MRI imaging of the temporo-mandibular joint (TMJ) with regard to degeneration and disk displacement.

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Learning objectives

The accurate diagnosis of diseases of the temporo-mandibular joint (TMJ) can be challenging. Also, many symptoms associated with the TMJ in the context of cranio-mandibular-dysfunction (CMD) can be misinterpreted and attributed to other potential causes. TMJ disease can cause severe pain or functional problems for the patient.

MRI provides a non-invasive technique to evaluate the joint.

Background

Diseases of the TMJ are numerous, including degeneration, disc luxation and displacement, inflammatory as well as posttraumatic changes just to name some. This can be a substantial cause of pain to the patient as well as other functional problems, such as clicking, inhibited ability to open the mouth or to chew. A large amount of "idiopathic" headaches and muscular tenderness might actually be caused by TMJ-problems.

Although MRI examination numbers of the TMJ seem to increase, it can still be considered one of the rarer examinations. Radiologists should be confident with regard to the scan protocol, anatomy and most common pathologies. Early and correct diagnosis can lead into the right treatment and can potentially slow down the progress of joint-destruction.

Imaging findings OR Procedure Details

This section begins with an overview of basic MRI sequences suitable for TMJ scanning, including optional sequences. After a short review of the anatomy, some imaging examples will be given, with a focus on degenerative changes and disc displacement. The cases have been selected from clinical routine.
Clinical aspects of cranio-mandibular-dysfunction (CMD) are addressed at the end of the section.

**Basic MRI sequences for TMJ evaluation - Suggestions**

Use of dual-surface coil in order to image both TMJ.

Field strength: 3.0 T.

Slice thickness 3 mm or less.

Evaluation planes and sequences:

- Coronal: closed mouth,
  - T1 or T2
  - Oblique sagittal (Fig. 1 on page 6): separate closed and open mouth acquisitions
  - PD/ T2 with fat saturation

Past studies have demonstrated that the fast spin-echo-wave sequence (oblique sagittal imaging plane) and PD imaging were the most suitable for the evaluation of the anatomic structures and disc or condylar position of TMJ [1].

PD-weighted images can provide higher contrast than T1-weighted images [2].

The fat saturation is helpful in identifying edema and effusion in the joint.

In cases of suspected dislocation of the articular disc or clinically inhibited ability to open the mouth

- Sagittal (dynamic) sequence separately for each side (e.g. FIESTA, TrueFISP)

Dynamic FIESTA MRI with a slow open and close movement (1-3 cycles) can be used to obtain additional dynamic TMJ images and might be helpful to evaluate the movement of the articular disc and condyle [3].
An additional T1 fat saturated sequence with Gadolinium is suggested in cases of suspected synovitis.

**Anatomy**

The basic structure of the TMJ is formed by the mandibular fossa, the condylar head, the articular eminence and the articular disc (Fig. 2 on page 7).

The **meniscus**, a biconcave fibrocartilaginous structure, divides the joint into a superior and inferior department. The disc prevents articular damage, as its intermediate zone is interposed between the temporal bone and the mandibular condyle, facilitating the opening of the mouth.

The so called bilaminar zone is formed by the retrodiscal tissue. It can be subdivided into superior and inferior retrodiscal layers, which attach to the posterior band of the disc. Those structures are important for the stabilisation of the disc and also include neurovascular structures [4] (Fig. 3 on page 8).

**Stabilisation and attachment of the disc:**

*anteriorly* to the joint capsule and the lateral pterygoid muscle:

- superior belly of the lateral pterygoid muscle inserts onto the disc.
- inferior belly of the lateral pterygoid muscle usually inserts onto the mandibular condyle (Fig. 4 on page 9)

*posteriorly* through bilaminar zone:

- Superior layer is attached to posterior mandibular fossa
- Inferior layer is attached to posterior margin of mandibular condyle
- The superior layer prevents slipping of the disc during wide jaw opening. The inferior layer prevents excessive rotation of the disc over the condyle [5].

In the closed-mouth position the posterior band or portion of the disc is usually at the 12 o'clock position (usually plus/minus 10°) (Fig. 5 on page 10).

**Motions during jaw opening**
Two different motions occur during jaw opening.

**The first motion** is rotation around a horizontal axis through the condylar head.

**The second motion** is anterior translation in which the condyle and disc move together anteriorly beneath the articular eminence and the central part of the disc is interposed between the condyle and the articular tubercle [4] (Fig. 6 on page 11, Fig. 7 on page 13, Fig. 8 on page 13).

