ORIGINAL SCIENTIFIC ARTICLE

CBCT ANALYSIS OF MORPHOLOGICAL AND ANTHROPOMETRIC PARAMETERS OF THE TEMPOROMANDIBULAR JOINT IN PATIENTS WITH DIFFERENT DENTAL STATUS

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DOI 10.69559/issn.2233-1794.2025.14.2.2

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Short title: CBCT TMJ AND DENTAL STATUS
Word count of the abstract: 271
Word count of text: 3225

ABSTRACT

Objective: Investigate the relationship between age, gender and dental status with changes in the osseous structures of the TMJ.

Material and Methods: The study included 110 CBCT images of patients. According to age, the CBCT images of patients were divided into three groups: 20-40 years old, 40-60 years old, group over 60 years old. According to dental status, the images of patients were divided according to the Eichner's classification I, II and III. Analysis and measurements, vertical, linear and angular were performed on CBCT images: condylar morphology, medio-lateral and antero-posterior width condyles, height and inclination of the articular eminence and depth of the glenoid fossa.

Results: One-way ANOVA revealed no statistically significant differences in any TMJ measurements across Eichner classes I, II, and III and between the different age groups. Significant difference was observed for antero-posterior condylar width between the age groups ($p = 0.016$). Males showed significantly greater medio-lateral condylar width ($p = 0.0006$), as well as a larger articular eminence height and inclination ($p = 0.003$, $p = 0.006$,), and a greater glenoid fossa depth ($p = 0.0036$) compared to females. Coronal morphology was not significantly associated with sex and age. Sagittal condylar morphology showed a trend toward statistical significance in relation to age ($p = 0.055$).

Conclusion: Antero-posterior condylar width was significantly shorter with increasing age. Men showed significantly greater medio-lateral condyle width, articular eminence height and inclination, and greater glenoid fossa depth in relation to women. Dental status classified according to Eichner showed no measurable association with temporomandibular joint morphology in this sample. Only sagittal condylar morphology showed a trend toward statistical significance with respect to age.

Keywords: Tooth loss, Temporomandibular joint, Articular eminence, Condyle morphology, Cone-Beam Computed Tomography

Introduction

The temporomandibular joint (TMJ) is a specific joint of vital importance, as it enables mandibular movements during mastication, swallowing, and speech. Any morphological or functional alteration leads to disruption of normal function. Throughout life, continuous adaptation and remodeling of these structures occur. The process of physiological remodeling represents the TMJ's response to masticatory forces and loading [1, 2]. Furthermore, the process of remodeling of the mandibular condyles and associated osseous changes may be response to degenerative alterations within the temporomandibular joint (TMJ) [3–5].

Cone-Beam Computed Tomography (CBCT) is the method of choice for assessing and diagnosing morphological changes of the TMJ, providing accurate and precise analysis of osseous structures and detailed information on all present pathological processes [6]. Morphological changes of the TMJ associated with excessive loading or tooth loss remain a subject of ongoing research. The articular eminence, as the anterior border of the articular surface of the mandibular fossa influences the kinematics of the joint through its shape and size and determines the inclination of the condylar path. Its morphological change can be associated with dental status [7].

Previous studies have shown that patients with loss of posterior tooth may have changes in terms of the inclination of the articular eminence and the reduction of the depth of the glenoid fossa [8–10]. Changes in the dental status increase the loading on the condyle and articular eminence, resulting in structural changes of the TMJ in terms of functional adaptation or functional disorders [11]. While some studies report a steeper articular eminence and greater depth and height of the mandibular fossa in patients with temporomandibular disorders (TMD), other studies indicate that individuals without TMD present with a steeper articular eminence [12, 13]. Changes in the osseous structures of the temporomandibular joint, anatomical and functional as well as the inclination of the mandibular condyle, may be associated with dislocation of the articular disc]14, 15]. The aim of the study is to investigate the relationship between age, sex and dental status with changes in the osseous structures of the temporomandibular joint.

Subjects and methods

In this retrospective study, the sample consists of CBCT images of patients, who were previously recorded for diagnostics, therapy and treatment planning, archived in the database of the Radiology Department of the Faculty of Dentistry, University of Sarajevo. The Ethical committee of the Faculty of Dentistry University of Sarajevo issued its approval of this research under no: 02-3-4-19-2-2/2023. The study included 110 CBCT images of patients from the Bosnian-Herzegovinian population. According to age, the CBCT images of patients were divided into three groups:

group 20-40 years old, group 40-60 years old and group over 60 years old.

According to dental status, the images of patients were divided according to the Eichner's classification:

> Class I - antagonistic contact of teeth exists in all four supporting zones,

> Class II - antagonistic contact of teeth exists in one, two or three supporting zones or only in the area of the frontal teeth

> Class III – absence of antagonistic occlusal contact in the supporting zones with a few remaining teeth or complete edentulism in one or both jaws.

