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Role of Magnetic Resonance Imaging in the Diagnosis of Internal Derangement of Temporomandibular Joint

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ABSTRACT

Background: The aim of this study is to evaluate the temporomandibular joint (articular disc) in patients with temporomandibular joint (TMJ) disorders using Magnetic Resonance Imaging (MRI).

Materials & Methods: This study was undertaken at the inpatient and outpatient units in the Division of Oral & Maxillofacial surgery, Rajah Muthiah Dental College & Hospital, Annamalai University, Chidambaram from June 2008 to November 2009. We evaluated 7 patients who were symptomatic by performing bilateral Magnetic Resonance Imaging in both open and closed mouth positions.

Results: In the present study, all the patients except one patient had internal derangement on Magnetic Resonance Imaging in both open and closed mouth positions. We evaluated deformities and displacement of the articular disc and osseous changes of the condylar head. Four joints of symptomatic patients with moderate to severe pain had progressive joint disease with the diagnosis of non-reducible discs with no degenerative changes. Four joints of symptomatic patients with mild to moderate pain had joint disease with the diagnosis of reducible discs with no degenerative changes. One case of a clinically diagnosed case of dysfunction did not show any signs of disc displacement and diffusion on MRI.

Conclusion: In this study, we concluded that this diagnostic modality could have a vital role to diagnose and evaluate the components of the joint and their relationships with each other in normalcy and disease.

Keywords: Temporomandibular joint, Magnetic Resonance Imaging.

INTRODUCTION

Paul Leutenbar (1973) was the first to demonstrate the use of MRI as magnetic waves to generate readable images. From these, we have come a long way to such fine digital images that specific technique is being recognized for Magnetic Resonance Imaging (MRI) for the temporomandibular joint (TMJ). Due to the complexity of the joint, three-dimensional evaluations are necessary to accurately assess common form and function.

MRI of TMJ is useful in the evaluation of abnormal disc morphology, position and mobility of the disc, synovial fluid effusion, bony and pericapsular soft tissue abnormalities, abnormal condylar translation, various osseous pathologic conditions, condyle marrow abnormalities and it's relating to

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various functional disturbances of the joint.[1,2] MRI has the sensitivity to detect fine structural details of the disc attachment, configuration changes of the disc shape and signal intensity alteration in the disc.[3] The diagnostic accuracy of MRI is higher than arthrography for soft tissue evaluation and is also higher than tomography for the assessment of skeletal changes. MRI may be the prime imaging modality for the assessment of both soft and hard tissues of the TMJ.[4] Standard MRI technique in the assessment of TMJ are (1) sagittal and coronal oblique T1 or proton density-weighted images with the mouth closed, oriented parallel and perpendicular to the long axis of the condyle, for optimal assessment of anatomy (2) T2 weighted sagittal sequence, for the assessment of joint effusions, synovial proliferation and marrow oedema

(3) gradient echo pseudo-dynamic opening sequence for the evaluation of the disc and condylar movements.[5] Combined imaging in the sagittal and coronal planes provides a good definition of the spatial relationships between the disc and condyle and direct form of soft tissue visualization.1 MRI is also a non-invasive, painless procedure that has the potential to produce high-quality tomographic images in any plane with an excellent soft-tissue resolution, without exposing the patient to ionizing radiation or any known biologic hazards that might produce tissue damage.[6] MRI provides almost 95% diagnostic accuracy in determining the disc condyle relationship in patients diagnosed for the dysfunction of the joint.[7]

MRI is the most recent, versatile and exciting technology in the field of medical imaging due to its superior resolution of both soft tissues as well as hard tissues of TMJ. It is considered as the imaging of choice in the diagnosis of TMJ internal derangement. MRI slices could be obtained in any plane of depth, which allows for simultaneous evaluation of the joint's soft and hard tissue relationship in both sagittal as well as coronal planes resulting in a more precise and accurate diagnosis in all three planes. Negative aspects include high cost of the examination, may not be widely available, inability to accurately depict soft tissue perforations and lack of dynamic visualization. MRI might be regarded as the gold standard for imaging the soft tissue components of the complex apparatus of the TMJ.8 The aim of this study is to evaluate the TMJ (articular disc) in patients with internal derangement of TMJ using MRI.

