ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2017; 3(2): 80-85

www.oraljournal.com
Received: 08-02-2017
Accepted: 09-03-2017

Altaf Hussain Chalkoo
Professor and HOD government Dental College and Hospital Srinagar, India

Dr. Zahoor Ahmad Bhat
PG scholar, oral medicine and radiology, government Dental College and Hospital Srinagar, India

Dr Anum Maqbool
Dental surgeon, government Dental College and Hospital Srinagar, India

Correspondence
Dr. Zahoor Ahmad Bhat
PG scholar, oral medicine and radiology, government Dental College and Hospital Srinagar, India

MRI characteristics of disc displacement of temporomandibular disorders and its correlation with clinical findings in symptomatic and asymptomatic subjects

Altaf Hussain Chalkoo, Dr. Zahoor Ahmad Bhat and Dr Anum Maqbool

Abstract
Objectives: Pain caused by temporomandibular disorders originates from either muscular or articular conditions, or both. Distinguishing the precise source of the pain is a significant diagnostic challenge to clinicians, and effective management hinges on establishing a correct diagnosis temporomandibular joint (TMJ) dysfunction is a common condition that is best evaluated with magnetic resonance (MR) imaging. The important step in MR imaging of the TMJ is to evaluate the articular disk, or meniscus, in terms of its morphologic features and its location relative to the condyle in both closed- and open-mouth positions. Disc location is of prime importance because the presence of a displaced disk is a critical sign of TMJ dysfunction. However asymptomatic volunteers can have disc displacement. It is important for the maxillofacial radiologist to detect early MR imaging signs of dysfunction, thereby avoiding the evolution of this condition to its advanced and irreversible phase which is characterized by osteoarthritic changes such as condylar flattening or osteophytes. Henceforth, the aim of the study was to evaluate MRI Characteristics of Disc Displacement of temporomandibular disorders and its correlation with clinical findings in symptomatic and asymptomatic subjects
Materials and Methods: In this clinical study, 30 patients (60 TMJs) were examined clinically and divided into two groups. Group 1 consisted of 15 patients with clinical signs and symptoms of TMDs either unilaterally or bilaterally and considered as study group. Group 2 consisted of 15 patients with no signs and symptoms of TMDs and considered as control group. MRI was done for both the TMJs of each patient. Displacement of the posterior band of articular disc in relation to the condyle was quantified as anterior disc displacement with reduction (ADDR), anterior disc displacement without reduction (ADDWR), posterior disc displacement (PDD).
Results: Disk displacement was found in 13 (86.7%) patients of 15 symptomatic subjects in Group 1 on MRI and 2 (13.3%) were diagnosed normal with no disc displacement. In Group 2, 1(6.7%) of 15 asymptomatic patients were diagnosed with disc displacement while 14 (93.3%) were normal. Sensitivity and Specificity tests were applied in both the groups to correlate MRI characterstics of disc displacement and clinical finding of TMD and results showed Sensitivity of 92.9% and Specificity of 87.5%.
Conclusion: Disk displacement on MRI correlated well with presence or absence of clinical signs and symptoms of temporomandibular disorders with high Sensitivity and Specificity of 92.9% and 87.5% respectively.

Keywords: Temporomandibular joint disorders, disc displacement, magnetic resonance imaging

Introduction
The temporomandibular joint (TMJ) is a compound articulation formed from the articular surfaces of the temporal bone and the mandibular condyle. Both surfaces are covered by dense articular fibrocartilage. Each condyle articulates with a large surface area of temporal bone consisting of the articular fossa, articular eminence, and preglenoid plane.
The TMJ functions uniquely in that the condyle both rotates within the fossa and translates anteriorly along the articular eminence. Because of the condyle's ability to translate, the mandible can have a much higher maximal incisal opening than would be possible with rotation alone. The joint is thus referred to as "gynglimodiarthrodial": a combination of the terms ginglymoid (rotation) and arthroidial (translation) [1].
According to American Academy of Orofacial Pain (Jeffery P. Okeson), temporomandibular disorders (TMD) are defined as

"A collective term embracing a number of clinical problems that involve the masticatory muscles, temporomandibular joint and associated structures or both [2].

