Magnetic resonance imaging assessment of temporomandibular joint disorders

Hassan Ibrahim Meggaly[a], Abolhasan Haseib[a], Mohamed Hasan Osman[b], Abeer M. Salah[a]

[a]Department of Radio-Diagnosis, [b]Maxillofacial Unit, Department of General Surgery, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence to Abeer M. Salah, BSc, Department of Radio-Diagnosis, Assiut University Hospitals, Faculty of Medicine, Assiut University, Assiut, Egypt.
Postal Code 71526;
Tel: +20 101 339 8549;
e-mail: abeertageldin2@gmail.com

Received 19 September 2019
Revised 23 September 2019
Accepted 16 October 2019
Published 16 May 2020

Journal of Current Medical Research and Practice
2020, 5:185–190

Background
This prospective study aimed to detect the temporomandibular joint (TMJ) disk position in patients with TMJ dysfunction and asymptomatic patients using MRI.
Results
Out of 40 joints clinically diagnosed as internal derangement, MRI showed anterior disk displacement without reduction in five (12.5%) joints, anterior disk displacement with reduction in 12 (30%) joints while 23 joints showed no disk displacement (57.5%). MRI results of 20 asymptomatic joints showed ADDWR in two (10%) joints and no dis displacement in the remaining 18 (90%) joints. The associations of clinical diagnosis with MRI scan findings in both symptomatic and asymptomatic groups were statistically highly significant ($P < 0.001$).
Conclusion
From our study, we could conclude that in most of asymptomatic normal TMJs, the disk will be in the normal position with few exceptions. Among displaced disks, ADDWR is the most frequent MRI diagnosis in patients with internal derangement.

Keywords:
temporomandibular joint dysfunction, MRI, disc displacement, osteoarthritis, internal dearragment

J Curr Med Res Pract 5:185–190

2357-0121

Introduction

The temporomandibular joint (TMJ) is a synovial joint located at the skull base in front of the ear and connects the mandible with the temporal bone. Anatomically, the most important TMJ structure is the articular disk (meniscus). This is a biconcave fibrocartilaginous structure which divides the TMJ into superior and inferior compartments. The presence of the articular disk between the temporal bone and mandibular condyle prevents articular damage in the closed-mouth and open-mouth positions [1].

According to some studies, TMJ dysfunction affects up to 28% of the population, although these studies did not show adequate imaging findings. The most frequent cause of TMJ dysfunction, or TMJ disorder, is internal derangement (ID), which is defined as an abnormal relationship of the disk to the condyle [2,3].

Recently, MRI has been considered as the imaging modality of choice in the evaluation of TMJ dysfunction. The technique of MRI in this entity uses 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-mouth and open-mouth positions. Furthermore, a dynamic study can be performed during progressive mouth opening with cine MRI [4,5].

Together with the progress of MRI, there have been significant improvements in both hardware and software that currently allow better visualization of small structures such as the retrodiscal layers or the lateral pterygoid muscle (LPM) attachments [6].

Accurate localization of the disk is very important in the diagnosis of TMJ ID and can easily be achieved with MRI. Anterior disk displacement has been seen in up to 34% of asymptomatic volunteers [7,8]) and a normal disk position has been depicted in 16–23% of symptomatic patients [9]. These findings have led the investigators to question if anterior disk displacement is the precursor of clinical ID or merely an anatomic variant [10].

Aim

The aim of this study was to detect the TMJ disk position in patients with TMJ dysfunction and asymptomatic patients using MRI.

Patients and methods

Patients

This study was conducted at the Maxillofacial Surgery Unit and Diagnostic Radiology Department of Assiut University hospitals in the period from April 2016 to February 2017. A total of 35 cases were selected for the study (25 patients and 10 control healthy volunteers). The study was based on 40 joints of 25 symptomatic patients with various temporomandibular dysfunction (TMD) (study group; where 15 patients complained of both TMJs and 10 patients complained of one TMJ) and 20 joints of 10 asymptomatic volunteers (control group). The patients mean ± SD age was 29.36 ± 7.09 years. The ethics committee approval was obtained and all selected patients and controls filled a written consent form.

All patients were assessed using the Research Diagnostic Criteria for TMD [11]. Asymptomatic (control) individuals were included for our study after fulfilling the following evaluation:

(1) A clinical questionnaire to exclude the presence of jaw pain, joint noise, locking, and history of TMD.
(2) Clinical TMJ and dental examination for symptoms and signs usually associated with ID.
(3) A detailed medical and dental history to exclude the presence of any nonfunctional habits and systemic diseases.

