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RESEARCH ARTICLE

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Frequencies of the disk displacements and joint effusions of temporomandibular joint disorders using 3T MRI.

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ABSTRACT

Aim: The purpose of this study was to assess frequencies of the disk displacements and joint effusions of temporomandibular joint disorders using 3T MRI.
Methods: We retrospectively evaluated 229 temporomandibulars (TMJs). We recorded 1) pattern of disk displacement (anterior, anterolateral, anteromedial, posterior, medial, and posteromedial disk displacement); 2) prevalence of the disk displacement; 3) presence/absence, of joint effusions in each disk displacement; and 4) prevalence of dynamics of the disk (with or without reduction) in each disk displacement; and 5) prevalence of the disk displacement in each age group and gender. The data were collected in 2023 and the study was conducted in 2023.
Results: One hundred nineteen out of 229 TMJs showed anterior disk displacement. Anteromedial and lateral disk displacement had joint effusions. In anterior disk displacement, 46 joints showed with reduction of the disk and 73 joints showed without reduction of the disk. Anterior disk displacement was more frequent in females than in males in the 20's, 50's, 60's, and 70's.
Conclusions: The disk displacements showed age and gender differences. More than 60% of joints showed a reduction in anterior disk displacement. These findings may be useful for age- and gender-specific treatment interventions of the TMDs.

ARTICLE HISTORY

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KEYWORDS

Temporomandibular disorder; 3T MRI.

Introduction

In temporomandibular joint disorders (TMDs), disk displacement [1–3] and osteoarthritic (OA) changes [4–6] of mandibular condyles can be detected by MR imaging [7–9]. TMDs are commonly seen in adults [10]. The common symptoms of TMDs are clicking, pain, and trismus [10]. In most cases, anterior disk displacement within the temporomandibular (TMJ) is caused by clicking [10]. OA changes may be a sign of disease progression, and severe OA changes are often seen in advanced-stage TMDs [4–6]. It is important to detect disk displacement to prevent progression to severe OA; therefore, identifying disk displacement is crucial. In addition, detecting disk displacement can be the point to start proper treatment. Anterior disk displacement is the most common, according to Whyte et al. [8]. The disk displacement defines the turning or rotational displacement of the disk through either the anterior–posterior or medial-lateral direction to the condylar poles. For example, in anterolateral disk displacement, the disk is anteriorly displaced on the sagittal, and its position is laterally displaced on the coronal images [8]. There are some reports that described TMJ disk displacements using 1.5T MR images [1,2,4,6–9,11–14]. Schmid-Schwap et al. [10] reported that 3T MRI delivers better quality images as regards evaluability of disk position and shape as compared to 1.5T MR. We hypnotized that 3T MRI may provide additional diagnostic assurance that is crucial for therapeutic decisions in TMDs [10]. However, no articles described characteristic MR findings of TMDs using 3T MRI. The purpose of this study was to assess frequencies of disk displacements and effusion of TMDs using 3T MRI.

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Methods and materials/patients

This retrospective study was approved by the Ethics Committee on Epidemiological Studies (20042 Epi). We have read the Helsinki Declaration and have followed the guidelines in this investigation. The data were collected in 2023 and the study was conducted in 2023.

Patients

One hundred forty-nine patients with 298 TMJs who were TMDs at our hospital between July 2018 and April 2022 were enrolled in this study. Exclusion criteria were 1) degenerative changes in the condyle or congenital anomalies such as bifid condyle, hypoplastic or hyperplastic, 2) history of trauma, 3) tumors, cysts, and other lesions seen in the TMJ region, and 4) patients younger than 15 years.