The prevalence of TMD differs between studies, probably because of variations in methodology and definitions of TMD. According to Gopal *et al*., the prevalence of signs and symptoms of TMD was found to be 52% which was less than the prevalence found by Modi P *et al*. (68.6%) and Ryalat *et al.* (55%) but more than prevalence found by Mutalu N *et al.* (17%) [3, 6-8]. Signs and symptoms of temporomandibular disorders (TMDs) may include pain, impaired jaw function, malocclusion, deviation or deflection, limited range of motion, joint noise, and locking. Headache, tinnitus, visual changes, and other neurologic complaints may also accompany TMDs. Because of many etiologic factors, the diagnosis and treatment of patients with TMDs is complex. [1]

The prevalence of signs and symptoms has been reported to be four times higher in women than men in younger population [1, 2, 4, 9].

As stated by Laskin [5], the difficulty began with the introduction of a "TMJ syndrome." Then clinicians erroneously grouped a "variety of etiologically unrelated conditions into one diagnostic category based on the fact that they produced similar signs and symptoms," and this led to "one diagnosis equals one treatment." Only later was it recognized that many of these patients suffered from muscle-related conditions. The terms myofascial pain (MFP) and myofascial pain and dysfunction (MPD) evolved [6], and "TMJ disorders" became "TMDs."

Furthermore, disc displacement which is also known as internal derangement, is one of the most frequent disorders of TMJ which has been considered as an underlying mechanism in pathogenesis of TMJ dysfunction [12]. It is defined as "disruption within the internal aspects of TMJ whereby the disk is displaced from its normal functional relationship with the mandibular condyle and articular portion of temporal bone" [12]. Disc displacement may be either anterior displacement with reduction, anterior displacement without reduction or posterior displacement [3]. In Disc Displacement with Reduction (DDR), the disc is anterior to the condyle in the closed mouth position and returns to its normal position when jaw is opened. On the contrary, in Disc Displacement without reduction (DDWR), the disc is anterior to the condyle in the closed mouth position and does not return to its normal position when the jaw is opened, while in Posterior Displacement (PD), the posterior band of the disc is in apparent contact with the bilaminar zone and its anterior band is at a 2 o'clock or 3 o'clock position [13].

The incidence of ADD is unknown. Numerous radiographic, clinical, and cadaveric studies of asymptomatic subjects have shown rates up to 30% [14]. The clinical significance of this finding remains uncertain.

MRI has been reported to be 95% accurate in assesement of disc position and form and 93% accurate in assesement of osseous changes [2, 11]. In recent years, MR imaging has been confirmed as the imaging technique of choice in the study of TMJ dysfunction. MR imaging technique in this context includes the use of dual surface coils, sagittal oblique and coronal thin sections of 3 mm or less, and proton-density–weighted and T2-weighted sequences in both closed- and open-mouth positions. Furthermore, a dynamic study can be performed during progressive mouth opening with cine MR imaging [15]. Precise localization of the disk is very important in the diagnosis of TMJ internal derangement and can easily be achieved with MR imaging.

Henceforth the aim of study was to evaluate the MRI Characteristics of disc displacement of temporomandibular disorders and its correlation with clinical findings.

Materials and methodology

In this clinical study, 30 patients (60 TMJs) of either sex, between 20-42 years of age, reporting to the Department of Oral Medicine and Radiology were selected. All the subjects were divided into 2 groups. Group I consisted of 15 subjects with clinical signs and symptoms of temporomandibular disorders considered as Study group. Group II consisted of 15 subjects with no clinical signs and symptoms of temporomandibular disorders considered as Control group. Selection of subjects in Group I was based on the Research diagnostic criteria Axis 1-2011 by Daniele Manfredini, Inclusion and Exclusion criteria [16] as follows:

1. Clicking in the TMJ on both vertical range of motion either opening or closing, either unilaterally or bilaterally, which can be reproducible on two of three consecutive trials and is eliminated on protrusive opening.
2. Reduced mouth opening less than 35mm along with deviation towards the ipsilateral side.
3. Pain as a complaint in the jaws, face, temple or inside the ear along with tenderness on palpation in at least three or more muscle sites which are located in only the masseter, temporalis and lateral pterygoid muscles, with or without reduced mouth opening.
4. Pain in one or both the joints sites on palpation along with pain as a complaint during maximum mouth opening and lateral excursion.