Inclusion criteria for the study group were based on the presence of the following clinical findings:

(1) Restricted mouth opening.
(2) Deviated opening and/or closing of the mandible.
(3) TMJ pain during mandibular movement.
(4) Tenderness of masticatory muscles on palpation.
(5) Crepitation/clicking during mouth opening and/or closing movement.

The exclusion criteria for both groups (study and control) were as follows:

(1) Claustrophobic and uncooperative patients.
(2) Patients with a cardiac pacemaker, metallic prosthesis heart valves, cerebral aneurysm clip, or ferromagnetic foreign bodies.
(3) Patients with obvious skeletal jaw deformity, history of traumatic extraction, history or undergoing orthodontic treatment.

Methods

MRI examination

All MRI examinations were performed on a 1.5 T MRI system (Achieva; Philips Medical Systems, Best, The Netherlands).

For optimal imaging of the TMJ, small bilateral surface coils with a small field of view were used to achieve a higher signal-to-noise ratio and simultaneous bilateral acquisition. Coronal and axial T1 sequences were done in the closed mouth to evaluate the overall anatomy and bone marrow as well as the adjacent soft tissues to exclude other adjacent pathologies.

In our study, axial T1 was obtained as a localizer. Bilateral closed-mouth and open-mouth T2, proton density, and dynamic sequences are obtained in an oblique sagittal plane. Dynamic MRIs were obtained as a rapid acquisition of static images using a single-shot fast spin echo proton density sequence during progressive opening and closing of the mouth. These images were then displayed sequentially as a cine loop (Table 1).

To maintain an open-mouth position, a rubber bite block was used. We did not use mouth opening devices as passive mouth opening with a device might not reproduce the physiological conditions occurring during mouth opening with the possible role of the LPM that keeps disk stabilization during mouth opening.

Image interpretation

The criterion used to interpret the disk position in closed as well as the open mouth was the intermediate zone (IZ) criterion [12].

The condition of each joint was categorized according to the following diagnosis:

(1) No disk displacement (NDD).
(2) Anterior disk displacement with reduction (ADDWR).
(3) Anterior disk displacement without reduction (ADDWOR).

The position of the disk in the closed mouth (Fig. 1a, Fig. 2a) was considered normal (NDD),

Table 1 MRI protocol for temporomandibular joint imaging

Plane	Sequence	Slice thickness	TR	TE	Mouth open/closed
Axial	T1	2 mm, 0 skip	500	Minimal	Closed
Coronal	T1	3 mm, 0.5 skip	500	Minimal	Closed
Bilateral sagittal oblique	T2 and PD	3 mm	3500	Minimal and 85	Closed and open
Bilateral sagittal oblique	T2	3 mm	1180-2000	64	Dynamic cine

PD, proton density; TE, echo time; TR, repetition time.

when IZ was located between the anterior–superior aspect of the condyle and posterior–inferior aspect of articular eminence in middle or above a line that joined the centers of two imaginary circles fitted to these structures. In the open mouth (Fig. 1b, Fig. 2b), disk position was considered normal (NDD), if IZ of the disk was located between the condyle and articular eminence in the middle of a line that joined the centers of two imaginary circles fitted to these structures [13]. In both positions, the circles were drawn to closely approximate condyle and eminence outlines. The upper limit of eminence circle was set to be within the bone boundary to the cranial cavity (Fig. 1).

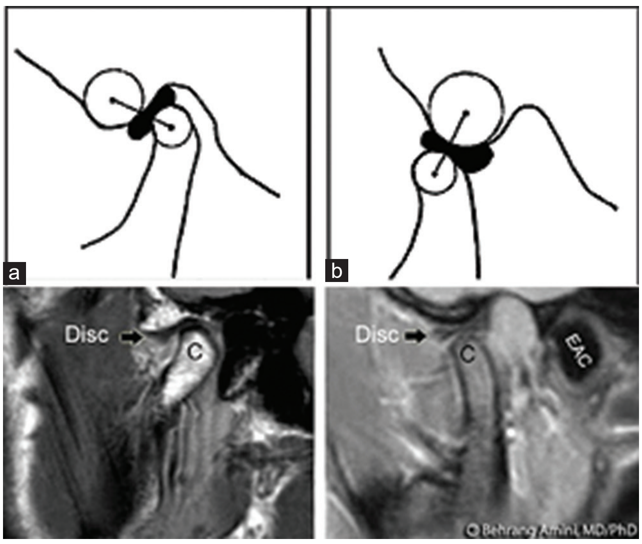
Diagnosis of ADDWR was considered when a displaced disk in the closed-mouth position assumed the normal position in the open mouth (Figs. 3 and 4). ADDWOR was considered when the displaced disk in the closed-mouth position has not achieved a normal position in the open mouth (Figs. 5).

