Diagnostic Accuracy of Ultrasonography for Evaluation of Internal Derangement of the Temporomandibular Joint

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Abstract: The diagnostic accuracy of ultrasonography for diagnosing internal derangementoftemporomandibular joint, and comparing its accuracy with the magmatic resonance imaginggold standard was evaluated in 20 Patients. Patients were divided into two groups: Group I include five patients without any sign or symptoms of temporomandibular joint disorders (control *group*). Group II included 15 patients suffering from unilateral or bilateral temporomandibular joint disorders such as pain, clicking dislocation, difficulty in opening the mouth. All patients were examined with panoramic radiography, ultrasonography followed by Magnetic resonance imaging. In Group I, ultrasonographic imaging demonstrated a normal disc space ranged between 2.8 and 5 mm in the closed mouth position, and a space ranging between 5 to 7 mm in the opened mouth position. While,magnetic resonance imaging demonstrated normal disc position in relation to the condyle and the glenoid fossa. *In group II*: Ultrasonographic imaging demonstrated a disc space within normal range in four cases; the remaining 11 cases demonstrated increased the disc space which ranged between 7 and l0 mm in the closed mouth position and between l0 and 17 mm in the opened mouth position. While,magnetic resonance imaging demonstrated 12 cases (88%) with anterior disc displacement. The remaining three cases were demonstrated normal disc position. The ultrasonography, as non-invasive and significantly low cost diagnostic technique, can be used for patients clinically suspected to have temporomandibular joint disorders to exclude the negative results before request the more expensive and invasive images.

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1. Introduction

Internal derangement is one of the most common intra-articular abnormalities of the temporomandibular joint (TMJ) [1], defined as an abnormal positional and functional relationship between the articulardisk and the mandibular condyle and the articular surfaces of the temporal bone [2].Different imaging techniques may be used for TMJ evaluation. Conventional radiographic techniques and computed tomography allow accurate evaluation of bony components but are not useful for examining the disc and soft tissues [3–5]. Magnetic resonance imaging (MRI) has become the gold standard for evaluating the soft tissue structures of the TMJ, especially disk position[6], and it has the major advantage of not introducing radiationor known biologic hazards to the patient that might produce tissue damage [7]. However, MRI unit are quite expensive and not available in a traditional dental setting. The clinician must often rely on the patient's history and clinical examination findings.

Ultrasonography (US) has been introduced recently for the study of the TMJ. This technique allows evaluation of all the components of the TMJ: the condylar head, the glenoid fossa of the temporal bone, the disc, the joint capsule, the articular ligaments and the insertions of tendons. Dynamic US is an inexpensive and non-invasive diagnostic technique [8–10]. So this study was aimed to evaluate the diagnostic accuracy of US for diagnosing internal derangement, and comparing its accuracy with the MRI gold standard.

2. Patients and Methods

Twenty cases were included in this study, the age ranged between 20 and 55years

The cases were divided into two groups: Group I (GI) include five cases not complain from any sign or symptoms of TMJ disorders and so used as a control group. Group II (GII) 15 cases were included in this group and they were suffered from unilateral or bilateral TMJ disorders such as pain , clicking

dislocation , difficulty in opening the mouth, deviation of the mandible during movements.

All patients in both groups were examined with panoramic radiography, US followed by MRI.

US, using vertical scans was performed with a linear MHz small-part transducer was connected to a Hitachi EUB-565A, ultrasound scanner. Hitachi medical Corporation- Japan. The transducer was positioned against the patient's face in a vertical direction overlying the zygomatic arch and TMJ to perform a vertical scan. The transducer was gradually shifted posteriorly and in up and down direction to obtain optimal visualization of the lateral pole of the mandibular condyle, which was clearly seen to be nearest to the skin surface while the patient, was in opened or closed mouth position. The distance between the superior surface of the condyle and the inferior surface of the glenoid fossa was measured on the display of the sonographic equipment in both closed and opened mouth position.