MRI Examination: The detailed MRI assessment of each pair of TMJs was performed in all subjects with a 1.5-T MRI system (General Electric-HDxt made in USA) Parameters: 150 × 150 mm field of view (FOV) in head coil with the jaw first in the closed rest position and then at the maximal opened position, Routine T2WI, T1WI with and without fat suppression images were obtained in coronal, sagittal, and axial planes with thin cuts – slice thickness 3 mm with spacing of 1 mm

The MRI procedure was explained verbally to the subjects and they were transferred to the Department of Radio diagnosis and Imaging. Each individual included in the study was subjected to the standard temporomandibular joint open and close mouth imaging in sagittal plane using MRI with adequate protective measures. All the scans were performed on the same MRI scanner using the same protocols and prints out of the selected images were obtained. The relationship between position of articular disc and the condyle was carried out.

The position of the disc was classified as follows:

1. **Normal State (N):** The posterior band of the disc is centered in relation to the condyle and the bottom of the glenoid fossa.in closed mouth position and in open mouth position head of the condyle articulates central zone of articular disc (Fig. 1)
2. **Disc Displacement with Reduction (DDR):** The disc is anterior to the condyle in the closed mouth position and returns to its normal position when the jaw is opened (Fig. 2).
3. **Disc Displacement without Reduction (DDWR):** The disc is anterior to the condyle in the closed mouth position and does not return to its normal position when the jaw is opened (Fig. 3).

4. **Posterior Displacement (PD):** The posterior band of the disc is in apparent contact with the bilaminar zone and its anterior band is at a 2 o'clock or 3 o'clock position.

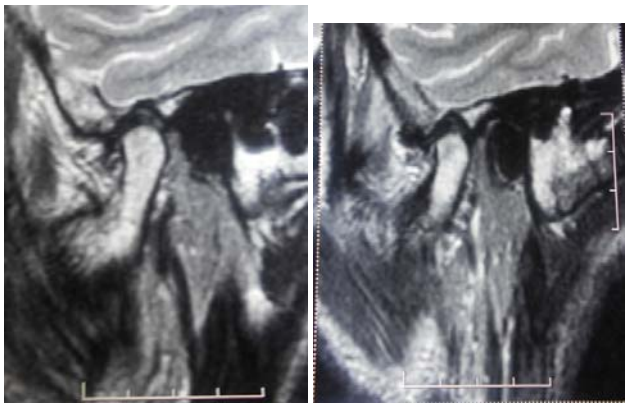

Fig. 1: MR image showing normal disc-condyle relationship in closed mouth position and open mouth position.

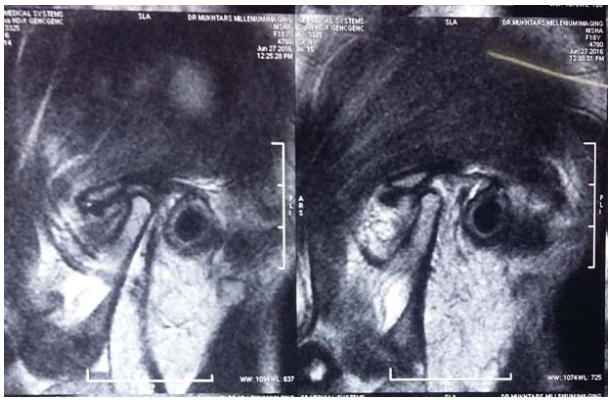

Fig. 2: MR image showing Anterior Disc Displacement in closed mouth position and opened mouth position