CBCT images showing fractures or pathological processes on the structures of the temporomandibular joint and mandible, as well as developmental anomalies were excluded from the study. Also, images of patients younger than 20 years were not included due to incomplete growth. The imaging was performed using a Galileos Comfort plus (Sirona Dental Company, Germany). The field of view (FOV) was a spherical volume of 15.4 cm, collimated to 15 × 8.5 cm, with an operating voltage of 98 kV, current of 3–6 mA, exposure time of 14 s, and isotropic voxel size of 0.25/0.125 mm. The recording was performed with the mouth closed. The patient's head was positioned so that the Frankfurt plane was parallel to the floor. CBCT images were placed in the position of multiplanar reconstruction - MPR ensuring that sections were analyzed in accordance with the correctly positioned head of the patient and the area of analysis. CBCT images were analyzed and measured in sagittal, coronal and axial sections. For data analysis and measurements, Sidexix 4 software for diagnostics and three-dimensional treatment planning was used.

Analysis and measurements, vertical, horizontal linear and angular were performed on CBCT images:

1. Condylar morphology was analyzed in coronal and sagittal sections. The coronal plane was aligned parallel to the long axis of the condyle, and the sagittal plane was oriented perpendicular to the coronal plane. Condyles were classified as convex, round, flat, angular, or irregular in shape in the coronal plane [16, 17]. In the sagittal plane, condyles were classified as round and flat [18].
2. Medio-lateral (ML) width of the right and left condyles was measured in the coronal section from the point of the medial to the point of the lateral pole of the condyle at the widest section of the condyle.
3. Antero-posterior (AP) width of the right and left condyles was measured in the sagittal section from the most anterior to the most posterior point of the widest condylar section. The sagittal section evaluated where the mediolateral width of the condyle was the greatest on the axial section, which represents the reference [19, 20].
4. Height and inclination of the articular eminence were measured in the sagittal section. The axial section where the widest mediolateral diameter of the condyle was used as a reference for the reconstruction of the sagittal section. The height of the articular eminence was measured as the vertical distance between the lines passing through the highest point of the glenoid fossa and the lowest point of the articular eminence. The inclination of the articular eminence was determined as the angle between the plane passing through the highest point of the glenoid fossa and the lowest point of the top of the articular eminence with the Frankfurt horizontal. Measurements were made on the central sagittal section of the condyle [20, 21].
5. Depth of the glenoid fossa was measured as the vertical distance between the highest point of the glenoid fossa and the line passing through the lowest point of the articular eminence and postglenoid process [12].

Statistical methods of data analysis

Descriptive statistics were calculated for all demographic and morphometric variables. To compare the right and left temporomandibular joint (TMJ) measurements paired t-tests were used.

Morphometric differences between age groups were analyzed with a one-way ANOVA. Sex-related differences in TMJ measurements were checked using independent-samples Welch's t-tests, which seemed more appropriate due to some unequal variances. The effect of dental status, classified by the Eichner index (I–III), on TMJ morphology was also examined using one-way ANOVA, and Tukey's post-hoc tests were applied when needed. Associations between categorical variables, including condylar morphology (both coronal and sagittal) and sex, age group, or Eichner class, were evaluated with chi-square tests. Pearson's correlation coefficients were computed to explore linear relationships between selected morphometric variables—specifically AP width with fossa depth, eminence angle with fossa depth, and ML width with the eminence angle. These correlations were checked just to see if they moved together in any meaningful way.

A multiple linear regression model was used to assess the combined influence of sex, age group, Eichner classification, and glenoid fossa depth on the articular eminence angle. Model diagnostics were inspected, though briefly, and explanatory strength was reported using adjusted R^2. In addition, a multinomial logistic regression was performed to determine whether sex, age group, and Eichner classification predicted the different coronal condylar morphology types, using the round shape as the reference. Odds ratios (ORs) with 95% confidence intervals were presented, but results for the irregular morphology type were interpreted cautiously because it appeared very rarely. A significance level of $p < 0.05$ was considered statistically important for all analyses. All statistical procedures were carried out using R software (version 4.1.2)

Results

In this study, the sample included CBCT images of 110 patients, 220 temporomandibular joints and 1.540 measurements. Of the total, 45 (40.9%) were men and 65 (59.1%) were women. According to age groups, the group of 20-40 years included 22 (20%)

subjects, the group of 40-60 years 66 (60%) and the group over 60 years 22 (20%). According to dental status (Eichner class) group I included 30 (27.3%), group II 45 (40.9%) and group III 35 (31.8%) images.

No statistically significant differences were found between the right and left sides of TMJ for any of the parameters that were analyzed ($p > 0.05$). The distribution of values for each parameter is shown in Figure 1.

One-way ANOVA revealed no statistically significant differences in any temporomandibular joint measurements across Eichner classes I, II, and III (Table 1). Follow-up Tukey post-hoc comparisons confirmed the absence of pairwise differences between any Eichner groups (all adjusted $p > 0.12$) (Table 2). These findings indicate that tooth loss classification according to Eichner did not show measurable association with TMJ morphology in this sample.

