MRI is the study of choice in the overall evaluation of the temporomandibular joint. The modality is reported to be 95% accurate in assessing the position and configuration of the TMJ disc and 93% accurate in assessing osseous changes. MRI provides detailed multiplanar evaluation of the soft tissues and osseous structures that form the TMJ, and assessment in various degrees of opening provides an opportunity to evaluate the joint for internal derangement, the most common abnormality that affects it.

TMJ syndrome refers to the symptoms caused by internal derangement of the joint. Internal derangement results from an abnormal relationship of the TMJ disc to the mandibular condyle, articular eminence, and glenoid fossa. It may affect up to 28% of the population, with the early stages of disc derangement identified in up to 30% of the asymptomatic population. Symptomatic TMJ disc displacement typically appears in the second to fourth decade of life, with a peak incidence reported during puberty for both sexes, and a female to male ratio, considering all age groups, of approximately 3:1.

A review of TMJ anatomy will aid in understanding internal derangement. The TMJ is a diarthrodial joint bounded by the glenoid fossa and articular eminence of the temporal bone above and the mandibular condyle below. A fibrous capsule surrounds the joint in the form of an inverted pyramid. The joint is divided into a superior joint space and a smaller inferior joint space by a biconcave, fibrous structure called the TMJ disc. The disc has three distinct segments visible on MRI: an anterior band, an intermediate zone, and a posterior band. Both the anterior and posterior bands are triangular in shape, connected by the thin intermediate zone. The articular surfaces of the condylar head and articular eminence are lined with fibrocartilage.

The main stabilizing force for the joint is the posterior ligament, also called the bilaminar zone, consisting of elastic tissue fibers that extend from the posterior band of the disc to the condylar neck and the temporal bone, allowing for mobility of the disc. Katzberg et al have further defined the anatomy of the posterior ligament into three zones: the temporal zone, visible on MRI as a dark thin line arching posterior; an intermediate zone; and a condylar zone, generally not visible on conventional 1.5T MRI.

Normal TMJ function requires synchronized and coordinated motion of the disc, the condylar head, and the muscles of mastication, with the lateral pterygoid muscle representing the only major contributor to jaw opening. Fibers of the superior head of the lateral pterygoid (SHLP) insert onto the joint capsule and the condylar neck. Some of the fibers from the tendinous portion extend through the joint capsule, attaching directly to the anterior band of the disc. The inferior head of the lateral pterygoid muscle inserts onto the anterior aspect of the condylar neck.

Jaw opening occurs in two phases. The first, short phase is rotation of the condylar head within the glenoid fossa to about 10 degrees of opening. The second phase is translation of the condylar head/disc complex along the slope of the glenoid fossa to assume a position directly inferior or slightly anterior to the articular eminence. At maximum open mouth position, the disc assumes a bow-tie configuration, with the thin intermediate zone of the disc positioned between the articulating surfaces of the mandibular condyle and the articular eminence (Figure 1).

Ideally, when the jaw closes, the dentition fits perfectly together and the bilateral condylar heads, along with their respective discs, are normally situated within the glenoid fossa. When the patient with an occlusal disorder bites together, however, premature contacts of the teeth may cause the
jaw to unconsciously and automatically seek a more comfortable position to rest in. This causes the muscles of mastication, including the lateral pterygoid, to activate.

Wang et al have published electromyographic studies looking at the contraction patterns of the muscles of mastication during both rest and motion and demonstrated maximal activity of the SHLP during clenching. They suggest that its major function is to act as a stabilizer of the disc and condylar head.8 In occlusal disorders, the SHLP, which typically inserts on the capsule of the TMJ and therefore the anterior edge of the disc, has been postulated to undergo spasm. This prolonged contraction of the SHLP places forward traction on the disc, which can result in anterior disc displacement, the main cause of internal TMJ derangement.9

In the early stages of internal derangement, patients usually complain of pain and clicking, which is often audible as the displaced disc shifts in and out of its normal position within the joint (Figure 2). As internal derangement progresses, the displaced disc may become deformed and the stretched posterior ligament may lose its elasticity, resulting in failure of the disc to shift back into its normal position (Figure 3). As a result, patients frequently experience limited range of motion and/or intermittent closed lock, as well as pain.

In the more advanced stages of internal derangement, the posterior ligament may undergo fibrosis or perforation, allowing the displaced disc to migrate anterior to the articular eminence, resulting in paradoxical improvement of the patient's symptoms. However, bone-to-bone contact between the condylar head and glenoid fossa and articular eminence promote the development of osteoarthritic degenerative changes within the joint.

