ROLE OF MAGNETIC RESONANCE IMAGING IN DIAGNOSIS OF TEMPOROMANDIBULAR DISORDERS

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Abstract: Magnetic resonance imaging (MRI) is a noninvasive technique, considered to be the gold standard in imaging the soft tissue components of the Temporomandibular Joint. Magnetic Resonance Imaging is not only used to evaluate the articular disc in terms of location and morphology, but also determines the early signs of Temporo-mandibular disorders and the presence of joint effusion.[1]The aim of this article is to understand the role of magnetic resonance imaging in diagnosis temporomandibular joint disorder.[2]

Keywords : TMJ – Temporomandibular joint, **TMD –** Temporomandibular disorders, **MRI –** Magnetic Resonance Imaging

Introduction

The **Temporomandibular joint (TMJ)** is a synovial joint, which is formed by the articulation of the condyle of the mandible and the mandibular fossa of the zygomatic arch.The TMJ is a ginglymoarthrodial joint (i.e. both a hinge and a gliding joint[2] The hinge-like movement represents the first half of the mouth opening, whereas the sliding movement represents the second half, as well as the protrusion and lateral movements.[3]

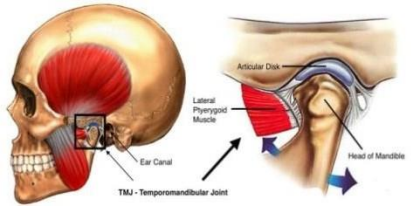

Fig 1 Normal anatomy of Temporomandibular joint

Main component of Temporomandibular Joint:

Cavities	Superior (discotemporal) cavity (translational movement) Inferior (discomandibular) cavity (rotational movement)	Cavities
Rotational movements	Elevation: Temporalis, masseter and medial pterygoid muscles Depression: Lateral pterygoid, digastric, geniohyoid and mylohyoid muscles	Rotational movements
Transitional movements	Protrusion: Lateral pterygoid, medial pterygoid muscle, masseter Retraction: Posterior fibers of temporalis, deep part of masseter Lateral deviation (left or right): Posterior fibers of temporalis, digastric, mylohyoid and geniohyoid muscles (ipsilateral movement); lateral and medial pterygoid muscles (contralateral movement)	Transitional movements

Articular surfaces	Temporal bone: Mandibular fossa and articular tubercle, Mandible: Condylar process
Main components	Joint capsule, Synovial membrane Articular disc (anterior/posterior bands, intermediate zone)
Ligaments	Major: Lateral temporomandibular ligament (thickened lateral portion of capsule, strengthens TMJ laterally), Minor: Stylomandibular ligament, sphenomandibular ligament