Magnetic resonance imaging of the temporomandibular joints

MRI was carried out on a Philips Ingenia 3T CX with a head/neck 20-channel coil. All patients were examined in the supine position. In closed mouth position, we obtained oblique sagittal T1 weighted image (T1WI) turbo spin echo (TSE), repetition time (TR), 450 ms; echo time (TE), 10 ms; imaging time of 1 minute 11 seconds; field of view (FOV) = 100 × 100 × 29.4 mm (FH × AP × RL); acquisition matrix, 256 × 204; acquisition voxel size = 0.39 × 0.49 mm; reconstruction voxel size = 0.19 ×0.19 mm; slice thickness, 3 mm and number of sample averaged (NSA), 1 oblique sagittal T2WI "(TSE, TR, 3,500 ms; TE, 80 ms; imaging time of 2 minutes 20 seconds; FOV = 100 × 100 × 29.4 mm (FH × AP × RL); acquisition matrix, 240 × 189; acquisition voxel size = 0.42 ×0.52 mm; reconstruction voxel size = 0.19 × 0.19 mm; slice thickness, 3 mm and NSA, 1) coronal T1WI "(TSE; TR, 450 ms; TE, 10 ms; imaging time of 1 minute 22 seconds; FOV = 100 × 100 × 29.4 mm (FH × AP × RL); acquisition matrix, 256 × 202; acquisition voxel size = 0.39 ×0.49 mm; reconstruction voxel size = 0.19 × 0.19 mm; slice thickness, 3 mm and NSA, 1) and coronal T2WI TSE, TR, 3,500 ms; TE, 80 ms; imaging time of 2 minutes 41 seconds; FOV = 100 × 100 × 29.4 mm (FH × AP × RL); acquisition matrix, 240 × 188; acquisition voxel size = 0.42 ×0.52 mm; reconstruction voxel size = 0.19 × 0.19 mm; slice thickness, 3 mm and NSA, 1.In the open-mouth position, we obtained oblique sagittal T1WI and T2WI. The sections are parallel or perpendicular to the long axis of the condyle. The evaluation of TMJ using T1WI and T2WI was referred to the articles [15,16].

Assessment of MR imaging

We recorded the following findings on MR imaging, 1) pattern of disk displacement (anterior, anterolateral, anteromedial, posterior, medial, and posteromedial disk displacement); 2) prevalence of the disk displacement; 3) presence/absence, of joint effusions in each disk displacement; 4) prevalence of dynamics of the disk (with or without reduction) in each disk displacement; and 5) prevalence of the disk displacement in each age group. The anterior or posterior disk displacement was defined as the junction of the posterior band with the bilaminar zone being more than ± 10% above the apex of the condylar head (12 o'clock position) on sagittal images in a closed-mouth position [17]. The lateral or medial disk displacement was defined as the disk crossing one of the sagittal plane tangents to one of the condylar poles laterally or medially on coronal images in the closed-mouth position [17]. The amount of joint effusions assessed on sagittal T2WI and classified into 5 categories (no joint effusion, minimal, moderate, marked, and extensive) as described in the literature [3–18]. The prevalence of disk displacement in each age group was recorded. All data were recorded in Microsoft Excel (Microsoft Corp, Redmond, WA).

All images were retrospectively evaluated by two oral and maxillofacial radiologists with 13 and 28 years of experience. They independently observed MR axial images on the monitor. After an interval of 2 weeks, 1) pattern of disk displacement; 2) prevalence of the disk displacement; 3) presence/absence, of joint effusions in each disk displacement; and 4) prevalence of dynamics of the disk in each disk displacement were evaluated in 30 randomly selected patients to statistically evaluate intra- and inter-observer reliability.

Results

Intra and inter observer reliability

The intra and inter observer reliability ranged between 0.79 and 0.85.

The study cohort comprised 116 patients, and 229 TMJs (41 male and 75 female; age range, 15–79 years; mean age ± standard deviation [SD], 31.2 ± 15.9 years).

Table 1. The amount of joint effusions in each disk displacement.

Patterns of the disk displacement	Dynamics of the disk	The amount of the joint effusions			
		No joint effusion	Minimal	Moderate	Marked
Anterior (119 joints)	With reduction (46 joints, 38.7%)	32 joints (69.6%)	12 joints (26%)	2 joints (4.3%)	0 joint
	without reduction (73 joints, 61.3%)	51 joints (69.9%)	19 joints (26.0%)	2 joints (2.7%)	1 joint (1.3%)
Anterolateral (20 joints)	with reduction (8 joints, 25%)	3 joints (37.5%)	3 joints (37.5%)	1 joint (12.5%)	1 joint (12.5%)
	without reduction (12 joints, 75%)	6 joints (50%)	3 joints (25%)	1 joint (8.3%)	2 joints (16.7%)
Anteromedial (1 joint)	with reduction (1 joint, 100%)	0 joint	1 joint (100%)	0 joint	0 joint
Lateral (1 joint)	with reduction (1 joint, 100%)	1 (100%)	0 joint	0 joint	0 joint

