# Magnetic resonance imaging evaluation of temporomandibular joint derangement in symptomatic and asymptomatic patients

*Manar T. El-Essawy,* MD, FRCR, *Nizar A. Al-Nakshabandi,* MD, FRCPC, *Ahmad A. Al-Boukai,* MD.

## ABSTRACT

**الأهداف:** توضيح مدى أهمية أشعة الرنين المغناطيسي ( MRI ) في تقيم حالة المفصل الفكي الصدغي ( TMJ ).

**الطريقة:** تم إجراء أشعة الرنين المغناطيسي ( MRI ) في مستشفى الملك خالد الجامعي – الرياض – المملكة العربية السعودية، خلال الفترة مابين يناير 2006م وحتى نوفمبر 2007م، على 34 مريضاً ( 68 مفصل )، 10 منهم كانوا بلا أعراض سريرية لألم أو خلل وظيفي في المفصل الفكي الصدغي ( TMJ ). أما المجموعة المتبقية فكان لديهم علامات وأعراض لخلل وظيفي وألم في المفصل الفكي الصدغي ( TMJ )، من بينها قلقلة وقصور في الحركة، وقد تم فحص المرضى في حالتي فتح وغلق الفك. أخذت الصور بطريقة 1.5- T بأشعة الرنين المغناطيسي ( MRI )، بمسطح سهمي مائل عامودي على المحور الطولي لقمة الفك باستخدام متسلسلة ثلاثية الذبذبة تتضمن زمن الاسترخاء الطولي ( SE – T2 – T1 )، بالإضافة على مسلسلة ( SPGR ). تم تقييم الصورة لشكل القرص، بالإضافة إلى موضع قوة الإشارة من قبل طبيبي أشعة.

**النتائج:** بالنسبة للحالات التي كانت بلا إعراض 16 من أصل 20 مفصلاً كان طبيعياً، أما الحالتين الأخرتين كان لديها أعراض خلل وظيفي، فقد أظهرت صور أشعة الرنين المغناطيسي ( MRI ) إنزياح أمامي للأقراص مصحوب برجوع وذلك في ثلاثة مفاصل، وخشونة في مفصلين آخرين. أما بالنسبة للأشخاص اللذين لديهم أعراض فقد أظهرت صور أشعة الرنين المغناطيسي أن 26 مفصل ( 45% ) من بين 48 كان طبيعياً، أما الـ22 مفصل الباقين فقد أظهرت ترتيب داخلي غير طبيعي بدون عودة. كما ظهرت أيضا خشونة في 18 مفصل.

**خاتمة:** أن استخدام أشعة الرنين المغناطيسي ( MRI ) مع الملفات السطحية قام بتوضيح الإنزياح الداخلي للمفصل الفكي الصدغي ( TMJ )، و بالتالي ساعد على زيادة القدرة على اكتشاف التغيرات الغير طبيعية التي ثبت أن لها ارتباط إحصائي واضح مع الحالات التي يظهر عليها اختلال وظيفي.

**Objectives:** To highlight the importance of MRI in evaluation of the tempromandibular joint (TMJ).

**Method:** The MRI examination was performed at King Khalid University Hospital, Riyadh, Saudi Arabia with the approval from the local ethics committee, on 34 patients (68 joints) between January 2006 and November 2007, in which 10 were considered asymptomatic subjects (control). The remaining had symptoms and signs of TMJ pain or dysfunction, including limitation of movement and clicking. All our subjects were examined in both closed and open mouth position. Images were obtained by 1.5-T MRI system, in oblique sagittal plane utilizing 3 pulse sequences including T1 and T2 spin-echo, and spoiled gradient recall sequences. The evaluation of the meniscal disc configuration and position was carried out by 2 radiologists.