**OPTIMAL MRI FOR TMJ**

MRI is well suited to evaluate the TMJ in all stages of internal derangement. Optimal MR imaging of the TMJ requires the use of a surface coil, which allows for a small field-of-view and provides a high signal-to-noise ratio. A dual three-inch surface coil allows simultaneous imaging of both TMJs, significantly decreasing examination time.

The imaging protocol currently used at our institution includes T1-weighted axial localizer imaging, which allows identification of the condylar heads and mandibular rami. Proton density images in a sagittal oblique plane, perpendicular to the condylar head, are obtained in both closed and open mouth positions.10 T2-weighted fast spin-echo sagittal oblique images are obtained in the closed mouth position to evaluate for joint effusions, and coronal T1-weighted images are obtained to evaluate the joint for medial or lateral disc displacement. For the open mouth images, we use the Burnett opening device, placed between the upper and lower incisors, allowing 1-mm incremental opening. It is controlled by the patient to provide maximal tolerable opening.

MRI evaluation of the TMJ begins with the determination of disc position in the sagittal plane with the mouth closed. Normally, the posterior band lies at the 10:00 to 12:00 position in relation to the condylar head. If the posterior band is positioned more anteriorly, it is said to be anteriorly displaced. If the posterior band is noted to extend beyond either the medial or lateral pole of the condylar head, the displacement is said to have a rotational component, which is described as anteromedial or anterolateral displacement.

The next step is to determine the disc position with the mouth open. Pain or suboptimal effort may reduce the maximum degree of opening. Normally, in the maximal open mouth position, the condylar head should lie directly inferior or slightly anterior to the articular eminence, and if the disc is seen in its expected position relative to the condylar head and articular eminence, it is said to be reduced, or recaptured. When a disc remains anteriorly positioned, it is called anterior displacement without reduction or recapture.

**DISC MOBILITY**

Documentation of discal mobility is important because TMJ function and range of motion can be compromised by formation of intracapsular adhesions that can cause a fixed or "stuck" disc, in either a normal or a displaced position. If there is no significant movement of the disc on open mouth imaging, the presence of a stuck disc must be considered.12

The T2-weighted images are then evaluated to look for joint effusions as well as marrow signal alteration. A small amount of joint fluid may be present normally. Moderate to large joint effusions are always considered abnormal. Changes in T1 and T2 signal intensity are helpful in evaluating retrodiscal tissue. Increased T2-weighted signal intensity with enhancement in the retrodiscal tissue
MRI proves modality of choice for temporomandibular joint
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has been described in internal derangement patients with painful joints and is attributed to increased vascularity within the retrodiscal tissue.13,14 Decreased T1-weighted signal intensity of retrodiscal tissue described in pain-free patients with advanced stages of internal derangement is attributed to decreased vascularity and fibrosis of the retrodiscal tissue.15,16 T2-weighted imaging also has a role in the objective evaluation of the lateral pterygoid muscle. Finden et al have demonstrated a measurable difference in signal intensity involving the SHLP when compared with the normal inferior head of the lateral pterygoid in patients with internal derangement. This finding is postulated to represent edema as well as possible fatty atrophic changes within the superior head, whose increase in T2 signal intensity correlates in a nearly linear fashion with the severity of internal derangement.17

TMJ osteoarthritis may be the end result of internal derangement. As many as 20% of patients with internal derangement have osteoarthritis at the time of initial presentation.18,19 Osteoarthritis of the TMJ typically results in narrowing of the joint space, articular erosion, eburnation, and osteophyte formation, typically at the margins of the articular surfaces of the mandibular condyle and articular eminence.

New MRI techniques and sequences are constantly being developed, resulting in continued improvement in image quality and more efficient image acquisition with increased patient throughput. Recent research on image quality of 3T MRI shows greatly improved resolution, including delineation of the three components of the bilaminar zone not readily identified on 1.5T imaging.20 Whether the improved resolution provides any benefit in the diagnosis and treatment of TMJ disorders is yet to be determined.

Cine MRI is also enjoying a resurgence. First reported as early as 1987, it has sparked renewed interest in using ultrafast image acquisition, such as HASTE imaging techniques, which provide improved resolution of pseudodynamic TMJ motion and disc position compared with earlier techniques.21 Research is ongoing and will certainly lead to ever faster and more detailed imaging in the evaluation of the TMJ.

References


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Disclosures:

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