ORIGINAL ARTICLE

Magnetic resonance imaging evaluation of temporo-mandibular joint disorders, criterial analysis and significance in comparison with arthroscopy

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KEYWORDS
Temporo-mandibular joint; Magnetic resonance imaging; Arthroscopy

Abstract  Aim: The aim of our study was to analyze magnetic resonance imaging criteria in assessment of TMJ disorders and evaluate the important MRI role in comparison with arthroscopy.

Patients and methods: The study was performed on eighty TMJs. TMJs are examined by 1.5 tesla MRI machine using sagittal oblique T1, PD & T2 weighted images & coronal oblique T1 and PD weighted images. The disk position, configuration, presence or absence of joint effusion, osteo-arthritis and mandibular condyle morphology were assessed. Comparison was done with arthroscopy in 49 joints.

Results: Disk displacement was found in all cases symptomatic 80 joints, 60% bilateral and 40% unilateral. Joint pain and tenderness were the most clinical symptom followed by joint noise/clicking. Thirty-five joints showed anterior disk displacement with reduction, while forty-five joints showed anterior disk displacement without reduction and one of them shows stuck disk in displaced position. MRI has sensitivity of 95, specificity of 88 and accuracy of 94 in comparison with arthroscopy.

Conclusion: MRI is proper diagnostic modality for TMJ disorders due to non invasiveness, excellent soft tissue contrast and multiplaner capabilities.

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Abbreviations: TMJ, temporo-mandibular joint; MRI, magnetic resonance imaging; ADDWR, anterior disk displacement with reduction; ADDWOR, anterior disk displacement without reduction

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1. Introduction

Temporo-mandibular joint (TMJ) pain and dysfunction are commonly seen important clinical problems and according to some studies, affect up to 28% of population (1).

The most frequent cause of TMJ dysfunction, or TMJ disorder, is internal derangement, which is defined as an abnormal relationship of the disk to the condyle. MR imaging helps in assessment of signs of TMJ dysfunction. Since the advent of MR imaging there have been substantial improvements in both hardware and software that currently allow better visualization of small structures such as retrodiscal layers or lateral pterygoid muscle attachment (1).

Magnetic resonance imaging is accepted as the most advanced imaging modality for diagnosis of TMJ abnormalities. It is non invasive and has the potential to yield high quality tomographic imaging in any plane with bone as well as soft tissue spatial resolution. Additionally, the patient was not exposed to ionizing radiation or any biological hazards. Other advantages of MR imaging are its sensitivity, specificity and diagnostic accuracy (2).

MR imaging represents the best method for studying clinically affected joints, for the evaluation morphological status of TMJ and for the analysis of dynamic process during mouth opening (3). This is not true dynamic images but it is pseudo dynamic MR imaging obtained from the serial multiple static images (4).

MR imaging is the best technique to correlate and compare TMJ components such as bone, disk, fluid, capsule and ligaments with autopsy specimens (5).

Our issue is to analyze magnetic resonance imaging criteria in assessment of TMJ disorders especially internal disk derangement and evaluate the important MRI role in comparison with arthroscopy (see Figs. 1–6).

2. Patients and methods

In this retrospective study, we included 50 consecutive patients (80 joints) who were referred from dentist’s and rheumatologist’s clinics. They were suffering from clinical manifestations of temporo-mandibular joint affection.

Fig. 1 Sagittal oblique (A) closed- and (B) open-mouth show right TMJ anterior disk displacement with reduction and joint effusion.

Fig. 2 Sagittal oblique (A) closed- and (B) open-mouth show right TMJ anterior disk displacement without reduction with joint effusion and deformed disk.
This study was performed at the period from April 2013 to October 2015.

The clinical inclusion criteria for the study group were assessed on following clinical characteristics:

1. Limited mouth opening or crepitiation.
2. Deflection of mandible or pain at mouth opening.

The exclusion criteria for the study group were as follows:

1. Patient with systemic disease affects TMJ as rheumatoid arthritis.
2. Patient with obvious skeletal jaw deformity or previous trauma.
3. Contra-indication to MRI as claustrophobic and uncooperative patients, or who had cerebral aneurysm clip and cardiac pace maker.
4. Metallic prosthesis like heart valves and ferromagnetic foreign bodies in critical location like eye.