The one-way ANOVA showed no statistically significant differences between the different age groups for medio-lateral condylar width, articular eminence height and inclination, or the depth of the glenoid fossa ($p > 0.05$). However, a statistically significant difference was observed for antero-posterior condylar width between the age groups ($F = 4.29$, $p = 0.016$), suggesting that AP condylar dimensions may change with increasing age. The distribution of AP condylar width in relation to age groups is illustrated in Figure 2. Tukey post-hoc analysis revealed that AP condylar width is significantly shorter in age group 60+ compared to 40-60 ($p = 0.014$), while differences between other age groups are not statistically significant.

Males showed significantly greater medio-lateral condylar width ($p = 0.0006$), as well as a larger articular eminence height and inclination ($p = 0.003$ and $p = 0.006$, respectively), and also greater glenoid fossa depth ($p = 0.0036$) when compared to females. On the other hand, no statistically significant difference was noted in the antero-posterior condylar width between the two sexes ($p > 0.05$) (Table 3). Boxplot figures of the parameters that showed significant differences between males and females are presented in Figure 3.

The analysis of the distribution of condylar morphology in the coronal plane with different dental status showed in Eichner class I, the most common forms of condyles were round and angular (41.38%, 41.38%) for the right TMJ and left TMJ (40.00%, 33.33%). In class II, the most common shape was angular on the right condyle (34.09%), followed by round and flat shape equally (27.27%), while on the left side of the TMJ the most common shape was flat condyle (40.00%), followed by round and angular shape equally (26.67%). In Class III, the flat shape of the condyle for the right and left TMJ was dominantly present (44.12% and 41.18%). In the sagittal plane, the dominant shape of the condyles of the right and left TMJ with different dental status was round, class I (83.33%,83.33%), class II (73.33%,71.11%), class III (65.71,62.86%). There was no statistically significant association between coronal and sagittal condylar morphology and Eichner classification ($\chi^2 = 11.68$ $p = 0.166$), ($\chi^2 = 2.59$, $p = 0.274$), ($\chi^2 (2) = 3.37$, $p = 0.186$).

There was no statistically significant association between coronal condylar morphology and sex ($\chi^2 = 5.52$, $p = 0.24$). In a similar way, coronal morphology was also not significantly associated with age group ($\chi^2 = 12.98$, $p = 0.11$). However, sagittal condylar morphology showed a trend toward statistical significance in relation to age ($p = 0.055$). The

Table 1.
TMJ morphology according to Eichner classification (mean ± SD, with ANOVA p-values)

Parameter	Eichner I (mean ± SD)	Eichner II (mean ± SD)	Eichner III (mean ± SD)	p
ML width (mm)	16.33 ± 2.13	16.52 ± 2.05	16.39 ± 2.09	0.629
AP width (mm)	7.38 ± 0.92	7.59 ± 0.91	7.48 ± 0.89	0.119
Eminence height (mm)	8.14 ± 1.12	8.21 ± 1.11	8.18 ± 1.12	0.873
Eminence angle (°)	46.28 ± 7.01	46.20 ± 7.18	46.05 ± 7.18	0.962
Fossa depth (mm)	8.46 ± 1.22	8.54 ± 1.22	8.45 ± 1.21	0.755

Figure 1.
Right and left TMJ (AP condyle width, eminence inclination, eminence height, glenoid fossa depth, ML condyle width)

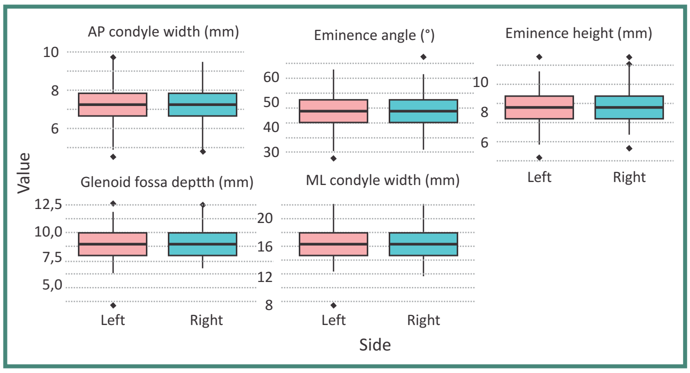


Table 2.
Tukey post-hoc comparisons
between Eichner classes for all TMJ parameters

Parameter	Comparison	Mean difference	95% CI	p
ML means	II-I	0.347	-0.826-1.521	0.762
	III-I	0.492	-0.747-1.731	0.614
	III-II	0.145	-0.977-1.267	0.950
AP means	II-I	-0.132	-0.651-0.387	0.818
	III-I	-0.458	-1.006-0.09	0.121
	III-II	-0.325	-0.822-0.171	0.268
Eminence height means	II-I	-0.107	-0.728-0.514	0.912
	III-I	0.009	-0.646-0.665	0.999
	III-II	0.116	-0.478-0.71	0.888
Eminence angle means	II-I	0.464	-3.551-4.479	0.959
	III-I	0.336	-3.902-4.574	0.98
	III-II	-0.127	-3.966-3.712	10.997
Fossa depth means	II-I	-0.219	-0.912-0.474	0.734
	III-I	-0.125	-0.857-0.607	0.913
	III-II	0.094	-0.569-0.757	0.939