Consensus on interobserver diagnosis was taken from two different radiologists who were blinded to each other's MRI analysis and clinical diagnosis. The values obtained from two observers were compared to assess the agreement among them regarding MRI diagnoses.

Results

Among the study group, joint tenderness was the most frequent and joint noise was the least common clinical finding. Thirty (75%) joints were tender, 22 (55%) showed restricted opening, 18 (45%) showed muscle tenderness, 16 (40%) showed joint deviation while 14 (35%) showed joint noise (Fig. 6).

Figure 1



Normal disk position in (a) closed- and (b) open-mouth position.

As regards clinical diagnosis in the study group, 15 (37.5%) joints were diagnosed as ADDWR, six (15%) joints were ADDWOR, five (12.5%) were myositis, and two (5%) were osteoarthritis. The remaining 12 (30%) joints were diagnosed as free of NDD (Fig. 7).

MRI diagnosis: out of 40 joints of the study group, five were diagnosed as ADDWOR, 12 were diagnosed as ADDWR while the remaining 23 joints did not show any disk displacement; so were diagnosed as NDD. As regards 20 joints of the control group, MRI revealed NDD in 18 (90%) of them while two (10%) joints were diagnosed as ADDWR (Table 2).

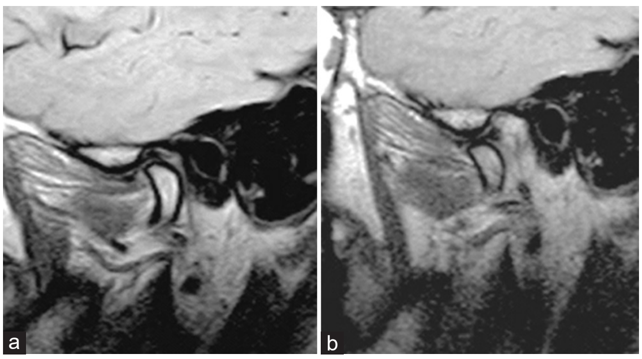
Comparing the clinical and MRI diagnosis of disk position, out of the six joints clinically diagnosed as ADDWOR, MRI confirmed the diagnosis in five (83.3%) while one joint was diagnosed as NDD. Out of the 15 joints clinically diagnosed as ADDWR, MRI confirmed the diagnosis in 11 (73.3%) while four joints were diagnosed as NDD. Out of the 12 joints clinically diagnosed as NDD, MRI confirmed the diagnosis in 11 (91.7%) while one joint was diagnosed as ADDWR (Table 2).

The associations of clinical diagnosis with MRI findings in both symptomatic and asymptomatic groups were statistically highly significant ($P < 0.001$).

Discussion

TMJ disk displacement occurs when the articular disk located between the condyle and the mandibular fossa moves out from these two structures so that the mandible and temporal bone contact is made on tissues other than the articular disk. This is usually very painful because unlike these adjacent tissues, the central portion of the disk contains no sensory innervations [14]. This could be the reason for the occurrence of joint tenderness as the

Figure 2



Sagittal oblique PDW images of the right TMJ in closed (a) and open (b) mouth positions showing normal disk position with no disk displacement (NDD). TMJ, temporomandibular joint.

Table 2 Comparison of clinical diagnosis and MRI diagnosis in symptomatic and asymptomatic groups