**Results:** Sixteen out of 20 joints of asymptomatic subjects were normal. In the other 2 asymptomatic subjects, the MRI showed anterior disc displacement with reduction in 3 joints, and degenerative changes in 2 joints. Out of the 48 symptomatic joints, 26 (45%) joints were considered normal, while the other 22 joints showed anterior dislocation without reduction. Degenerative joint disease was also seen in 18 joints.

**Conclusion:** The MRI with the use of surface coils markedly improves the delineation of internal derangement of the TMJ, therefore, it enhanced the capability of detecting certain abnormalities, which proved to have a statistical significance in symptomatic patients.

***Saudi Med J 2008; Vol. 29 (10): 1448-1452***

*From the Department of Radiology and Medical Imaging, King Khalid University Hospital, Riyadh, Kingdom of Saudi Arabia*

*Received 31st May 2008. Accepted 6th September 2008.*

*Address correspondence and reprint request to: Dr. Manar T. El-Essawy, Department of Radiology and Medical Imaging, King Khalid University Hospital, PO Box 7805 No. 40, Riyadh 11472, Kingdom of Saudi Arabia. E-mail: manar970@hotmail.com*

Internal derangement of the temporomandibular joint (TMJ) refers to the abnormal relationship or position of the disc to the mandibular condyle and articular eminence.[1] It is considered one of the major causes of pain and dysfunction of the TMJ.[2] The MRI can provide direct visualization and accurate determination of the temporomandibular disc position in non- invasive manner, therefore, it proved to be extremely useful in assessing the internal derangement of the TMJ.[1-3] We present here the spectrum of MRI findings in patients with TMJ symptoms compared to asymptomatic patients. The rational of this study was to investigate whether asymptomatic patients have normal TMJ, and to compare the findings to those of symptomatic patients.

**Methods.** A total of 68 joints in 34 subjects were examined by MRI in the last 8 months from January 2007 to August 2007 (10 asymptomatic and 24 symptomatic subjects) at King Khalid University Hospital with the approval from the local ethics committee. The 10 asymptomatic subjects (20 joints) were determined by the clinical absence of any signs or symptoms of current or past TMJ pain and dysfunction. The age ranged between 24-46 years with a mean of 34.3 years. Three of them were men and 7 were women. The remaining 24 subjects (6 males, 18 females), had either TMJ pain or symptoms of TMJ dysfunction, including limitation of movement and clicking. The age range were from 18-52 years with a mean of 36.2 years. All our patients were subjected to MRI examination. Children were excluded from the study. Examination was performed on superconducting MRI machine (Signa; GE Medical Systems, Milwaukee, USA) operating at 1.5 tesla using 3 inch surface coil. First, an axial scout was used to locate the mandibular condyle, then 3 pulse sequences were obtained: T1 weighted spin-echo sequence (600/30 TR/ TE, 13 cm field of view, 3mm slice thickness, 256x192 matrix), T2 weighted spin-echo sequence (3000/100, 13 cm field of view, 5mm slice thickness, 256x256 matrix), and a spoiled gradient recall acquisition in the steady state (SPGR) sequence (35/8, 12 cm field of view, $60^0$ flip angle, 256x192 matrix). T1 and T2 weighted images, in oblique sagittal plane perpendicular to the long axis of the mandibular condyles, in both closed and open mouth positions, were obtained first, and then orthogonal sagittal SPGR images were performed. The interpretations of TMJ MR images were carried out by 2 radiologists. They were evaluated by the meniscal disc configuration/shape, disc position relative to the mandibular condyle and articular eminence in both position, and its signal intensity as well. A normal disc shape is similar to a small drumstick, or asymmetric bow tie with the posterior band being somewhat larger than the anterior band. When the disc shape varied from these 2 patterns, being buckled, distorted, or discontinued, it was considered abnormal. The disc was considered of normal position if the posterior margin of the posterior band is over the apex of the condyle, at almost 12 o'clock position, and the thin intermediate zone is in between the closely opposed bony cortices of the articular eminence and condyle in the closed mouth position. When the mouth is opened the disc and the condyle translate anteriorly under the eminence normally, then the disc rotates posteriorly over the condyle to retain the meniscus between it and the fossa. The amount of anterior displacement, if any, was quantified in terms of degrees from 12 o'clock position. The anterior displacement to the 12 o'clock position was termed positive, and posterior displacement was termed negative. The presence of joint effusion, joint space narrowing, osteophytes, erosions and cortical thickening were recorded, and if these findings were present the joint would be then designated osteoarthritic.

