Turk J Med Sci
31 (2001) 337-343

Mehmet DALKIZ[1]
Emre PAKDEMİRLİ[2]
Bedri BEYDEMİR[1]

Evaluation of Temporomandibular Joint Dysfunction by Magnetic Resonanance Imaging

Received: February 01, 2001

[1]Department of Prosthetic Dentistry, Dental Sciences Center, Gülhane Military Medical Academy, Ankara, [2]Department of Radiology, Faculty of Medicine Pamukkale University, Denizli - TURKEY

Abstract: Many diagnostic imaging techniques are available to aid clinicians, including transcranial radiography, conventional tomography, computed tomography, arthrography, single photon emission computed tomography (SPECT) imaging and magnetic resonance imaging (MRI). The aim of this study was to evaluate clinical findings and MRI features of temporomandibunlar joint (TMJ) disorders.

The clinical histories of 251 patients (502 joints) with MR images were evaluated. Eight clinical variables (articular pain, clicking, locking, limitation of mouth opening, dislocation (luxation), headache (temporal, facial or neck), occlusal disharmony) and imaging findings "Normal, Anterior Disk Displacement With Reduction (ADDR), Anterior Disk Displacement Without Reduction (ADDWR) Anterior Disk Displacement With Reduction + Effusion (ADDR +E), Anterior Disk Displacement Without Reduction + Effusion (ADDWR+E), Degeneration, Osteophyte, Posterior Disk Displacement (PDD)) were evaluated.

A total of 175 of the TMJs were found to be normal according to MRI findings. Fifty-six unilateral, and 210 bilateral anterior disc displacement with reduction were detected, as well as nine unilateral, and 12 bilateral ADDWR, 21 unilateral, and 58 bilateral ADDR+E; 10 unilateral, and 18 bilateral ADDWR+E; 28 unilateral, and 35 bilateral degenerative arthritic changes; 44 unilateral, and 19 bilateral osteophytes were found. The MRI of TMJs were found normal in 17.9% patients (29.2% female, 5.6% male) with clinical variables. Most of the patients (190 female, 56 male) with TMJ disorders were found to have psychological problems.

All of the patients displaying clinical symptoms of TMJ disorders have occlusal disharmony (ground teeth, premature contact, mandibular prognathy or retrognathy, overbite, deepbite, openbite, laterognathy) In this current study jaw pain, locking, limitation of mouth opening, dislocation, and clicking were found 98%, 7.17%, 90.43%, 54.98%, and 75.7% respectively. In addition, etiological factors, noticed as psychological factors, inheritance, and prosthetic appliances were found 98%, 0.39%, 71.71% respectively, but none as a results of unknown trauma, orthodontic treatment, general anesthesia, or maxillofacial intervention.

MRI of the TMJ can detect the abnormal changes within the disc, joint and other tissues. Disc displacement is the most common diagnosis of these patients.

Key Words: TMJ, MRI

Introduction

The imaging of the TMJ has been historically challenging. The mandibular condyle is relatively small and located close to other radiologically dense and complex anatomic structures that make it difficult to image the TMJ.

Patients that display TMJ dysfunction generally produce diagnostic difficulties for clinicians. Symptoms may range from muscle pain, diffuse or focal jaw pain and headaches, limited mandibular opening, TMJ sounds and/or pain. The diagnosis of TMJ disorders includes clinical evaluation and imaging modalities (1-8).

MRI is a unique imaging modality that produces cross-sectional multiplanar images without using ionizing radiation. Using MRI, the evaluation of the internal derangement of TMJ (the depiction and localization of the disc) can be detected (3-5).

The objective of MRI is to document both soft and osseous tissue abnormalities of the joint and its surrounding structures. MRI is helpful to indicate the neoplastic, arthritic, and traumatic pathology around TMJ. Rapid scan MRI methods provide us with a good method for the functional imaging of the TMJ. MRI is the standard imaging modality for the diagnosis of TMJ

disorders (3). The aim of this study was to evaluate clinical findings and MRI features of TMJ dysfunction.

Materials and Methods

A total of 251 patients (502 joints) with TMJ dysfunction were included in this study. Cases for the study were obtained from 1993 to 1998, prospectively. The patients ranged in age from 19 to 71 (190 female, 61 male) All cases were accepted into the study after successfully completing the following evaluations.

a. Evidence of jaw pain, joint sound, and locking.

b. Clinical TMJ and dental examination for signs of the symptoms associated with TMJ disorders.