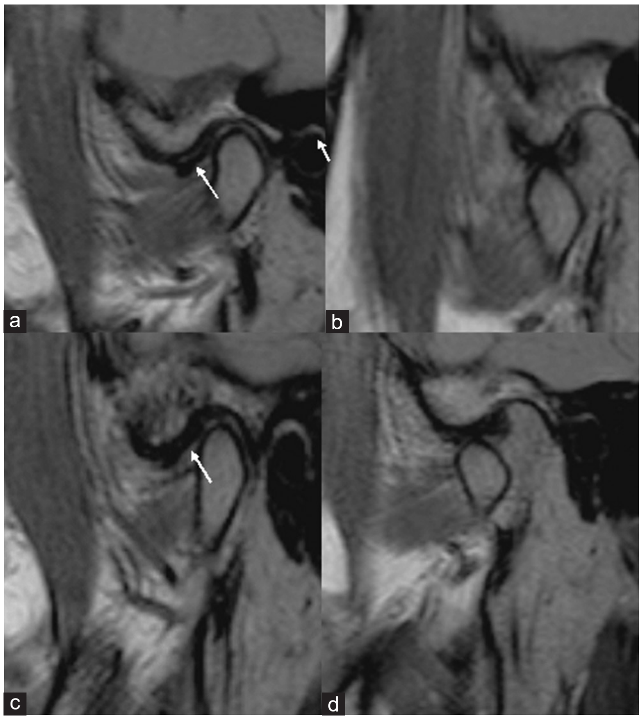
	MRI diagnosis [*n* (%)]					*P*
	ADDWOR	ADDWR	NDD	Total	χ^2	
Clinical diagnosis						
ADDWOR	5 (83.30)	0	1 (16.70)	6 (100)	76.298	<0.001
ADDWR	0	11 (73.30)	4 (26.70)	15 (100)		
Myositis	0	0	5 (100)	5 (100)		
NDD	0	1 (8.30)	11 (91.70)	12 (100)		
Osteoarthritis	0	0	2 (100)	2 (100)		
Asymptomatic	0	2 (10)	18 (90)	20 (100)		
Total	5 (8.30)	14 (23.30)	41 (68.30)	60 (100.00)		

ADDWOR, anterior disk displacement without reduction; ADDWR, anterior disk displacement with reduction; NDD, no disk displacement.

Figure 3

Sagittal oblique STIR closed-mouth (a) and proton density open mouth (b) showing anterior disk displacement with reduction (ADDWR). The disk is arrowed.

Figure 4



Sagittal oblique proton density closed and open mouth of the right TMJ (a and b) showing anterior disk displacement with reduction (ADDWR). Sagittal oblique proton density closed and open mouth of the left TMJ of the same patient (c and d) also showing ADDWR. The disk is arrowed. TMJ, temporomandibular joint.

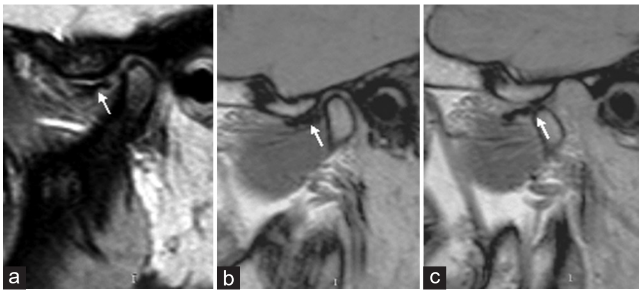
most common clinical symptom among symptomatic patients in our study. Many authors mentioned joint tenderness as the most frequent presenting symptom among their study groups [13–15].

Using MRI analysis obtained with sagittal oblique projections, the disk position within the TMJ is considered normal when the posterior band of the disk is seen located at '12 o'clock' where the posterior disk band is positioned over the upper portion of the mandibular condyle (i.e. closed-mouth and dental contact) [16,17]. Nevertheless, many studies have shown that such '12 o'clock position' of the disk is not observed in ~30% of asymptomatic patients [18,19]. Thus, this condition raises a question about the definition of the normal position of the disk.

The present study included 20 joints of an asymptomatic 10 volunteers (control group). MRI scan showed two of the (10%) joints as ADDWR and the remaining 18 did not show any disk displacement. Kircos *et al*. [8] and Kishor Kanneppady *et al*. [14] also found a small percentage of disk displacement in asymptomatic volunteers (10 and 5%, respectively). In a study by Tallents *et al*. [15] which involved MRI analysis of disk position in asymptomatic volunteers and symptomatic patients, the researchers observed up to 33% of disk displacement in asymptomatic volunteers. In another study by Uchida, *et al* [20]. Disk displacement was present in 37% of asymptomatic patients. The occurrence of such silent displacement of articular disks in asymptomatic, normal joints could be just a variant of joint anatomy or it may be an alarming sign of future TMD.