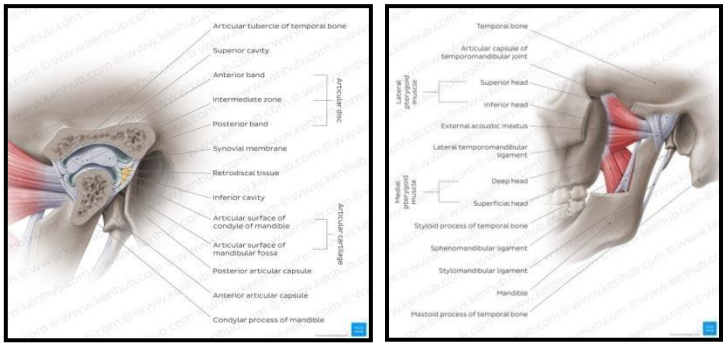

Fig 2: Main components of a Temporomandibular Joint

The pathophysiology of temporomandibular joint disorders (TMD), a frequent condition in the oral and craniofacial region, is not entirely understood.[4]Because magnetic resonance imaging can clearly depict the state of the TMJ, it is the most widely used or popular modality for imaging, inspection, evaluation, and diagnosis of TMD.[5]Bilateral temporomandibular joint MRI application in clinical practice has demonstrated a great deal of promise in medical science in recent years. The best modality for assessing intra-articular processes is magnetic resonance imaging (MRI). Oblique sagittal and coronal proton density-weighted (PDWI) sequences in closed- and open- mouth postures make up the typical MR imaging protocol. The mandibular condyle's long axis is imaged either parallelly or perpendicularly to maximize the visibility of the disc and osseous components.[5,6.] Moreover, T2WI is helpful in identifying joint effusions and degenerative peri-articular alterations. Although it is not often utilized, gadolinium contrast might be useful if an infection, inflammatory arthropathy, or tumor is suspected. Disc movement is shown in cine gradient echo (GRE) pictures, which can be utilized to assess condylar translation. More recent dynamic methods that can help assess the disc movement include the balanced steady-state free precession sequence (SSFP) and half-Fourier acquired single shot turbo spin-echo (HASTE).[6.] Compared to 1.5 T. anatomy, 3T MRI magnets offer the advantage of showing better anatomic and pathologic details of the TMJ and a better evaluation of the pathological states of the TMJ, particularly internal derangement of the TMJ. This is because 3T MRI magnets have greater signal-to-noise ratios.[7]

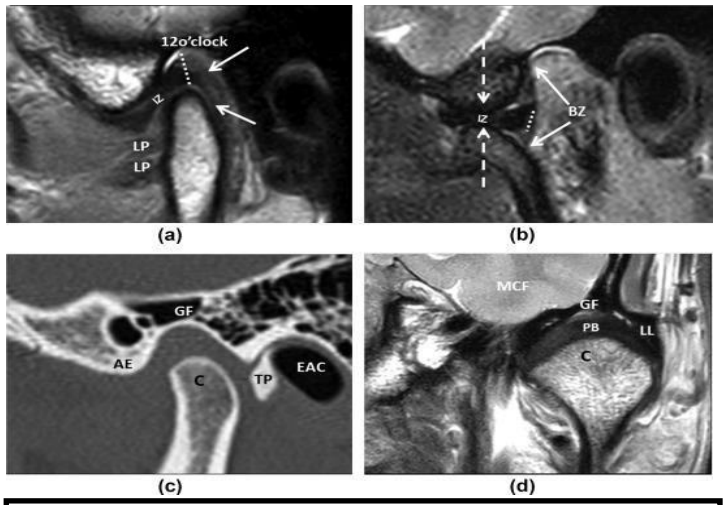

Fig. 3 Normal Anatomical Landmark TMJ In MRI(a) PDWO image through the mid-portion of the TMJ demonstrating the normal soft-tissue and osseous anatomy. The disc is of low signal and shaped like a bow-tie with a thin intermediate zone (IZ). The junction (white dotted line) of the posterior band of the disc and the low signal laminae (white arrows) of the bilaminar zone (BZ) is at 12 o'clock. **(b)** A fast T2 scan in the open-mouth position. The disc is positioned between the condyle and the articular eminence with a normal range of translation (mobility) of the condyle. The superior and inferior laminae of the BZ are widely separate with intervening, relatively high signal soft tissue (white arrows).**(c)** The normal osseous anatomy of the TMJ depicted by an oblique sagittal reconstruction from MDCT. The articular eminence (AE) and glenoid fossa (GF) form the temporal side of the articulation. The condyle (C), the external auditory canal (EAC) and tympanic plate (TP) of the temporal bone are also indicated. **(d)** A slightly oblique coronal PD scan through the mid-portion of the left TMJ. The posterior band (PB) of the disc, thickened lateral capsule (LL, lateral ligament), glenoid fossa, middle cranial fossa (MCF) and condyle (C)

Diagnosing TMJ disorders :

Internal Derangement (ID)

Internal derangement (ID), which suggests a mechanical interruption of the smooth joint movement, is the most prevalent type of TMD. ID in MRI may result from articular disc displacement. Osteoarthritis may result from disc displacement, as is commonly believed. The most used imaging modality for evaluating ID in TMJ is HMRI. analyzing the MRI for signs of internal derangement in the jaw joint (TMJ), taking into account the condylar translationusing dynamic imaging, the position and morphology of the disc and signal of the mandibular condyle, and the existence of joint effusion. The posterior band of the disc should lie superior to the condylar head at the 12 o'clock position when the mouth is closed on an oblique sagittal plane. If the posterior band is shifted more than thirty degrees, the disc is displaced anteriorly.[8]

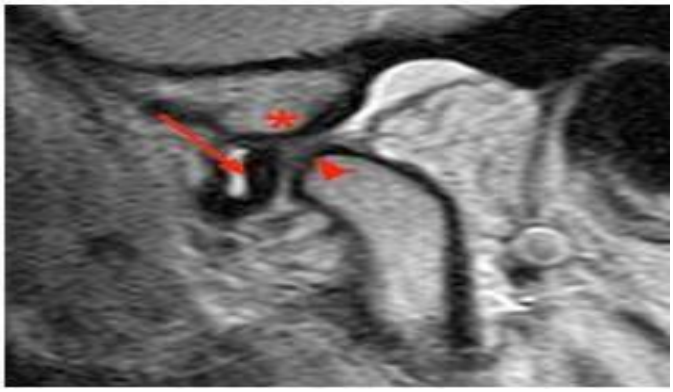

Fig. 4: Internal Derangement(With mouth opening, the disc remains anteriorly displaced and has a buckled or folded appearance (arrow). Normal anterior translation of the mandibular condyle results in the condyle (arrowhead) articulating with the articular eminence of the temporal bone (asterisk).)

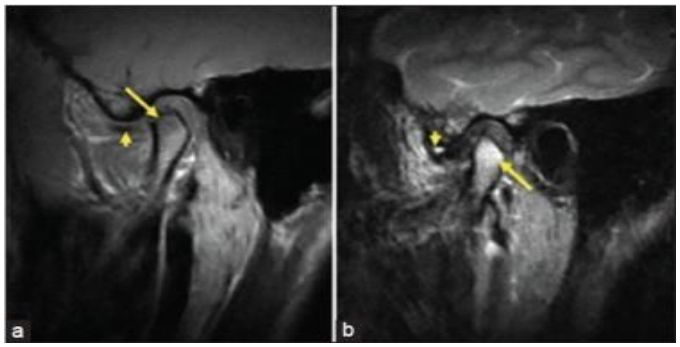

Fig. 5 : Osteoarthritis associated with bone marrow edema. (a) Sagittal T1-weighted magnetic resonance imaging (MRI) shows surface irregularities of the anterior slope of the condylar head suggestive of osteoarthritis (arrow). Articular disc is anteriorly displaced (arrowhead). (b) Sagittal T2-weighted MRI of the same joint shows high signal intensity of the condylar head suggestive of bone marrow edema (arrow). Note fluid effusion in the upper joint compartment (arrowhead)]

It has 4 stages :

I. In the **earliest stage** of internal derangement, the disc has a normal biconcave morphology but anteriorly displaced in the closed mouth position. However, the disc returns to thenormal anatomical position or recaptures as the condyle translates anteriorly during mouth opening.

II. In the **intermediate stage**, the disc still has a normal morphology, is displaced in a closed-mouth position, and does not recapture with mouth opening.

III. In the **later stages,** the disc is chronically displaced and has an abnormal morphology, e.g., it is perforated or the posterior attachment to the bilaminar zone is disrupted.

IV. In **Advanced stages** , Imaging features of degenerative joint disease such as flattening of the condyle, osteophytes, joint effusion, or the abnormal T1 and T2 signal of the condyle can also be seen . A commonly used classification of TMJ disc displacement using clinical and imaging findings was described by Wilkes.[8]

- **Osteoarthritis**

The deterioration of subchondral bone and joint cartilage is known as osteoarthritis (OA). Formerly described as an organic alteration of the joint, osteoarthritis is a disease. MRI can identify degenerative changes in the discs, cartilage, and articular bone. Common MRI imaging abnormalities include narrowing of the joint space due to subchondral sclerosis, flattening of the condyles, osteophytes, bone erosions, and aberrant marrow signal.[9]

Idiopathic Condylar Resorption: Also known as "cheerleader syndrome," idiopathic condylar resorption is a poorly understood condition. This type of TMJ degenerative disease is aggressive. It might be an overreaction to a small traumatic event.[10]

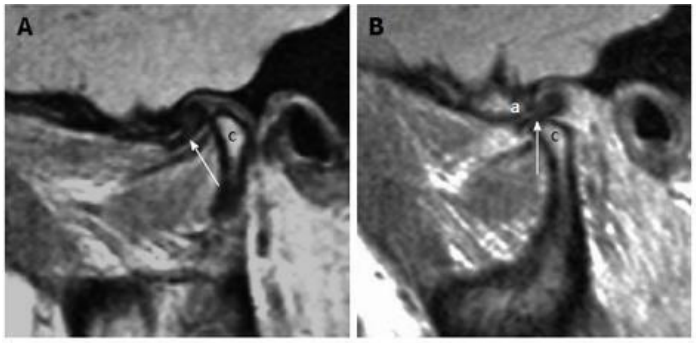

Fig. 6 : Idiopathic Condylar Resorption (Anterior displacement with reduction. A: Sagittal proton density weighted magnetic resonance imaging (MRI) in the closed mouth position demonstrates anterior displacement of the disk (arrow) in front of the mandibular condyle (the letter, c); B: Sagittal proton density weighted MRI in the open mouth position demonstrates reduction of the disk (arrow) between the articular eminence (the letter, a) and the mandibular condyle (the letter c)

Injury induced by excess estrogen receptors.MRI demonstrates loss of condylar bone mass and flattening of the anterior or superior aspect of the condyle.[10]

- **Inflammatory Arthropathies**

1. Rheumatoid Arthritis: MRIs are frequently utilized to assess RA symptoms. Synovial proliferation, joint space narrowing, articular erosion, condyle flattening, disc deformity, shortened condylar height, and aberrant condylar motion are among the

MR imaging abnormalities associated with RA. Later in the course of the disease, articular disc displacement happens in RA, and the disc can stay in a normal position even in the face of significant alterations to the underlying condylarbone.[11]

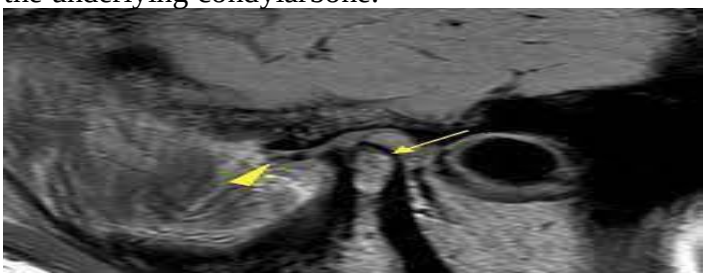

Fig. 7: Rheumatoid arthritis
[The sagittal MR image shows the disk displaced anteriorly (right arrow) and the condyle with flattening and erosion (left arrow).

2. Juvenile Idiopathic Arthritis:In children and teenagers, the most prevalent rheumatologic condition is juvenile idiopathic arthritis (JIA). Because delayed diagnosis might harm the mandibular growth plate and impair normal face growth, it is crucial to diagnose and treat TMJ involvement in JIA patients as soon as possible. Because the patient might not exhibit any symptoms until a comparatively advanced stage of the illness, clinical diagnosis might be challenging.[12]

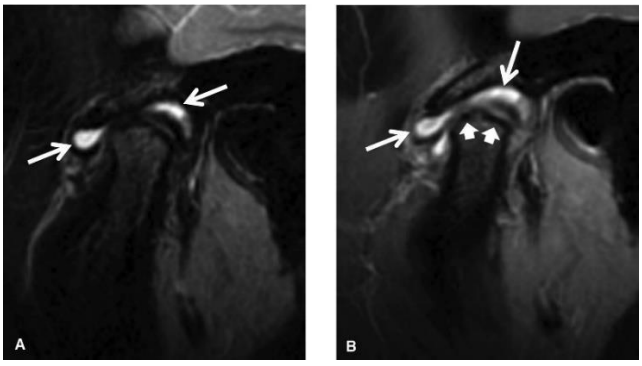

Fig. 8: Juvenile Idiopathic arthritis(Active temporomandibular joint synovitis. Sagittal T2-weighted fat-saturated (FS) precontrast (A) and T1-weighted postcontrast FS (B) images show synovial fluid (A, arrows) and enhancement (B, large arrows). Erosive changes at the condylar head are also evident on B (small arrows).

The best imaging method is magnetic resonance imaging (MRI), which can display both acute and chronic secondary degenerative arthritis. The most typical observations early in the course of the disease are synovial thickness, joint effusion, and synovial enhancement. Based on the presence or degree of MRI findings such as bone marrow edema and enhancement, joint effusion, synovial thickening or enhancement, condylar flattening or erosion, and abnormal discmorphology, chronic secondary arthritic changes such as pannus formation, bone erosions, and disc destruction eventually lead to condylar flattening and deformity and damage of the temporomandibular joint in JIA patients.For the radiological grading of inflammation and injury to the temporomandibular joint in individuals with JIA, a number of scoring systems have been proposed based on the presence.[13]

3. Septic Arthritis TMJ:Although septic arthritis is uncommon, it is linked to a high rate of morbidity and substantial long-term disability. Staphylococcus aureus, the most often cultured pathogen, can infect a joint through hematogenous dissemination or direct inoculation. The easiest way to see TMJ septic arthritis signs on an MRI is to look for synovial enhancement, joint effusion, surrounding soft tissue, and bone marrow edema.[14]

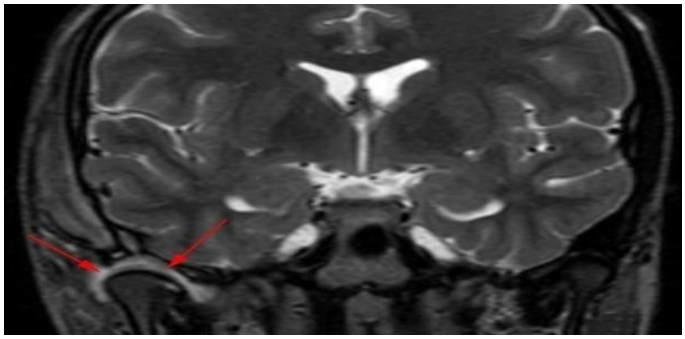

Fig. 9 :Septic Arthritis of TMJ leading to and epidural abscess [MRI showing fluid collection in the right temporomandibular joint]

2. Trauma : A condylar fracture, glenoid fossa fracture, or TMJ dislocation can result from jaw trauma. Between 25 and 50 percent of mandibular fractures are condylar fractures, which can be either intra- or extra-articular condylar head fractures or neck fractures. The lateral pterygoid muscle's unopposed force typically results in the inferior and anteromedial dislocation of the condylar head, as well as the lateral displacement and telescoping of the ramus,

In individuals with condylar fractures. In the acute environment, multi detector MRI is the preferred modality for assessing mandibular and face fractures.[14]

Fig. 10 : Trauma induced disc displacementMRI showed acute phase of ATDD, disc displaced in front of the condyle (red arrow) with normal shape and length.: The posterior band was disrupted and elongated with or without effusion (white arrow).

Most condylar fractures will show functionally favorable outcomes after closed reduction. However, traumatic dislocation of the disc or injury to the retro-discal soft tissue can lead to joint ankylosis, a devastating complication. MRI is the modality of choice to evaluate retro-discal tissue injury and disc dislocation.[15]

2.Tumor and Tumor-like Lesions

a] Osteochondroma

Osteochondroma is a benign bone lesion that can arise from the mandibular condyle or glenoid fossa. It is considered to be the most common benign tumor of the TMJ.

Fig. 11: Osteosarcoma of mandible [Preoperative axial magnetic resonance image. The left mandibular condyle has a blurred contour and the tumor is expanding into the adjacent soft tissues (arrow)]

Based on the growth pattern on MRI, Chen et al. classified osteochondromas into two main types:

Type 1: It is the type which protrudes from the condyle and involves less than two-thirds of the surface of the condyle,

Type 2 : It is the type which is causing global expansion of the condyle . MRI shows a predominantly low T1 signal exophytic mass with a T2-hyperintense cartilage cap. [14]

b] Synovial Chondromatosis

A rare and benign synovial proliferative condition called synovial chondromatosis (SC) is characterized by the development of cartilaginous nodules in the synovium that eventually calcify and separate from the joint. Consequently, numerous loose bodies and joint effusion are typical presentations of SC. In SC, loose bodies usually calcify, unlike PVNS, which never does. Joint effusion, which is characterized as an increase in the volume of intra-articularfluid, may result from synovial inflammation. [15]

Fig. 12 :**SynovialChondromatosis of temporomandibular joint:**[Hypointense loose bodies surrounded by hyperintense joint fluid (arrow) was detected on a T2 sequence of MRI, A; Isolated chondrified loose bodies (arrow) was detected during arthroscopic surgery]

C.Chondrosarcoma: The development of a cartilaginous matrix is a characteristic of chondrosarcoma, a malignant tumor derived from embryogenic cartilaginous cells. Primary chondrosarcoma does not originate from a pre-existing benign lesion, whereas secondary chondrosarcoma is a result of pre-existing benign lesions like osteochondroma or enchondroma. TMJ chondrosarcoma is incredibly uncommon; about 50

cases have been documented in theliterature. Patients' average age is 45.5 years, with a 1:4 female to male ratio. Preauricular swelling is the main symptom of TMJ chondrosarcoma, which is followed by preauricular discomfort and trismus. All TMDs frequently present with additional abnormalities such limited jaw opening, hearing loss, pain during mastication, and obstruction of the external auditory canal. A low T1 foci and an intermediate-to-low T1 and high T2 signal mass are the features of chondrosarcoma on MRI.[14,15]

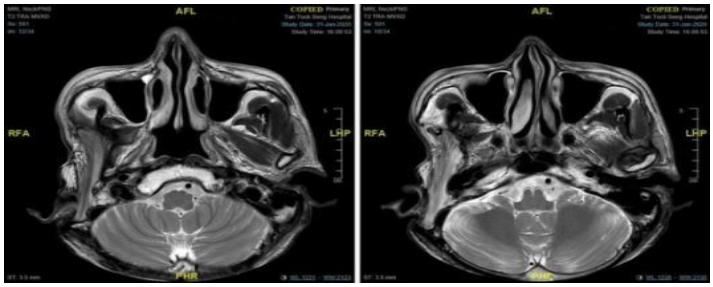

Fig 13: Chondrosarcoma [MRI T2 Axial showing no recurrence of the Right TMJ chondrosarcoma]

CONCLUSION: The most prevalent TMJ pathology, internal derangement, is best assessed by MRI. Whether or not recapture is present, disc displacement is the primary imaging finding on MR. Osteoarthritis, idiopathic condylar resorption, inflammatory arthropathies, trauma-related disorders, tumors, and tumor-like lesions are additional significant but less common TMJ diseases.

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