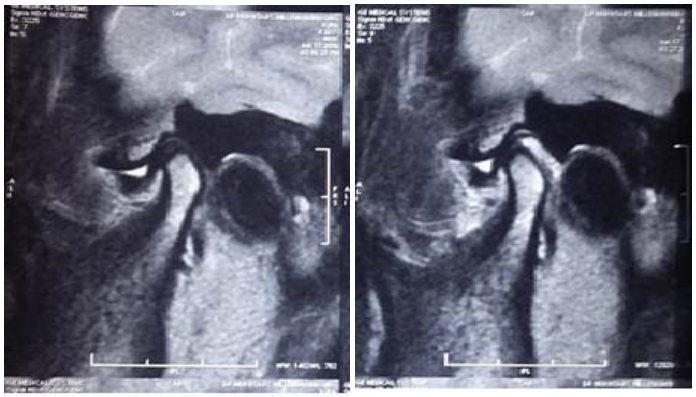

Fig. (3). MR image showing Anterior Disc Displacement in closed mouth position and opened mouth position.

The obtained data were subjected to statistical analysis for evaluation.

Statistical Methods: The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Descriptive Statistics of data including the mean and standard deviation for numerical variables and the percentages of different categories for categorical variables was obtained. Frequency distribution tables, bar and pie diagrams were used for data presentation. Student's Independent t-test was employed for parametric data and for non-parametric data, Chi-square or Fisher's exact test, whichever appropriate, was used. Sensitivity and specificity were applied for correlating clinical diagnosis with MRI findings. P-value less than 0.05 was considered statistically significant.

Table 1: Age distribution of study patients

Age (years)	N	Mean	SD	Range	P-value
Group 1 (Symptomatic)	15	24.8	5.89	20-39	0.508
Group 2 (Asymptomatic)	15	26.1	4.65	23-42	

Table 2: Gender distribution

Gender	Group 1 (Symptomatic)		Group 2 (Asymptomatic)		P-value
	No.	%age	No.	%age	
Male	6	60	7	47	0.464
Female	9	40	8	53	

Table 3: Distribution of patients on the basis of clinical diagnosis in Group 1

Clinical Diagnosis	No. of patients	Percentage
LT Sided TMD	8	53.3
RT Sided TMD	4	26.7
LT and RT TMD	3	20.0

Table 4: Presence of articular disc displacement in Group 1 and Group 2 on MRI

Groups	N	Clinically Diagnosed TMD	DD Diagnosed by MRI
Group 1 (Symptomatic)	15	15	13 (86.7%)
Group 2 (Asymptomatic)	15	0	1 (6.7%)

Table 5: Distribution of patients in Group 1 on the basis of type of disc displacement based on MRI findings

MRI Diagnosis	No. of Patients	Percentage
Normal	2	13.3
LT Ant. DDR	2	13.3
RT Ant. DDR	3	20.0
LT Ant. DDWR	4	26.7
RT Ant. DDWR	1	6.7
LT Post. DD	0	0.0
LT Ant. DDWR, RT Ant. DDR	1	6.7
LT Ant. DDR, RT Ant. DDWR	2	13.3

Table 6: Evaluation of total disc displacement by MRI diagnosis between Group 1 and Group 2

MRI Findings	Group 1		Group 2	
	No.	%age	No.	%age
Total no. of patients	15	-	15	-
Total no. of joints examined	30	-	30	-
No DD	14	46.7	29	96.7
Ant. DDR	8	26.7	1	3.3
Ant. DDWR	8	26.7	0	0.0
Post. DD	0	0.0	0	0.0
Total Disc Displacement	16	53.3	1	3.3
Chi-square=16.09	D.F.=1		P-value<0.001*	

*Statistically Significant Difference (P-value<0.05)

Table 7: Evaluation of total disc displacement by MRI diagnosis between Group 1 and Group 2