Figure 2.
Antero-posterior condylar width according to age group

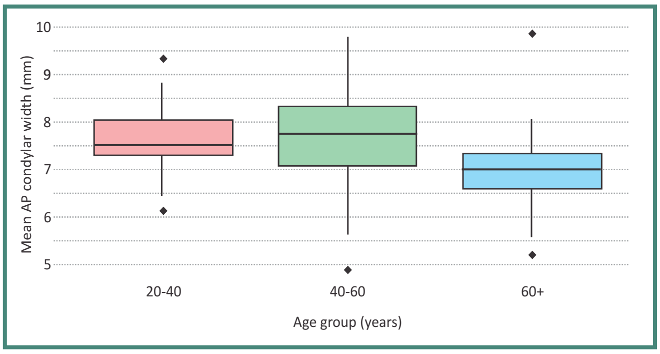
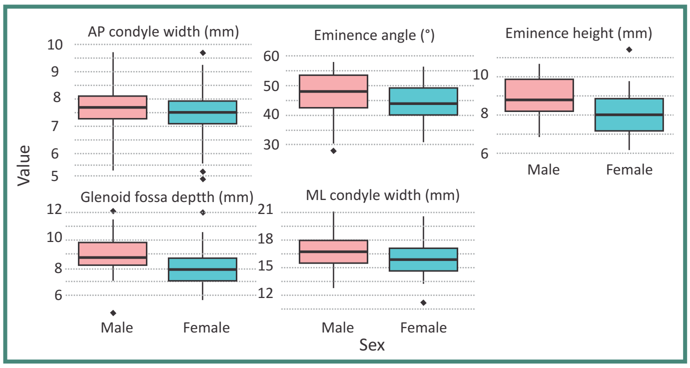


Table 3.
Sex differences in temporomandibular joint parameters (ML width, eminence angle, and fossa depth).

Parameter	Male mean ± SE	Female mean ± SE	Mean difference	95% CI	p
ML width	17.22 ± 0.32	115.82 ± 0.23	1.40	0.61 – 2.18	0.001
AP width	7.60 ± 0.13	7.38 ± 0.12	0.22	-0.14 – 0.57	0.231
Eminence height	8.54 ± 0.164	7.89 ± 0.128	0.65	0.23 – 1.06	0.003
Eminence angle	48.41 ± 1.06	44.65 ± 0.83	3.77	1.08 – 6.45	0.006
Fossa depth	8.89 ± 0.19	8.19 ± 0.14	0.70	0.23 – 1.17	0.003

Figure 3.
Sex differences in TMJ



percentage distribution of different condylar shapes according to sex and age groups is shown in Tables 4 and 5.

A moderate positive correlation was found between antero-posterior condylar width and glenoid fossa depth (r = 0.255, p = 0.007), as well as between articular eminence inclination and fossa depth (r = 0.271, p = 0.004). In addition, a significant positive correlation was also observed between medio-lateral condylar width and articular eminence inclination (r = 0.254, p = 0.007). The correlation coefficients and related p-values are presented in Table 6.

A multiple linear regression model was constructed to evaluate the combined influence of sex, age group, Eichner classification, and glenoid fossa depth on articular eminence inclination. This model excluded medio-lateral and antero-posterior condylar width, in accordance with anatomical considerations indicating that condylar size does not directly determine eminence inclination.

The overall model was statistically significant (F = 2.32, p = 0.039), explaining 11.9% of the variance in articulation eminence inclination (adjusted R^2 = 0.068). Among the included predictors, only glenoid fossa depth showed a statistically significant effect on articular eminence inclination (β = 1.21, p = 0.033). A deeper fossa is associated with a steeper articular eminence slope. Sex showed a trend toward significance (p = 0.054), with males tending to exhibit slightly steeper eminence inclinations, although this did not reach the conventional 0.05 level. Age group and Eichner classification were not significant predictors (all p > 0.40) (Table 7.).

Table 4.
Distribution of coronal condylar morphology according to sex (%)

	Round	Convex	Flat	Angular	Irregular
Male	31.1	2.2	35.6	28.9	2.2
Female	32.7	9.7	22.6	35.5	0.0

Table 5.
Distribution of coronal condylar morphology according to age group (%)

	Round	Convex	Flat	Angular	Irregular
20 - 40	38.1	9.5	14.3	38.1	0.0
40 - 60	35.9	3.1	28.1	32.8	0.0
60+	13.6	13.6	40.9	27.3	4.6

Table 6.
Correlation between selected temporomandibular joint parameters.

