Magnetic Resonance in Diagnosing Temporomandibular Joint Disorders

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Summary

The purpose of the paper is to present magnetic resonance imaging as a useful technique in establishing a diagnosis of functional disorders of the temporomandibular joint, on the basis of case studies, as this technique is not yet widely used in this country. The MR images were used for assessment of normal functional anatomy, as well as forms of functional disorders of the temporomandibular joints (disc displacement with and without reduction). Standard oblique sagittal planes with T1 sequences obtained using Magneton Impact (Siemens) apparatus at 1.0 T with surface coil of 10 cm diameter were used. The MR images were taken in the open mouth and closed mouth positions in the oblique sagittal plane vertical to the longitudinal axis of the condyle.

Magnetic resonance imaging is a non-invasive technique using magnetic field and radio frequency pulses instead of ionising radiation for image creation. Of all known radiologic techniques, magnetic resonance imaging proved to be the best technique of choice for visualization of soft and hard tissues of the temporomandibular joints. In general, the magnetic resonance technique is used in cases of doubtful diagnosis and therapeutic failure of temporomandibular disorders. Apart from diagnostics, the technique can also be used in assessment of various methods of treatment of temporomandibular disorders (where conditions before and after treatment are assessed). It is also used for better understanding of the pathophysiology and biomechanics of temporomandibular joints, which has been shown in numerous scientific studies.

Key words: *magnetic resonance (MR), diagnosis, temporomandibular disorders.*

Acta Stomat Croat
2001; 397-401

CASE REPORT
Received: March 5, 2001

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Introduction

The medical history of the patient and thorough clinical examination have always been the most important method in examination of the temporomandibular joint. A considerable number of radiologic imaging techniques (transcranial and panoramic radiography, conventional tomography, computerised tomography, arthrography, arthroscopy, ultrasound, etc.) is used for visualization of temporomandibular joints (soft and hard tissues) and the surrounding structures. However, magnetic resonance imaging has proved to the best technique for visualization of soft and hard tissues of the temporomandibular joint (1).

Bell outlined the diagnostic classification that logically categorized temporomandibular joint disorders (2). The American Academy for Orofacial Pain (3) adopted the classification. The classification has been integrated into the existing medical diagnostic classification in order to establish the best possible accurate differential diagnosis.

Temporomandibular joint disorders are associated with characteristic clinical signs and symptoms (clicking, crepitation and pain) resulting as a consequence of various etiological factors, necessitating a multidisciplinary approach to management of the disorder. According to the mentioned diagnostic classification, temporomandibular disorders are divided into:

1. Derangement of the articular disc-condyle complex
   a. Disc displacement
   b. Disc displacement with reduction
   c. Disc displacement without reduction
2. Structural incompatibility of the articular surfaces;
   a. Deviation in form (articular disc, condyle, glenoid fossa)
   b. Adhesions (between the articular disc and condyle, between the articular disc and articular eminence)
   c. Subluxation (hypermobility)
   d. Spontaneous dislocation
3. Inflammatory disorders of the temporomandibular joint
   a. Synovitis / Capsulitis
   b. Retrodiscitis
   c. Arthritis / arthrosis (osteoarthritis, osteoarthrosis, polyarthritis)
   d. Inflammation of the surrounding structures (temporal tendonitis, inflammation of the stylomandibular ligament) (4).

Because of the high prevalence, the most important subgroup of articular disorders include various forms of derangement of the condyle-disc complex, i.e. "internal derangement" of the temporomandibular joint, which occur in symptomatic populations, and also in asymptomatic populations (5-9).

The purpose of the paper is to present three case reports of functional disorders of temporomandibular joints, in the diagnosis of which the technique of magnetic resonance imaging was used, as the best technique for this disorder, and because it is not yet widely used in this country.

Case presentations

Three subjects are described in the paper of which one had normal function of the temporomandibular joints. On the basis of the clinical examination one subject, was classified into the group with disc displacement with reduction, and the third subject had disc displacement without reduction. The patients were scanned in standard oblique sagittal plane with T1 sequences, using Magneton Impact (Siemens) apparatus at 1.0 T with surface coil of 10 cm diameter. The MR images were taken in the mouth closed and mouth open positions in the oblique sagittal plane vertical to the longitudinal axis of the articular condyle.

The anatomy of the left temporomandibular joint in the closed mouth position of the asymptomatic subject is presented in Figure 1. Anatomic structures of normal form and position are seen (condyle, articular disc, articular eminence, upper and lower articular space).

