ORIGINAL RESEARCH

Dimensional and Positional Characteristics of the Temporomandibular Joint of Skeletal Class II Malocclusion with and without Temporomandibular Disorders

Maged S Alhammadi[1]

Abstract

Aim: This study sought to evaluate dimensional and positional temporomandibular joint (TMJ) features in three-dimensions in skeletal class II malocclusion with and without temporomandibular disorders (TMDs).

Materials and methods: A total of 91 (182 joints) adult patients were divided into the following two groups: (1) Group I – TMD ($n = 56$; 112 joints) and (2) group II – non-TMD ($n = 35$; 70 joints). Dimensional and positional TMJ characteristics including glenoid fossae, mandibular condyles, and joint spaces were assessed using cone–beam computed tomography (CBCT).

Results: The mandibular fossa in the TMD group was significantly more lateral than in the non-TMD group, and the mandibular fossa anterior wall inclination to the horizontal plane showed a significantly more vertically inclined wall in the TMD group compared to the non-TMD group. Significantly vertical mandibular condylar changes in the form of less vertical inclination, more vertical position, and lower vertical dimension (height) in addition to more upward position within the joint space were found. The TMD group showed significantly decreased superior and posterior joint spaces in addition to significantly increased medial joint spaces.

Conclusion: Patients with TMDs are associated with laterally positioned mandibular fossa with the more vertically inclined anterior wall. They are characterized by vertical mandibular condylar changes in the form of less vertical inclination, more vertical position, and lower vertical dimension (height) in addition to more upward positioning within the joint space is accompanied by a decrease in superior and posterior and an increase in medial joint spaces.

Clinical significance: The TMJ characteristics of skeletal class II make it more susceptible to TMDs and any orthodontic and/or surgical interventions in a direction possibly change these characteristics are to be considered.

Keywords: Cone–beam computed tomography, Joint spaces, Mandibular condyle, Skeletal class II malocclusion, Temporomandibular joint disorder.

The Journal of Contemporary Dental Practice (2022): 10.5005/jp-journals-10024-3441

Introduction

Malocclusion is the abnormal intra- and/or interarch relation between the upper and lower jaws; it can be assessed either by evaluating the relationship between the maxillary and mandibular first permanent molars (dental malocclusion) or by evaluating the maxillary and mandibular bony bases (skeletal malocclusion).[1] Skeletal class II malocclusion is the retroposition of the mandible relative to the maxillary bony base and is considered the most prevalent malocclusion seen in daily orthodontic practice.[2] It causes esthetic, functional, and psychological disturbances of varying intensity. The severity of this malocclusion depends on the amount of anteroposterior (AP) discrepancy and its interaction with the related soft tissue structures. Retroposition of the mandible is more common than maxillary protrusion in this form of malocclusion.[1,2] This posterior positioning is also reflected in the posterior positioning of the condyle with several biodynamical changes that are expected to occur in this unique and complex craniofacial structure.

The TMJ is a delicate, complex structure that articulates the temporal bone of the human skull with the mandible to produce the required movements. It has bilateral mandibular condyles that function concurrently either by movement in the same or in opposite directions.[3] The components of the TMJ are unique in their position, dimension, and range of movements. The two main components, the mandibular condyles, and glenoid fossa are separated by a disc that serves as a cushion for stress absorption and allows easy condyle movement during opening and closing actions. The articular disc divides the TMJ into two synovial cavities lined by the synovial membranes. The bony articulating surfaces are covered with fibrocartilage, rather than hyaline cartilage.[4]

Temporomandibular disorder is a generic term comprising a complex group of heterogeneous diseases that usually are of multifactorial etiologies. These etiologies affect the masticatory

[1]Department of Preventive Dental Sciences, College of Dentistry, Jazan University, Jazan, Saudi Arabia

Corresponding Author: Maged S Alhammadi, Department of Preventive Dental Sciences, College of Dentistry, Jazan University, Jazan, Saudi Arabia, Phone: +00966502209874, e-mail: magedorth@gmail.com

How to cite this article: Alhammadi MS. Dimensional and Positional Characteristics of the Temporomandibular Joint of Skeletal Class II Malocclusion with and without Temporomandibular Disorders. J Contemp Dent Pract 2022;23(12):1203–1210.

Source of support: Nil

Conflict of interest: None

musculature of the head and neck, including the osseous and soft tissue structures of TMJ, such as the disc and its attached ligaments. One of the most common etiologies of this complex problem includes injuries involving the mandible, TMJ, and/or head and neck muscles. Other potential etiologies are teeth clenching and/or grinding, which lead to an increase in pressure on the TMJ. Other etiologies include rheumatoid arthritis, osteoarthritis, disc dislocation, or long-standing psychosocial stress and it's associated tightening of muscles of the face and jaw.[5]

Great variability in TMD signs and symptoms exist; however, they are divided into the following six major groups: (1) Tender muscles in the patient's face, neck, and shoulders; (2) pain dysfunction syndrome, non-dental pain involving the orofacial region, which is the most common TMJ disorder; (3) joint noise: clicking, crepitation, and grinding, (4) TMJ locking: incapability of full opening or closing; (5) ear symptoms: otalgia, tinnitus; and (6) psychosocial complaints.[6,7]