MRI; was performed with a 0.5- tesla superconductive system (GE Sigma contour) using the TMJ surface coil (6.5cm in diameter) placed over the joint as a receiver. The surface coil provides significant improvement in signal to noise ratio and, therefore improves spatial resolution when compared with images obtained when using the standard head coil as a receiver. T1 weighted fast spin – echo (500/11[TR/TE/excitation]) imaging with a 150- mm field view, 3mm slices thickness and no interslice gap were obtained. Multiple oblique parasagittal slices were obtained perpendicular to the line indicating the long axis of the mandibular condyle on axial slice in both closed and opened moth positioned. MRI was preformed while the patient was in a supine position. All the selected patients gave their informed consents to participate in this study. The study protocol was reviewed and approved by the central regional ethics committee.

3. Results

Group 1(G1)

US results: Ultrasonographic examination of this group demonstrated that, in the closed mouth position, the distance between the superior surface of the condyle and the inferior surface of the glenoid fossa ranged between 2.8 to 5 mm with a mean of 3.6 mm. In the opened mouth position the distance between the superior surface of the condyle and the inferior surface of the glenoid fossa ranged between 5 to 7 mm with a mean of 5.8 mm (Fig.1).

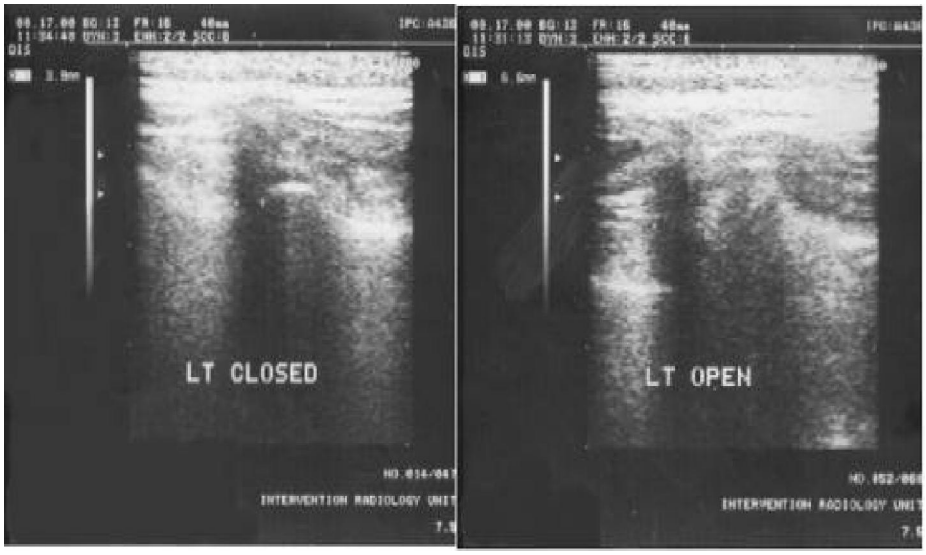

Figure 1:Sonographic scanning showing normal distance between the condyle and the glenoid fossa (3.9 mm), *left* closed mouth position, *right* opened mouth position.

MRI results:

MRI examination of this group demonstrated normal disc position in both the closed and opened mouth positions. The disc appeared as a law signal intensity structure (black) as a result of its dense fibrous components. The spongiosa of the condyle, the glenoid fossa and the articular eminence appeared as high signal intensity structures (white) due to the presence of marrow fat. The cortical bone appeared as a low signal intensity structure (black) which interfaces directly with the disc tissue. (Figs. 2&3).

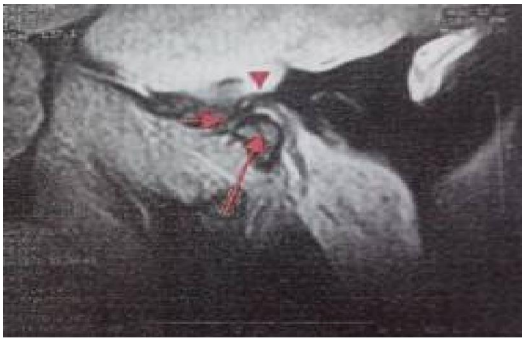

Figure 2: Sagittal MR image (control group) demonstrating normal relation between the condyle (log arrow), the disc (short arrow) and the glenoid fossa (arrow head) in the closed position. The condyle is centered below the intermediate zone.

Figure 3: Sagittal MR image (control group) demonstrating normal relation between the condyle, the disc and the glenoid fossa (arrow) in the opened mouth position.

