

# Analysis of the Correlation between Morphological Characteristics and Reducibility of Displaced Articular Disc in Saudi Population.

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## ABSTRACT

The objective of this study was to identify the most common patterns of articular disc displacement directions and the associated morphological alterations of the TMJ meniscus in the Saudi population that had MRI examinations for TMJ dysfunction. A total of 61 MRI scans of temporomandibular disorders (TMDs) patients were selected for this retrospective study. The patients were imaged using Proton Density (PD) weighted MRI, the imaging protocol consists of oblique sagittal images (closed and open mouth) and oblique coronal images (closed mouth). The DICOM (Digital Imaging and Communication in Medicine) files of each MRI scan were exported and evaluated. There were 42 (34.4%) TMJs that did not have articular disc displacement (ADD). However, 80 (65.6%) TMJs reveal ADD in different directions with the anteromedial disc displacement was the most common direction of displacement (32%). There is a significant relationship between the existence of reduction and Articular disk (AD) morphology, that ADD without reduction has much lower frequency of normal right TMJ than those with reduction ( $\chi^2 = 12.246$ ,  $p = 0.002$ ). This is also valid for left TMJ ( $\chi^2 = 19.950$ ,  $p < 0.001$ ). MRI samples investigated revealed that the articular disc morphology may influence the reduction ability of the displaced articular disc.

## Keywords

Articular disc, Disc displacement, Internal derangement, MRI.

## INTRODUCTION

Temporomandibular joint dysfunctions (TMJDs) are a clinical term that includes a number of conditions characterized by muscle- and joint-related pain, decreased jaw mobility, headaches, tinnitus, and stiffness [1–4]. Almost 75% of the general population will experience temporomandibular disorder (TMD)-associated symptoms at some point during their life [1–4]. The etiology of TMJDs remains unclear, but it is likely multifactorial, including abnormal occlusion, parafunctional habits, stress, or abnormalities of the intra-articular disc [5].

Internal derangement of the temporomandibular joint (TMJ) is defined as an abnormal relationship of the articular disc to the mandibular condyle,

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fossa, and/or articular eminence [6]. Different imaging modalities such as X-ray, CT, and joint arthrography are used to evaluate the anatomical changes of the TMJ [6–9]. However, magnetic resonance imaging (MRI) is considered the most valuable imaging modality for visualizing disc morphology and position and facilitating the interpretation of topographic changes in the muscular, osseous, meniscal, and ligamentous structures of the TMJ [10–12].

Articular disc displacement (ADD) is a type of internal derangement of the TMJ and is considered a very common finding in patients with TMD [13–15]. The articular disc can be displaced anteriorly (the most common direction of displacement), anteromedially, anterolaterally, purely sideways (medially or laterally), or posteriorly, which is very rare [13–17].

Anterior disc displacement can occur with reduction (ADDWR), which happens when the disc regains its normal position over the condyle during jaw opening [18]. This is the initial stage of anterior disc displacement and is usually accompanied by pain and a clicking sound during opening (clicking joint) [18]. As the condition progresses, when the mandibular condyle fails to adapt anteriorly with the displaced articular disc, the condyle is left with a limited range of motion, resulting in restricted mouth opening and disappearance of the clicking sound observed in the initial stage (locked joint) [19].

The displaced disc may undergo morphological changes characterized by thickening of the posterior band and a reduction in the thickness of the anterior band and central thin zone, resulting in a biconvex, rounded, flattened, or irregular disc shape. These changes can occur even in the early stages of internal derangement despite preservation of the overall disc morphology [1,20,21]. Studies investigating the patterns of articular disc displacement in the Saudi population remain limited. Previous research has primarily focused on the role of the lateral pterygoid muscle in articular disc displacement [22] and temporomandibular joint space dimensions among Saudi patients with temporomandibular disorders [23]. Therefore, the aim of the present study was to identify the most common patterns of articular disc displacement directions and the associated morphological alterations of the TMJ

meniscus in the Saudi population undergoing MRI examinations for TMJ dysfunction.

### Clinical relevance

This study emphasizes primarily on investigating the correlation between temporomandibular joint (TMJ) disc morphology and displacement in the Saudi population. This was achieved by analyzing the direction of disc displacement, disc reducibility, and disc morphology, as well as the correlation between disc reducibility and morphology, thereby filling the research gap in the field of temporomandibular disorders (TMDs) among the Saudi population.

## MATERIALS AND METHODS

### Study Setting and Ethical Consideration

To perform this retrospective investigation, consent from the relevant committees of the King Faisal Specialist Hospital & Research Center in Riyadh was required from the institutional review board (IRB). The procedures were followed in compliance with the necessary regulations and norms. MRI scans from Saudi patients receiving TMD treatment at King Faisal Specialist Hospital & Research Center in Riyadh, Saudi Arabia, were retrospectively analyzed.

### Eligibility criteria

#### Inclusion criteria

This study comprised Saudi national patients who were referred to the Department of Oral and Maxillofacial Surgery with the main chief complaint of TMD symptoms; they received MRI for diagnostic purposes.

#### Exclusion criteria

Individuals who have undergone TMJ surgery, have a history of head and neck neoplasms, have a history of osteoporosis, rheumatoid arthritis, idiopathic juvenile arthritis, or any other systemic disease that may alter the structure or function of the TMJ and its surrounding structures were not allowed to participate in the study. Neither were those who had recently experienced facial trauma.

### Magnetic resonance imaging

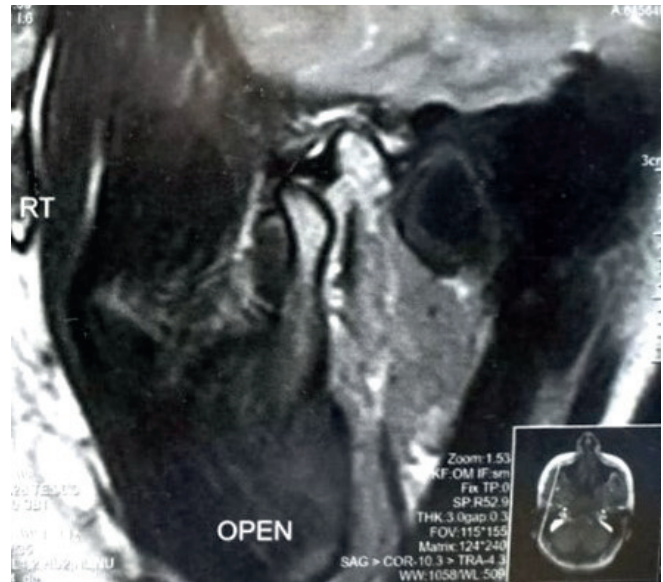
MRI scans were obtained using a 3-T imager with a head coil (MAGNETOM Trio, Siemens Healthineers USA). The patients were imaged using a proton density

(PD)-weighted spin-echo (SE) MRI sequence in the closed mouth position (TR/TE 2400/20; 2 mm slice thickness for both sagittal and coronal views; 150 mm FOV; 256 × 256 matrices). The analysis of each MRI was done from two views (sagittal and coronal) in both closed and open mouth position. And (oblique coronal images) closed mouth position. For every MRI scan, the DICOM (Digital Imaging and Communication in Medicine) files were exported. The examinations were de-identified and assigned a random case number prior to evaluation.

RadiAnat DICOM viewer version 4.6.9 (Medixant, Poznań, Poland) were used to assess the DICOM files of every scan, the initial evaluations of the two oral and maxillofacial radiologists were compared prior to reaching consensus. A 27-inch Dell UltraSharp LCD display (Dell Technologies, Round Rock, Texas, U.S.) with a resolution of 3840 x 2160 pixels was used to view the images. Each joint is visualized in the sagittal view to record the anteroposterior position of the articular disc, then the joint is visualized in the coronal view to record any medial or lateral displacement of the disc. The direction of articular disc displacement was evaluated, and the results were recorded using the scoring system that was developed by the authors. (Figure 1,2) (Table 1, 2)



**Figure 1:** MRI showing Anterior disc displacement in closed position (Right side)



**Figure 2:** MRI showing Reduction of the disc in opening position (Right side)

**Table 1:** The Type of displacement

Readings (sagittal- coronal)	Type of displacement
0 - 0	Normal articular disc position
1 - 0	Anterior ADD
1 - 3	Anteromedial ADD
1 - 4	Anterolateral ADD
0 - 3	Medial ADD
0 - 4	Lateral ADD
2 - 0	Posterior ADD
2 - 3	Posteromedial ADD
2 - 4	Posterolateral ADD

**Table 2:** Scoring Direction of articular disc displacement through the sagittal and coronal views in both open and closed mouth positions and AD morphology

Direction of ADD *sagittal	Direction of ADD *sagittal	Direction of ADD *coronal	Direction of ADD *coronal	AD Morphology	AD Morphology
Null	0	Null	0	Normal "biconcave"	0
Null	0	Null	0	Round	1
Anterior ADD	1	Medial ADD	3	Teared	2
Anterior ADD	1	Medial ADD	3	Perforated	3
Posterior ADD	2	Lateral ADD	4	Irregular	4

Null = None displaced, ADD = Articular disc displacement

## RESULTS

Seventy-six cases (152 TMJs) were collected initially; however, 15 cases (30 TMJs) were excluded due to the history of facial trauma (6 cases), the presence of syndromic craniofacial deformity (3cases), metal /

motion artifacts (5 cases), and the patient underwent Orthognathic surgery (one case). The study comprised 61 patients, and the ratio of male (20 case) to female (41 case) is 1:2. The patients' ages ranged from 21-30 years with the mean age was 29 years. (table 3)