All patients had bilateral MRI scans in the sagittal (closed and open mouth) plane (Fig. 1) to evaluate the TMJ (dual surface coils were positioned over the TMJ). MRI technology has enabled the routine visualization of the articular disc position (Fig. 2) and configuration with such clarity that MRI has largely supplanted arthrography and computed tomography in the evaluation of internal derangement. With its superb soft tissue contrast resolution and multiplanar imaging capabilities, MRI permits a thorough examination of the joint anatomy not possible with other imaging modalities. Magnetic resonance imaging is noninvasive and does not rely on ionizing radiation, further adding to its overall appeal.

The patients were classified as normal, disc displacement with reduction, disc displacement without reduction, and with or without degenerative changes.

Subjects were categorized into eight groups on the basis of MRI findings.

1. Normal disc position,
2. Anterior disc displacement with reduction (ADDR),
3. Anterior disc displacement without reduction (ADDWR),
4. Anterior disc displacement with reduction + Effusion (ADDR+E),
5. Anterior disc displacement without reduction + Effusion (ADDWR+E),
6. Degenerative arthritic changes,
7. Osteophyte,
8. Posterior disc displacement.

The history of trauma (falls, accident, sports, alteractions), family history of temporomandibular joint disease (TMD), other joint problems, orthodontic treatments, prosthodontic applications, psychological problems Environmental "familiar, educational and job" problems (asked by clinician), and maxillofacial surgical interventions were elicited during the clinical examination (Table 1 and Table 2).

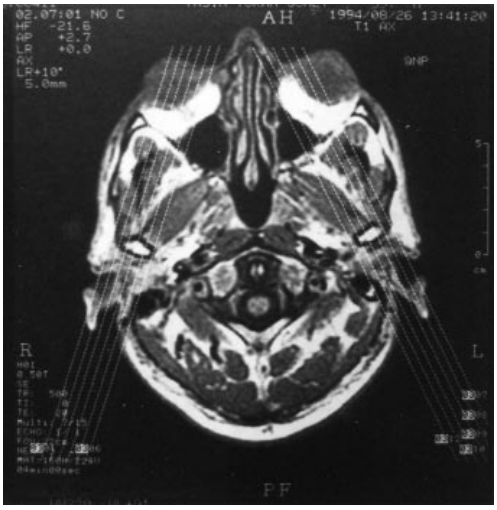

Fig. 1. Axial localizer sections through the TMJ are obtained to set up precise series of sagittal sections through the joint.

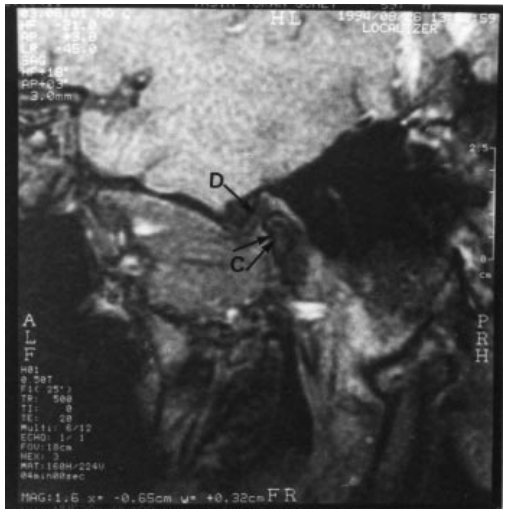

Fig. 2. Direct sagittal scan of the TMJ MRI (Anterior displacement)((arrow C= Mandibular condyle), (Double arrow D = Disc)).

Table 1. Prevalence of clinical findings (No-%).

Clinical Findings	FEMALE (190-75.7%)	MALE (61-24.3%)
Occlusal Disharmony	190 (100%)	61 (100%)
Articular Pain	185 (97.3%)	61 (100%)
Clicking	140 (73.6%)	50 (81.9%)
Locking	13 (6.8%)	5 (8.2%)
Limitation of Mouth Opening	167 (87.9%)	60 (93.3%)
Dislocation (Luxation)	117 (61.5%)	21 (34.4%)
Headache (Temporal or Facial or Neck)	190 (100%)	61 (100%)

Table.2. Prevalence of subjects having positive response to risk factors.