In our work, we used Chi-square test and Fisher's exact test to assess the significance of our findings in relation to patient symptoms, presence of abnormal disc configuration and position, and prevalence of degenerative joint disease in these patients. A $p<0.05$ was considered statistically significant.

**Results.** Based on MRI findings, 16 out of 20 joints of asymptomatic subjects were classified normal with a prevalence of 80%, as they demonstrated normal configuration of the meniscal disc with drum-stick or asymmetrical bow-tie appearance, and normal position with the posterior band of the disc being at almost 12 o'clock location in relation to the mandibular condyle in closed mouth position (variation between $5^0$-$10^0$ anteriorly were considered still within normal), and relative posterior rotation in relation to the condyle in the open mouth position. The meniscal disc demonstrates homogenous and relatively moderate low signal intensity in T1 and T2 spin-echo sequences, while it shows a relative focal area of high signal intensity within the central portion of the posterior band in the SPGR images. The 4 components of the disc of these joints are visualized well (anterior and posterior bands, intermediate zone and bilaminar posterior zone). In the rest 2 asymptomatic patients, the MRI showed anterior disc displacement with reduction in 3 joints, while degenerative changes were seen in 2 joints (10%) with varying degrees of joint space narrowing, and small osteophyte formations. None of the control subjects had MRI evidence of deformity of disc configuration. Out of the 48 joints of symptomatic patients, 26 joints (54%) were considered normal, as they demonstrated normal configuration and position of the meniscal

disc. The other 22 joints (46%) showed abnormal configuration of the disc, 4 being buckled, 17 were distorted, and one was not visualized due to blooming artifacts from previous surgery. These changes were statistically significant ($p<0.005$). Anterior displacement without reduction were identified in 19 joints (39%) of the symptomatic patients, which appeared to be also statistically significant ($p<0.001$), and in one the dislocation was reducible, while in another the disc was retained posteriorly leading to abnormal fixed anterior alignment of the condyle in relation to the glenoid fossa, which was due to infiltration of the infra-temporal soft tissue muscle planes by lymphoma, in particular the pterygoid muscle. Degenerative joint disease was considered in 18 joints (bilateral in 7 patients and unilateral in 4 patients). The MRI findings in these patients ranged between joint space narrowing in 14 joints, marginal osteophytes in 12 joints and joint effusion in 9 joints. There were subchondral cysts in 2, subchondral sclerosis in 6 joints and hypertrophy of retro-discal tissue in one. In 2 of the unilateral joint involvement by degenerative joint disease the underlying cause was previous trauma with fractured condyle and subsequent hypertrophic changes of the condyle.

**Discussion.** Internal derangement of the temporomandibular joint is considered one of the major causes of pain and dysfunction of the joint.[2] It usually refers to the abnormal relationship or position of the meniscal disc to the mandibular condyle and articular eminence.[1] Several imaging modalities have been utilized previously, to evaluate this joint, including conventional x-ray, computed tomography and arthrography, which have helped a lot in understanding the morphology of the meniscal disc and its position, in both open and closed mouth positions, in particular the later procedure.[4] However, due to the limitation of these techniques in the delineation of the soft tissue component of the joint and meniscus, MRI was introduced with its better capabilities of soft tissue characterization.[3] Many reports have described the high sensitivity and specificity of MR imaging in the diagnosis of internal derangement of TMJ.[5] This has been enhanced more with the use of surface coil technology in the visualization of the disc abnormalities, regarding its configurations, position and signal intensity.[6] It has markedly improved the signal-to-noise ratio of soft tissue structures in and around the TMJ, and therefore increased the accuracy of such diagnostic modality.[6,7]