Figure 2 shows the asymptomatic subject in the open mouth position. The mandibular condyle is beneath the articular eminence with the interposed articular disc (having the form of a bow-tie).

Figure 3 shows the right temporomandibular joint in the closed mouth position of the symptomatic patient (clicking during closing and opening of the mouth, with occasional pain in the temporo-

mandibular joint). Anterior displacement and changes in the form of the articular disc are seen.

Figure 4 presents the right temporomandibular joint in the open mouth position in the same patient. The articular disc is anteriorly displaced presenting as a kind of functional disorder of the temporomandibular joint (disc displacement with reduction).

Figure 5 presents the right temporomandibular joint in the symptomatic subject (pain and clicking in the right side of the joint, with limited opening of the mouth) in the closed mouth position. The anteriorly displaced articular disc, a wide separation between the anterior and posterior ligaments of the articular disc, changes in the normal morphology and narrowing of the articular spaces can be seen.

Figure 6 shows the temporomandibular joint of the same subject in the open mouth position. The mandibular condyle is behind the articular eminence, with the articular disc anteriorly to the condyle. The clinical manifestation of this finding includes disturbances in the kinetics of the condyle--disc complex, and limited opening of the mouth (disc displacement without reduction or "closed lock").

Discussion

Magnetic resonance imaging is a technique without parallel in visualisation of the anatomy and function of the temporomandibular joint, using the oblique sagittal planes and oblique coronal planes within standardized protocols for imaging temporomandibular joints (10).

Drace and Enzmann (11), and Murakami et al. (12) attempted to measure the normal position and configuration of the articular disc. They found that the normal position occurs when posterior ligaments of the articular disc and the posterior attachment stay in the 12 o'clock position relative to the condylar pole.

However, Orsini et al. (13) used magnetic resonance imaging in 137 patients with temporomandibular disorders and 23 asymptomatic volunteers to evaluate different diagnostic criteria to establish the relation the posterior attachment - articular disc - condyle (10 o'clock; 11 o'clock; 12 o'clock; and the intermediate zone). The results of the study demonstrated that the intermediate zone criteria is the most accurate in defining the normal position of the articular disc relative to the pole of the mandibular condyle in asymptomatic volunteers, as well as in patients with a diagnosis of disc displacement, in the closed mouth position and/or in the open mouth position.

Disc displacement is the most common arthropathy of the temporomandibular joint with several stages of clinical dysfunction, including an irregular relationship or position of the mandibular condyle and the articular disc relative to the articular eminence. In functional studies, disc displacement is divided into two categories: *disc displacement with reduction*, and *disc displacement without reduction*.

Disc displacement with reduction most often means that the articular disc is displaced anteriorly relative to the condyle in the closed mouth position, returning to its normal position and shape at one point of the articular movement. In this condition, mandibular movements are not restricted, but clinical signs of clicking (reciprocal and nonreciprocal) occur during the stage of opening and closing of the mouth, with pain, if present, occurring during temporomandibular movements (4, 5, 14, 15).

Disc displacement without reduction ("closed lock") is characterized by a condition when, due to the elasticity of the upper layer of the posterior attachment, the articular disc (placed beneath the condyle) only allows for rotation of the joint (limited opening of the mouth, 25 - 30 mm), and not for movement of translation. Pain, if present, usually occurs with the mouth opening beyond the articular restriction (4, 16).

Although posterior displacement (17, 18) and sideways (medial and lateral) disc displacements (19-21) have been described, the most common are those in the anterior, anterolateral (rotational) and anteromedial direction (4-6, 21, 22).

Because of uncertainty of interpretation of MR images of the temporomandibular joint and high prevalence of articular disc displacement in asymptomatic subjects as well, a more accurate quantitative measurement of the position and configuration of the articular disc, and establishment of a diagnostic classification was needed. Recent studies show that using calibration by several observers

interpreting MR images decreases differences and increases interobserver agreement (23, 24).

Besides static images (of the temporomandibular joint in closed, partially open, and open mouth positions) technology progress brought about the appearance of dynamic three dimensional visualisation of articular kinetics, offering a tool for better understanding of functional and dysfunctional relations, and of morphological and dysmorphological forms and structures of the temporomandibular joint (25-27).