Variables	r	P
AP width – Fossa depth	0.255	0.0073
Eminence angle – Fossa depth	0.271	0.0042
ML width – Eminence angle	0.254	0.0074

These findings support the anatomical assumption that vertical skeletal morphology (fossa depth) plays a key role in shaping the articular eminence, whereas condylar width and tooth-loss status do not provide additional explanatory value.

In addition, multinomial logistic regression analysis did not identify any statistically significant predictors for the other coronal shape categories. The irregular shape category was not included in the main interpretation because of unstable estimates caused by its low frequency in the sample. The results for this analysis are presented in Table 8.

Model assumptions were verified through inspection of residual and Q–Q plots. Multicollinearity

Table 7.
Multiple linear regression predicting articular eminence inclination

Predictor	Estimate (β)	Std. Error	T	p-value
Intercept	36.56	5.36	6.82	<0.001
Sex (Female)	−2.76	1.42	−1.95	0.054
Age 40–60 (20-40)	1.38	1.85	0.75	0.455
Age 60+ (20-40)	1.95	2.42	0.81	0.422
Eichner II (I)	0.06	1.75	0.04	0.971
Eichner III (I)	−0.83	1.98	−0.42	0.676
Fossa depth (mm)	1.21	0.56	2.16	0.033

was assessed using variance inflation factors (VIF), which remained below 5 for all predictors. Homoscedasticity and linearity were additionally verified through residual vs fitted plots.

Discussion

In this retrospective study, CBCT images of women were more prevalent than men, aged 40-60 years. According to dental status, the most prevalent subjects were group II classified according to Eichner with preserved support zones, but not in all four zones, followed by subjects with a small number of remaining teeth with loss of support zones of group III, and subjects of control group I with contact of teeth in all four support zones.

No statistically significant differences were found between the right and left sides of TMJ for any of the parameters that were analyzed ($p > 0.05$) (Figure 1.)

These findings indicate that dental status as classified by Eichner showed no measurable association with temporomandibular joint morphology in this sample (Table 1 and Table 2.).

Chen et al. [22] in a study conducted on CBCT images showed that subjects divided according to Kenedy classes with unilateral and bilateral tooth loss and the control group had a larger medio-lateral width of the condyle, a shallower glenoid fossa and a smaller inclination of the articular eminence compared to the results of this study. Also, they proved that there is no

Table 8.
Multinomial logistic regression analysis of factors associated with coronal condylar morphology

Outcome	Predictor	B	SE	OR (95%CI)	p
Convex	(Intercept)	-2.656	1.39	0.07 (0.005-1.07)	0.056
	Female (Male)	1.489	1.185	4.434 (0.435-45.24)	0.209
	40-60 (20-40)	-0.68	1.159	0.507 (0.052-4.918)	0.558
	60+ (20-40)	2.339	1.462	10.375 (0.591-182.03)	0.109
	Eichner II (I)	0.18	1.157	1.198 (0.124-11.562)	0.876
	Eichner III (I)	-1.498	1.631	0.224 (0.009-5.475)	0.359
Flat	(Intercept)	-1.359	0.892	0.257 (0.045-1.474)	0.127
	Female (Male)	-0.293	0.534	0.746 (0.262-2.125)	0.583
	40-60 (20-40)	0.243	0.809	1.276 (0.261-6.233)	0.764
	60+ (20-40)	1.284	1.07	3.609 (0.444-29.366)	0.230
	Eichner II	1.195	0.793	3.303 (0.699-15.614)	0.132
	Eichner III	1.326	0.844	3.766 (0.72-19.699)	0.116
Angular	(Intercept)	-0.153	0.657	0.858 (0.237-3.109)	0.816
	Female (Male)	0.194	0.508	1.214 (0.449-3.284)	0.703
	40-60 (20-40)	0.048	0.628	1.049 (0.306-3.596)	0.939
	60+(20-40)	1.059	0.992	2.882 (0.413-20.131)	0.286
	Eichner II (I)	0.094	0.593	1.099 (0.344-3.512)	0.874
	Eichner III (I)	-0.53	0.717	0.589 (0.144-2.398)	0.460

significant difference in TMJ morphological parameters between the examined groups, which corresponds to the findings of this study, but the depth of the glenoid fossa of the control group was greater than in the group with bilateral and unilateral tooth loss, which is not in accordance with the findings of this study. The inclination of the articular eminence in this study was within the normal value for different dental status. It has been proven that there is a connection between the inclination of the articular eminence and the inclination of the occlusal plane [23]. Articular eminences with inclination values <30° are considered flat, and articular eminence inclination values >60° are considered steep, and may be the cause of TMD [25, 26].

Previous studies have indicated that age and gender can influence the bone morphology of the TMJ [9, 23, 24]. This study showed that antero-posterior condylar width (AP) significantly shorter in the group over 60 years of age. Considering that age group over 60 years old had a dental status without preserved support zones, although a direct association was not proven in this study due to the small sample, it can be assumed that in addition to age, dental status may also have an influence on the AP parameter (Figure 2.).