Group II(GII)

US results:

Ultrasonographic examination of this group demonstrated normal range for the distance between the superior surface of the condyle and the inferior surface of the glenoid fossa in 4 cases (27%) (Fig. 4).The remaining 11 cases (73%) demonstrated increased distance between the superior surface of the condyle and the inferior surface of the glenoid fossa. The distance ranged between 7-10 mm in the closed mouth position with a mean of 8 mm and ranged between 10-17 mm in opened mouth position with a mean of 14.5 mm (Fig. 5).

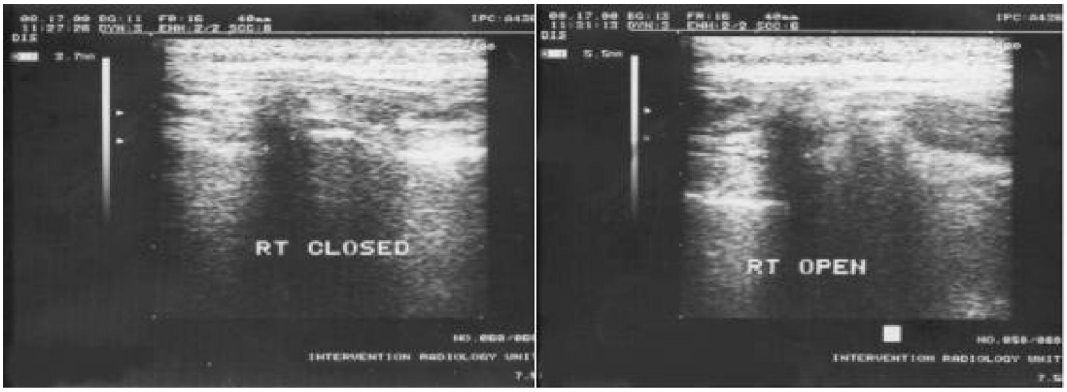

Figure4: Sonographic scanning for patient in GII showing normal distance between the condyle and the glenoid fossa (= 3.7mm), *left* closed mouth position, *right* opened mouth position (=5.5)

Figure 5 :Sonographic scanning showing abnormal distance between the condyle and the glenoid fossa *left*, mouth position (= 10.2mm), *right,* opened mouth position (= 14.4mm).

MRI results:

Three cases (20%) demonstrated normal disc position in relation to the condyle, the glenoid fossa and the articular eminence (Fig. 6). Five cases (33%) demonstrated the disc in normal relation in closed mouth position, and anteriorly displaced in opened mouth position (anterior disc displacement with reduction). (Fig.7). In seven cases (47%) the MRI demonstrated anterior disc displacement without reduction. In the closed mouth position the disc appeared anteriorly displaced (Fig. 8), while in the opened mouth position the disc appears grossly displaced below the apex of the eminence.

Table (1) summarizes of MRI results in GII

Diagnosis	No. of cases	%
Normal	3	20%
Anterior disc displacement with reduction	5	33%
Anterior disc displacement without reduction	7	47%
Total	15	100%

Figure 6: Sagittal MR image (TR= 500msec; TE=11msec) of the left TMJ showing normal disc relation (*left*; closed mouth. *Right*; opened mouth)

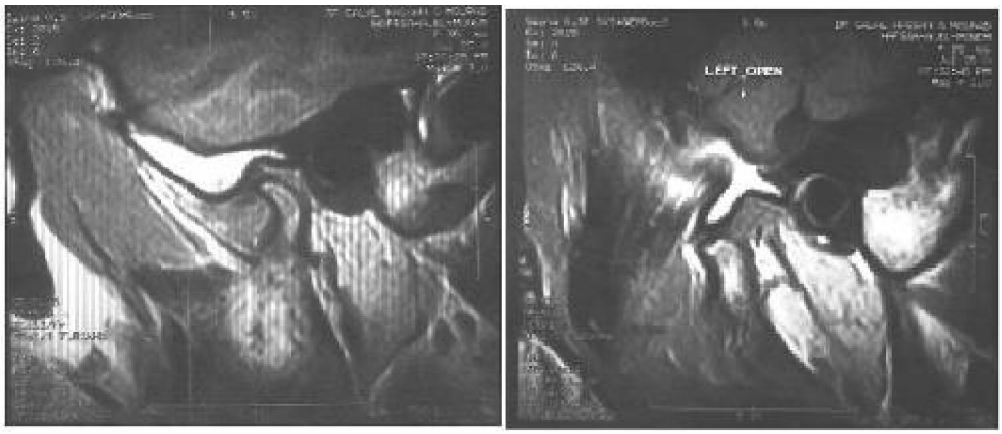

Figure 7: Sagittal MR image (TR= 500msec; TE=11msec) of the left TMJ showing anterior disc displacement with reduction (*left*; closed mouth. *Right*; opened mouth)