Groups	TMD based on clinical findings		Disc Displacement on MRI findings		Sensitivity	Specificity
	TMD	Normal	TMD	Normal		
Group 1	15 (100%)	0 (0.0%)	13 (86.7%)	2 (13.3%)	92.9%	87.5%
Group 2	0 (0.0%)	15 (100%)	1 (6.7%)	14 (93.3%)		

Results and analysis

In both the groups, all the subjects were in the range of 20-42 years. In Group 1, out of 15 symptomatic subjects, 6 (40%) subjects were male and 9 (60%) were female. The minimum age in Group 1 was 20 years and maximum age was 39 years. The mean age in Group 1 was 24.8 ± 5.89. In

Group 2, out of 15 asymptomatic subjects, 7 (47%) subjects were male and 8 (53%) were female. The minimum age in Group 2 was 23 years and maximum age was 42 years. The mean age in Group 2 was 26.1 ± 4.65.

Out of total 15patients in Group 1 (Table **3**), 3 (20%) were clinically diagnosed as Bilateral TMD, 8 (53.3%) were clinically diagnosed as Left TMD and 4 (26.7%) were clinically diagnosed as Right TMD. In Group 1, out of 15 symptomatic subjects, 13 (86.7%) subjects were diagnosed with Disc Displacement by MRI. In Group 2, out of 22 asymptomatic subjects, 1(6.7%) subjects were diagnosed with Disc Displacement by MRI.

Out of total 15patients in Group 1 (Table **5**), 2(13.3%) were diagnosed as Normal. Left and Right sided Anerior Disc Displacement with reduction was found in 2 (13.3%) and 3 (20%) patients respectively. 4 (26.7%) patients were diagnosed as left sided Anterior Disc Displacement without Reduction. Only 1(6.7%) patient was diagnosed as Right sided Anterior Disc Displacement without Reduction, while none of the patients presented with Posterior Disc Displacement. 1 (6.7%) patients were diagnosed as Bilateral TMD with Left sided Anterior Disc Displacement without Reduction and Right sided Anterior Disc Displacement with Reduction. 2 (13.3%) were diagnosed as Bilateral TMD with Left sided Anterior Disc Displacement with Reduction and Right sided Anterior Disc Displacement without Reduction. Out of total 15 asymptomatic subjects in Group 2, 14 (93.3%) subjects were diagnosed as normal with no disc displacement on MRI, while 1 (6.7%) subject were diagnosed with only Anterior disc Displacement with Reduction. Table 6 depicts the MRI findings of TMJs evaluated in Group 1 (Symptomatic subjects) and Group 2 (Asymptomatic Subjects). In Group 1, out of 30 TM joints, based on MRI findings, 14 (46.7%) joints were diagnosed as normal with no disc displacement, 8 (26.7 %) were diagnosed as Anterior Disc Displacement with Reduction, 8(26.7%) were diagnosed as Anterior Disc Displacement without Reduction In Group, 2 out of 30 TM joints, 29 (96.7%) joints were diagnosed as normal and 1 (3.3%) joints were diagnosed as Anterior Disc Displacement with Reduction. Chi – square test revealed that the occurrence of total disc Displacements between Group 1 and Group 2 was highly significant with P<0.001. In Group 1,

out of 15subjects clinically diagnosed as TMD on the basis of RDC/RMD, 13 (86.7%) subjects were diagnosed with Disc Displacement on MRI and 2 (13.3%) were diagnosed normal with no Disc Displacement on MRI. In Group 2, out of 22 asymptomatic subjects, 1 (96.7%) were diagnosed with Disc Displacement, while 14 (93.3%) were normal with no Disc Displacement on MRI. In both the groups, MRI findings of Disc Displacement correlated well with clinical findings of TMD with Sensitivity of 92.9% and specificity of 87.5% (Table 7).