CLINIC	FEMALE (190)	MALE (61)
Other Joint Disease	18	5
Trauma (Accident, False, Alteration, Sports)	Unknown	Unknown
Heredity	-	1
Maxillofacial Intervention	-	-
Orthodontic Treatment	-	-
Prosthodontic Appliances	130	50
Psychological Factors	190	56
General Anesthesia	-	-

Results

A total of 175 of the TMJ were found to be normal according to MRI findings. As well, 56 unilateral, and 210 bilateral anterior disc displacement with reduction were found; 9 unilateral, and 12 bilateral ADDWR; 21 unilateral, and 58 bilateral ADDR+E; 10 unilateral, and 18 bilateral ADDWR+E; 28 unilateral, and 35 bilateral degenerative arthritic changes; 44 unilateral, and 19 bilateral osteophytes were detected. However, unilateral and bilateral posterior disc displacement were not be detected in any of the MRI images (Table 3).

The MRI of the TMJ were found normal in 17.9% of patients (29.2% female, 5.6% male) with clinical variables. Most of the patients (190 female, 56 male) with TMJ disorders were found to have psychological problems.

All of the patients with clinical symptoms of TMJ disorders had occlusal disharmony (ground teeth, premature contact, retrognathy, prognathy, overbite, deep bite, open bite, and laterognathy)

In this study, jaw pain, locking, limitation of mouth opening, dislocation, and clicking were found to be 98%, 7.17%, 90.43%, 54.98%, and 75.7% respectively.

In addition, etiological factors were noticed as psychological factors, inheritance, and prosthetic appliances were found 98%, 0.39%, 71.71% respectively, but none as a result of unknown trauma, orthodontic treatment, general anesthesia, or maxillofacial intervention.

The TMJs of the patients with clinical findings of occlusal disharmony, articular pain, locking, clicking, limitation of mouth opening, dislocation and headache were evaluated with MRI. Some of the patients' TMJs were found to be normal (175 of the 502 TMJs). As a result, TMJs disorders can not be caused by imageable disorders. In this case, the MRI gives normal imaging.

Discussion

TMJ's disorders results from other joint disease, trauma, heredity, maxillofacial intervention, orthodontic treatment, prosthodontic and restorative appliances, psychologic factors, general anesthesia and condition of the profession. Its' clinical findings are occlusal disharmony, articular pain, clicking, locking, limitation of mouth opening, dislocation and headache.

Disc displacement may represent a risk factor when it is coupled with other predisposing, initiating, and perpetuating factors. Multiple host and environmental factors may combine to increase the risk of the development of pain. Pain and dysfunction TMJ disorders seem to affect women more than men (1,3-5,7-13). Clinical reports have emphasized the high ratio (8:1) of

Table 3. Prevalence of subjects having MRI findings of temporomandibular joint (No-%).

		FEMALE (190,380 Joint)	MALE (61, 122 Joint)
NORMAL	RIGHT	84 (16.7%)	7 (1.4%)
	LEFT	63 (12.5%)	21 (4.2%)
ADDR (Anterior disc displacement with reduction)	RIGHT	98 (19.5%)	28 (5.6%)
	LEFT	133 (26.5%)	7 (1.4%)
ADDWR(Anterior disc displacement without reduction)	RIGHT	- (0%)	7 (1.4%)
	LEFT	7 (1.4%)	7 (1.4%)
ADDR+E(Anterior disc displacement with reduction +Effusion)	RIGHT	14 (2.8%)	7 (1.4%)
	LEFT	14 (2.8%)	14 (2.8%)
ADDWR+E(Anterior disc displacement without reduction +Effusion)	RIGHT	7 (1.4%)	7 (1.4%)
	LEFT	7 (1.4%)	7 (1.4%)
DEGENERATION	RIGHT	42 (8.4%)	14 (2.8%)
	LEFT	21 (4.2%)	21 (4.2%)
OSTEOPHİT	RIGHT	21 (4.2%)	14 (2.8%)
	LEFT	14 (2.8%)	14 (2.87%)
PDD(Posterior Disk Displacement)	RIGHT	- (16.7%)	- (0%)
	LEFT	- (16.7%)	- (0%)

female to male patients for TMJ disorders (11). In comformity with other studies, we found female dominance over males at the rate of 8:1.

Headache is a frequent occurrence in epidemiological studies. In some recent studies of TMD subjects, frequent headaches were reported from 63% to 69% of samples (6). In symptomatic TMD patients, the frequency of the headaches was greater. Temporal headache, facial headache and neck headache were increased in TMD. In this current study, headaches (temporal and facial) were observed in 97% of the subjects (244 patients).