This study was conducted according to the guidelines of the ethics committee of our university and was approved by our institutional review board. All patients gave written informed consent to be imaged in our study.

All the patients were subjected to the following:

1. Detailed history with special emphasis on: history of the present illness rheumatoid arthritis and trauma previous interference.
2. Clinical examination including palpation of the TMJ and muscles of mastication for pain, palpation of joint sounds, stability as well as measurement of the range of motion.
3. Laboratory investigations: such as complete blood picture, rheumatoid factor and ESR.
4. Diagnostic examination and imaging:
Conventional MR study:

1. The MRI machine: MRI scans were performed using (General Electric SIGNA) HS (high speed) 1.5 T system in MRI unit of Radiodiagnosis and Medical Imaging Department at Tanta University Hospital.

2. Technique Patient was laid supine with both arms adducted where the special TMJ dual coil was applied for the examination.

Imaging started by axial localizer including the whole skull base.

Pulse sequences spine echoes were obtained from all patients in closed and maximal open mouth positions on corrected (oblique) sagittal T1 weighted; proton density (PD) and T2 weighted images with corrected (oblique) coronal views done in T1 and PD weighted images.

Matrix: 256 × 128, field of view: 10–12 cm. Number of slices: 18, Slice thickness/space: 3 mm, Imaging time: 3.14 min.

TMJ Localizer: plane: Axial, Pulse sequence: Spin-echo, Number of slices: 10, Slice thickness/space: 5/2 mm, TR/TE:300 ms/12 ms. Imaging time: 28 s.

Sagittal and coronal oblique T1 weighted image – Repetition time: 400–500 ms, Echo time: 10–20 s.

Sagittal and coronal oblique PD weighted image – Repetition time: 2000 ms, Echo time: 10–14 ms.

Sagittal oblique T2 weighted image – Repetition time: 2600 ms, Echo time: 120 ms.

True FISP sequence. It uses ultrashort TR allowing higher spatial resolution (by decreasing the FOV) or higher temporal resolution (by reducing the FOV and raw data matrix size).

3D fast spoiled gradient echo recalled sequence (3D FSPGR). Best depiction of cortical bone thinning, erosions, surface irregularities and subcortical bone cysts.

Dynamic images are obtained as rapid acquisition of static images using a single shot fast spin echo (SSFSE) T2 weighted image (as SSFSE proton density sequence not routinely used in our machine) during progressive opening and closing of the mouth. These images are displayed sequentially as a cine loop. Mouth opening devices such as Burnett opening devices may be used or anything like empty syringe put in mouth to keep it opened. Oblique imaging entails 30° medial from the true sagittal plane. Eight sequences are performed. Dynamic imaging is performed in straight sagittal orientation along the anticipated path of condylar motion.

Fig. 5 Right TMJ sagittal oblique (A) closed- and (B) open-mouth show right TMJ anterior disk displacement without reduction with deformed disk. Left TMJ sagittal oblique (C) closed- and (D) open-mouth show Left TMJ anterior disk displacement with reduction.
Intravenous contrast is not routinely done in our study, as it is used in suspicion of severe inflammatory arthritis or neoplasm.

Images interpretation was done by two consultant radiologists with experience of fifteen years and six years.

Arthroscopy was done in 40 cases (49 joints) after MRI in patients with relatively advanced complaint that agrees to do arthroscopy according to surgical decision.

Both TMJs were examined for disk position, disk configuration, presence or absence of joint effusion in TMJ space and morphology of mandibular condyle.

3. Statistical analysis

Statistical presentation and analysis of the present study was conducted, using the P value and chi-square test by SPSS V.20.

Statistical analysis was undertaken to prove the efficacy of MRI in diagnosis of internal derangement of TMJ as it is considered the most important and most prevalent pathology of TMJ and its grade, either reducible or not.

Sensitivity, specificity and accuracy of MRI findings in comparison with arthroscopy were calculated.