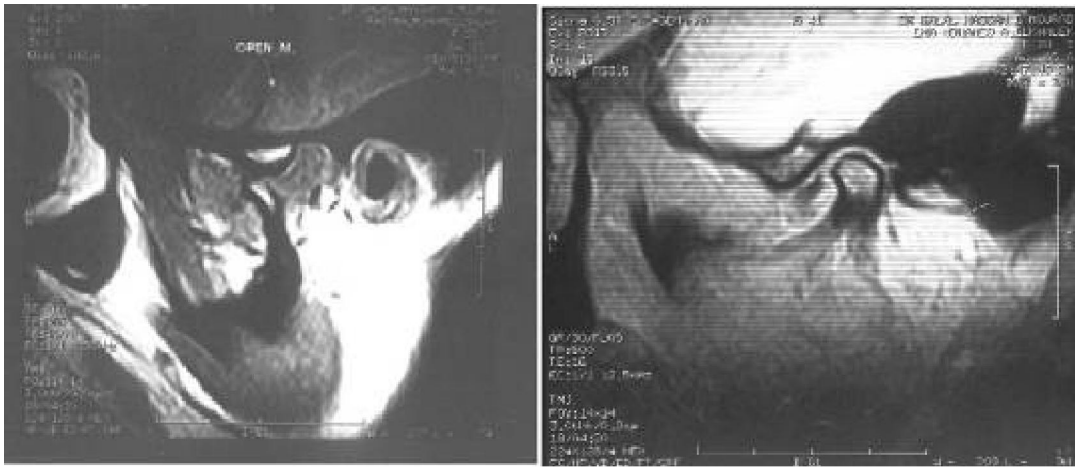

Figure 8: Sagittal MR image (TR= 500msec; TE=11msec) of the left TMJ showing anterior disc displacement without reduction (*left*; closed mouth. *Right*; opened mouth

4. Discussion

Studies regarding the different imaging modalities for the TMJ believe that none of the techniques available today can meet all the requirements for an ideal imaging technique for studying the disc-condyle relationship [11]. The availability of non-expensive, non-invasive, less comprehensive and less complicated radiographic modality that does not cause any complications or reactions is very important in order to make proper diagnosis, management and follow up of the cases [12].

The present study was conducted to identify as well as to compare the accuracy of images obtained by MRI and ultrasonography in the diagnosis of TMJ disorders.

Magnetic resonance imaging is considered overall the best diagnostic modality for the thorough assessment of the internal derangement of the TMJ [13, 14].Stegenga*et al.*[15] stated that MRI is rapidly becoming the gold standard for evaluating the soft tissue of the TMJ, especially disc position. A high sensitivity (67% -100%) of MRI for diagnosis of the correct disc position and bone changes of the TMJ was confirmed by autopsy studies [16-19].On the other hand ultrasonography, represents a diagnostic modality that is simple to do, painless non-invasive and does not expose the patient to radiation, in addition, it is inexpensive and easily gains patient's acceptance, offers instantaneous tissue display and it is readily available [12].

MRI results of the 20 cases included in the present study demonstrated normal disc position in relation to the condyle and the glenoid fossa in the 5 asymptomatic volunteers. These findings are very close to those of Kaplan and Helms [1], who found 30 asymptomatic joints investigated by arthrography and 31 asymptomatic joints investigated by MRI respectively to be normal. The specificity of MRI as calculated from the results of this study was l00 %, a percentage similar to that reported by Smith and Larheim[20].

Twelve cases (88%) in GII demonstrated anterior disc displacement. This finding correlate well with the results reported by Eriksson and Westesson[21]. The remaining three cases were normal in the MRI images; a finding that can be explained by the probability that the symptoms experienced by those patients might not reflected an actual TMJ problem but a problem in other anatomical site with referred pain to the joint area. The sensitivity of the technique was 88%, this correlates well with the results of Schellhas*et al.*[22].