Normally, the meniscal disc has 4 distinctive parts with asymmetrical biconcave "bow tie" configurations.[4-7] It consists of thick posterior band, thinner anterior band, central intermediate zone, and bilaminar zone posteriorly. In MRI oblique sagittal plane, the normal disc and its 4 distinct parts are visualized in the closed mouth position, the posterior band being located at 12 o'clock position directly on top of the condyle and the anterior band does not extend beyond the apex of articular eminence.[7] While the intermediate zone is interposed between the 2 most closely opposed cortical surfaces, these configurations will change when the mouth is opened, as the disc and condyle translate anteriorly under the eminence, then the disc rotates posteriorly over the condyle retaining its intermediate zone in between the condyle and eminence. The overall signal intensity of the normal disc is moderately low, however in T1 sequence the central portion of the normal posterior band has higher signal intensity representing mucin deposit, and is of no clinical importance,[8] while the signal intensity of the disc markedly increases in gradient recall acquisition which may be contributed to hydration.[9] When the disc degenerates it loses its normal shape and eventually becomes as a mass of fibrous tissue or scar anterior to the condyle[10,11] which appears desiccated and deformed (**Figure 1a**) later on, other findings becomes more obvious such as joint effusion, narrowing of joint space, and marginal osteophytosis (**Figure 1b**). In internal derangement of the TMJ, the configuration and position of the disc will

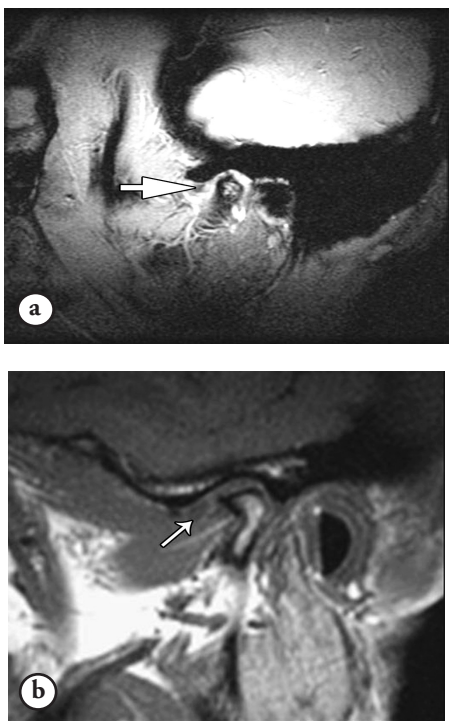


**Figure 1 -** Sagittal MR image of temporomandibular joint **a**) demonstrates abnormal shape and configuration of the disk, which is displaced anteriorly (arrow), **b**) different patient - demonstrating the development of osteoarthritis changes in association with abnormal shape and configuration of the disk which is displaced