The incidence of TMDs based on a recently published systematic review and meta-analyses showed that overall prevalence for adults includes TMJ disorders (31.1%), disc displacement (19.1%), and degenerative joint disease (9.8%). Furthermore, for children/adolescents, the prevalence includes TMJ disorders (11.3%), disc displacement (8.3%), and degenerative joint disease (0.4%). Considering the individual diagnosis meta-analyses, the most prevalent TMJ disorder was disk displacement with a reduction for adults (25.9%) and children/adolescents (7.4%).[8] In terms of gender distribution, another systematic review and meta-analysis assessed gender differences in TMDs in adult population studies and concluded that this difference was two times greater in terms of development in women compared to men.[9]

Many radiographic techniques are utilized for the assessment of the positional and morphological features of hard and soft tissue components of TMJ using conventional two-dimensional (2D) imaging, multidetector computed tomography (MDCT), magnetic resonance imaging (MRI), and computed tomography (CT).[10,11] However, the most common limitation of using conventional 2D radiography is the superimposition of the structures neighboring the TMJ. Recently, CBCT has been utilized to produce high-resolution images with little distortion, it is more rapid with a smaller irradiation dose when compared with CT and the measurement of the length and volume in multiple planes can be obtained using a 3D CBCT scan, which yields a correct diagnosis and good predictability of therapeutic outcomes.[12]

To date, no comprehensive 3D comparative study has evaluated the morphological and positional structures of TMJ in adult patients' having skeletal class II malocclusion with and without TMD and similar transverse skeletal and vertical malocclusions. Thus, this study was designed to evaluate the dimensional and positional TMJ features in 3D in skeletal class II malocclusion with and without TMDs.

Materials and Methods

Study Design

This cross-sectional study obtained its approval from the research ethics committee of the Faculty of Dentistry, Cairo University, Egypt (No. 21052012). The procedures were performed following relevant laws and regulations. Every patient signed a written consent upon registration in the institution and was informed about the goal and methods of study. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.

Sample Size

The sample size calculation was performed based on a power of 95% and an α value of 0.05 following a study conducted by Al-Rawi et al.[13] in which the mediolateral measurements of the condyle were 18.98 ± 2.55 and 15.81 ± 3.05 mm in the two studied groups. The sample size was calculated to be at least 42 joints for valid results.

Selection Criteria

Patients were considered desirable based on the following general selection criteria: (1) Age between 18 and 30 years, (2) patients have all permanent teeth erupted except for the third molars, (3) skeletal class II malocclusion (The anteroposterior skeletal relation; ANB $\geq 4°$), and (4) with almost similar transverse and vertical skeletal measurements.[14] The specific selection criteria included several parameters as in the following: (1) Patients without a history of painful TMJ and/or jaw muscles, painful or limited movement of the mandible or joint noise, were enrolled in this study as the control group and (2) patients with a history or clinically diagnosed TMJ disorders considered for TMD group. The exclusion criteria consisted of several parameters as mentioned in the following: (1) Patients with a history of growth abnormalities, condylar degenerative illnesses (such as erosion, subchondral cysts, and condylar hyperplasia),[15] polyarthritis, acute trauma, and/or tumors of the TMJ, (2) patients with a history of medications that could influence the TMJ, and/or (3) patients who previously underwent orthodontic therapy or had orthognathic or TMJ surgeries. Ninety one patients (182 joints) who met the previously mentioned inclusion and exclusion criteria were selected out of 1,063 individuals who were examined at the outpatient clinic of the Department of Orthodontics, Faculty of Dentistry, Cairo University, Egypt.

Clinical Examination

Clinical examination was done under the close supervision of an experienced TMD specialist. A pre-designed diagnostic chart was utilized following the diagnostic criteria for temporomandibular disorders (DC/TMD).[7,16] Clinical evaluation of the enrolled patients included several parameters as follows: (1) The TMJ palpation (2) masticatory muscles evaluation and palpation, (3) mandibular movements' evaluation, and (4) TMJ sounds assessment.

The total sample was divided into the following two groups: (1) The TMD group (56 patients; 112 joints) and (2) the non-TMD group (35 patients; 70 joints). Patients were examined using the chart following DC/TMD. CBCT was used to assess the 3D positional and dimensional characteristics of TMJ, which included the glenoid fossa, mandibular condyles, and TMJ spaces.

Cone–Beam Computed Tomography Analysis

Three-dimensional images were acquired using the I-CAT CBCT system (Imaging Sciences International, Hatfield, US). The machine was set with the following specific exposure parameters: (1) A current flow of 18.54 mA s at 120 kV, (2) capture for 8.9 seconds with a 0.30-mm voxel size, (3) 2-mm slice thickness, and (4) large field of view (17 cm). The CBCT images were captured in the Frankfort horizontal (FH) plane reoriented parallel to the floor and a crossing laser guide, and teeth were occluded in the centric occlusion (CO). During the scanning process, patients were instructed to avoid swallowing or movement.