4. Results

In this study, 50 patients were included suffering from clinical manifestations of temporo-mandibular joint (TMJ) affections.

- Age and sex distribution of examined patients discussed in (Table 1).
- Clinical manifestations of the examined patients (Table 2 and Diagram 1).
- Of these 50 patients there were 30 patients suffering from bilateral complaints representing 60% of cases and 20 patients had unilateral affection representing 40%, 14 of them were right sided while 6 were left.

The final results of the TMJs of the patients examined by conventional MRI were categorized as shown in Table 3 into:

Grade I Anterior disk displacement with reduction (ADDWR):

In the closed mouth position, the posterior band of the disk is anterior to the condylar head in all the sagittal sections. When the jaw is opened, the disk is recaptured by the condyle and the disk condyle relation appears as normal.
There were 35 joints (35%) showing grade I internal derangement. They were 19 patients (16 were bilateral and 3 were unilateral).

Of these 35 joints, 29 joints showed normal shaped disk and only 6 joints showed deformed disks with altered signal intensity.

Three joints showed associated effusion. No joints showed secondary degenerative osteo-arthritic changes.

\[(X^2 4.362 \ P \text{value } 0.003^*)\]

Grade II Anterior disk displacement without reduction (ADDWOR): In close and open mouth position, the posterior band of the disk is anterior to the superior aspect of the condylar head in all sagittal section. When the jaw is opened, the disk is anteriorly compressed, whether its shape is modified or not.

There were 45 joints showing grade II internal derangement. They were 31 patients (17 were unilateral and 14 were bilateral). Of these 45 joints, 17 joints showed normal shaped disk and 28 joints showed deformed disks. Also 20 of them show altered signal while 25 of them show normal signal. 11 joints showed associated effusion and secondary degenerative osteo-arthritic changes.

\[(X^2 5.257 \ P \text{value } 0.009^*)\]

- Pattern of disk deformity and disk signal displayed in Table 4.
- Temporo-mandibular joint effusion & osteo-arthritis shown in Table 5.

Comparison study between MRI and arthroscopy for evaluation of temporo-mandibular joint internal derangement was done on selected 40 patients (of 49 TMJs, 31 unilaterally and 9 bilaterally affected) showing that MRI detects anteriorly displaced disks in 41 joints out of 49 joints representing 83.7%, while 8 TMJs (16.3%) showed normal disk position.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Age and sex distribution of the examined patients.</th>
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<tbody>
<tr>
<td>Age group</td>
<td>Number</td>
</tr>
<tr>
<td>Patients age</td>
<td></td>
</tr>
<tr>
<td>14–20 years</td>
<td>25</td>
</tr>
<tr>
<td>21–30 years</td>
<td>18</td>
</tr>
<tr>
<td>31–49 years</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
<tr>
<td>Patients sex</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>33</td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Table 2</th>
<th>Distribution of patients according to clinical presentations.</th>
</tr>
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<tbody>
<tr>
<td>Clinical presentation</td>
<td>Patients number</td>
</tr>
<tr>
<td>Joint pain and tenderness</td>
<td>36</td>
</tr>
<tr>
<td>Joint noise/clicking</td>
<td>32</td>
</tr>
<tr>
<td>Deflection/deviation</td>
<td>22</td>
</tr>
<tr>
<td>Limited mouth opening</td>
<td>21</td>
</tr>
<tr>
<td>Muscle tenderness</td>
<td>19</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Table 3</th>
<th>Distribution of patients according to MRI grading of TMJs disk displacement.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of disk displacement</td>
<td>Grade I</td>
</tr>
<tr>
<td>Reducibility</td>
<td>Reducible</td>
</tr>
<tr>
<td>Number of joints</td>
<td>35 (44%)</td>
</tr>
<tr>
<td>(X^2)</td>
<td>6.250</td>
</tr>
<tr>
<td>(P)-value</td>
<td>0.012*</td>
</tr>
</tbody>
</table>