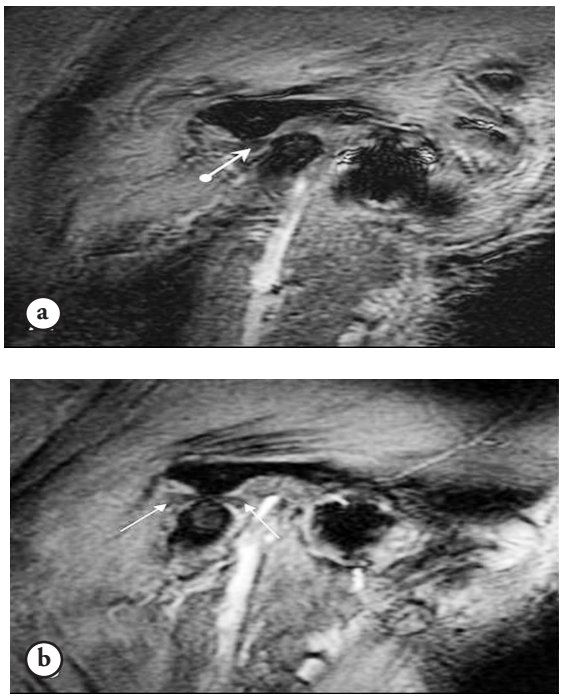


**Figure 2 -** Sagittal MRI of temporomandibular with anteriorly displaced disc with reduction: A - the disc is anteriorly displaced (arrow) in a closed mouth, B - recaptured (arrows) in an open mouth with translation of the condyle.

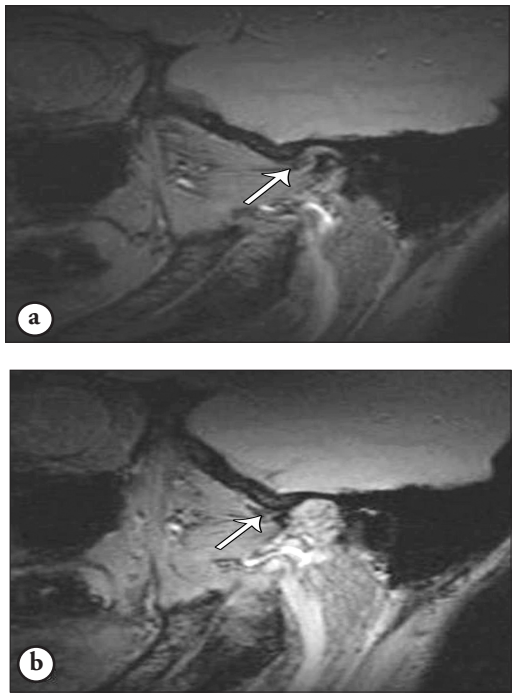


**Figure 3 -** Sagittal MRI of temporomandibular joint with anteriorly displaced disk without reduction. A - the disk is displaced in a closed mouth, B - remain anterior in open mouth with translation of the condyle.

alter, as it will appear anteriorly positioned in relation to the condyle when the mouth is closed.[9] The posterior band will move anteriorly while the condyle is resting in the retrodiscal tissue. When the mouth opens, the disc may return to its normal position, anterior displacement with reduction, (**Figures 2a & 2b**), or it remains anteriorly displaced, anterior displacement without reduction[12] (**Figures 3a & 3b**). Other causes of internal derangement with disturbance of the normal alignment of the mandibular condyle to the glenoid fossa can be also demonstrated by MRI examination such as the case of lymphomatous infiltration of the infra-temporal muscle planes, in which both CT scan and MRI examination demonstrated the fixed anterior displacement of the condyle and infiltration of the pterygoid muscle as well.

Several protocols and techniques have been used in the evaluation of the internal derangements of the TMJ as well as the relationship between the MRI findings and pain,[1,12,13] Brooks and Westesson[13] recommended the use of coronal images as a supplement to the sagittal images, for more information as regard to disc displacement in particular in the medio-lateral direction with increased diagnostic accuracy, as well as avoiding the false diagnosis of displacement. Suenaga et al,[12] demonstrated in their study a significant relationship of contrast enhancement of the posterior disc attachment and anterior disc displacement without reduction in patients with joint pain, which helped in differentiating intraarticular from extraarticular causes of pain in and around the TMJ. Katzberg et al[6] emphasized the importance of surface coil technology in the MRI of the TMJ, which has markedly improved the signal-to-noise ratio of soft tissue structures, and thus enhanced the anatomical details of this region and better understanding of the internal derangement of this joint. Other studies[4,14] showed that at both closed- and opened-mouth MRI, a medially located TMJ discs seems to be within the normal range of variation. The disc seems to shift even more medially when the mouth is opened.