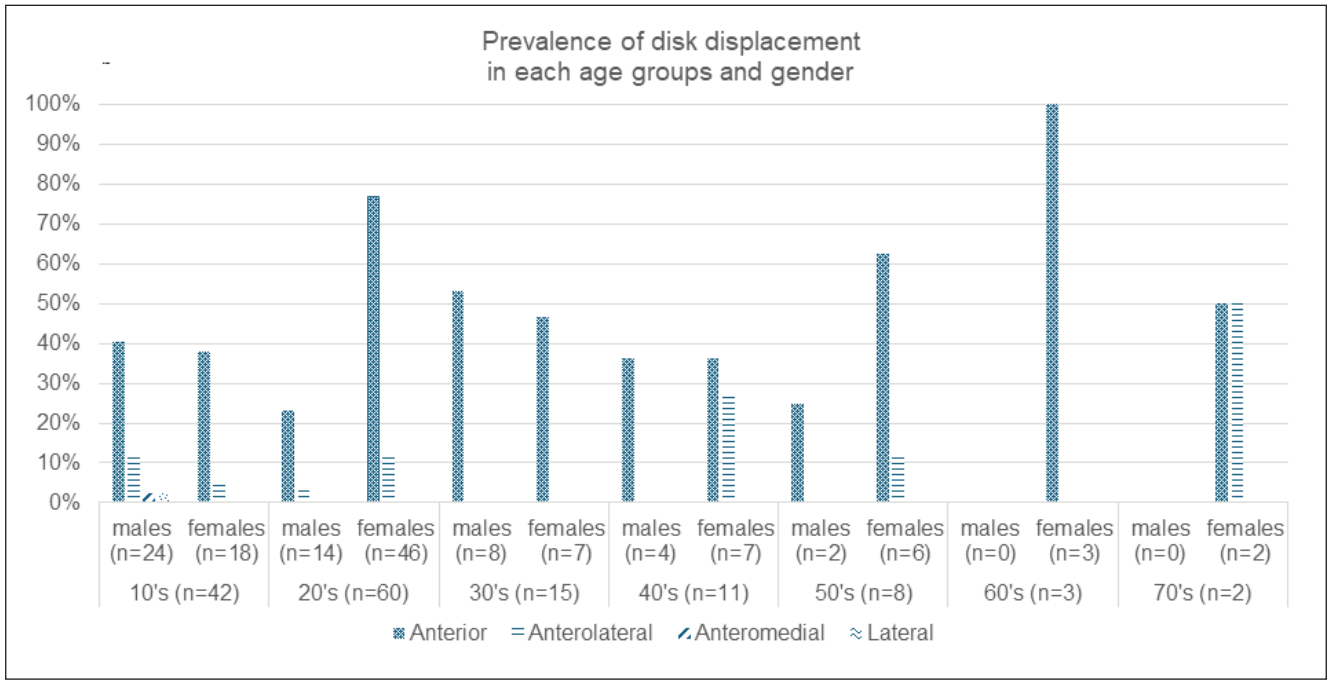


Figure 1. Prevalence of disk displacements in each age group and gender. The ages of 10's 30's, and 40's, anterior disk displacement was the most common disk displacement in both males and females.

Patterns and prevalence of disk displacement

Eighty eight out of 229 TMJs (38.4%) showed normal disk dynamic. One hundred nineteen out of 229 TMJs (52.0%) showed anterior disk displacement, anterolateral disk displacement (20 TMJs, 8.7%), anteromedial disk displacement (1 TMJ, 0.4%), and lateral disk displacement (1 TMJ, 0.4%) (table 1). There were no posterior or posteromedial disk displacements.