In Group 1 with 15 symptomatic subjects, 30 TM joints were examined in which 18 (60%) were symptomatic joints and 12 (40%) were asymptomatic joints on the basis of clinical findings. Out of total 18 symptomatic joints diagnosed clinically, 11 joints were diagnosed Left sided TMD and 7 joints were diagnosed Right sided TMD clinically. But on MRI study, out of these 18 joints, 14 were diagnosed with disc Displacement and 4 joints with no Disc Displacement. Further, out of 12 asymptomatic joints, 2(16.7%) joints were diagnosed with disc displacement on MRI and 10 (83.3%) were diagnosed with no disc displacement. In Group 2, 30asymptomatic TM joints were examined by MRI. Only 21(3.3%) joints showed Disc Displacement on MRI.

Sensitivity and specificity tests were applied. It implied the 87.5% sensitivity and 71.4% specificity in Group 1 between MRI diagnosis and clinical findings. Whereas in Group 2, sensitivity was 0% because no clinically symptomatic joint was there and specificity was 100% (Table 7)

Discussion

Temporomandibular disorders is a collective term used to describe a number of related disorders affecting the temporomandibular joints, masticatory muscles, and associated structures, all of which have common symptoms such as pain and limited mouth opening. About 60-70% of the general population has at least one sign of a temporomandibular disorder, yet only around one in four people with signs is actually aware of, or reports any, symptoms [17-18]. Furthermore, only about 5% of people with one or more signs of a temporomandibular disorder will actually seek treatment [19-21]. Most of those who seek treatment for temporomandibular disorders are female-they outnumber male patients by at least four to one [20-22]. Although temporomandibular disorders may occur at any age, patients most commonly present in early adulthood [19, 20, 23]. Further, various authors have debated regarding the role of presence of Disc Displacement on MRI and presence of signs and symptoms of TMJ disorders [10]. Apart of the fact that this aspect is a topic of debate, no concrete conclusions have been achieved. Henceforth, the present study was focused on evaluating the presence of signs and symptoms of TMDs in symptomatic and asymptomatic subjects and correlating these findings with MRI findings of Disc Displacement.

It was found that 86.7% of symptomatic subjects presented with Disc Displacement on MRI examination. These results were in agreement with previous studies done by Kannan A *et al*, Ribeiro RF *et al.* and Milano V *et al.* who reported the prevalence of disc displacement in the range of 77 ± 91% [2, 10]. On the contrary, recent literature also advocates the presence of disc displacement in a number of asymptomatic subjects.

In this study, 6.7 % of the asymptomatic subjects presented with Disc Displacement which was in agreement with various studies in literature [10, 14] In addition, many authors reported higher prevalence of Disc Displacement in asymptomatic subjects like Ribeiro RF *et al.* in 1997 reported 25% cases of disc displacement while, Larheim TA *et al.* in 2001 reported a 35% prevalence of Disc Displacement on MRI evaluation in asymptomatic subjects [10, 14]. When comparison was done between Group 1 and Group 2 for the presence of Disc Displacement based on MRI findings, there was highly significant difference in the presence of Disc Displacement with P value of <0.001.This result was in agreement with Larheim *et al.* [14, 24, 25]. In this study, 26.7% of the joints showed Anterior Disc Displacement with reduction and the same number i.e. 26.7% showed Anterior Disc Displacement without reduction on MRI in Group 1 (Symptomatic subjects). This may be attributed to the fact that the normal position of the disc is anterior to the condyle [26]. However, in Group 2, Disc Displacement was found in 1 joint and was diagnosed with Disc Displacement with reduction. Further, in 12 asymptomatic joints of Group 1, 2 joints showed Disc Displacement with reduction. These results were in agreement with previous studies done by Maizlin ZV *et al.*, Kannan *et al.* and Sener S *et al*. Maizlin recorded 37% joints with DDR and 17% with DDWR in symptomatic joints. However, Sener reported 65% joints with DDR and 35% with DDWR. Furthermore, Kannan *et al.* recorded 63 % joints with DDR and 10 % joints with DDWR. From this we can conclude that there is higher prevalence of Disc Displacement with reduction in symptomatic and asymptomatic joints [2, 12, 13].