Table 1: Definitions of skeletal and temporomandibular three-dimensional landmarks used in the study

No.	Landmark	Definition
Skeletal landmarks (Fig. 1)		
1	S	The center point of the pituitary fossa in the middle cranial fossa in sagittal and axial views
2	N	The most anterior and midpoint of the fronto–nasal suture
3	Or	The most inferior and middle point of each infraorbital rim
4	Po	The most outer and superior bony points of the external acoustic meatus
5	ANS	The most anterior midpoint of the anterior nasal spine of the maxilla
6	A point	The deepest midpoint of the maxillary anterior surface
7	B point	The deepest midpoint of the mandibular anterior surface
8	Me	The most inferior midpoint of the chin on the outline of the mandibular symphysis
9	Go	The right and the left midpoint on the angles of the mandible, halfway between the corpus and ramus
10	J	Point of maximum concavity on the inferior–lateral surface of the zygomatic process of maxilla
11	Ag	The most inferior extent of the cortical bone at the point of maximum concavity from the gonial angle of the mandible to the body of the mandible
Temporomandibular landmarks (Fig. 2)		
1	MF	The most superior and midpoint of the hard tissue right or left mandibular fossa region
2	AT	The most inferior point of articular tubercle
3	IM	The most inferior point of internal auditory meatus
4	AFPi	The most anterior and inferior point in the right or left anterior wall of the mandibular fossa
5	AFPs	The most superior point in the right or left anterior wall of the mandibular fossa
6	PFPi	The most posterior and inferior point in the right or left anterior wall of the mandibular fossa
7	PFPs	The most superior point in the right or left posterior wall of the mandibular fossa
8	SCP	The most right or left superior point of the condylar head
9	LCP	The most right or left lateral point of the condylar head
10	MCP	The most right or left medial point of the condylar head
11	ACP	The most right or left anterior point of the condylar head
12	PCP	The most right or left posterior point of the condylar head
13	MJSF	The most right or left lateral point of the medial wall of mandibular fossa
14	AJSF	The most posterior point of the right or left anterior wall of the mandibular fossa opposed to the shortest anterior condylar–fossa distance
15	AJSC	The most anterior point of the right or left condyle opposed to the shortest anterior condylar–fossa distance
16	PJSF	The most anterior point of the right or left posterior wall of the mandibular fossa opposed to the shortest posterior condylar–fossa distance
17	PJSC	The most posterior point of the right or left condyle opposed to the shortest posterior condylar–fossa distance

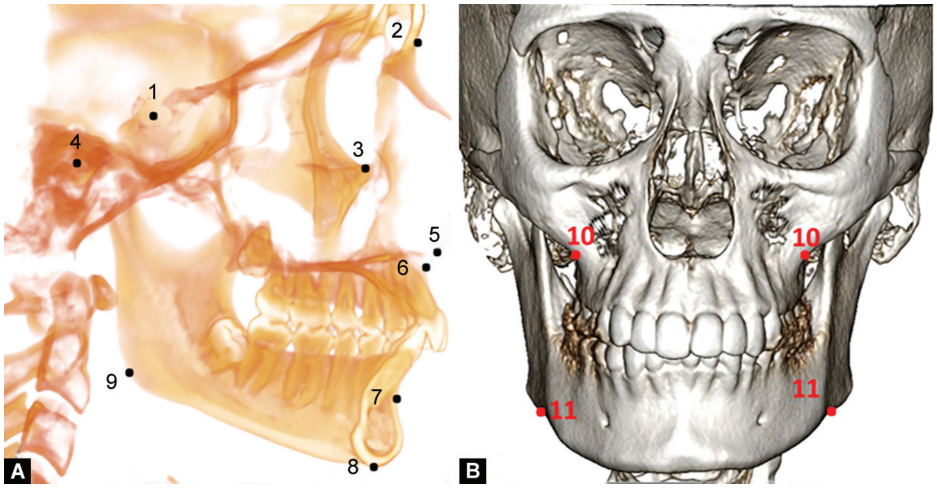
To avoid any confounding effect of the skeletal anteroposterior, vertical and transverse components of malocclusion; all selected cases were free of transverse discrepancy with average vertical pattern and the degree of severity of skeletal class II was considered to be almost similar across both studied groups.

The CBCT images were acquired based on Digital Imaging and Communications in Medicine (DICOM) files and then exported to *in vivo* Anatomage 5.01 (Anatomage, San Jose, US) for 3D examination. The landmarks of craniofacial structures and TMJ were recognized in a 3D view (Table 1) (Figs 1 and 2). The standardized innovative 3D-imaging analysis including linear and angular measurements described by Abdulqader et al.[17] and Alhammadi et al.[18–21] was used in this study and is described in Table 2. Dimensional and positional condylar parameters relative to skull base reference and mandibular fossa measurements were evaluated, and TMJ spaces including superior joint space (SJS), posterior joint space (PJS), and medial joint space (MJS) were measured using the reported formula.[22]

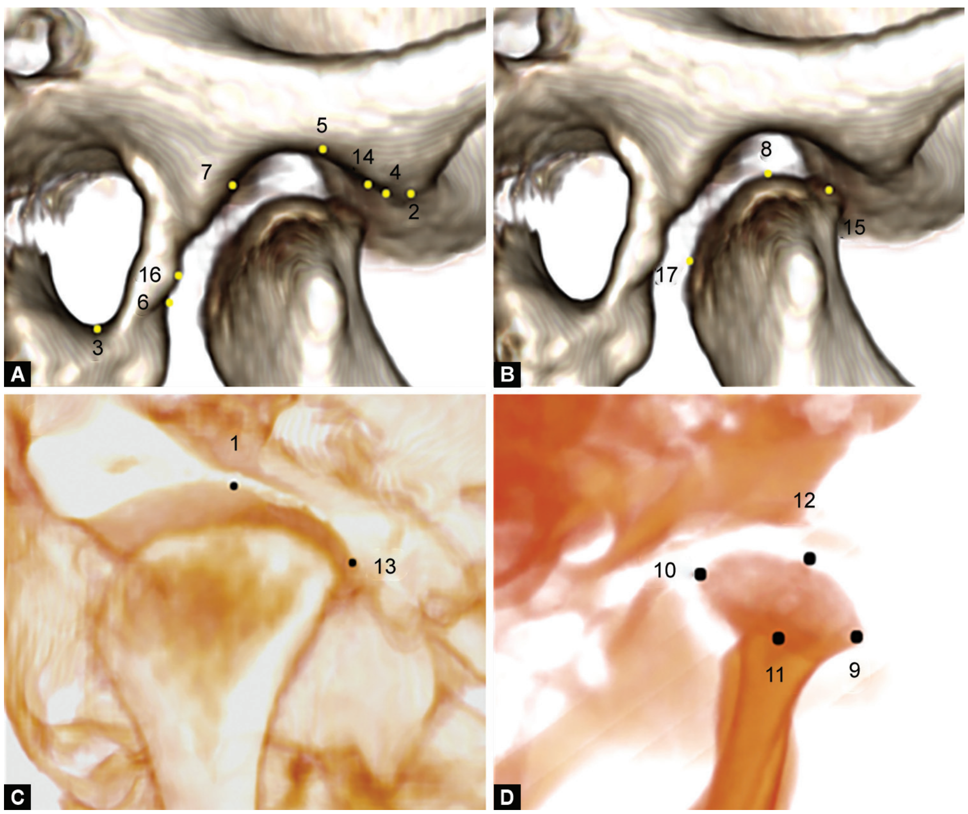
A reliability analysis was performed before the start of the project by measuring 30 randomly selected that were measured twice, two weeks apart by the same operator and once by another operator.

Statistical Analysis

The data were analyzed using the SPSS statistics program for Windows, version 26.0 (IBM Corp., IBM Armonk, NY). The reliability analysis was done using the intraclass correlation coefficient (ICC), and the quantitative data were first tested for normality by Shapiro–Wilk test and were considered normally distributed if $p > 0.05$. All data were represented as means ± standard deviations (SDs).



Figs 1A and B: Three-dimensional views of the skeletal landmarks. (A) Anteroposterior landmarks; (B) Mediolateral landmarks



Figs 2A to D: Three-dimensional views TMJ landmarks. (A) Sagittal view; mandibular fossa landmarks; (B) Sagittal view; condylar landmarks; (C) Coronal view; (D) Axial view

An independent t-test was used for comparing normally distributed quantitative data between both groups. The significance of a result was set at a p-value less than 0.05.

Results

Regarding the baseline AP, vertical, and transverse measurements, no significant differences existed between groups. The mean ANB angles in TMD and non-TMD groups were 6.71 ± 1.54 and 7.07 ± 1.40° ($p = 0.25$), respectively, and the mean mandibular plane/Sella–Nasion (MP/SN) angles were 37.79 ± 6.61 and 37.16 ± 6.42° ($p = 0.65$) in TMD and non-TMD groups, respectively. For the transverse measurements, it was 15.91 ± 5.66 and 15.16 ± 2.99 mm ($p = 0.74$) in TMD and non-TMD groups, respectively (Table 3).

For mandibular fossa measurements (Table 4), the AP and vertical mandibular fossa positions were not significantly different

Table 2: Reference planes, skeletal, and TMJ measurements used in the study

3D skeletal reference planes		
HP	Horizontal plane	Constructed by three-point right orbital with two sides porion
MSP	Midsagittal plane	Constructed by three-points N, S, and ANS
VP	Vertical plane	Constructed Sella point and perpendicular to the sagittal and horizontal plane
TM	Tuberculo–metal Line	Line between AT and IM
3D skeletal measurements		
ANB	Skeletal anteroposterior jaw relation	The angle between points A, N, and B
MP/SN	Skeletal vertical jaw relation	The angle between Sella–Nasion (SN) and Go–Me
Mx–Md diff	Maxillo–mandibular transverse difference	The difference between maxillary [jugale right (JR) and jugale left (JL)] and mandibular (AgR and AgL) transverse width
3D skeletal TMJ measurements		
MFVP	Mandibular fossa vertical position	The perpendicular distance between MF and HP
MFAP	Mandibular fossa anteroposterior position	The perpendicular distance between MF and VP
MFML	Mandibular fossa mediolateral position	The perpendicular distance between MF and MSP
GFH	Mandibular fossa height	The perpendicular distance between MF and TM lines
GFW	Mandibular fossa width	The horizontal distance between AFPi and PFPi
AFI/HP	Mandibular fossa anterior wall inclination	The angle between AFPi, AFPs, and HP
PFI/HP	Mandibular fossa posterior wall inclination	The angle between PFPi, PFPs, and HP
HCI	Mandibular condyle horizontal inclination	Angle of ACP–PCP line with HP
VCI	Mandibular condyle vertical inclination	Angle of MCP–LCP line with VP plane
APCI	Mandibular condyle anteroposterior inclination	Angle of MCP–LCP line with MSP
VCP	Mandibular condyle vertical position	Perpendicular distance between SCP and HP
APCP	Mandibular condyle anteroposterior position	Perpendicular distance between ACP and VP
MLCP	Mandibular condyle mediolateral position	Perpendicular distance between MCP and MSP
CL	Condylar length	The distance between MCP and LCP
CW	Condylar width	The condyle width between CAP and PCP
CH	Condylar height	The perpendicular distance between SCP and a line passing through the constricted condylar neck points
AJS	Anterior joint space	Closest distance between AJSC–AJSF
PJS	Posterior joint space	Closest distance between PJSC–PJSF
SJS	Superior joint space	Closest distance between SCP–MFS
MJS	Medial joint space	Closest distance between MCP–MJSF
VCJP	Vertical condylar joint position	The difference between condyle height to TM line and condyle height to the condyle neckline
APCJP	AP condylar joint position	Anteroposterior position of condyle according to Pullinger and Hollander equation