Trauma may increase the risk of TMJ disorders in patients with disc displacement, but it does not explain those patients with symptomatic, but normal, joints (6). In this study, the patients did not remember any previous trauma concerning the maxillofacial region.

A number of host and environmental factors have been hypothesized to play a role in the etiology of TMD. TMD has been noted to have increased frequency in individuals with mitral valve prolapse, which indicates a possible etiologic association with an altered collagen metabolism. An altered collagen metabolism may also be important in joint laxity. Higher ratios of type III to type III plus type I collagen have been reported in patients with TMJ disorders and systemic joint laxity compared with controls (6). Recognition of a possible association between joint laxity and TMJ disorders is not new.

MRI clearly differentiates the soft tissue components of the TMJ. The TMJ is useful for demonstrating the positional relationship between the disc and the osseous components. Magnetic resonance signaling in the images helps to identify fluids associated with inflammation, effusion, capsulitis, hematoma, cyst, tumor, and so on (2).

Direct sagittal CT imaging or corrected cephalometric polytomography is more suitable than MRI for demonstrating cortical changes of osseous components of the TMJ secondary to bone disease such as degenerative joint disease or rheumatoid arthritis (1,2). CT would be used when a greater amount of detail about the form and internal structure of the osseous components is required. Attempts at imaging the articular disc using soft tissue window imaging have not been very successful when compared with arthrography or MRI. The extent of a tumor's involvement in the surrounding soft tissues or osseous structures can be shown (1).

Unlike MRI, the arthrographic procedure has an associated morbidity and exposure to ionizing radiation. It is also declining in use, in light of the increased availability of MRI (1). Disorders such as abnormalities in position shape and the internal structure of the disc may be detected through the use of arthrography and MRI. The soft tissue (internal derangement, disc displacement) and bony changes that occur in joints represent varying stages of arthritis (osteoarthritis, degenerative joint disease [DJD]). There are no available methods that predict the risk of progressing to DJD.

Toller (15) presented a study of the basic nature of the ultrasutructure of degenerative disease within the

TMJ. He demonstrated the pathologic changes in hard and soft tissues of the TMJ. Kirc (3) also reported that the earliest degenerative changes of the mandibular condyle could be detected with MRI. Severe changes in disk and capsule soft tissue led to osseous changes in the condylar surfaces and other articular layers. Early surface and subarticular degeneration preceded advanced condylar disease.

Adame et al. (5) believe that effusion could be one of the initial phenomena appearing with ADDWR or ADDR. The pathologic sequence of osteoarthrosis in TMJ remains unclear. Effusion on MRI could warn the clinician of the possibility of degeneration in these patients. Further prospective studies could explain this relationship.

The presence of joint effusion may impair chondrocyte nutrition by increasing the diffusion path through the synovial fluid, and this could be involved in early metabolic changes. The metabolism of the condylar articular surface could be altered resulting in osteochondritis, subchondral degeneration and osteoarthrosis.

Schellhas and Wilkes (15) in their article based on a sample of 100 joints in pairs found 88 joints with effusion using imaging techniques with high sensitivity for inflammation and effusion. Joint fluid was directly observed "in many of the 28 joints operated", and percutaneous joint fluid aspiration was performed.

Adame et al. (5) reported that effusion was found in approximately 10% of cases reviewed. The MRI technical features (tesla, surface coil, etc.) used by other authors are more advanced than those currently in use in their hospital are. A hyperintensity signal in MRI is always shown in the T2-weighted view. They think that this hyperintensity signal reflects the presence of fluid simply due to the density grading of the image.

No correlation was found between the clinical stages and MRI findings. It is possible that the effusion group could represent a more advanced stage. Adame et al. (5) reported the control MRI studies in a few patients and found effusion 3 or 4 years later.

TMJ disc consists of dense fibrous tissue made up of proteoglycan and elastin. Defining diagnostic landmarks, especially the border between the posterior band and the bilaminar zone, is essential for the diagnosis of discal displacement (8).

The cause of pain associated with disc displacement remains unclear. Adame et al. (5) explained that the cause of pain result from retrodiscal tissue alterations, inflammatory reaction, and synovitis. However, Özpınar et al. (16) regarded disc displacement of the TMJ as an important cause of facial and TMJ pain clicking, crepitus and dysfunction. They maintained that disc displacement is an anatomic and functional abnormality of the relationship between the disk, condyle, and TMJ components (16).

Adame et al. (5) reported that 46% of cases with effusion had clicking, and the incidence of anterior displacement on MRI was greater in the effusion group.