Males had a greater medio-lateral (ML) condyle width, higher and steeper articular eminence and deeper glenoid fossa in relation to women but there was no difference in AP width (Table 3. and Figure 3.). Previous studies have shown that men had higher values of height and inclination of the articular eminence compared to women [17, 29]. Other studies have shown that men have higher morphometric values of the condyle and glenoid fossa, but there was no difference in the inclination of the articular eminence between the sexes [30].

A study that included CBCT analysis of 1820 TMJs have shown that the morphology of the condyle in the coronal plane was flat in persons with partial and total edentulism, and convex in persons with a full set of teeth. The flat shape of the condyle was common in men, the round shape in women. The authors found a significant difference between condylar morphology

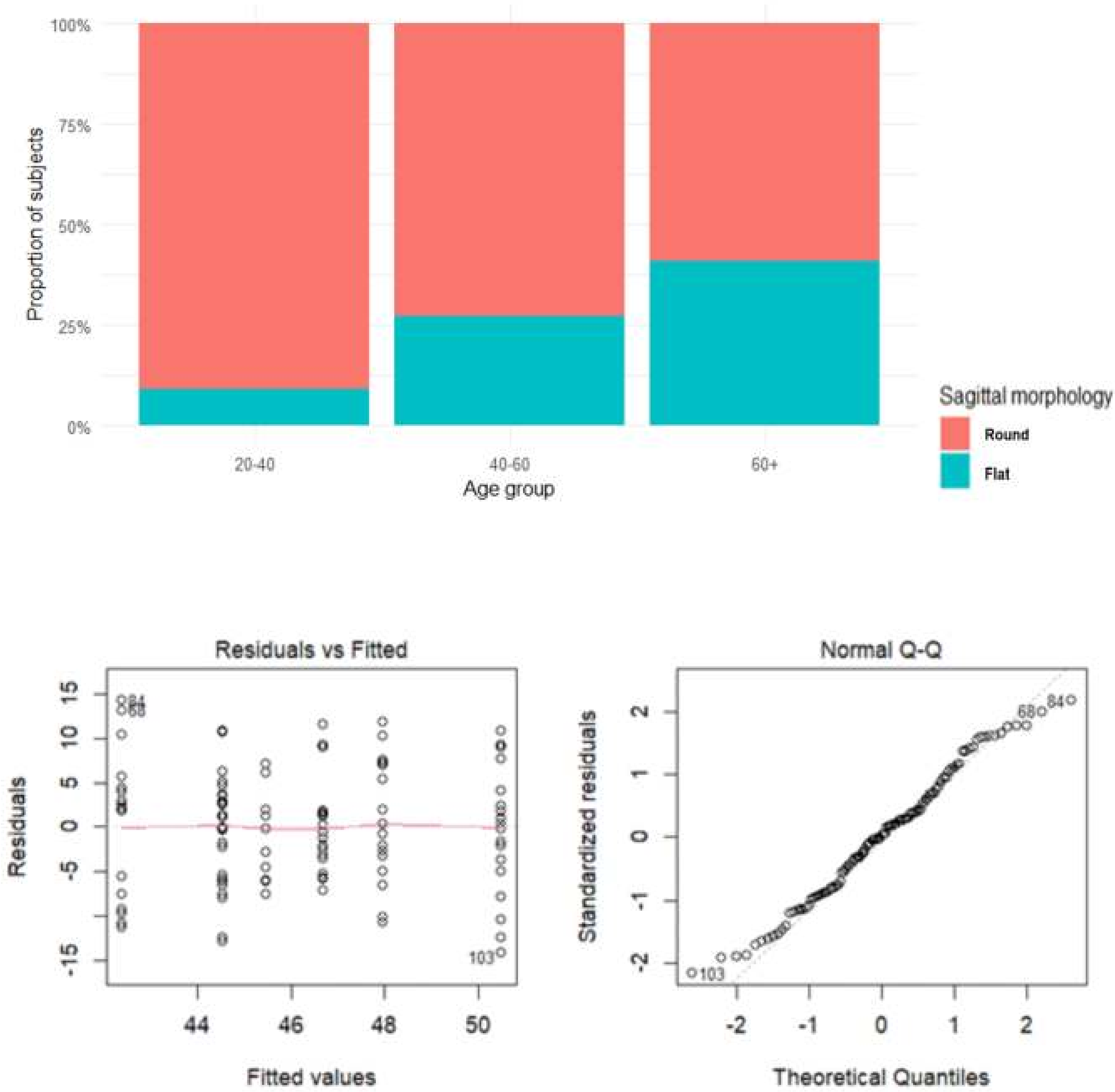


Figure 4.
Sagittal condylar morphology by age group

and age. The angular shape was most common between 30-59 years of age compared to people between 18-29 and people over 60 [27]. In this study, the round and angular shape of the condyle were most often represented in Eichner class I, in class II angular on the right TMJ and flat on the left TMJ, and in Eichner class III the flat shape of the condyle was most often present, which corresponds to the findings of the Yalcin and Ararat. In the sagittal plane, the dominantly round shape of the condyle was present in different dental statuses. There was no association between condylar morphology in the coronal and sagittal planes and different dental status according to Eichner. The flat condylar shape was most common in men, and the angular condylar shape in women, but there was no significant association between coronal condylar morphology and gender and age. The round shape was most common in the 20-40 and 40-60 age groups, and the flat shape was most common in those over 60 years of age. However, sagittal condylar morphology showed a trend towards statistical significance with age (Table 4 and 5.).