Magnetic resonance imaging is reliable for revealing congenital anomalies (aplasia, hypoplasia, hyperplasia and dysplasia), acquired disorders (tumors and fractures), connective tissue and bone ankyloses, temporomandibular luxations, degenerative joint conditions (osteoarthrosis, osteophyte, erosions of the cortical bone, avascular necrosis), and inflammatory conditions of the temporomandibular joints (synovitis, capsulitis, osteoarthritis, rheumatoid arthritis, juvenile rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis) (5, 28, 29).

Magnetic resonance imaging technique is considered particularly superior in relation to other imaging techniques, in evaluation of inflammatory reactions such as joint effusions and bone marrow oedema. Joint effusion is a term used by radiologists for a more intensive signal seen within the temporomandibular joint, which is most clearly visualized using T2 sequences (unlike changes in the bone which are most clearly visualized using T1 sequences), and most often associated with pain in the temporomandibular joint and disc displacement (5, 28, 30-32).

Takahashi, Nagai, Seki and Fukuda (33) investigated the relationship between joint effusion, joint pain, and protein levels in joint lavage fluid of patients with internal derangement and osteoarthritis of the temporomandibular joint. They demonstrated that painful joints are more likely to show joint effusion on MR images, and higher protein levels in joint lavage fluid than in pain-free joints. These results also suggest that joint effusion may be related to inflammatory changes seen in patients with internal derangement and osteoarthritis.

Apart from the diagnostic importance of imaging technique, its application is recommended in various forms of treatment of patients with temporomandibular joint disorders. Numerous studies have demonstrated most accurate information on the effectiveness of the treatment. They are categorized into studies of *conservative reversible* treatment, and those of *non-conservative irreversible* treatment. Results of the conservative treatment (medications, physical therapy, biofeedback, relaxation, selective occlusal adjustment, splints, transcutaneous electrical nerve stimulation) range from 70 - - 95% (34-39), and those of the non-conservative treatment (selective occlusal adjustment, condylectomy, discectomy, orthodontic surgery, implants) range from 70 - 93% (40-43).

Using magnetic resonance imaging technique and clinical assessment, Kurita et al. (44) evaluated the results of the treatment of 74 patients with disc displacement with reduction after application of a splint repositioning appliance. According to the clinical assessment, 75.6% of the joints were treated successfully. When compared with the results of magnetic resonance imaging assessment, clinical assessment showed an accuracy rate of 91.5%, although the incidence of false negatives was high (40%).

Gaggl et al. (45) established significant association between clinically obtained findings and magnetic resonance images (preoperatively and postoperatively) of the temporomandibular joints of patients treated by orthodontic surgery.

Application of magnetic resonance imaging technique has also been described in studies of anatomy (46-48) and biomechanics (49-51) of temporomandibular disorders. MR imaging (application of intravenous contrast dimeglumine gadopenthetate) (5, 52) with three-dimension visualization of the temporomandibular joint areas will be a reliable requirement in future longitudinal clinical investigations, which together with improvement in technology makes it the leading technique in imaging temporomandibular joints.

Conclusion

Magnetic resonance imaging temporomandibular joints provides high quality three-dimensional tomographic images with excellent space and con-

trast resolution of soft and hard tissue visualizations. Advantages of this radiologic technique include non-invasiveness, painlessness, minimum risk, and avoidance of ionising radiation exposure, while the major disadvantage consists of its high cost.

The majority of patients with temporomandibular disorders should not be examined using the magnetic resonance imaging technique (or any other imaging technique) if accurate diagnosis can be established by clinical examination, followed by appropriate successful treatment. If the treatment fails, a new clinical examination should indicate the use of an imaging technique. If so, magnetic resonance imaging is the technique of choice, offering MR image interpretation as a complement to the clinical examination when deciding on further treatment.

Although all-inclusive information on the adverse effects of magnetic resonance is not available, some contraindications should be absolutely respected in connection with the use of an intensive magnetic field: "pacemakers" or other implanted electronic apparatuses, because of the magnetic field interfering with the functioning of such devices; metal bodies in the organism (bullets, fragments, clamps after surgery of brain vessels, artificial heart valves, intrauterine spirals); pregnancy (although there are no known adverse effects of MR on the foetus).

Children and anxious patients should be given a tranquillizer prior to the examination. Claustrophobia rarely poses a serious problem if the patient is adequately prepared. The patient should remove all metal objects, such as watches, credit cards, glasses, dental prostheses, before the procedure, which lasts several minutes.