In addition, MRI was accurate in discriminating patients suffering from anterior disc displacement with reduction and those suffering from anterior discdisplacement without reduction, a data that might be of great value to surgeons for proper planning of the treatment regimen.

Seven cases (47%) were diagnosed as anterior disc displacement without reduction and five (33 %) cases were diagnosed as anterior disc displacement with reduction a finding similar to that reported by Rausita*et al.*[23].

Since 1992 US has been suggested for the diagnosis of TMJ disorders [24]. US represents a diagnostic modality that is simple to do, painless, non-invasive and does not expose the patient to radiation. It also easily gains patient's acceptance, offers instantaneous tissue display and is readily available [25].

In the present study actual visualization of the articular disc with US was not available, the distance between the highest point of the superior surface of the head of the condyle and the inferior surface of the glenoid fossa was measured. This space represents

the anatomical site in which the disc is located and is referred to as the disc space.

Ultrasonographic imaging of the patients in GI demonstrated a normal disc space ranged between 2.8 and 5 mm in the closed mouth position, and a space ranging between 5 to 7 mm in the opened mouth position. This finding is similar to that stated by Hayashi et al. who examined the accuracy of ultrasonography in 18 patients suffering from TMJ dysfunction, and reported that a distance between the articular capsule and the lateral surface of the mandibular condyle more than 4 mm is diagnosed as dysfunction of the TMJ. The specificity of ultrasonography as calculated from the results of this study was 100%. A percentage similar to that reported by Hayashi *et al.*[26].

On the other hand, Gateno*et al.*[12] stated that the specificity of ultrasonography is 95% for the diagnosis of disc displacement. Ultrasonographic scanning of patients in GII demonstrated a disc space within normal range in four cases. The remaining 11 cases demonstrated an increased distance of disc space. The distance ranged between 7 and l0 mm in the closed mouth position and ranged between l0 and 17 mm in the opened mouth position.

None of the articles available in the literature gave definite ultrasonographic diagnostic criteria for disc displacement. Yet Hayashi *et al.*[26] theorized that a widened distance between the articular capsule and mandibular condyle identified by the use of ultrasonography might mainly result from the interposition of a displaced disc between them. They also stated that a distance between the articular capsule and the lateral surface of the mandibular condyle exceeds 4 mm only if the articular disc is displaced anterolateral. In the study of Hayashi *et al.*[26] they taken two reference points one is hard tissue (lateral surface of the mandibular condyle) and the other is soft tissue (articular capsule). But in this study we have taken 2 hard tissue points (the superior surface of the condyle and the inferior surface of the glenoid fossa) which are considered more accurate to measure the disc space in both closed and opened mouth position.

The 11 cases demonstrating increased dick space in ultrasonography more than that interpreted in the normal control cases might be due to abnormal positioning or deformity of the articular disc. An explanation similar to that presented by Hayashi *et al.*[10].

When comparing the results of ultrasonography and the results of MRI it was evident that all cases that demonstrated an increase in the distance between the superior surface of the condyle and the inferior surface of theglenoid fossa where diagnosed in MRI as anterior disc displacement. While only one case from the 4 cases that demonstrated normal distance in ultrasonography was diagnosed as anterior disc displacement with reduction in MRI.

It was not possible to differentiate by ultrasonographic scanning between anterior disc displacement with reduction and anterior disc displacement without reduction Ultrasonography was valuable in determining whether the TMJ was normal or not and whether the patient is in need for MRI imaging. Although the sensitivity and the predictive value of negative test for the diagnosis of TMJ disorders were slightly inferior in ultrasonography compared to MRI, yet ultrasonography could be considered a useful and safe imaging method for primary diagnosis of TMJ disorders.

5. Conclusion

Ultrasonography was less sensitive or specific than was MR imaging in detecting internal derangement in the TMJ. However, internal derangement of the TMJ should be suspected if a distance between the superior surface of the condyle and the inferior surface of the glenoid fossa (disc space) more than 7 mm in closed mouth position and more than 10 mm in opened mouth position. So the significance of ultrasonography as non-invasive and significantly low cost diagnostic technique can be used for patients clinically suspected to have TMJ disorders to exclude the negative results before request the more expensive and invasive images especially in patients with limitation to be examined by MRI such as patients with artificial metallic devices, vascular clips, base maker or even during pregnancy.

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