Presence/absence and amount of joint effusions in each disk displacement

Anteromedial and lateral disk displacement had joint effusions (100%) (table 1). Thirty six out of 119 joints (30.3%) in anterior disk displacement and 11 out of 20 joints (55%) in anterolateral disk displacement had joint effusions, whereas lateral disk displacement showed no joint effusion (100%) (table 1). The amount of joint effusions in each disk displacement is shown in Table 1.

Prevalence of dynamics of the disk in each disk displacement

In anterior disk displacement, 46 joints (38.7%) showed with reduction of the disk and 73 joints (61.3%) showed without reduction of the disk. The dynamics of the disk in other disk displacements are shown in Table 1.

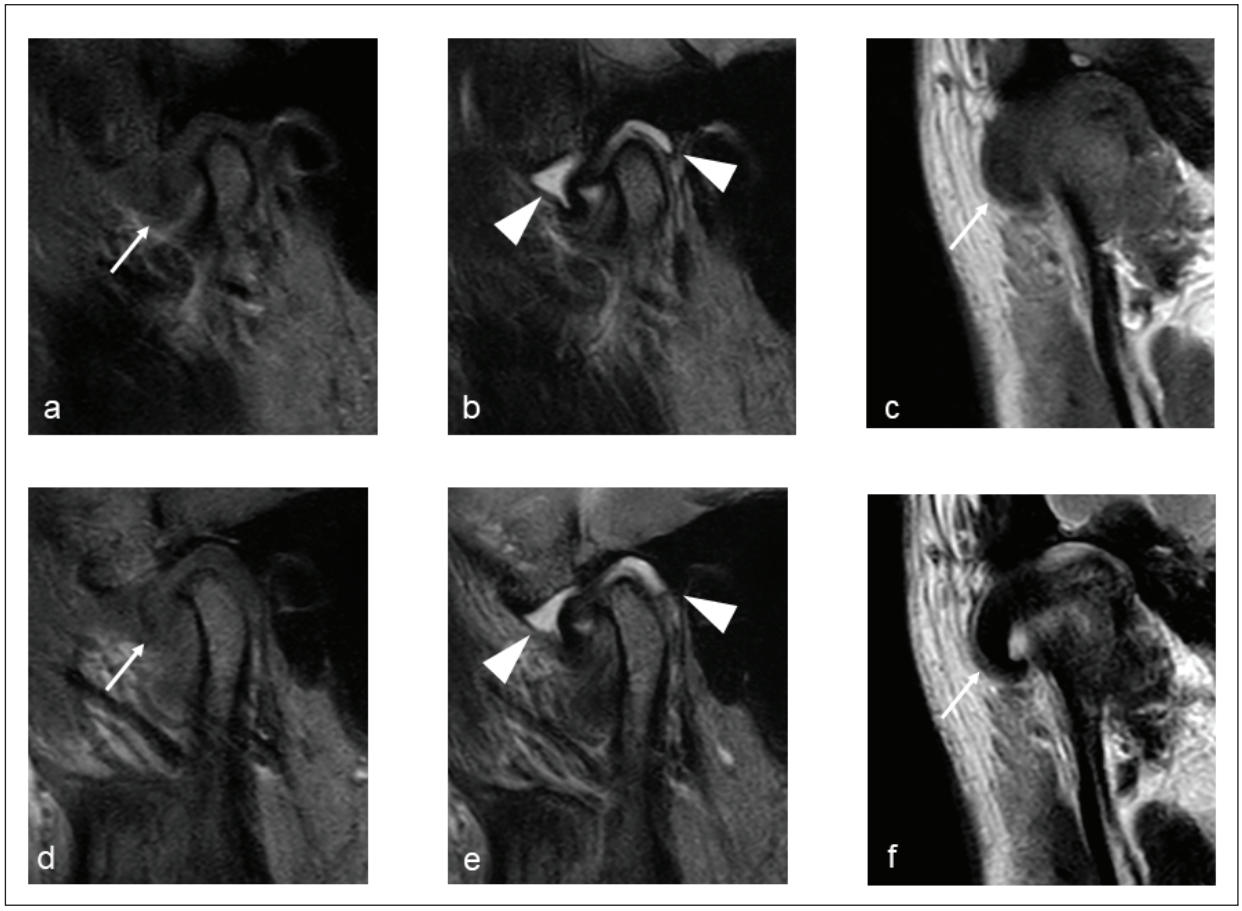


Figure 2. Anterolateral disk displacement without reduction in a 42-year-old female. The disk (white arrow) is anterolaterally displaced in the closed mouth position (a, b, c, and f). The disk showed without reduction in open mouth position (d and e). There is extensive joint effusion (white arrow head) in the superior joint space (b and e).