A-Grade I anterior disk displacement with reduction (ADDWR).
B-Grade II Anterior disk displacement without reduction (ADDWOR).
* Significant.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Pattern of disk shape and disk signal.</th>
</tr>
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<tbody>
<tr>
<td>Type of disk displacement</td>
<td>(X^2)</td>
</tr>
<tr>
<td>Grade I</td>
<td>Grade II</td>
</tr>
<tr>
<td>Pattern of disk shape</td>
<td></td>
</tr>
<tr>
<td>Normal disk shape</td>
<td>29 (83%)</td>
</tr>
<tr>
<td>Deformed disk shape</td>
<td>6 (17%)</td>
</tr>
<tr>
<td>Pattern of disk signal</td>
<td></td>
</tr>
<tr>
<td>Normal disk signal</td>
<td>29 (83%)</td>
</tr>
<tr>
<td>Deformed disk shape</td>
<td>6 (17%)</td>
</tr>
</tbody>
</table>

* Significant.

<table>
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<tr>
<th>Table 5</th>
<th>Temporo-mandibular joint effusion &amp; osteo-arthritis changes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of disk displacement</td>
<td>(X^2)</td>
</tr>
<tr>
<td>Grade I</td>
<td>Grade II</td>
</tr>
<tr>
<td>Joint effusion</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>3 (9%)</td>
</tr>
<tr>
<td>Absent</td>
<td>32 (91%)</td>
</tr>
<tr>
<td>Secondary osteo-arthritis changes</td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>Negative</td>
<td>35 (100%)</td>
</tr>
</tbody>
</table>

* Significant.
MRI revealed 14 TMJs (28.6%) with anterior disk displacement with reduction (ADDWR), while 27 TMJs (55.1%) with anterior disk displacement without reduction (ADWWOR).

Arthroscopy revealed 39 cases are true positive TMJs out of 49 joints (79.6%) with anteriorly displaced disks. Two cases are false positive (4.1). 7 TMJs (14.3%) are true negative. while one joint was false negative (2%).

Arthroscopy revealed 13 TMJs (26.5%) with anterior disk displacement with reduction (ADDWR), while 26 TMJs (53.1%) show anterior disk displacement without reduction (ADWWOR).

Sensitivity 95, specificity 88 and accuracy 94 with positive predictive value (PPV = 95%) and negative predictive value (NPV = 87.5%) (Table 6 and Diagram 2).

5. Discussion

Major components of the TMJ include the mandibular condyle, the articular disk, the glenoid fossa, and the articular eminence of the temporal bone. Unlike most joints, the articulating surfaces are fibrous and not cartilaginous. The fibrocartilaginous articular disk is biconcave, dividing the joint space into superior and inferior compartments. With the rapid progress made in TMJ imaging techniques, many studies have focused on the importance of internal derangement, osteoarthrosis (OA), effusion, and bone marrow edema (BME) as the underlying mechanisms in the etiology of TMJ disorders (6).

MRI with the use of surface coils has markedly improved the delineation of internal derangement of the TMJ and has expanded the knowledge of the anatomical details of such joint enhancing the capabilities of the diagnosis of certain pathological processes involving this joint. (7).

In the present work, sex showed statistically significant differences between the studied groups. Out of total 50 patients studied, 33 were females and 17 were males. The ratio of female to male in this group of patients with temporomandibular joint disorders was 1.9:1. Higher female ratio in this study is in agreement with that of Amin et al., (8) who found increased ratio of female to male patients with temporomandibular joint dysfunctions (2.5:1). Other study by Okeson (9) reported with comparable results.

Another study done by Dalkiz et al. (10) showing that pain and dysfunction TMJ disorders seem to affect women more than men with clinical reports has emphasized the high ratio (8.67:1) of female to male patients for TMJ disorders.

The factors responsible for this predominance are not known however. It has been suggested in animal studies that joint laxity involving any joint occurs more commonly in females than in males. It is suggested that individuals with joint laxity as a result of altered collagen synthesis are at greater risk of developing bilateral temporomandibular joint dysfunction (TMD) when subjected to etiological factors such as trauma, joint overextension, or joint over-use (11).

