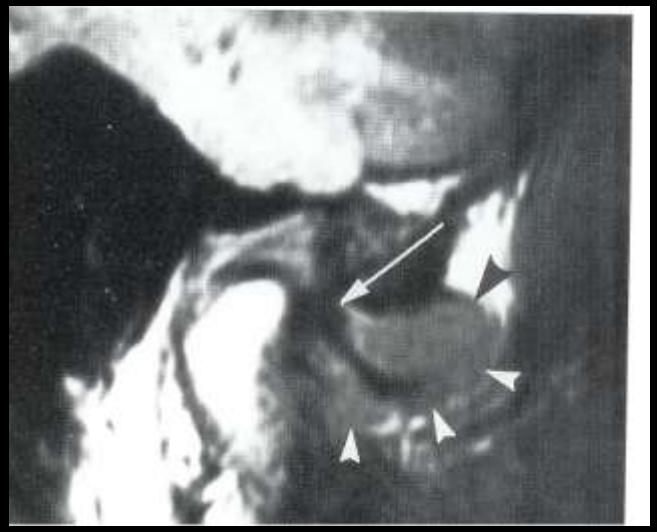
Osteochondroma

- TOP - Right condyle is 2-3 times larger than the left
  - Irregular minerlization of the condyle
- BOTTOM - Mixed low and high signal in the condyle

Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Synovial Chondromatosis

- May be locally aggressive with reported intracranial extension.
- Often significant joint expansion



Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Synovial Chondromatosis

- A – Sag PD lateral aspect of the joint. Expansion of the capsule and multiple low signal foci.
- B – Expansion of the medial and lateral joint

Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

PVNS

- Rare
- Presents as an enlarging mass
- Dense on CT
- Low signal on MRI
- Erosion of the condyle head

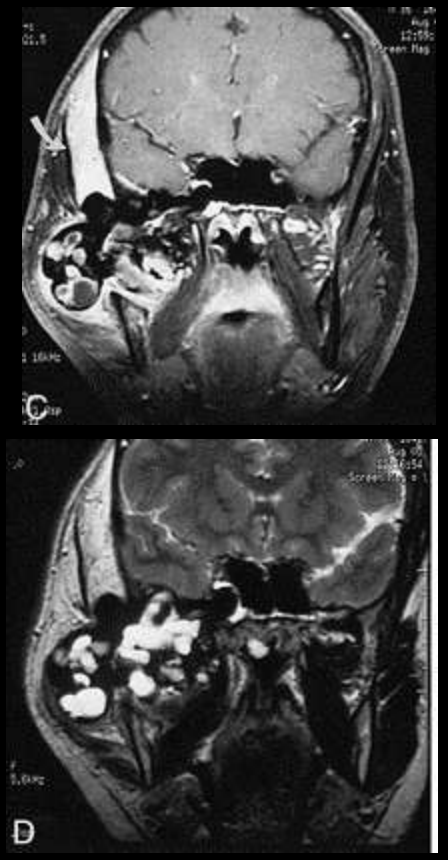
PVNS

- 37 yo with rapidly expanding periauricular mass
- A – Large heterogeneous mass in the region of the right TMJ.
  - Extension into the infratemporal fossa and bowing of the maxillary sinus
  - Arrows – susupected hemosiderin and calcium
- B – Destruction of the sphenoid and temporal bones

Bemporada JA, Chaloupka JC, Putmana CM, Rotha TC, Tarroa J, Mitraa S, Sinarda JH, Sasakia CT, American Journal of Neuroradiology 20:159-162 (1999).

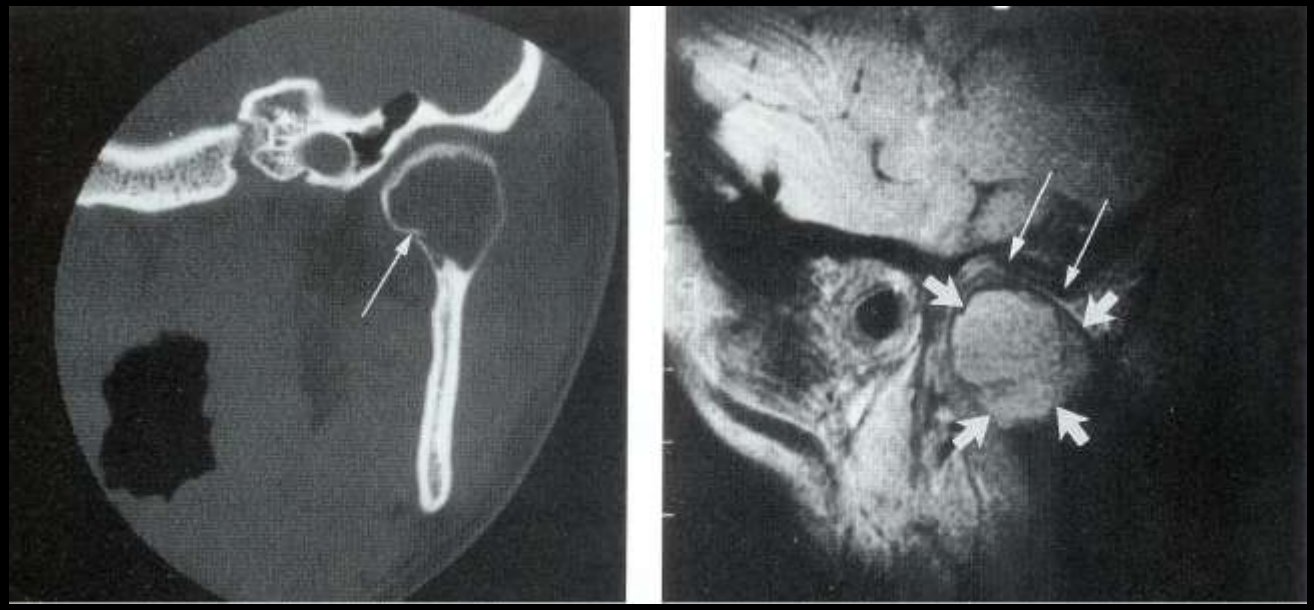
PVNS

- C – T1 post-contrast: low signal intensity with peripherial enhancement. Thickening and enhancement of the temporalis muscle
- D – T2 blooming consistent with hemosiderin. High signal consistent with cysts or necrosis



Bemporada JA, Chaloupka JC, Putmana CM, Rotha TC, Tarroa J, Mitraa S, Sinarda JH, Sasakia CT, American Journal of Neuroradiology 20:159-162 (1999).

Simple bone cyst



- Large cystic lesion of the condyle head
- Thinning of the cortex and a small pathologic fracture
- MRI: Intermediate signal. Normal disk.

Som PM, Curtin HD Head and Neck Imaging 3rd ed Mosby 1996.

Summary

- Characterization of the TMJ disk is important in TMJ dysfunction.
- Open and closed mouth imaging is necessary to completely characterize dysfunction.
- Disk abnromalities are the most common cause of TMJ disfunction.
- Progression of TMJ disease:
  - Anterior disk displacement with reduction
  - Anterior disk displacement without reduction
  - Anterior disk displacement with abnormal morphology of the disk
  - OA of the TMJ
- A displaced disk may not cause symptoms, however patients with pain usually have displaced disks. Clinical correlation is therefore suggested ☺

Thank you

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