Correlation between AP width of condyle and depth of glenoid fossa, then inclination of articular eminence and depth of glenoid fossa and ML width of condyle and inclination of articular eminence was proven (Table 6). A multiple linear regression model showed that only glenoid fossa depth had a significant effect on articular eminence inclination. Thus, a deeper glenoid fossa was associated with a steeper articular eminence (Table 7.) Also, a correlation between the inclination of the articular eminence and the depth of the glenoid fossa was demonstrated in a previous study by analyzing MRI of the TMJ [27].

Multinomial logistic regression determined that gender, age and Eichner classification did not predict different types of coronal condylar morphology (Table 8.) Contrary to these findings, Arayapisit et al. [5] proved the relationship of all the mentioned clinical factors with flat condylar morphology.

The limitation of this study is a small sample. Larger sample sizes are needed to investigate these associations.

Conclusion

Antero-posterior condylar width was significantly shorter with increasing age. Men showed significantly greater medio-lateral condyle width, articular eminence height and inclination, and greater glenoid fossa depth in relation to women. Dental status classified according to Eichner showed no measurable association with temporomandibular joint morphology in this sample. Only sagittal condylar morphology showed a trend toward statistical significance with respect to age.

There is no conflict of interest.

References

1. Cohen A, Sela MC, Verkauf TA, Alterman M, Talisman S, Casap N.The influence of mandibular condyle morphology on TMJ anterior dislocations.Oral Surg Oral Med Oral Pathol Oral Radiol. 2021 Oct;132(4):393-397.
2. Abbate V, Audino G, Dell'Aversana Orabona G, Friscia M, Bonavolontà P, Lo Faro C, Committeri U, Cuéllar CN, Iaconetta G, Califano L. Condylar Reshape in Orthognathic Surgery: Morpho-volumetric and Densitometric Analysis Based on 3D Imaging and Digital Workflow. J Maxillofac Oral Surg. 2022 Jun;21(2):501-509.
3. Aboalnaga AA, Amer NM, Alhammadi MS, Fayed MMS. Positional and dimensional TMJ characteristics in different temporomandibular disorders: A cross-sectional comparative study. Cranio. 2022 Jan 21:1-9.
4. Alfaleh W. Relationship between horizontal condylar angle and radiographically detectable morphological changes of the condyle in asymptomatic and symptomatic patients with TMD. Saudi Dent J. 2021 Dec;33(8):1154-1159.
5. Arayapisit T, Ngamsom S, Duangthip P, Wongdit S, Wattanachaisiri S, Joonthongvirat Y, Mitrirattanakul S. Understanding the mandibular condyle morphology on panoramic images: A conebeam computed tomography comparison study. Cranio. 2020 Dec 9:1-8.
6. Whyte A, Boeddinghaus R, Bartley A, Vijeyaendra R. _Imagingof the temporomandibular joint. Clin Radiol. 2021 Jan;76(1): 76.e21-76. e 35.

7. Erzurumlu ZU, Celenk P. A radiological evaluation of the effects of edentulousness on the temporomandibular joint. J Oral Rehabil. 2020 Mar;47(3):319-324.

8. Zhang Y, Huang H, Hao P, Zhang G, Wang Y, Chen F, Yang C, Liu Z. The impact of posterior tooth loss on the biomechanics of the temporomandibular joints. Comput Methods Biomech Biomed Engin. 2025 Feb 17:1-10.

9. Vîrlan MJR, Păun DL, Bordea EN, Pellegrini A, Spînu AD, Ivașcu RV, Nimigean V, Nimigean VR. Factors influencing the articular eminence of the temporomandibular joint (Review). Exp Ther Med. 2021 Oct;22(4):1084.

10. Chen M, Lin Y, Wei R, Li Y, Yang R, Wang Z, Li P, Sui L. A cone beam computed tomography study on the osseous morphology of temporomandibular joint with free loss of posterior teeth. Arch Oral Biol. 2025 Sep; 177:106337.

11. Chen Y, Wang J, Li Y, Li L, Luo N, Wu Y, Dai H, Zhou J. Age-related variations in position and morphology of the temporomandibular joint in individuals with anterior openbite and crossbite: a multi-cross-sectional comparative study. BMC Oral Health. 2022 May 23;22(1):200.