Prevalence of the disk displacement in each age group and gender

Anterior disk displacement was more frequent in females than in males in 20's, 50's, 60's, and 70's (fig. 1). Anterior disk displacement was the most frequent disk displacement in 10's, 30's, and 40's in both males and females (fig. 1). Anterolateral disk displacement was more frequent in males than in females in 10's; however, more frequent in females than in males in 20's, 40's, 50's and 70's. Figure 2 shows anterolateral disk displacement without reduction in 42 years old female. Figure 3 shows anteromedial disk displacement with reduction in a 22-year-old male.

Discussion

Our results revealed that anterior disk displacement is a common disk displacement followed by anterolateral disk displacement, anteromedial disk displacement, and lateral disk displacement. Thirty point 3% in anterior disk displacement and 55% in anterolateral disk displacement had joint effusions. Most of the disk displacement had minimal joint effusions.

The disk displacement in TMDs is one of the image findings on MRI [1,2,4,6–9,11–14]. Whyte et al. [8] reported that anterior disk displacement is the most common disk displacement (44%) followed by antero-lateral disk displacement (29%) and lateral disk displacement was seen in 4% of the patients. Our results were partially similar to their study. However, anteromedial and lateral disk displacement were seen in our study. Our results may be new image findings in TMD using 3T MRI which could not evaluate on 1.5T MRI. Foucart et al. [17] and Tasaki et al. [19] reported that antero-lateral disk displacement is more common than antero-medial or lateral disk displacement. Our results are similar to their studies. The disk is frequently displaced anterolaterally but seldom displaced