The current work included 50 patients with symptoms and signs of TMJ dysfunction as follows: joint pain and tenderness, joint noise and clicking sensation, limited jaw opening and muscle tenderness.

In the present study, the most common clinical symptom/sign of the examined patients group was pain/tenderness in preauricular region (36 out of 50 patients) representing 72% with regard to the patients who suffer TMJ pain, and numerous studies based on examination of the MR findings have been carried out. The main findings that are responsible for the etiology are disk malposition, effusion and osteoarthrosis (12). This is in agreement with those of Okeson (9) who reported that disk displacement of TMJ is the important cause of facial and TMJ pain.

On the contrary, Adame et al. (13) in his study stated that the cause of pain/tenderness could be associated with retrodiscal tissue alteration, capsulitis, synovitis. This is in agreement with a study done by Farina et al. (14) showing that MR signal changes in retrodiscal tissue are highly correlated with TMJ pain.

In the present study, joint noise was found in 32 out of 50 patients (64%), thus indicating that TMJ clicking might occur as a consequence of frictional incompatibility between disk and the eminence, when the posterior band of the disk moves anteriorly or posteriorly beyond the apex of the articular eminence. Other causes may be deviation in condylar form (remodeling), adhesion or muscular incardination. Our explanation goes with the study done by Imamimoghaddam et al. (15) who concluded that strong correlation exists between disk displacement on MRI and TMJ click.

The diagnosis of medullary bone signs is influenced by the type of parameter used for MRI. T2 WI is best while any of the parameter such as T1W, T2W, or PDW was used to evaluate disk morphology and function (16) and this goes with our MRI sequences in this search.
In our study, bilateral affection of the temporomandibular joints was noted in 60% of the examined patients. In the study done by Romanelli et al. (17), bilateral temporomandibular joints affection was noted in 63% of cases examined with MRI. It is suggested that the incidence of bilateral internal derangement in patients may be in the range of 50–60%. The reason for the high incidence of bilateral involvement of the TMJs is unknown. However, it may be hypothesized that patients who have a prior history of injury or trauma to the head, neck or jaws may have sustained either direct or indirect damage to the TMJ. Therefore, any exogenous factor that may participate in the development of internal derangement in one temporomandibular joint may lead to development of internal derangement in the contra-lateral joint. While symptoms may be present in both joints, the patient may experience pain and dysfunction of greater intensity and severity on the other side (17).

In the present study the incidence of disk displacement was reported in all cases representing 100% compared to 86% in the study done by Emshoff et al. (6). This disagrees with a study done by Samara et al. (18) revealed that 30% of the studied cases show no abnormalities on MRI examination.

In a study done by Amin et al. (8) on 28 joints examined by MRI, 8 joints showed disk displacement with reduction (28.7%), while 16 joints showed disk displacement without reduction (57.1%). This agrees with our study, as there were 35 joints showing anterior disk displacement with reduction representing 44% of cases and there were 45 joints showed anterior displacement without reduction representing 56% of examined joints.

In a study done by Yilmaz & Toller (19) evaluating 133 temporomandibular joints by MRI, they found that the articular disk is deformed in 52.38% of the joints with reduced anteriorly displaced disk whereas 85.71% of the non reducible disks were deformed. In the present study, the deformed disks represent 83% of the anteriorly displaced non reducible. In the anteriorly displaced reducible disks, disk deformities represented 17% all agree to fact the close association between permanent disk displacement (without reduction) and bone changes is well documented (20).

In our study bony osteoarthritic changes were diagnosed in 11 joints out of 45 joints showing anteriorly displaced disk without reduction representing 24%. This is in agreement with those of Milano et al. (20), and they found bony changes in 15 joints out of the 43 joints with non reducible anterior disk displacement. Also, these results agreed with those of Emshoff et al. (6), and they found a significant relationship between grade II TMJ internal derangement and osteoarthritis and bone marrow edema as well as a significant increase in risk of pain.

Sano et al. (21) reported that degree of pain in TMJs with bone marrow abnormalities was significantly higher than in TMJs with normal bone marrow signal on MR images which supports the concept that bone marrow abnormalities represent a response to an increased intra-articular pressure in conditions of pronounced inflammatory process such as synovitis.