Table 3: Comparison of the baseline anteroposterior, vertical and transverse skeletal measurements between TMDs and non-TMDs groups with skeletal class II

Group		*TMD group N = 56 (112 joints)*	*Non-TMD group N = 35 (70 joints)*	
Craniofacial measurements		*Mean ± SD*	*Mean ± SD*	*p-value**
Anteroposterior	ANB	6.71 (1.54)	7.07 (1.40)	**0.25**
Vertical	MP/SN	37.79 (6.61)	37.16 (6.42)	**0.65**
Transverse	Mx–Md diff.	15.91 (5.66)	15.16 (2.99)	**0.74**

*Significant when $p \leq 0.05$; SD, standard deviation

Table 4: Comparison of the mandibular fossa measurements between TMD and non-TMD groups with skeletal class II

Group		*TMD group N= 56 (112 joints)*		*Non-TMD group N = 35 (70 joints)*		
Mandibular fossa measurements		*Mean*	*SD*	*Mean*	*SD*	*p-value**
Mandibular fossa position	MFVP	1.42	0.84	1.18	0.82	**0.178**
	MFAP	8.82	2.10	9.87	3.44	**0.075**
	MFML	47.74	2.25	46.13	3.06	**0.009**
Mandibular fossa parameters	GFH	8.50	1.00	8.40	1.06	**0.658**
	GFW	17.70	1.58	17.60	2.03	**0.797**
	AFI/HP	53.83	10.56	47.35	9.40	**0.004**
	PFI/HP	47.18	13.03	44.53	9.48	**0.299**

*Significant when $p \leq 0.05$; SD, standard deviation

Table 5: Comparison of the mandibular condyle measurements between TMD and non-TMD groups with skeletal class II

Group		*TMD group N= 56 (112 joints)*		*Non-TMD group N = 35 (70 joints)*		
TMJ condyle measurement		*Mean*	*SD*	*Mean*	*SD*	*p-value**
Mandibular condyle inclination	HCI	5.74	3.23	6.59	2.92	**0.208**
	VCI	79.39	6.62	74.28	10.58	**0.014**
	APCI	73.73	6.83	73.32	6.38	**0.776**
Mandibular condyle position	VCP	1.85	1.24	2.72	1.68	**0.006**
	APCP	4.67	2.14	4.98	3.86	**0.668**
	MLCP	41.28	3.98	40.32	3.61	**0.250**
Mandibular condyle parameters	CL	17.66	2.09	17.70	2.11	**0.919**
	CW	6.90	1.21	6.53	0.97	**0.136**
	CH	8.58	1.24	11.16	1.76	**0.000**
Intrajoint condylar position	APJCP	–0.51	21.43	6.34	27.03	**0.183**
	VJCP	3.60	1.08	2.62	1.50	**0.001**

*Significant when $p \leq 0.05$; SD, standard deviation

between study groups while the mediolateral position revealed significant differences between both groups with a more lateral mandibular fossa in the TMD group (47.74 ± 2.25 mm) than in the non-TMD group (46.13 ± 3.06 mm) ($p = 0.009$). The mandibular fossa parameters showed no statistically significant differences regarding glenoid fossa width, glenoid fossa height, and mandibular fossa posterior wall inclination (PFI/HP), while the mandibular fossa anterior wall inclination (AFI/HP) showed statistically significant differences between both groups as it was more inclined vertically in the TMD group (53.83 ± 10.56°) compared to the non-TMD group (47.35 ± 9.40°) ($p = 0.004$).

The mean mandibular condyle inclination and position showed no significant differences except for the vertical condylar inclination, which was less inclined toward the horizontal plane in the TMD group (79.39 ± 6.62 vs 74.28 ± 10.58°; $p = 0.014$) in addition to the vertical condylar position, which was closer to the reference plane relative to the horizontal plane in the TMD group (1.85 ± 1.24 vs 2.72 ± 1.68 mm; $p = 0.006$) (Table 5). Regarding the mandibular condyle parameters, only the vertical dimension (height) was significantly smaller in the TMD group compared to the non-TMD group (8.58 ± 1.24 vs 11.16 ± 1.76 mm; $p \leq 0.001$). In terms of the intrajoint condylar position, it was significantly more vertical or upward within the joint in the TMD group (3.60 ± 1.08 vs 2.62 ± 1.50 mm; $p = 0.001$).