In our study, MRI findings confirmed what has been previously reported in regard to the high sensitivity and specificity of this modality in demonstrating internal derangement of the TMJ, in particular those with

degenerative joint disease. The study revealed statistically significant relationship between symptomatic patients (pain) and anterior displacement without reduction as well as abnormal disc configuration. Also it showed significant relation between degenerative joint disease and joint effusion which is in consensus with previous reports. It also shows the prevalence normal findings of 80% in normal asymptomatic subjects which is not in consensus with the study by Nassif et al.[14] This we believe is due to the small sample size in our study. The only limitation of our study is claustrophobia and some of the patients cannot open the mouth properly in open mouth series.

In conclusion, MRI with the use of surface coils has markedly improved the delineation of internal derangement of the TMJ. It has expanded the knowledge of the anatomical details of such joint, and therefore enhanced the capabilities of the diagnosis of certain pathological processes involving this joint. It clarified also the relationship of certain MRI findings and patient's symptoms. The imaging potential for MRI with its multiplanar capability, and surface coil utilization, with no radiation hazards warrants its use for demonstrating TMJ pathology.

## References


1. Davant TS, Green CS, Perry HT, Davant TS 6th, Greene CS, Perry HT, Lautenschlager EP. A quantitative Computer-assisted analysis of disc displacement in patients with internal derangement using sagittal view magnetic resonance imaging. ***J Oral Maxillofac Surg*** 1993; 51: 974-979.
2. Harms SE, Wilk RM. Magnetic resonance imaging of the tempromandibular joint. ***Radiographics*** 1987; 7: 521-542.
3. Rao VM. Imaging of the temporomandibular joint. ***Semin Ultrasound CT MR*** 1995; 16: 513-526.
4. Janzen DL, Connell DG, Munk PL. Current imaging of temporo-mandibular joint abnormalities: a pictorial essay. ***Can Assoc Radiol J*** 1998; 49: 21-34.
5. Helms CA, Kaplan P. Diagnostic imaging of the temporomandibular joint: recommendations for use of the various techniques. ***AJR Am J Roentgenol*** 1990; 154: 319-322.
6. Katzberg RW, Bessette RW, Tallents RH, Plewes DB, Manzione JV, Schenck JF, et al. Normal and abnormal temporomandibular joint: MR imaging with surface coil. ***Radiology*** 1986; 158: 183-189.
7. Orsini MG, Kuboki T, Terada S, Matsuka Y, Yamashita A, Clark GT. 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.
8. Drace JE, Young SW, Enzmann DR. Temporomandibular joint meniscus and bilaminar zone : MRI of substructure-Diagnostic landmarks and pitfalls of interpretation. ***Radiology*** 1990; 177: 73-76.
9. Helms CA, Kaban LB, McNeill C, Dodson T. Temporomandibular joint: morphology and signal characteristics of the disc at MR imaging. ***Radiology*** 1989; 172: 817-820.
10. Isberg AM, Isacsson G. Tissue reactions OF temporomandibular joint following retrusive guidance of the mandible. ***Cranio*** 1986; 4: 143-148.
11. Westesson PL, Bronstein SL, Liedberg J. Internal derangement of the temporomandibualr joint: Morphologic description with correlation of function. ***Oral Surg Oral Med Oral Pathol*** 1985; 59: 323-331.
12. Suenaga S, Hamamoto S, Kawano K, Higashida Y, Noikura T. Dynamic MR imaging of the temporomandibular joint in patients with arthrosis: relationship between contrast enhancement of the posterior disk attachment and joint pain. ***AJR Am J Roentgenol*** 1996; 166: 1475-1481.
13. Brooks SL, Westesson PL. Temporomandibular Joint: Value of Coronal MR Images. ***Radiology*** 1993; 188: 317-321.
14. Nassif NJ, Al-Salleeh F, Al-Admawi M. The prevalence and treatment needs of symptoms and signs of temporomandibular disorders among young adult males. ***J Oral Rehabil*** 2003; 30: 944-950.


## Ethical Consent

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed.