Prevalence of temporomandibular joint sideways disc displacement in symptom-free volunteers and comparison of signal intensity ratios of masticator muscles on magnetic resonance images

Kaan Orhan[1], Ozlem Ucok[2], Cagri Delilbasi[3], Candan Paksoy[1], Necdet Dogan[4], Kemal Karakurumer[2], Tuncer Ozen[2]

[1] Department of Oral Diagnosis and Radiology, Faculty of Dentistry, Ankara University, Ankara-Turkey
[2] Department of Oral Diagnosis and Radiology, Division of Dental Sciences, Gülhane Military Medical Academy, Ankara-Turkey
[3] Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Yeditepe University, Istanbul-Turkey
[4] Department of Oral and Maxillofacial Surgery, Division of Dental Sciences, Gülhane Military Medical Academy, Ankara-Turkey

Summary

The objectives of this study were to figure out the prevalence of sideways disc displacement of the temporomandibular joint (TMJ) in symptom-free volunteers and to compare signal intensity ratios of masticator muscles in normal joints and in sideways disc displacements.
The study was based on bilateral Magnetic Resonance Images (MRI) of 112 joints in 56 symptom-free volunteers. Sideways displacements were identified as medial disc displacement (MDD) and lateral disc displacement (LDD). The signal intensity ratios (SIR) of masticator muscles for both normal joints and pure sideways displacements were measured with elliptic ROI on T1 and T2 weighted MRIs.
Of the 112 TMJ images, one showed LDD and two showed MDD. The signal intensity ratios increased for pterygoid lateral and temporal muscles in sideways disc displacements.
The results of this study suggest that the temporal muscle fibres are also inserting into the TMJ disc like the pterygoid muscle. Therefore, sideways disc displacements have direct effect on pterygoid lateral and temporal muscles.

Key words: signal intensity; temporomandibular joint; Magnetic Resonance Imaging; masticator muscles, disc displacement.

Introduction

The understanding and interest in the diagnosis and management of patients with various temporomandibular joint (TMJ) disorders have lately increased. Many researches have examined TMJ disorders for both symptomatic and asymptomatic patients with Magnetic Resonance Imaging (MRI) and made classifications of disc displacements [1]. MRI is currently the first choice of diagnostic imaging for patients with TMJ disorders. MRI can clearly demonstrate TMJ structures and signal intensities. Moreover, MRI is the most reliable procedure for imaging soft tissues (such as disc and muscles) and TMJ disorders without using ionizing radiation [1-6].

The aim of this study was to determine the prevalence of TMJ sideways disc displacement in symptom-free volunteers and to evaluate signal intensity of the masticator muscles in a series of 112 joints in order to compare signal intensity ratios of masticator muscles in normal joints and sideways displacements.

Material and method

In this study, MRI of the 168 joints in 84 symptom-free volunteers were evaluated. The volunteers consisted of 32 females and 24 males with a median age of 39.7 years for females and 29.7 years for males. The age range for females was 18 to 81 years, while age range for males was 19 to 67 years. Symptom-free volunteers were selected on the basis of having no previous or present clinical signs and symptoms of TMJ disorders including pain, no previous or present treatment for TMJ disorders, no joint sound on auscultation with a stethoscope or palpable noises, having normal range of vertical (> 39 mm) and horizontal (> 5mm) movement, and a willingness to participate in the study. All joints were studied with a 1.5-T Magnet (Gyroscan Intera, Philips Medical Systems, Washington, USA) using a dual phased array surface coil (6 x 8 cm). All patients underwent imaging in axial, coronal and sagittal planes using fast-spin echo sequences (FSE). Imaging parameters were as follows: T1 weighted images were obtained with a repetition time (TR) of 800 ms, an echo time of (TE) of 17 ms, T2 weighted images were obtained with a TR/TE 2500/102, 192 × 256 matrix, 3 mm slice thickness, NEX = 2, and bandwidth = 15.6 kHz. DICOM 3.0 formatted MR images were sent to the DICOM server and downloaded to a personal computer (MS Windows XP, PIV 2.0 Ghz). The images were evaluated with a special software package for interactive display and manipulation of medical images using density functions (Osiris 4.09, University Hospital of Geneva, Geneva, Switzerland). Two oral and maxillofacial radiologists without knowledge of the clinical conditions evaluated all the images separately. If the assessments were different, the final diagnosis was obtained by consultation between the two radiologists. The TMJ discs were classified according to the following criteria [3,7]:

Normal state: The disc was located superior to the condyle in which the posterior band of the TMJ disc was at the apex of the condylar head (12 o'clock position). In the coronal plane of imaging, the disc was centred perfectly on the condylar head.

Sideways displacements: This state was classified as medial and lateral disc displacement without an anterior component. Sideways displacements of the disc were well documented in the coronal plane. The disc crosses over one of the sagittal plane tangents to one of the condylar pole. Twenty-eight patients were excluded, because anterior disc displacements were noticed on the MRIs. Finally, 112 joints from 56 patients were evaluated.

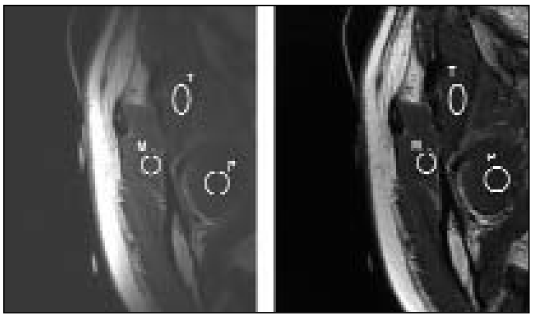

Figure 1. The measurement of masticator muscles' signal intensities with elliptic ROI on T1 and T2 weighted images.

Masticator muscles' signal intensities were measured with elliptic ROI on T1 and T2-weighted coronal MRIs (Figure 1). The muscles that were investigated for signal intensities are as follows: temporal muscle, lateral pterygoid muscle, and masseter muscle. We did not investigate the medial pterygoid muscle, because this muscle located far from the surface coil. Unlike body or head

Figure 2. MR image of lateral disc displacement.

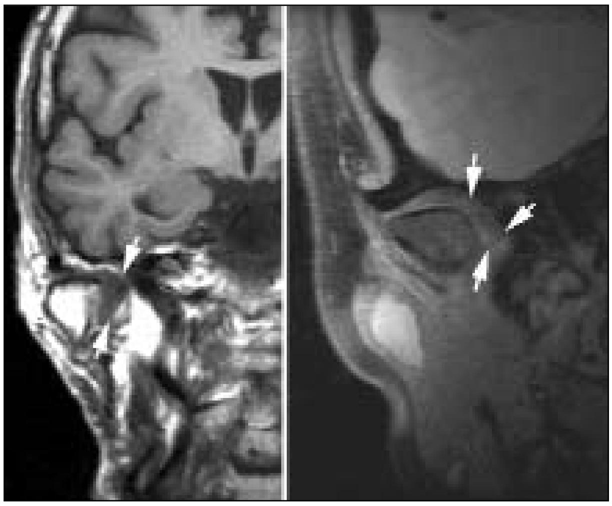

Figure 3. MR images of medial disc displacement

coils, the response of surface coils is basically nonuniform and falls off especially beyond a distance of approximately one radius of surface coil [8]. Pterygoid medial muscle is located far than one radius of surface coil; therefore, we excluded this masticator muscle from the study. Data were analysed with SPSS/PC+ (11.0 Version; SPSS Inc, Chicago, IL). Independent Samples t-test was used for statistical analysis and results were considered significant for $p < 0.05$.

Results

Analysis of the MRIs of the 112 joints showed one lateral disc displacement and two medial disc displacements (Figures 2 and 3). The rest of the joints were classified as normal. The signal intensity ratios of pterygoid lateral and temporal muscles increased in sideways displacements and there was a statistical difference for both muscles ($p = 0.025$, $p = 0.017$ respectively). Signal intensity ratios of masseter muscle were approximately the same for both normal discs and sideways displacements ($P = 0.144$).

Discussion

The relationship between the temporomandibular joint disc and masticator muscles is a controversial subject. Some studies report the insertion and relation of masticator muscles; particularly the lateral pterygoid muscle, with the TMJ. Bertlsson and Strom reviewed publications from past 100 years concerning the relationship between the lateral pterygoid muscle and the disc [9]. They reported that majority of the articles (60%) found that the lateral pterygoid muscle inserted into the disc, the capsule and the condyle. 30% of the investigations found that only a few muscle fibres inserted into the disc; the remainder inserted into the condyle. Only 10% of investigations held the view that the lateral pterygoid muscle inserted exclusively into the condyle. It is commonly accepted that the lower head of the pterygoid muscle inserts into the pterygoid fovea of the condyle and the upper head inserts into the anteromedial portion of the disc [10-15].

The insertion of masseter and temporal muscles is also a controversial subject. Some investigators observed no insertion of these muscles into the disc [16-18], while others observed the opposite. Le Toux [19] described discotemporal muscle bundle having a supplementary function for guiding the articular disc anteriorly. Two other studies reported a muscle bundle, which originates from the medial surface of the middle part of temporalis muscle and inserts into disc [20,21]. Akita et al. [22] reported the discotemporal muscles for all specimens, which originate from middle and posterior part of the temporalis muscle and insert into disc. They suggested the discotemporal bundle and lateral pterygoid muscle are in cooperation during closing. Velasco et al. [10] reported that temporalis muscle fibres attaching to the disc arose from the posterior third of the muscle. Once these fibres extended beyond the root of the zygomatic process of the temporal bone, they curved downward, thus reaching the disc.

In this study we found a significant increase in SIR for pterygoid and temporal muscles in sideways disc displacements. This may cause inflammation of the muscles, oedema or morphological changes. A possible explanation of this significance can be due to positional relationship of the muscles with TMJ disc. In our opinion temporal muscle fibres are also inserting into the TMJ disc like the lateral pterygoid muscle. It can be concluded that when the disc is depressed medially or laterally, structural changes occur in the masticator muscles, particularly lateral pterygoid and temporal muscles. These results are comparable with previously published studies.

Raustia et al. [23] reported that the patients with long duration of internal derangements of TMJ showed morphological changes in their masticator muscles. Liu et al. [24] concluded in their study that the morphology of lateral pterygoid muscle may not be related to a specific disc displacement. Our findings can be argued with this study, but only disc displacement with and without reduction were reported in the mentioned study, but no data on sideways disc displacement were present. Thus, there can be a difference between anterior disc displacements and sideways disc displacements.

We believe that further studies are needed to examine the effect of disc displacement on the masticator muscles and to examine insertion of the muscles into TMJ disc from the radiological point of view.

References

1. Brooks LS, Brand WJ, Gibbs J, Hollender L, Lurie GA, Omnell K, Westesson P, Arbor A: Imaging of temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol Oral Endod, 1997; 83: 609-618.

2. Harms S, Wilk R, Wolford L, Chiles D, Milam S: The temporomandibular joint magnetic resonance imaging using surface coils. Radiology, 1985; 157: 133-136.

3. Tasaki MM, Westesson P, Isberg A, Ren Y, Tallents R: Classification and prevalence of temporomandibular joint disc displacement in patients and symptom-free volunteers. Am J Orthodontics and Dentofacial Orthopedics, 1996; 109: 250-261.

4. Helms AC, Kaban BL, Mcneill C, Dodson T: Temporomandibular joint morphology and signal intensity characteristics of the disc at MR imaging. Radiology, 1989; 172: 817-820.

5. Katzberg W: Temporomandibular joint imaging. Radiology, 1989; 170: 297-307.

6. Takaku S, Sano T, Yoshida M: Long term magnetic resonance imaging after Temporomandibular joint Discectomy without replacement. J Oral Maxillofac Surg, 2000; 58: 739-745.

7. Foucart J, Carpentier C, Pajoni D, Marguelles-Bonnet R, Pharavoz C: MR of 732 TMJs: anterior, rotational, partial and sideways discs displacements. European Journal of Radiology, 1998; 28: 86-94.

8. Ehman L: MR Imaging with the Surface Coils. Radiology, 1985; 157: 549-550.

9. Bertilsson O, Strom D: A literature survey of a hundred years of anatomic and functional lateral pterygoid muscle research. J Orofac Pain, 1995; 9:17-23.

10. Velasco JR, Vazquez JF, Collado J: The relationship between the temporomandibular joint disc and related masticatory muscles in humans. J Oral Maxillofac Surg, 1993; 51: 390-395.

11. Heylings D, Nielsen L, McNeill C. Lateral pterygoid Muscle and the temporomandibular Disc. J Orofac Pain, 1995; 9: 9-15.

12. Naidoo L: Lateral pterygoid muscle and its relationship to the meniscus of the temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol Oral Endol, 1996; 82: 4-9.

13. Carpentier P, Yung JP, Marguelles-Bonnet R: Insertions of the lateral pterygoid muscle. J Oral Maxillofac Surg, 1988; 46: 477-482.

14. Pajoni D: Le complexe condylo-meniscal. Orthod Fr, 1987; 58: 501-505.

15. Bade H, Schenck C, Koebke J: The functional of discomuscular relationships in the human temporomandibular joint. Acta Anatomy, 1994; 151: 258-267.

16. Isacsoon G, Isberg AM: Tissue identification of the TMJ disc and Disc attachments and related vascularization. J Craniomandibular Practice, 1985; 3: 375-379.

17. Wilkinson TM: The relationship between the disc and the lateral pterygoid muscle in human temporomandibular joint. J Prosth Dent., 1988; 60: 715-724.

18. Wilkinson TM, Chan K: The anatomic relationship of the insertion of superior pterygoid muscle to the articular disc in the temporomandibular joint of human cadavers. Aust Dent J., 1989; 34: 315-322.

19. Le Toux G, Duval JM, Darnault P: The human temporomandibular joint. Surg Radiol Anatomy., 1989; 11: 283-288.

20. Sugisaki M, Komori E, Nakazawa M, Tanabe H, Kato S: Anatomical studies of the lateral pterygoid muscle by the superior approach and a review of the literature. Japanese Journal of Oral and Maxillofacial Surgery, 1986; 32: 251- 264.

21. Naohara H: The macroscopic and microscopic study of the human lateral pterygoid muscle. Tsurumi Shigakubu, 1989; 15: 1-26.

22. Akita K, Shimokawa T, Sato T: Positional relationships between masticatory muscles and their innervating nerves with special reference to the lateral pterygoid and the midmedial and discotemporal muscle bundles of temporalis. J Anat., 2000; 197: 291-302.

23. Raustia AM, Oikarien KS, Pyhtinen: Densities and sizes of main masticatory muscles in patients with internal derangements of the temporomandibular joint obtained by computed tomography. J Oral Rehabilitation, 1998; 25: 59-63.

24. Liu Z, Yamagata K, Kuroe K, Suenaga S, Noikura T, Ito G: Morphological and positional assessments of TMJ components and lateral pterygoid muscle in relation to symptoms and occlusion of patients with temporomandibular disorders. J Oral Rehabilitation, 2000; 27: 860-874.

Correspondence to: Dr. Cagri Delilbasi, Lecturer, Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Yeditepe University - Bagdat Caddesi No: 238, 34728 Goztepe-Istanbul, Turkey. E-mail: delilbasi@hotmail.com