The measurements of joint spaces are presented in Table 6 in which our findings revealed significant differences between the two groups. The TMD group showed significantly decreased superior (3.60 ±1.08 vs 4.86 ± 2.06 mm; $p = 0.002$) and posterior joint spaces (2.60 ± 0.92 vs 3.27 ± 1.71 mm; $p = 0.017$) in the TMD patients in addition to significantly increased medial (3.81 ± 0.97 vs 2.73 ± 0.98 mm; $p \leq 0.001$) in the same group.

Discussion

Temporomandibular disorder is considered a musculoskeletal disorder causing orofacial pain of non-dental origin affecting the head, face, and related structures.[23] Temporomandibular disorder is a multifactorial disease with numerous direct and indirect causal factors.[24]

Several clinical studies have tried to investigate the relationship between malocclusion and TMD. These studies aimed to relate mainly the relationship between dental malocclusion and the signs and symptoms of TMD.[25–28] In the vertical dimension, the relationships between the TMD and open bite in some studies

Table 6: Comparison of the TMJ spaces measurements between TMD and non-TMD groups with skeletal class II

Group	*TMD group N = 56 (112 joints)*		*Non-TMD group N = 35 (70 joints)*		
Mandibular joint spaces measurements	*Mean*	*SD*	*Mean*	*SD*	*p-value**
AJS	2.56	0.71	2.79	1.19	**0.300**
SJS	3.60	1.08	4.86	2.06	**0.002**
PJS	2.60	0.92	3.27	1.71	**0.017**
MJS	3.81	0.97	2.73	0.98	**0.000**

*Significant when $p \leq 0.05$; SD, standard deviation

were reported[26–28] and between the TMD and deep bite in other reports.[25] In the transverse plane, a significant association of TMD with midline displacement and with mediolateral inverse bite was also recorded.[28] In the AP plane, a recently published study evaluated the correlation between malocclusions and TMDs and found that 48% have a class II, 16% have class I, and 28% have class III. The researchers concluded that class II malocclusion is not a causative factor of TMD but may be considered a predisposing factor.[29]

The retroposition of the mandibular condyle in skeletal class II malocclusion makes it more susceptible morphologically to anterior disc displacement due to this retropositioning of the mandible; this needs to be confirmed in a well-designed study.[19,20] The question that needs an answer is "Does the TMD associated with any specific features in the configurations of the TMJ, especially in those patients who reported to be of high incidence, class II malocclusions?" Several studies separately investigated the morphological or the positional features of the TMJ either in a non-TMD or in a TMD group.[16,18,19,30,31] Only two studies[32,33] evaluated the differences in a comparative manner, but their variables were limited only to the glenoid fossa roof thickness[33] which is minimally involved in the dynamic changes of the TMD patient; the other study[32] evaluated the condylar bone density between both groups. Practically speaking, a recent systematic review[34] documented that the most common TMD is the displacement of the articular disc either with or without reduction and this mechanism is mainly accompanied by changes in the condylar position which is associated with changes in the TMJ spaces and possible remodeling of the housing structure; the glenoid fossa. No study comprehensively comparing the TMJ features in a comparative study between both groups is available.

This study used CBCT to investigate 3D and positional characteristics of TMJ structures in skeletal class II malocclusion with and without TMDs. The 3D TMJ comprehensive analysis by Alhammadi et al.[18–21] was adopted, and this comprehensive analysis aimed to recognize all TMJ features, which may be associated with different TMD categories if present. All participants had comparable skeletal patterns without AP, vertical, or transverse discrepancies to ensure skeletal demographic standardization with minimal variations. Since our study is the first one to comprehensively compare both groups in 3D, comparing the results with other studies is invalid.

In this study, the mediolateral position revealed significant differences among both study groups with a more lateral mandibular fossa position in the TMD group than in the non-TMD group. This finding can be explained by possible anteromedial disc displacement followed by remodeling of the glenoid fossa to accommodate the new disc position. This process is associated with a significant mandibular fossa anterior wall inclination, which is more inclined vertically in the TMD group. This result might confirm the expected anteromedial disc displacement as the mandibular condyle displaced posteriorly resulted in less dynamic pressure on the anterior wall of the fossa.

The former changes were also reflected in the significant changes in the mandibular condyle in the TMD group. These changes were reported in four aspects in the same direction, the vertical condylar inclination was significantly less inclined toward the horizontal plane, the vertical condylar position, which was closer to the reference plane, the horizontal plane, which was significantly lower in the vertical dimension (height), and more vertical or upward positioning within the joint in the TMD group. These changes occurred only if the condyle moved in posterior and superior directions as a result of anteromedial disc displacement either with or without reduction.