**Table 3:** Demographic information of the sample

Demographic Variables	Demographic Variables	Demographic Variables	Demographic Variables	Demographic Variables	Demographic Variables
Gender	Gender	Male	Male	Female	Female
Gender	Gender	Count	Percentage	Count	Percentage
Gender	Gender	20	32.7%	41	67.3%
Age	Mean	Median	SD	Min	Max
Age	33.75	29	13.227	16	86
Age	Age Groups	Count	Percentage		
Age	20	5	8.2 %		
Age	21 - 30	30	49.2 %		
Age	31 - 40	11	18.0 %		
Age	41 - 50	9	14.8 %		
Age	51 - 60	3	4.9 %		
Age	> 61	3	4.9 %		

The frequencies and percentages of the Articular disc characteristics for right and left TMJ are summarized and presented (table 4). No posterior or lateral articular disc displacement was present among the patients participated in this study. In terms of Articular disc Morphology characteristics,

no teared or perforated disc was recorded. There were 42 (34.4%) TMJs that did not have articular disc displacement. On the other hand, anteromedial ADD was found in 39 joints (32%), followed by anterior articular disc displacement which occurred in 35 joints

(28.7%). We found only 5 (4.1%) cases which showed pure medial side displacement, and only 1 (0.8%) anterolateral articular disc displacement.

In relation to the morphological variations found in the examined cases, 95 joints showed normal biconcave disc shape, which represents 77.9% of the examined joints. Moreover, only 54 joints out of the discs with normal AD morphology were displaced whereas 41 joints showed no articular disc displacement. Among the deformed articular discs, 22 (18%) joints demonstrated irregular

**Table 4:** Frequencies & Percentages of ADD direction and morphology

Characteristic	Category	Frequency	%
Direction of ADD	Null	42	34.4
Direction of ADD	Medial	5	4.1
Direction of ADD	Anterior	35	28.7
Direction of ADD	Anteromedial	39	32.0
Direction of ADD	Anterolateral	1	0.8
AD Morphology	Normal Biconcave	95	77.9
AD Morphology	Round	5	4.1
AD Morphology	Teared	0	0.0
AD Morphology	Perforated	0	0.0
AD Morphology	Irregular	22	18.0

disc shape, and all of them were displaced. The remaining 5 (4.1%) joints showed round AD and they were all displaced.

Regarding whether the AD morphology may influence the reduction ability of the articular disc. The results which are presented numerically in table 5, indicate that there is a significant relationship between the existence of reduction and AD morphology. In this study the percentage of with or without reduction is almost similar 48.7 % and 51.3% respectively. ADD without reduction has much lower frequency of normal

right TMJ than those with reduction ( $\chi^2 = 12.246$ ,  $p = 0.002$ ). This is also valid for left TMJ ( $\chi^2 = 19.950$ ,  $p < 0.001$ ). Furthermore, articular disc displacements with reduction showed significantly lower frequencies (2.7%) of irregular articular discs, both in Right and left TMJ. Prevalence of articular disc displacement in right TMJ is 69%

**Table 5:** Prevalence and significance of ADD with and without reduction among various AD morphologies

Reduction	Both TMJs (76)	Right TMJ	Left TMJ	NB	RO	IR
With reduction (37)	37 (48.7%)	-----	-----	36 (97.3%)	0 (0%)	1 (2.7%)
Without reduction (39)	39 (51.3%)	-----	-----	14 (35.9%)	5 (12.8%)	20 (51.3%)
Prevalence (%)	-----	69%(NB),10%(IR)	75%(NB),0%(IR)	72%	0%	5%
$\chi^2$ (right TMJ)	-----	12.246	-----	-----	-----	-----
p value (right TMJ)	-----	0.002	-----	-----	-----	-----
$\chi^2$ (left TMJ)	-----	-----	19.950	-----	-----	-----
p value (left TMJ)	-----	-----	<0.001	-----	-----	-----
Overall $\chi^2$	-----	31.84	-----	-----	-----	-----
Overall p value	-----	<0.001	-----	-----	-----	-----

for normal biconcave AD and 10% for irregular AD, while in left TMJ, the prevalence was 75% and 0% respectively. Overall, it could be shown that the occurrence of reduction in articular disc displacement was statistically significant and dependent on the type of AD morphologies ( $\chi^2 = 31.84$ ,  $p < 0.001$ ). 97.3% of all TMJs with normal biconcave experienced articular disc displacement with reduction, while only 35.9% of the patients with normal biconcave morphology had ADD without reduction.