**Degenerative changes and disc displacement**

Internal derangement is defined as an abnormal anatomic relationship of the disc to the mandibular condyle [4].

Disc displacement can be found in asymptomatic patients but is relatively more common in symptomatic patients. A displaced disc may be reduced in early stages of internal derangement, or rather recaptured with mouth opening when the condyle moves anteriorly (often causing a clicking noise). In a long standing disc displacement the disc may be nonreducible, resulting in limited motion (the absence of an audible click).

Causes of disc displacement can be variable, including trauma, malocclusion, bruxism, stress, and primary osseous abnormalities. Most disc displacements occur anteriorly, some medially or laterally (30% of cases) [6]. Posterior disc displacement is rare.

We can differentiate between:

- Disc displacement **with reduction** (usually anterior disc displacement in the closed-mouth position, normal position in open mouth position. Disc degeneration is frequent in this setting (loss of T1 and T2 signal) [6].

- Disc displacement **without reduction**: increased laxity of retrodiscal soft tissues results in disc displacement without reduction presumably followed by adhesions [4] (Fig. 9 on page 14, Fig. 10 on page 15, Fig. 11 on page 16).

Additional degenerative changes (osteoarthritis) include:

- cortical erosions (Fig. 12 on page 17)
• limited anterior movement of condyle (Fig. 13 on page 18)
• condylar head flattening (Fig. 14 on page 19)
• osteophytes (Fig. 15 on page 20)
• subchondral marrow edema

The internal derangement usually leads to a hyperactive and hypertrophic lateral pterygoid muscle which can be seen as a thickened attachment, a "double-disc sign" [7, 4] (Fig. 13 on page 18).

**Clinical issues**

Craniomandibular disorders (CMD) or temporomandibular disorders (TMD) can be used as umbrella terms, which mostly include the following [8]:

• disorders involving the temporomandibular joint (TMJ),
• disorders involving masticatory muscles,
• occlusion or mouth opening problems (such as pain, restricted movement),
• muscle tenderness,
• intermittent joint sounds.

Pain in the TMJ seems to be relatively common, occurring in up to 10% of the population over age 18; it is primarily a condition of young and middle-aged adults [9].

Significant correlation was found between TMJ pain and the subtype of anterior disc displacement (ADD) without reduction, as compared to the ADD subtype with reduction [10].

CMD seems to have a high comorbidity with other typical chronic pain symptoms and orofacial pain is often accompanied by widespread pain [11].

**Images for this section:**
Fig. 1: Oblique sagittal plane
Fig. 2: Basic anatomy of the TMJ: 1 condyle; 2 temporal bone, mandibular fossa; 3 temporal bone, articular eminence; 4 disc; 5 bilaminar zone; 6 superior head of the lateral pterygoid muscle; 7 inferior head of the LPM
Fig. 3: 1 superior retrodiscal layer; 2 inferior retrodiscal layer; 3 capsular inferior attachment; 4 capsular superior attachment; a disc, anterior band; i disc, intermediate zone; p disc, posterior band; Sup: superior joint space; Inf: inferior joint space
**Fig. 4:** sup LPM: superior head of the lateral pterygoid muscle; inf LPM: inferior head of the LPM
Fig. 5: Normal position of disc usually at 12 o’clock position + or - 10°
**Fig. 6:** Closed mouth position

**Fig. 7:** Slight opening of the mouth. Rotation of condyle and beginning of anterior translation.
Fig. 8: Open mouth position with anterior translation.
Fig. 9: Anterior disc displacement. Closed mouth.
**Fig. 10:** Anterior disc displacement. Slight opening of the mouth.
Fig. 11: Anterior disc displacement without Reduction. Open mouth. Limited anterior movement of condyle.
**Fig. 12:** Anterior displacement of the disc (mouth closed and open) (grey arrow). Disc appears fragmented. Cystic, degenerative change in the condyle (yellow arrow).
Fig. 13: Same patient as in the previous figure. Limited anterior movement of condyle (open mouth position), disc remains anteriorly displaced. A "double disc sign" due to an overactive hyperactive lateral pterygoid muscle.
**Fig. 14:** Reduction in condylar size from superior surface ± thinning of cortex. Anterior displacement of the disc.
Fig. 15: Condylar osteophytes on the right side.
Conclusion

TMJ alterations can seriously restrict a patient’s quality of life. In many cases, the diagnosis is not straightforward as associated symptoms, e.g. headaches and muscular tenderness, can have numerous causes.

Therefore, it is of utmost importance to know and recognise the potential symptoms of TMJ disease and to be able to evaluate the joint properly.

References