Further in this present study, MRI findings of Disc Displacement correlated well with clinical findings of TMD in patients of Group 1 and Group 2 with Sensitivity of 92.9 % and specificity of 837.5%. Considering joints in Group 1, Sensitivity and Specificity was 87.5 % and 71.4 % respectively. In Group 2, Sensitivity was 0 % because all the joints were asymptomatic, while Specificity was 100 %. Related studies have been done by various authors. They recorded variations in sensitivity and specificity of MRI for Disc Displacement comparing with clinical findings i.e. Benbelaid R *et al*. (Sensitivity of 63%, Specificity of 81%), Shaefer JR *et al.* (Sensitivity 94%, Specificity of 36%) and Aoyama S *et al.* (Sensitivity of 95.65%, Specificity 71.43%) [26-28]. The reason for the variations may be attributed to the fact that they have taken the different criteria for diagnosing TMD and different protocols for diagnosing Disc Displacement on MRI. Keeping these results in mind, it can be tentatively concluded that MRI is highly sensitive and specific for the Disc Displacement and the diagnosis made with MRI can be correlated well with clinical signs and symptoms of temporomandibular joint disorders in symptomatic and asymptomatic subjects.

Further, it can also be commented that the above drawn conclusion would have been more concrete if the limitation of this study were dealt pertinently. In this study, sample size was small. Further, the Group 1 patients were selected according to RDC, but no concern was paid to the duration of the presence of these signs and symptoms. Furthermore, in this study, MR images were interpreted by a single Radiologist. Moreover, this study also does not correlate whether any particular clinical sign or symptom is related with the presence of Disc Displacement.

Henceforth, further studies are required to overcome the limitations of the present study and in substaining the above results.

Conclusion

We identified a significant correlation between clinical symptoms and MRI findings of disc displacement. The first

step of an MRI study of the TMJ is, without a doubt, to evaluate the disk, its morphology, and location in the closed- and open-mouth position with respect to the condyle.

However, special attention must be paid to analyze the presence of other indirect and early signs that can result in the diagnosis of TMJ dysfunction. The last stage of dysfunction is announced on the appearance of osteoarthritic changes such flattening or condylar osteophytes. It is important for the radiologist to detect early MRI signs to thereby avoid the evolution to these advanced and irreversible phase of dysfunction with osteoarthritic changes.

Conflict of Interest

No potential conflict of interest relevant to this article was Reported.