In the present study, joint effusion was diagnosed only in 11 joints of the anteriorly displaced disks without reduction with secondary bony changes representing 24% of the joints with grade II disk degeneration (45 joints). Also we diagnosed three joints in anteriorly displaced disk with reduction showing effusion. Thus, we diagnosed 14 joints with effusion out of the examined joints showing internal derangement.

This is in agreement with a study done by Emshoff et al. (6) who reported joint effusion in 8 of 16 temporomandibular joints with anterior disk displacement. These results also agreed with those of Orlando et al. (22) who found that there is a significant correlation between disk displacement and joint effusion and that a non reducible disk represents a risk factor for the occurrence of joint edema more than a reducible one.

In present study, one joint showed stuck disk in anteriorly displaced position. This agrees with that of Amin et al. (8), and they found that stuck disk represents 3 joints of studied group.

Milano et al. (20) found that sideway disk displacement is rare (1.5%) in their study, and we did not diagnose lateral or medial disk displacement in our study. One possible explanation for the rarity sideway disk displacement compared to anterior disk displacement is that the anterior direction is the line of least resistance for disk movements whereas the medial and lateral surfaces are more firmly supported by their ligaments while posterior disk displacement is much less likely to occur as the normal position of the disk is anterior to the condyle (23).

Comparison study between MRI and arthroscopy for evaluation of temporo-mandibular joint internal derangement was done on selected 40 patients (of 49 TMJs, 31 unilaterally and 9 bilaterally affected) showing that MRI detects anteriorly displaced disks in 41 joints out of 49 joints representing 83.7%, while 8 TMJs (16.3%) showed normal disk position.

MRI revealed 14 TMJs (28.6%) with anterior disk displacement with reduction (ADDWR), while 27 TMJs (55.1%) with anterior disk displacement without reduction (ADDWOR). Arthroscopy revealed 39 cases are true positive TMJs out of 49 joints (79.6%) with anteriorly displaced disks. Two cases are false positive (4.1). 7 TMJs (14.3%) are true negative, while one joint was false negative (2%).

Arthroscopy revealed 13 TMJs (26.5%) with anterior disk displacement with reduction (ADDWR), while 26 TMJs (53.1%) show anterior disk displacement without reduction (ADDWOR). This is in agreement with a study done by Amin et al. (8) which showed that MRI examination revealed 24 joints out of 28 joints with anteriorly displaced disks representing 85.7%, while arthroscopy revealed 20 joints out of 28 joints with anteriorly displaced disks representing 71.4%. It is noted that both MRI and arthroscopy are statistically correlated with each other in detecting TMJ internal derangement, with sensitivity 95, specificity 88 and accuracy 94 with positive predictive value (PPV = 95%) and negative predictive value (NPV = 87.5%) but reviewing the results highlighted the advantages of preoperative MRI as a non invasive highly yielded diagnostic modality in comparison with arthroscopy in diagnosing disk position.

Our results do not go with Zhang et al. (24) who concluded that the diagnostic accuracy of MRI for intra-articular adhesions was poor; most of the adhesions were not diagnosed by MRI, but intracapsular adhesions could be detected on T2 weighted-images with existing synovial fluid.

On the contrary our study results agree with Shen et al. (25) who concluded that MRI proved to be a good modality to diagnose disk perforation of TMJ, and the diagnostic result of disk perforation by MRI had certain guiding significance in our clinical work.
Different imaging modalities, each with inherent strength and weakness were used to image TMJ. MRI is diagnostic technique of choice due to its superior contrast resolution and its ability to acquire dynamic imaging to demonstrate its function (26).

6. Conclusion

Disk displacement or internal disk derangement is the most prevalent disorder. There is a statistically significant association between anterior disk displacement without reduction and deformed disk configuration, joint effusion and secondary osteoarthritic changes.

MRI is a proper diagnostic modality for TMJ disorders in comparison with arthroscopy due to non-invasiveness, the excellent soft tissue contrast and multi-planer capabilities.

Conflict of interest

The authors declare that there are no conflict of interest.

References