## DISCUSSION

Clinical examinations cannot reliably determine the presence of TMJ disorders [16]. MRI has been established as the preferred imaging method for the investigation of TMJ dysfunction in recent years [16,17]. Internal derangement, which is defined as an improper connection of the disc to the condyle, is the most common cause of TMJ problem [16]. Because of this, accurate localization of the disc is crucial for diagnosing TMJ internal derangement and is simple to do with MRI [17,18]. Our study sample showed a 1:2 M/F ratio (20 males/42 females), which demonstrates a female predilection (67%). Foucart [1] reported that their sample showed a 1:4 M/F ratio; however, we believe that this bigger number could be due to the larger sample size they examined. Many attempts have aimed to evaluate a number of possible factors behind the unequal gender distribution, including sensitivity to psychosomatic disorders [24], tension of the masticatory muscles, and adaptive morphologic changes in the TMJ [25,26].

Kumar et al. reported that there was a significant correlation between the presence of articular disc displacement in symptomatic versus asymptomatic individuals [27]. However, in our sample all subjects were symptomatic patients presenting with signs and symptoms, and we found that even symptomatic patients can show normal MRI findings [27,28]. Our results showed types of ADD in all directions except posterior and pure lateral displacement. Anteromedial ADD was the most common direction of displacement (32%), followed by Anterior ADD (28.7%).

Tasaki et al. found that the most frequent direction of displacement found in their symptomatic sample was anterolateral displacement (23.3%), followed by Anterior ADD (22.6%) [28]. On the other hand, Whyte et al. reported findings showing that anterior articular disc displacement was the most common direction of displacement (44%), and that anterolateral displacement was the second most common direction (29%) [17]. Furthermore, Foucart et al. [1] reported that the anteriorly displaced AD (with reduction) has a higher tendency to be displaced laterally (40%) more than medially (13%). In our sample, and among the anteriorly displaced articular discs, we found a more significant tendency for medial displacement than lateral displacement. This finding differs from those reported by Tasaki et al. [28], Whyte et al. [17], and Foucart et

al. [1], all of whom suggested a predominance of lateral articular disc displacement.

Kohinata K et al. [29] found a significant relationship between the angle of the superior head of the lateral pterygoid muscle and the long axis of the condyle in determining the medio-lateral position of the articular disc [29]. However, our current sample showed only five medially displaced ADs, without any case of pure lateral displacement. Our results show that 95 out of 122 ADs retained normal morphology (77.9%), and 54 of them were displaced.

The deformed AD was more prominent in cases with articular disc displacement without reduction (64.1%) [30]. This occurs because of thickening of the posterior band of the AD and shortening of the anterior band, eventually resulting in a round or irregular AD shape [30,31]. On the other hand, the majority of cases with articular disc displacement with reduction showed no AD deformity (97.3%), except for one joint with irregular disc deformation. There was a statistically significant correlation between AD morphology and the reduction ability of the articular disc ( $p < 0.001$ ) [31]. These findings suggest that when AD morphology is altered, reduction becomes unlikely.

Forty-six of the examined patients had bilateral internal derangements whereas 14 patients showed unilateral internal derangements. Foucart et al. [1] reported that bilateral derangements were more common, with a ratio of 3:1. Our findings agree with the results reported by Foucart et al., demonstrating a predominance of bilateral occurrence [1,32].

The main limitation of this retrospective study is that all patients were symptomatic and complained of temporomandibular joint dysfunction. The study did not include asymptomatic controls, who may have some undiagnosed internal derangements [28,33]. This might indicate that pain or functional disturbance is initiated when the AD is unable to reduce and the condyle occludes on the retrodiscal attachments, which are highly innervated and susceptible to pain [32,33].

## CONCLUSION

MRI samples investigated revealed that the articular disc morphology may influence the reduction ability of the displaced articular disc. Furthermore, Articular discs may retain their normal morphology even when they are displaced.

## Abbreviations

ADD Articular Disc Displacement, ADDWR Anterior Disc Displacement with Reduction, DICOM Digital Imaging and Communication in Medicine, ID Internal Derangement, MRI Magnetic Resonance Imaging, PD Proton Density, TMD Temporomandibular Dysfunction, TMJ Temporomandibular Joint.

## Data Availability

The datasets used to support the findings of this study are available from the corresponding author upon request.

**Conflict of interest:** The authors declare that there are no conflicts of interest regarding the publication of this paper.

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## Ethics approval

This study was approved by the Institutional Review Board (IRB) of King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia. The RAC approval number is 2171-184.

## Human and animal rights

This study has been done according to the international guidelines of experimental studies.

## Informed consent

No MRI Scan was performed for the purposes of this study because all MRI Scan data were obtained retrospectively from archived data. Informed patient consent was not required for this study.

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