De Leeuw et al. (9) reported that the classification criteria used to select TMJs with osteoarthrosis and internal derangement was highly accurate. In more than 90% of the TMJs with a history of osteoarthrosis and internal derangement, internal derangement was confirmed by MRI.

The MRI of the contralateral TMJs of patients also showed a high percentage of internal derangement.

In agreement with other studies De Leeuw et al. (9) found a strong correlation between radiographically detectable degenerative changes and the stage of internal derangement.

De Leeuw et al. (9) noticed that signs and symptoms had developed in the contralateral TMJ in their series with a ratio of 27%.

Recent imaging studies have shown frequencies of asymptomatic internal derangement varying from 15% to 60% (9).

An MRI study by Drace and Enzman (19) suggested a strong correlation among abnormal joint detected asymptomatic volunteers with histories of orthodontic treatment.

Katzberg et al. (11) reported no difference between asymptomatic volunteers and symptomatic subjects in relation to prior orthodontic treatment. Thus no relationship between a history of orthodontic treatment and TMJ disc displacement could be found. The interesting finding of a high prevalence of disc displacement in asymptomatic volunteers is not unique to the TMJ. MRI studies of asymptomatic subjects in the knee, cervical spine, and lumbar spine indicate similar

disease prevalence in asymptomatic subjects in these body parts as well (17). This emphasizes the necessity for comparison of clinical signs and symptoms with imaging findings.

Katzberg et al. (11) suggested that disc displacement of one TMJ is related to disc displacement on the contralateral side, while clicking and jaw pain that was side specific. The relatively high association of an abnormality on the contralateral side is related to the important, but often unappreciated, aspect of TMJ articulation that is the signified action of both TMJs linked by the bony voke of the jaw. TMJ disorders such as abnormalities in the position, shape and internal structure of the disc are detected through the use of MRI. A total of 17.9% of patients (29.2% female, 5.6% male) with the clinical variables (articular pain, clicking, locking, limitation of mouth opening, dislocation (luxation), headache (temporal, facial or neck), and occlusal disharmony) were found normal in their MRI. In all cases, MRI features did not correlate to the clinical findings for TMJ disorders.

The therapeutic effect of orthodontic treatment in the management of TMJ disorders remains controversial. It has been suggested that orthodontic treatment could be a possible risk for the development of TMJ disorder. There have been several studies examining this relationship, though none specific to internal derangement (17).

MRI modality can not diagnose perforations or adhesions. Metallic dental restorations may cause artifacts. MRI artifacts also cause difficulty in the diagnosis of TMJ pathologies (16-19).

This study showed that effusion was found in 19.4% of cases, while clicking was found in 75.69% of cases.

Occlusal problems are not a major cause of TMJ disorders. Parafunctional activity and increased psychological stress is much more important causally than occlusal problems (20). In this study, we found that all of the patients with clinical symptoms of TMJ disorders hadocclusal disharmony (ground teeth, premature contact, mandibular prognathy or retrognatly, overbite, deep bite, open bite, laterognathy). Occlusion, however, can play a role if it is manipulated. Under normal circumstances, it is not what the teeth do but what we do and what has been done (restorations and prosthetic appliances) to our teeth that is important.

The dynamic relationship between TMJ symptoms and psychologic factors is of preeminent significance to researchers, though it is less relevant for the task of clinicians treating patients with TMDs. What is important for the clinician is to detect the presence of psychologic factors that may be contributing to TMJ symptoms, and determine the most appropriate treatment. In this study, most of the patients with TMJ disorders were found to have psychological problems (as ascertained by the clinician).

It should be remembered that although patients with pain may appear to have depression, those with depression and other psychiatric disorders may have as their pain chief complaint. It is relevant to understand the importance of psychological factors involved in these disorders and other chronic pain problems.

It is doubtful whether any single psychological factor can explain all, or even most, cases of TMD. The patients appear to be quite heterogeneous, but future research using stricter diagnostic criteria for both physical and psychological factors may rectify the current confusion and provide new levels of understanding about this baffling problem.

Recent advances in imaging technology have greatly contributed to the understanding of diseases related to the TMJ. MRI is now the modality of choice in the evaluation of TMJ related symptoms. This article describes the normal anatomy and MRI characteristics of diseases affecting the TMJ. The TMJs of the patients with clinical findings of occlusal disharmony, articular pain, locking, clicking, limitation of mouth opening, dislocation and headache were evaluated with MRI. Some of the patients' TMJs were found to be normal (175 of the 502 TMJ's). As a result, TMJs disorders can not be caused by imageable disorders. In this case, MRI gives normal imaging.