So, the former question "Does the TMD associated with any specific features in the configurations of the TMJ, especially in those patients who reported to be of high incidence, class II malocclusions?" is now answered by finding that both glenoid fossa and mandibular condylar changes were highly consistent with the differences in the TMJ spaces. The TMD group showed significantly decreased superior and posterior joint spaces in the TMD patients in addition to significantly increased MJS in the same group; these differences might reflect possible anteromedial disc displacement either with or without reduction in the TMD group compared to the non-TMD group.

One of the limitations of this study is the inclusion of only adult patients, including growing patients, which may have changed the finding of this study. Another limitation is inclusion of only a specific ethnic group; thus, the finding cannot be generalized to other ethnicities or populations. The assessment was limited to the osseous structures. Similar studies to assess the soft tissue components of the TMJ (articular disc) itself using MRI are recommended for the future research.

Conclusion

Within the limitations of this study, the findings reveal a significant association between TMDs and TMJ positional and morphological characteristics. Patients diagnosed with TMDs presented with several distinct features including significantly more lateral mandibular fossa position and more vertically inclined anterior fossa wall, vertical mandibular condylar changes in the form of less vertical inclination, more vertical position, lower vertical dimension (height) in addition to more upward positioning within the joint space and significantly decreased superior and posterior in addition to significantly increased medial joint spaces.

From a biomechanical point of view, these changes might have occurred only if the condyle moved in posterior and superior directions as a result of anteromedial disc displacement either with or without reduction.

Acknowledgment

The author wants to express his acknowledgment to Prof. Dr. Mona Salah Fayed for her meticulous and detailed supervision of the process during case selection and measurements analysis of this study. Also, the author personally thanks Dr. Amira Aboalnaga for being supportive and for providing great help during the reliability of the studied measurements.