References

1. Fletcher MC, Piecuch JF, Lieblich SE. Anatomy and pathophysiology of the temporomandibular joint. In Peterson's nPrinciples of Oral and Maxillofacial Surgery, edn 2. Edited by Miloro M. Hamilton (Ontario): BC Decker. 2004, 933-947.
2. Okeson JP. Functional anatomy and biomechanics of masticatory system. 7th ed. Management of Temporomandibular Disorders and Occlusion, 2013, 1-20.
3. Kannan A, Sathasivasubramanian S. Comparative study of clinical and Magnetic resonance imaging diagnosis in patients with internal derangement of temporomandibular joint. J Indian Acad Oral Med Radiol. 2011; 23:569-75.
4. Yildirim D, Dergin G, Tamam C, Moroglu S, Gurses B. Indirect measurement of Temporomandibular joint elasticity with Magnetic Resonance Imaging. Dentomaxillofac Radiol. 2011; 40:422-8.
5. Wadhwa S, Kapila S. TMJ disorders: future innovations in diagnostics and therapeutics. J Dent Educ. 2008; 72:930-47.
6. Laskin DM. Diagnosis and etiology of myofascial pain and dysfunction. Oral Maxillofac Surg Clin North Am. 1995; 7:73-78.
7. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique J Craniomandib Disord. 1992; 6:301-355.
8. Modi P, Shaikh SS, Munday A. A cross sectional study of prevalence of temporomandibular joints in university students. Int J Sci Res Publ. 2012; 2(9):1-3.
9. Ryalata S, Baqaina ZH, Amina WM, Sawaira F, Samarab O, Badranb DH. Prevalance of temporomandibular joint disorders among students of university of Jordan. J Clin Med Res. 2009; 1(3):158-64.
10. Mutlu N, Herken H, Guray E, Oz F. Evaluation of the prevalence of temporomandibular joint disorders syndrome in dental school students with Psychometric analysis. Turk J Med Sci. 2002; 32:345-50.
11. Jerolimov V. Temporomandibular disorders and Orofacial pain. J Med Sci. 2009; 33:53-77.
12. Ribeiro RF, Tallents RH, Katzberg RW *et al*. The prevalence of Disc Displacement in symptomatic and asymptomatic volunteers aged 6 to 25 years. J Orofac Pain. 1997; 11:37-47.
13. Campos MIG, Campos PSF, Cangussu MCT, Guimaraes RC, Lines SRP. Analysis of magnetic resonance imaging characterstics and pain in temporomandibular joint with and without degenerative changes of condyle. Int J Oral Maxillofac Surg 2008; 37:529-34.
14. Sener S, Akgunlu F. MRI characteristics of anterior disc displacement with and without reduction. Dentomaxillofac Radiol. 2004; 33:245-52.
15. Gil C, Santos KCP, Dutra MEP, Kodaira SK, Oliviera JX. MRI analysis of the relationship between bone changes in the TMJ and articular disc position in symptomatic patients. Dentomaxillofac Radiol. 2012; 41:362-77.
16. Westesson PL, Eriksson L, Kurita K. Reliability of a negative clinical temporomandibular joint examination: prevalence of disk displacement in asymptomatic temporomandibular joints. Oral Surg Oral Med Oral Pathol. 1989; 68:551-554.
17. Katzberg RW, Bessette RW, Tallents RH *et al*. Normal and abnormal temporomandibular joint: MR imaging with surface coil. Radiology. 1986; 158:183-189.
18. Manfredini D, Nardini LG, Winocur E. Research diagnostic criteria for temporomandibular disorders: a systemic review of axis 1 epidemiological findings. Oral Surg Oral Med Oral Path Oral Radiol Endod. 2011; 112(4):453-62.
19. Schiffman E, Fricton JR, Haley D, Shapiro BL. The prevalence and treatment needs of subjects with temporomandibular disorders. J Am Dent Assoc. 1989; 120:295-304.
20. Greene CS, Marbach JJ. Epidemiologic studies of mandibular dysfunction: a critical review. J Prosthet Dent. 1982; 48:184-90.
21. 1 McNeill C, ed. Temporomandibular disorders—guidelines for classification, assessment and management. 2nd ed. Chicago: Quintessence Books, 1993.
22. Salonen L, Hellden L. Prevalence of signs and symptoms of dysfunction in the masticatory system: an epidemiological study in an adult Swedish population. J Craniomandibular Disord Facial Oral Pain. 1990; 4:241-50.
23. Hannson T, Milner M. A study of occurrence of symptoms of diseases of the temporomandibular joint, masticatory musculature, and related structures. J Oral Rehabil. 1975; 2:313-24.
24. Dworkin SF, Huggins KH, LeResche LR, Von Korff M, Howard J, Truelove E *et al*. Epidemiology of signs and symptoms in temporoman- dibular disorders. I. Clinical signs in cases and controls. J Am Dent Assoc. 1990; 120:273-81.
25. Greene CS, Marbach JJ. Epidemiologic studies of mandibular dysfunction: a critical review. J Prosthet Dent. 1982; 48:184-90.
26. Takatsuka S, Yoshida K, Ueki K, Marukawa K, Nakagawa K, Yamamoto E. Disc and condyle translation in patients with Temporomandibular disorder. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005; 99:614-21.
27. Katzberg RW, Tallents RH. Normal and abnormal temporomandibular joint disc and posterior attachment as depicted by Magnetic Resonance Imaging in symptomatic and asymptomatic subjects. J Oral Maxillofac Surg. 2005; 63:1155-61.
28. Shaefer JR, Riley CJ, Caruso P, Keith D. Analysis of criteria for MRI diagnosis of TMJ Disc Displacement and Arthralgia. Int J Dent. 2012, 1-8.