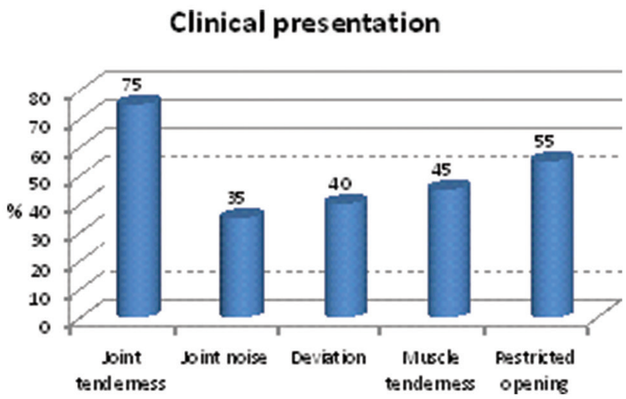
ADDWR is caused by an articular disk that has been displaced from its position on top of the condyle due to elongation or tearing of the restraining ligaments [14]. Multiple etiological factors of DDWR are partially attributed to abnormal biomechanical forces applied to the mandibular condyle, which alter the shape and function of the articular tissues causing articular noise during mouth opening and closing. Dental clenching,

Figure 5



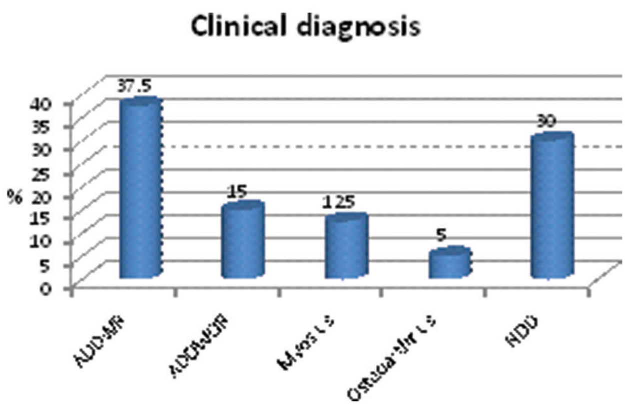
Sagittal oblique STIR and proton density closed-mouth (a and b) and sagittal oblique proton density open mouth (c) showing anterior disk displacement without reduction (ADDWOR). The disk is arrowed.

Figure 6



Clinical presentation among the study group.

Figure 7



Clinical diagnosis among the study group.

stress, mandible trauma, excessive mastication, shape alterations of the articular tubercle and articular surfaces, lack of lubrication, disk modifications, degenerative articular disorder, hyperactivity of the LPM, ligament sprains, abnormal dental occlusion, mandible hypoplasia, loss of posterior teeth, deflective dental occlusion, hypermobility, and, occasionally, whiplash injury, are also considered as possible risk factors for DDWR [17,18,21].

Disk displacement with reduction is common in the general population, and clicking or popping joint is of little clinical significance unless it is accompanied by pain, loss of function, and/or intermittent locking [14].

In the present study on 40 joints diagnosed clinically as ID, MRI confirmed ID in 17 joints, 12 (70.6%) of them were ADDWR and five (29.4%) were ADDWOR. The remaining 23 joints did not show any disk displacement by MRI. Among the displaced disks, ADDWR was the most common MRI finding in our study. This is similar to Hassan, *et al.* [22]) who also found ADDWR as the most common representing 60.7% of displaced disks. In another large study by Marpaung *et al.* [23] performed on 1562 patients, ADDWR was the most common, encountered in about 34% of patients. Lalue-Sanc hes *et al.* [24] concluded that anterior and anterior–lateral DDWR are the most common TMJ disk displacements.

Limitation

The data obtained by our study need confirmation by other study series with a larger number of cases.

Conclusion

From our study, we could conclude that in most of asymptomatic normal TMJs, the disk will be in the normal position with few exceptions. Among patients with TMJ ID, joint tenderness is the most common clinical presentation. Among displaced disks, ADDWR is the most frequent MRI diagnosis in patients with ID.

Acknowledgements

Abeer M. Salah carried out the collection of patients and volunteers, filled their complete clinical sheets, and was concerned till they have performed MRI examination. M.H. Osman carried out full clinical assessment of the patients. Abolhasan Haseib carried out reading MRI of the cases and performed the statistical analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Helms CA, Kaban LB, McNeill C, Dodson T. Temporomandibular joint: morphology and signal intensity characteristics of the disk at MR imaging.

Radiology1989; 172: 817–820.