Orcid

Maged S Alhammadi https://orcid.org/0000-0002-1402-0470

References

1. Alhammadi MS, Halboub E, Fayed MS, et al. Global distribution of malocclusion traits: A systematic review. Dental Press J Orthod 2018;23(6):40.e41–40.e10. DOI: 10.1590/2177-6709.23.6.40.e1-10.onl.
2. McNamara JA Jr. Components of class II malocclusion in children 8–10 years of age. Angle Orthod 1981;51(3):177–202. DOI: 10.1043/0003-3219(1981)051<0177:COCIMI>2.0.CO;2.
3. Alomar X, Medrano J, Cabratosa J, et al. Anatomy of the temporomandibular joint Semin Ultrasound CT MR 2007;28(3): 170–183. DOI: 10.1053/j.sult.2007.02.002.
4. Gallo L, Gössi D, Colombo V, et al. Relationship between kinematic center and TMJ anatomy and function. J Dent Res 2008;87(8):726–730. DOI: 10.1177/154405910808700810.
5. Murphy MK, MacBarb RF, Wong ME, et al. Temporomandibular joint disorders: A review of etiology, clinical management, and tissue engineering strategies. Int J Oral Maxillofac Implants 2013;28(6):e393–e414. DOI: 10.11607/jomi.te20.
6. Gauer R, Semidey MJ. Diagnosis and treatment of temporomandibular disorders. Am Fam Physician 2015;91(6):378–386. PMID: 25822556.
7. Okeson JP. Management of Temporomandibular Disorders and Occlusion, E-book. Elsevier Health Sciences, 2019.
8. Valesan LF, Da-Cas CD, Réus JC, et al. Prevalence of temporomandibular joint disorders: a systematic review and meta-analysis. Clin Oral Investig 2021;25(2):441–453. DOI: 10.1007/s00784-020-03710-w.
9. Bueno C, Pereira D, Pattussi M, et al. Gender differences in temporomandibular disorders in adult populational studies: A systematic review and meta-analysis. J Oral Rehabil 2018;45(9): 720–729. DOI: 10.1111/joor.12661.
10. Jian-rong C, Shui-qing D, Liang C, et al. Imaging features of temporomandibular joint disorder: Comparison of the efficacy of cone–beam CT, MRI. China Int J Oral Maxillofac Surg 2022;20(3): 273–276. DOI: 10.19438/j.cjoms.2022.03.012.
11. Almashraqi AA, Ahmed EA, Mohamed NS, et al. An MRI evaluation of the effects of qat chewing habit on the temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol 2018;126:272.e2–282.e2. DOI: 10.1016/j.oooo.2018.05.005.
12. Sümbüllü M, Çağlayan F, Akgül H, et al. Radiological examination of the articular eminence morphology using cone beam CT. Dentomaxillofac Radiol 2012;41(3):234–240. DOI: 10.1259/dmfr/24780643.
13. Al-Rawi NH, Uthman AT, Sodeify SM. Spatial analysis of mandibular condyles in patients with temporomandibular disorders and normal controls using cone–beam computed tomography. Eur J Dent 2017;11(1):99–105. DOI: 10.4103/ejd.ejd_202_16.
14. Almaqrami B-S, Alhammadi M-S, Cao B. Three dimensional reliability analyses of currently used methods for assessment of sagittal jaw discrepancy. J Clin Exp Dent 2018;10(4):e352–e360. DOI: 10.4317/jced.54578.
15. Barngkgei I, Halboub E, Almashraqi A. Effect of bisphosphonate treatment on the jawbone: An exploratory study using periapical and panoramic radiographic evaluation. Oral Radiol 2019;35(2):159–170. DOI: 10.1007/s11282-018-0358-4.
16. Aboalnaga AA, Amer NM, Alhammadi MS, et al. Positional and dimensional TMJ characteristics in different temporomandibular disorders: A cross-sectional comparative study. Cranio 2022:1–9. DOI: 10.1080/08869634.2022.2028115.
17. Abdulqader AA, Ren L, Alhammadi M, et al. Three-dimensional analysis of temporomandibular joint in Chinese adults with normal occlusion and harmonious skeleton. Oral Radiol 2020;36:371–382. DOI: 10.1007/s11282-019-00415-z.
18. Alhammadi MS, Fayed MMS, Labib A. Comprehensive three-dimensional cone–beam computed tomography analysis of the temporomandibular joint in different vertical skeletal facial patterns. J World Fed Orthod 2016;5(1):9–17. DOI: 10.1016/j.ejwf.2016.02.001.
19. Alhammadi MS, Fayed MS, Labib A. Three-dimensional assessment of temporomandibular joints in skeletal class I, class II, and class III malocclusions: Cone–beam computed tomography analysis. J World Fed Orthod 2016;5(3):80–86. DOI: 10.1016/j.ejwf.2016.07.001.
20. Alhammadi M, Fayed M, Labib A. Three-dimensional assessment of condylar position and joint spaces after maxillary first premolar extraction in skeletal class II malocclusion. Orthod Craniofac Res 2017;20(2):71–78. DOI: 10.1111/ocr.12141.
21. Alhammadi MS, Shafey AS, Fayed MS, et al. Temporomandibular joint measurements in normal occlusion: A three-dimensional cone–beam computed tomography analysis. J World Fed Orthod 2014;3:155–162. DOI: 10.1016/j.ejwf.2014.08.005.
22. Pullinger A, Hollender L. Variation in condyle–fossa relationships according to different methods of evaluation in tomograms. Oral Surg Oral Med Oral Pathol 1986;62(6):719–727. DOI: 10.1016/0030-4220(86)90270-7.
23. Christidis N, Ndanshau EL, Sandberg A, et al. Prevalence and treatment strategies regarding temporomandibular disorders in children and adolescents—A systematic review. J Oral Rehabil 2019;46(3):291–301. DOI: 10.1111/joor.12759.
24. Michelotti A, Iodice G. The role of orthodontics in temporomandibular disorders. J Oral Rehabil 2010;37(6):411–429. DOI: 10.1111/j.1365-2842.2010.02087.x.
25. Declercq C, Neyt L, Mommaerts M, et al. Temporomandibular joint symptoms in orthognathic surgery: A retrospective study. Acta Stomatol Belg 1993;90(2):77–85. PMID: 8237636.
26. Henrikson T, Ekberg EC, Nilner M. Symptoms and signs of temporomandibular disorders in girls with normal occlusion and class II malocclusion. Acta Odontol Scand 1997;55(4):229–235. DOI: 10.3109/00016359709115422.
27. Riolo ML, Brandt D, TenHave TR. Associations between occlusal characteristics and signs and symptoms of TMJ dysfunction in children and young adults. Am J Orthod Dentofacial Orthop 987;92(6):467–477. DOI: 10.1016/0889-5406(87)90228-9.
28. Sonnesen L, Bakke M, Solow B. Malocclusion traits and symptoms and signs of temporomandibular disorders in children with severe malocclusion. Eur J Orthod 1998;20(5):543–559. DOI: 10.1093/ejo/20.5.543.
29. Fichera G, Ronsivalle V, Santonocito S, et al. Class II skeletal malocclusion and prevalence of temporomandibular disorders: An epidemiological pilot study on growing subjects. J Funct Morphol Kinesiol 2021;6(3):63. DOI: 10.3390/jfmk6030063.
30. Almaqrami BS, Alhammadi MS, Tang B, et al. Three-dimensional morphological and positional analysis of the temporomandibular joint in adults with posterior crossbite: A cross-sectional comparative study. J Oral Rehabil 2021;48(6):666–677. DOI: 10.1111/joor.13156.
31. Imanimoghaddam M, Madani AS, Mahdavi P, et al. Evaluation of condylar positions in patients with temporomandibular disorders: A cone–beam computed tomographic study. Imaging Sci Dent 2016;46(2):127–131. DO: 10.5624/isd.2016.46.2.127.
32. Eisazadeh M, Khojastepour L, Haghnegahdar A, et al. Comparison of condylar bone density in cone–beam computed tomographic images of patients with and without temporomandibular joint disorders. J Orofac Sci 2021;13(1):3–7. DOI: 10.4103/jofs.jofs_89_21.
33. Khojastepour L, Haghnegahdar A, Eisazadeh M, et al. Comparison between glenoid fossa roof thickness in TMD and non-TMD patients, a CBCT study. J Dent 2019;20(3):165–170. DOI: 10.30476/DENTJODS.2019.44906.
34. Silva MAG, Pantoja LLQ, Dutra–Horstmann KL, et al. Prevalence of degenerative disease in temporomandibular disorder patients with disc displacement: A systematic review and meta-analysis. J Maxillofac Surg 2020;48(10):942–955. DOI: 10.1016/j.jcms.2020.08.004.