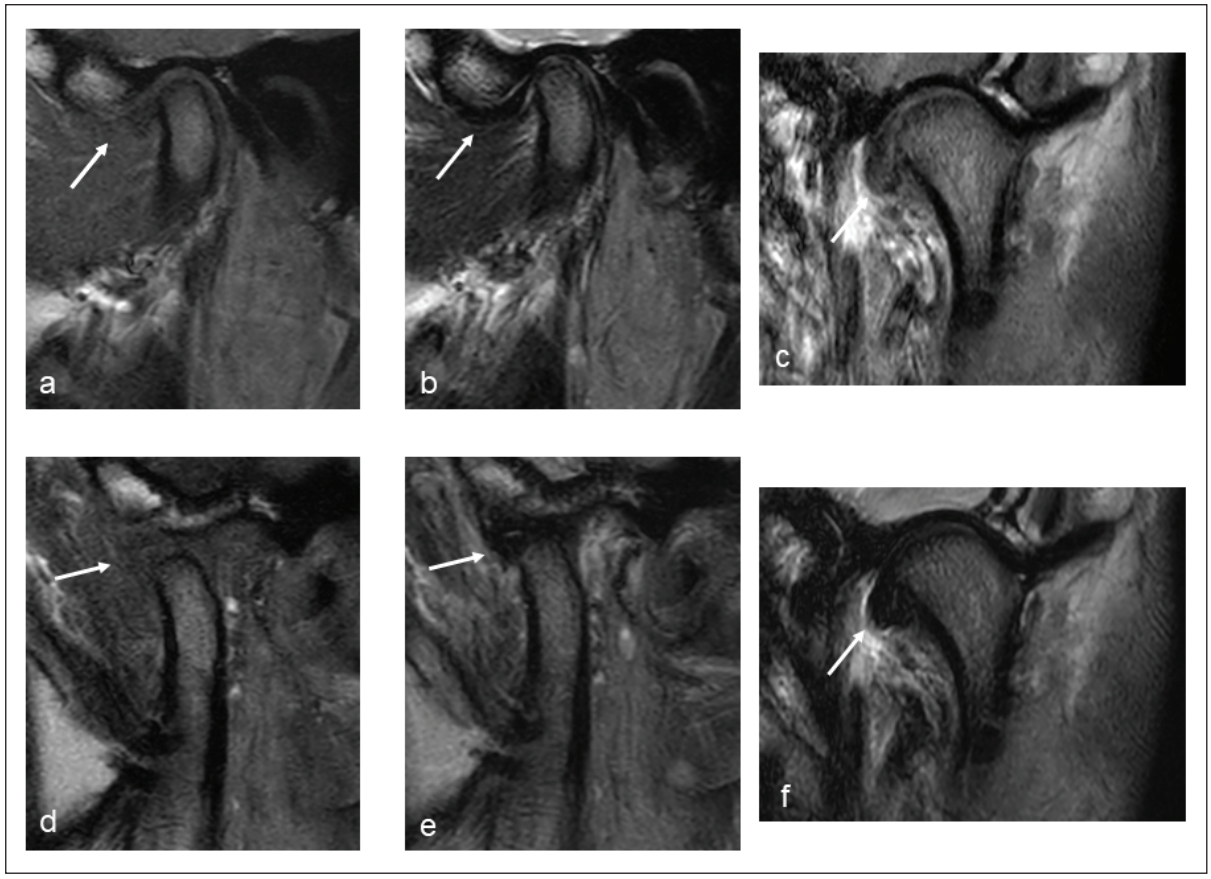


Figure 3. Anteromedial disk displacement with a reduction in 22-year-old male. The disk (white arrow) is anteromedially displaced in the closed mouth position (a, b, c, and f). The disk (white arrow) showed a reduction in open mouth position (d and e). There are no joint effusions in the joint spaces.

posteriorly or laterally [20]. This may be related to the weakness of the lateral disk attachment [8].

Disk displacement with reduction is related to TMJ noise [21,22]. Our results revealed that anterior and anterolateral disk displacement showed disk displacement without reduction in 60% to 75% of the cases. On the other hand, anteromedial and lateral disk displacement showed with disk reduction in all cases. Internal derangement of the TMJ is classified as disk displacement with or without reduction [13,23]. The worst type of internal TMJ derangement is disk displacement without reduction [23]. Inadequately treated or untreated disk displacement without reduction can cause osteoarthritis of the TMJ [24]. Our results suggest that anterior and anterolateral displacements are more likely to cause osteoarthritis of the TMJ compared with other disk displacements.

Yano et al reported that effusion is the state of accumulation of joint fluid in the joint spaces in high signal intensity on T2WI [25,26]. Past studies reported that joint effusions are frequently observed on MRI in patients with internal derangement of the TMJ [3,18,27–31]. An abnormal joint effusion is defined as moderate, marked, and extensive joint effusion [18]. Our results revealed that abnormal joint effusions were seen in 4.2% of the anterior disk displacement, whereas 25% of the anterolateral disk displacement showed abnormal joint effusions. This suggests that the anterolateral disk displacement results in a more enlarged joint space which could contain more effusions than other disk displacements. Manfredini et al. [33] reported that joint effusions were related to disk displacement without reduction. Our results revealed that the incidence of abnormal joint effusion was the same with and without a reduction in anterior and anterolateral disk displacement. Our result was differ from Manfredini et al. [33]. This suggests that joint effusion is related to both without and with reduction of the disk.

Our results revealed that the female groups in their 20s, 50s, 60s, and 70s had a higher frequency of anterior disk displacement than in males. The male and female groups in their 10's, 30's, and

40's showed the same distribution of anterior disk displacement. There was a gender difference in anterolateral disk displacement in 10's, 20's, 40's, 50's, and 70's. These findings suggested that these disk displacements showed age and gender differences. Accordingly, these findings may be useful for age- and gender-specific treatment interventions of the TMDs.

This study has a limitation. There were varying numbers of cases in each disk displacement, which may have affected the results. Further study with a large number of patients is necessary.

In conclusion, frequencies of disk displacements and effusion of TMDs may be useful for planning treatment interventions for TMDs.

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