12. Paknahad M, Shahidi S, Akhlaghian M, Abolvardi M. Is Mandibular Fossa Morphology and Articular Eminence Inclination Associated with Temporomandibular Dysfunction? J Dent Shiraz Univ Med Sci.2016 June; 17(2): 134-141.

13. Caglayam F, Sümbüllü MA, Akgüul HM. Associations between the articular eminence inclination and condylar bone changes, condylar movements, and condyle and fossa shapes. Oral Radiol. 2014; 30: 84–91.

14. Monaco EG, De Stefano AA, Hernandez-Andara A, Galluccio G. Correlation between condylar size on CT and position of the articular disc on MRI of the temporomandibular joint. Cranio. 2019;00(00).

15. de Farias JFG, Melo SLS, Bento PM, Oliveira LSAF, Campos PSF, de Melo DP. Correlation between temporomandibular joint morphology and disc displacement by MRI. Dentomaxillofac. Radiol. 2015;44(7):1–7.

16. Ejima K, Schulze D, Stippig A, Matsumoto K, Rottke D, Honda K. Relationship between the thickness of the roof of glenoid fossa, condyle morphology and remaining teeth in asymptomatic European patients based on cone beam CT data sets. Dentomaxillofac. Radiol. 2013;42(3):90929410.

17. İlgüy D, İlgüy M, Fişekçioğlu E, Dölekoğlu S, Ersan N. Articular eminence inclination, height, and condyle morphology on cone beam computed tomography. Scientific World Journal. 2014 Feb 13;2014.

18. Ma RH, Feng JL, Bornstein MM, Li G. Relationship between development of the condylar cortex and the changes in condyle morphology: a cone-beam computed tomography (CBCT) observational study. Quant Imaging Med Surg. 2023 Apr 1;13(4):2388-2396

19. Alam MK, Ganji KK, Munisekhar MS, Alanazi NS, Alsharif HN, Iqbal A, Patil S, Jamayet NB, Sghaireen M. A 3D cone beam computed tomography (CBCT) investigation of mandibular condyle morphometry: Gender determination, disparities, asymmetry assessment and relationship with mandibular size. Saudi Dent J. 2021 Nov;33(7):687-692.

20. Kim HO, Lee W, Kook YA, Kim Y. Comparison of the condyle-fossa relationship between skeletal class III malocclusion patients with and without asymmetry: a retrospective three-dimensional cone-beam computed tomograpy study. Korean J Orthod. 2013 Oct;43(5):209-17.

21. Shahidi S, Vojdani M, Paknahad M. Correlation between articular eminence steepness measured with cone-beam computed tomography and clinical dysfunction index in patients with temporomandibular joint dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013 Jul;116(1):91-7.

22. Chen M, Lin Y, Wei R, Li Y, Yang R, Wang Z, Li P, Sui L. A cone beam computed tomography study on the osseous morphology of

temporomandibular joint with free loss of posterior teeth. Arch Oral Biol. 2025 Sep; 177:106337.

23. Camacho-Álvarez FE, Martínez-Contreras SP, Rodríguez-Chávez JA, Martínez-Suárez G, González-Aragón Pineda ÁE, Ramos-Montiel RR, Ramírez-Martínez CM, Sánchez-García S, Cruz-Hervert LP, Jiménez-Corona ME. Characteristics of the Occlusal Plane Associated with Unilateral and Bilateral Articular Eminence Inclination: A Cross-Sectional CBCT Study. Dent J (Basel). 2024 Sep 29;12(10):316.
24. Wu Z, Lin Y, Lin Y. Impact of age on degenerative joint disease of the temporomandibular joint: A systematic review and meta-analysis. Medicine (Baltimore). 2025 Apr 25;104(17): e41915.
25. Ozkan A, Altug HA, Sencimen M, et al. Evaluation of articular eminence morphology and inclination in TMJ internal derangement patients with MRI. Int J Morphol 2012; 30:740–744.
26. Katsavrias EG. Changes in articular eminence inclination during the craniofacial growth period. Angle Orthod 2002; 72:258–264.
27. Yalcin ED, Ararat E. Cone-Beam Computed Tomography Study of Mandibular Condylar Morphology. J Craniofac Surg. 2019 Nov-Dec;30(8):2621-2624.
28. Saeed SS, Al-Falki DA. Detection of the Correlation between Glenoid Fossa and Mandibular Condyle in Closed and Opened Mouth Position by MRI. Int. J. Med. All Body Health Res. 2024; 05(04):25-29.
29. Razi T, Razi S. Association between the morphology and thickness of bony components of the temporomandibular joint and gender, age and remaining teeth on cone-beam CT images. Dent Med Probl. 2018 Jul-Sep;55(3):299-304.
30. Melo DP, Silva DB, Campos PF, Dantas JA. The morphometric measurements of the temporomandibular joint. Front Oral Maxillofac Med. 2021;3:(14) 1-11.