Correspondence author:

Mehmet DALKIZ

İvedik Caddesi 454/10

(Derya Ap. Kat.3)

Demetevler, Ankara - TURKEY

References

1. Pharoah MJ. Temporomandibular joint imaging. Dent. Clin. N. Am.; 37 (4) 627, 1993.
2. Yengin E, Evliyaoğlu G. The Evaluation of TMJ by Magnetic Resonance Imaging. J İstanbul University Dental Faculty 30: 37,1996.
3. Kirc WS. Sagittal Magnetic Resonance Image Characteristics and Surgical Findings of Mandibular Condyle Surface Disease In Staged Internal Derangement. J Oral Maxillofacial Surg 52: 64, 1994.
4. Tallents RH, Katzberg RW, Murphy W. Magnetic resonance imaging findings in asymptomatic volunteers and symptomatic patients with temporomandibular disorders. J Prosthet Dent 75: 529,1996.
5. Adame CG, Mange F, Munoz M, Granizo RM. Effusion in magnetic resonance imaging of the temporomandibular joint: A study of 123 joints. J. Oral Maxillofac Surg 56: 314,1998.
6. Oyar O, Üstün EE, Özpınar B, Sabah ME. MRI in the diagnosis of patient with temporomandibular joint dysfunction. Bilgisayarlı Tomografi Bül 3: 1,1995.
7. Muto T, Kohara M, Kanazawa M, Kawakamis J. The position of the mandibular condyle at maximal mouth opening in normal subjects. J Oral Maxillofac Surg 52: 1269,1994.
8. Niitsu M, Hirohata H, Yoshika H, Anno I, Campeau NG, Itai Y. Magnetization transfer contrast on gradient echo MR imaging of the temporomandibular joint. ACTA Radiologica 36:295,1995.
9. De Leeuw R, Boering G, Van Der Kuiji B, Stegonga B. Hard and soft tissue imaging of the temporomandibular joint 30 years after diagnosis of osteoarthrosis and internal derangement. J Oral Maxillofacial Surg 54: 1270, 1996.
10. Dawson PE.: A classification system for occlusions that relates maximal intercuspidation to the position and condition of the temporomandibular joints. J Prosthet Dent 75: 60,1996.
11. Katzberg RW, Westesson PL, Tallents RH, Drake CM. Orthodontics and temporomandibular joint internal derangement. Am J Orthod Dentofac Orthop 109: 515,1996.
12. Lieberman JM, Gardner CL, Motta AO, Schwartz RD. Prevalance of bone marrow signal abnormalities observed in the temporomandibular joint using magnetic resonance imaging. J. Oral Maxillofac Surg 54: 434,1996.
13. Behr M, Fellner C, Bayreuther G, Leibrock A, Held P, Fellner F, Handel G. MR imaging of the TMJ: Artefacts caused by dental alloys. Eur J Prosthodont Res Dent 4:111,1996.
14. Schelhas KP, Wilkes CH. Temporomandibular joint inflammation comparison of MR fat scanning with T1- and T2 weighted imaging techniques. Am J Radiol 10: 589, 1989.
15. Toller PA. Ultrastructure of the condylar articular surface and severe mandibular pain dysfunction syndrome. Int J Oral Surg 6: 297, 1977.
16. Özpınar B, Sabah ME, Oyar O, Üstün EE. The Evaluation of TMJ dysfunction by MRI. J Ege Dental Faculty: 14: 148, 1993.
17. Drace JE, Enzmann DR. Defining the normal temporomandibular joint closed partially open and mouth MRI of asymptomatic subjects. Radiology 177: 67, 1990
18. Erdem T, Özcan İ, Şermet B, Tunacı A, Şirin Ş. MRI Evaluation of artefacts caused by dental materials. Turkish J Radiol 31: 173, 1996.
19. Akan H, Aktan S, Danacı M, İncesu L, Cantürk F, Selçuk MB. MRI of TMJ in rheumatoid arthritis. Tr J Diagnostic Intervention Radiol 3: 348,1997.
20. Laskin DM. New concepts in the diagnosis and treatment of temporomandibular disorders. In Fagan MJ, İsmail JYH, Meffert RM, Fagan MJ: Implant prosthodontics. Year Book Medical Pub. Inc. Chicago, London, Boca Raton, Littleton, Mass. 1990, P: 238-248.