MATERIALS & METHODS

This study was undertaken in the patients who reported to the Division of Oral & Maxillofacial surgery, Rajah Muthiah Dental College & Hospital, Annamalai University, Chidambaram from June 2008 to November 2009. The objective of this study is to assess the role of MRI in the diagnosis of Internal Derangement of TMJ. The milestones of this study include analysis of disc position, disc movement during the opening and closing the mouth, disc morphology, shape and perforation of the disc, joint effusions and its extent, joint space narrowing, osseous erosions, assessment of condylar translation, degenerative joint diseases, soft tissue changes and haemarthrosis. All the symptomatic TMJ disorders patients were taken for preliminary evaluation with orthopantomogram and tomography. Out of all symptomatic patients, 7 patients presenting signs and symptoms of temporomandibular disorders were selected for this study.

The selection criteria for MRI of patients were made accordingly

1. Severity of Pain
2. Degree of mouth opening and range of motion
3. Clicking sounds
4. Deviation of jaw.

History of previous trauma to the joint, systemic inflammatory joint disease, facial growth disturbances were excluded from in this study. Immaterial of severity of pain, degree of mouth opening, clicking sounds and deviation of jaw, all the patients who had mild to moderate symptoms of internal derangement of TMJ were taken up for this study.

We evaluated 7 patients who were symptomatic, by performing bilateral MRI in both open and closed mouth positions. All MRI studies were obtained with image and consisted of coronal T2 fast spin echo and oblique sagittal T1 spin echo open and closed mouth. All Magnetic Resonance Images were taken using a "Siemens Magnetom C! medical system" unit with 0.2 telsa and 9 -inch surface coil.

All the assessments were done by a single examiner to avoid inter-examiner bias.

Table 1: MRI Findings.

S.No.	MRI Diagnosis	No. of Joints
i.	Anterior Disc Displacement with Reduction	3
ii.	Anterior Disc Displacement without Reduction	1
iii.	Rotational Disc Displacement	
	a. Anterior medial Disc Displacement with Reduction	1
	b. Anterior medial Disc Displacement without Reduction	2
iv.	Sideways Disc Displacement	
	a. Medial Disc Displacement	1
	b. Lateral Disc Displacement	0
v.	Deformed Disc	3
vi.	Dislocated Condyle	2
vii.	Adhesion	1
viii.	Normal	5

Table 2: MRI findings – Disc Displacement

Case No	Sagittal Image		Coronal Image	
	Right	Left	Right	Left
1	—	ADWR	—	Medial DD
2	—	—	—	Medial DD
3	ADWR	ADWR	—	—
4	—	ADWOR	—	—
5	ADWOR	—	Medial DD	
6	ADWR	ADWOR	—	Medial DD
7	—	—	—	—

[ADWR - Anterior Disc Displacement with Reduction; ADWOR - Anterior Disc Displacement without Reduction; DD - Disc Displacement]

RESULTS

In 7 patients, TMJs were studied for internal derangement of TMJ by MRI.
derangement on MRI in both open and closed mouth positions.

DISCUSSION

MRI is a modality capable of producing cross-sectional images of the human body in any plane without exposing the patient to ionizing radiation. Magnetic Resonance images are produced by the interaction of the body's hydrogen nuclei, high energy magnetic fields and radiofrequency pulses. MRI is not dependent on differences in electron density (as Conventional Radiography and Computed Tomography) but on proton density, tissue magnetic relaxation characteristics (T1, T2) and proton motion. The protons of the body (Hydrogen) are normally in a random state. Application of a magnetic field causes the hydrogen nuclei to align themselves along the poles of the field. If a radio frequency source is applied, the aligned nuclei will absorb energy and begin to resonate. If the original radio frequency source is removed, the nuclei will return to their original state giving a signal. The detection of the radio frequency by a sophisticated antenna and processing of the signal by a computer will generate an image of the body based on differences in proton density. Differences in proton density are primarily due to differences in water density.

Advantages of MRI

- The ability to distinguish various soft tissue structures from one another with precision
- Visualization of acquired images in different planes without distorting and degrading
- Adequate information can be generated even in short acquisition times
- No ionizing radiation exposure

Disadvantages of MRI

- Movement of artefact

• High cost
• Non-availability
• Long scanning time

Indications of MRI

• Chronic internal derangements
• Limitation of mouth opening, usually secondary to non reducing anterior disc displacement
• Postoperative follow up

Contraindications of MRI

• Patient with a cerebral aneurysm clip
• Patient with a cardiac pacemaker
• Claustrophobic patient
• Metallic prosthesis heart valves, ferromagnetic foreign bodies in a critical location like an eye.

The most frequent cause of TMJ disorder or TMJ dysfunction is internal derangement, which is defined as an abnormal relationship of the articular disc to the condyle and the articular eminence[2]. Precise localization of the disc is essential in the diagnosis of TMJ internal disorder and can be easily achieved with MRI. Studies indicate that MRI has a potential space in TMJ imaging in internal derangement.[9] These MRI studies have been traditionally approached with a two-step analysis by Vijay M Rao et al[10].

1. Documentation of disc position as normal or displaced on the basis of the relationship of the disc with the condyle in a closed-mouth position

2. Assessment of any reduction with jaw opening if the disc is displaced.

Vijay M Rao et al[10] interpreted MRI of internal disorder in the following manner: (a) the disc in a normal position and mobile, (b) the disc in a normal position but stuck, (c) the disc displaced but mobile with recapture by the condyle, (d) the disc displaced but mobile without recapture, (e) the disc displaced and stuck without recapture, (g) the joint frozen and the disc in a normal position, and (h) the joint frozen and the disc displaced.

The categories of disc displacement involve mainly two mechanisms, namely anterior disc displacement with reduction and anterior disc displacement without reduction[2]. These may be associated with subsequent morphological changes of the disc, desiccation of disc with effusion and condyle marrow abnormalities.

The relationship between the condyle and the disc in both closed and open positions in our study showed disc displacements in 8 joints out of 14 joints. This supports the general view that disc displacement plays a significant role in patients with TMJ dysfunction. On the basis of MRI studies, bilateral disc displacements appear to be much more common than unilateral1. But in our study, single disc displacement (4 patients) is common than bilateral disc displacements (2 patients).

In our study, the data is similar to the reports in the literature that the most frequent disc displacements were anterior and anterior-medial in direction10. Out of 14 joints, 7 joints are diagnosed with anterior disc displacement in our study.

While disc displacement is undoubtedly widespread in symptomatic patients, its significance is difficult to interpret. In the 1970s it was suggested that after disc displacement, pain and dysfunction was caused by the condyle pressing on the highly vascularized, innervated bilaminar zone, or, alternatively that the pain might be due to pressure on, and/or distension of, the joint capsule by the displaced disc. Doubts have been cast on these views by the findings of MRI in healthy, symptom-free volunteers, clinical and autopsy studies, clinical-arthroscopic-surgical evidence and clinical evidence pre- and post-treatment. All these findings suggest that disc displacement alone is unlikely to be the primary cause of pain. Disc displacement is now held to be a predisposing factor that increases the risk of signs and symptoms and an anatomic-physiological variant rather than an abnormality[1].

In this study, the data is similar to the reports in literature[11] that the disc displacement without reduction was usually associated with an absence of joint sounds, the presence of TMJ pain and muscle spasms, and a limited jaw opening with a deviation of the affected side. In our study, we reported in a patient with hypermobility of disc in 2 joints. Both the joints in this patient had an anterior disc displacement and dislocation of condyle[12]. Katzberg et al. described sideways and rotational displacement of the TMJ disc. Sideways displacement implies purely medial or lateral displacements, whereas rotational disc

displacement implies a combination of anterior and medial or lateral displacements[13].

In the present study, rotational disc displacements were observed in 3 joints, and the disc tended to be displaced in a medial direction (3/3 joints). In the sagittal images of the joints with rotational disc displacement, anterior disc displacement without reduction accounted for 2 joints, and anterior disc displacement with reduction accounted for 1 joint. In our study, simple sideways disc displacement was observed in only one joint which showed medial disc displacement.

Matsuda S et al. indicated that rotational anterolateral displacements of the disc are more common than rotational anteromedial and medial sideways displacements[14]. But our findings indicated that rotational anteromedial displacements of the disc are more common than rotational anterolateral and lateral sideways displacements.

In this study, the data is similar to the reports in the literature that the anterior displacement was found to be the most frequent type (3 Joints) and sideways the rarest (1 Joint). One possible explanation may be that the anterior direction is the line of least resistance to disc movements, whereas the medial and lateral surfaces are more firmly supported by their ligaments, while posterior displacement is much less likely to occur as the normal position of the disc is anterior to the condyle1.

The posterior disc displacement seems very uncommon, and there have been few studies dealing with such abnormality[15]. According to Larheim et al. study, posterior disc displacement was defined as disc tissue located posterior to the condyle, between the posterior surface of the condyle and the post glenoid tubercle and classified into 3 types as follows[16]:

• Thin flat disc type, in which the disc appeared as a flat band of tissue on top of the condyle extending posteriorly to it;

• Perforated disc type, in which the disc had a central perforation and a large part of the disc was displaced posterior to the condyle with a small portion anterior to it;

• The grossly posteriorly displaced disc type, in which the entire disc was posteriorly displaced.

In accordance with the available literature, posterior disc displacement is extremely uncommon, and it was not observed in our study.

Deformation of the disc was frequently found in non-reducing conditions, and the normal biconcave (bowtie) configuration seemed to change as a result of the displacement. Nergiz Taskaya – Yilmaz et al. categorized disc configuration as biconcave (normal), folded, lengthened, round, biconvex, and thickened posterior band. Folded and round discs were much more common in cases with anterior disc displacement without reduction[17].

Nergiz Taskaya – Yilmaz et al. explained that because the central part of the biconcave type disc was thin, the disc folded at this point due to pressure from condylar movement. In addition to the deformation, various types of pathologic changes occur in a displaced disc. Most of these changes are surface irregularities, such as fissuring and fibrillation, but others are proliferative surface changes, hyalinization, vessel ingrowth, and calcification. Surface irregularities of the disc and condyle were concluded to account for the crepitation[17].

In this study, a folded disc with anterior disc displacement without reduction is present in two joints and a biconvex disc with anterior disc displacement with reduction is present in one joint regarding disc configuration, the biconcave configuration was the most common type in disc displacement with reduction and the biconvex and folded configurations were more frequent in disc displacement without reduction[18]. In contrast, the biconvex disc is present in one joint with anterior disc displacement with a reduction in our study.

In our study, 2 joints (1 patient) did not show any MR images related to TMJ disorders who had clicking sound while on opening the mouth and deviation to the right side. The TMJ disc may be stuck in a normal or a displaced position and limits the normal degree of condylar translation, leading to restricted jaw opening. Although the literature is replete with MR imaging of internal disorder, attention has always focused on the position of the disc rather than the mobility of the disc. Vijay M Rao

et al have observed several cases in which the TMJ disc was "stuck," fixed or adherent and did not change position with jaw opening. They defined a stuck or fixed TMJ disc as the disc that remained fixed in position relative to the glenoid fossa and the articular eminence in both closed- and opened-mouth projections[10].

In our present study, a stuck disc was present in one joint. Recognition of disc fixation is important, as it might alter patient care; minor surgery such as joint lavage may be curative. Our study also supported the data given by Emshoff et al[19,20] that TMJ pain was related to MRI diagnoses of disc displacement without reduction than disc displacement with reduction. Our study findings suggest that the alterations in the position or morphology of the disc can be interpreted as a predisposing factor for the increase in the risk of signs and symptoms of TMJ disorders. The results of this study confirm the concept that the MRI finding of TMJ disc displacement is related to the finding of internal disorder. Therefore, using MRI to supplement the clinical findings appears warranted and necessary.

CONCLUSION

The present MRI study was designed to evaluate the TMJ dysfunction and its characteristic changes on these images, which could be correlated in patients suffering from the same disorder.
degenerative changes. One case of a clinically diagnosed case of dysfunction did not show any signs of disc displacement and effusion on MRI.

Based on the results of this study, MRI is the imaging technique of choice to diagnose, evaluate, the components of the joint and their relationships with each other in normalcy and disease, which has already been proven as the gold standard technique for imaging TMJ. MRI as a gold standard for assessing internal derangement of TMJ was reaffirmed by our study but the diagnostic quality of MRI examination can vary depending on the experience level of both the technologist and the radiologist who interpreted the MRI examination. It also depends on the field strength of the magnet, surface coil and software of the MR imager itself as well. More such studies with large patient groups are necessary in this regard.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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