2 Guralnick W, Kaban LB, Merrill RG. Temporomandibular joint afflictions. N Engl J Med 2006; 299:123–129.

3 Solberg WK, Woo MW, Houston JB. Prevalence of mandibular dysfunction in young adults. J Am Dent Assoc 2005; 98:25–34.

4 Katzberg RW, Bessette RW, Tallents RH. Normal and abnormal temporomandibular joint: MR imaging with surface coil. Radiology 2008; 158:183–189.

5 Rao VM. Imaging of the temporomandibular joint. Semin Ultrasound CT MR 2007; 16:513–526.

6 Lieberman JM, Hans MG, Rozencweig G, Goldberg JS, Bellon EM. MR imaging of the juvenile temporomandibular joint: preliminary report. Radiology 2010; 182:531–534.

7 Kaplan PA, Tu HK, Williams SM, Lydiatt DD. The normal temporomandibular joint: MR and arthrographic correlation. Radiology 2012; 165:177–178.

8 Kircos LT, Ortendahl DA, Mark AS, Arakawa M. Magnetic resonance imaging of the TMJ disc in asymptomatic volunteers. J Oral MaxillofacSurg 2005; 45:852–854.

9 Tallents RH, Katzberg RW, Murphy W, Proskin H. Magnetic resonance imaging findings in asymptomatic volunteers and symptomatic patients with temporomandibular disorders. J Prosthet Dent 2006; 75:529–533.

10 Katzberg RW, Westesson PL, Tallents RH, Drake CM. Anatomic disorders of the temporomandibular joint disc in asymptomatic subjects. J Oral Maxillofac Surg 2013; 54:147–153.

11 Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. J Craniomandib Disord 1992;6:301–355.

12 Orsini MG, Kuboki T, Terada S, *et al*. Diagnostic value of 4 criteria to interpret temporomandibular joint normal disk position on magnetic resonance images. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998; 86:489–497.

13 Barclay P, Hollender LG, Maravilla KR, *et al*. Comparison of clinical and magnetic resonance imaging diagnoses in patients with disc displacement in the temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005; 88:37–43.

14 Kishor Kanneppady S, Chatra L, *et al*. Assessment of articular disc position in normal and pathologic temporomandibular joints using MRI. J Oral Health Commun Dent 2012; 6:86–90.

15 Tallents RH, Katzberg RW, Murphy W, *et al*. Magnetic resonance imaging findings in asymptomatic volunteers and symptomatic patients with temporomandibular disorders. J Prosthet Dent 2010; 75:529–533.

16 Manfredini D. Etiopathogenesis of disk displacement of the temporomandibular joint: a review of the mechanisms. Indian J Dent Res 2009; 20:212–221.

17 Manfredini D, Basso D, Arboretti R, Guarda-Nardini L. Association between magnetic resonance signs of temporomandibular joint effusion and disk displacement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009; 107:266–27.

18 Manfredini D, Guarda-Nardini L. Agreement between research diagnostic criteria for temporomandibular disorders and magnetic resonance diagnoses of temporomandibular disc displacement in a patient population. Int J Oral Maxillofac Surg 2008; 37:612–616.

19 Pérez del Palomar A, Doblaré M. Influence of unilateral disc displacement on the stress response of the temporomandibular joint discs during opening and mastication. J Anat 2007 211:453–463.

20 Uchida T, Komiyama O, Okamoto Y, *et al*. Evaluation of temporomandibular joint disk displacement in asymptomatic volunteers using magnetic resonance imaging. Int J Oral-Med Sci 2015; 14:21–27.

21 Mazza D, Marini M, Impara L, *et al*. Anatomic examination of the upper head of the lateral pterygoid muscle using magnetic resonance imaging and clinical data. J Craniofac Surg 2009; 20:1508–1511.

22 Hassan TA, Mohey N, Haitham AD.Internal derangement of the temporomandibular joint: value of MRI imaging in symptomatic patients. Med J Cairo Univ 2014; 82:115–120.

23 Marpaung C, VanSelms MKA, Lobbezoo F. Temporomandibular joint anterior disc displacement with reduction in a young population: Prevalence and risk indicators. Int J Paediatr Dent 2019; 29:66–73.

24 Lalue-Sanches M, Gonzaga AR, Guimaraes AS, Ribeiro EC Disc Displacement with Reduction of the Temporomandibular Joint: The Real Need for Treatment. J Pain Relief January 2015; 4:200.