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Assessment of The Effects of Edentulousness on Temporomandibular Components by Using Cone Beam Computed Tomography

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ORIGINAL ARTICLE

Assessment of The Effects of Edentulousness on Temporomandibular Components by Using Cone Beam Computed Tomography

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ABSTRACT

Objective: The aim of this study is to evaluate the effects of edentulousness on the temporomandibular joint using cone beam computed tomography (CBCT). **Methods:** In this study, CBCT images were evaluated in a total of 48 patients (24 dentulous, 24 edentulous). Ninety-six temporomandibular joint CBCT images were examined. Eminence inclination, condyle head widths and joint space were measured and statistically compared between the edentulous and dentulous groups. **Results:** The articular eminence inclination value the mediolateral width of the condyle and the anteroposterior width of the condyle were found significantly higher in the dentulous group than in the edentulous group. There was no significant difference between the dentulous and edentulous groups in terms of the anterior, superior and posterior joint space. **Conclusion:** In the edentulous patients, the articular eminence inclination value, mediolateral and anteroposterior widths of the condyle head were found to lower in comparison to the dentulous patients.

Key words: CBCT, dentulous, edentulous, temporomandibular joint

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INTRODUCTION

The temporomandibular joint is an arthrodial joint formed by the condyle head fitting into the mandibular fossa of the temporal bone. The condyle head forms the convex side of the temporomandibular joint, while the concave side is formed by the glenoid fossa and the articular eminence in front of it.[1] The joint space between the condylar head and glenoid fossa is divided into two parts by a fibrous disc, forming the lower and upper joint spaces.[2] The temporal component of the joint is formed by the inferior side of the squamous process of the temporal bone. The glenoid fossa is in the posterior, while the articular eminence is in the anterior.[1] The depth of the glenoid fossa varies, and the development of the articular eminence depends on functional stimuli coming from the condyle. The articular eminence is exposed to functional loads as a result of chewing forces. There is a close relationship between the shape and size of the eminence and the loads to the joint. Joint loads are caused by the interaction between teeth and muscles.[3]

The aim of this study is to clarify the effects of edentulousness on the articular eminence, joint space, and bone components of the temporomandibular joint using cone beam computed tomography (CBCT).

METHODS

This retrospective study was conducted between 2018 and 2019 at the Inönü University Faculty of Dentistry's Department of Oral and Maxillofacial Radiology, in Turkey. Patients whose CBCT images had already been taken for different purposes were evaluated. Inönü University's Health Sciences Non-Interventional Clinical Studies Ethics Board approved the study (129/2019). All CBCT images were obtained by the same person, who had nine years of experience. Measurements were made on the CBCT images of 48 patients (96 temporomandibular joints), including 24 patients who were dentulous and 24 patients who were edentulous. The patients were between the ages of 41 and 75. Twenty-seven of these patients were female, while 21 were male. While the edentulous patients in the study were completely toothless, those comprising the control group were chosen from among the patients with at least one tooth that provided occlusal contact in each quadrant in a way that would not change the vertical size.

Any patient who had a systemic disease that could affect bone metabolism, those who had a syndrome, and those who had previously undergone a surgical operation in the field of study were excluded from the study. The records found to be missing the appropriate criteria, and those that were not of sufficient quality for assessment, were also excluded.

To define the intraobserver error rate, the measurements were repeated on a random sampling of 30% of all images, to calculate the intraclass correlation coefficients two weeks after the initial measurement.

Acquisition of CBCT images

The CBCT images were obtained with the patient in a standard supine position (scanning time, 18 s; field of view, 18 × 16 cm; exposure time, 3.6 s; kV = 110; mA = 1-20; voxel size, 0.2 mm^3) using a NewTom 5G device (QR Verona, Italy). The patient's head was placed in a horizontal position, so that the Frankfurt horizontal plane was perpendicular to the table, and the head was positioned within the circular gantry housing of the X-ray tube, to ensure consistent orientation of the sagittal images. The patient's teeth were in the maximum intercuspation position. All images were assessed using NNT software version 8.0.

Measurements

Measurements were made by an oral and maxillofacial radiologist with three years of experience. The mediolateral and anteroposterior sizes of the condyle were measured from the axial section showing the maximum mediolateral sizes of the condyle (Figure 1).

When acquiring images, the raw data were reconstructed to have a voxel size of 0.2 mm. Considering the maximum mediolateral length of the condyle when viewed from the axial section, 2-mm thick oblique sagittal sections were created. The oblique sagittal section containing the Po-Or points was taken as a reference to measure the articular eminence inclination and joint space (Figure 2).

Articular eminence inclination measurements were made by measuring the angle formed by the plane between the Frankfurt horizontal plane between the porion (the highest point of the outer ear canal) and the orbitale (the lowest point of the orbit), and the plane between the deepest point (S) of the glenoid fossa and the peak of articular eminence (R) (Figure 3).

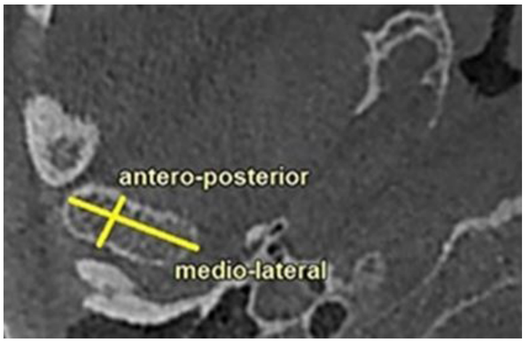

Figure 1. Axial section image showing the anteroposterior and mediolateral length of the condyle.

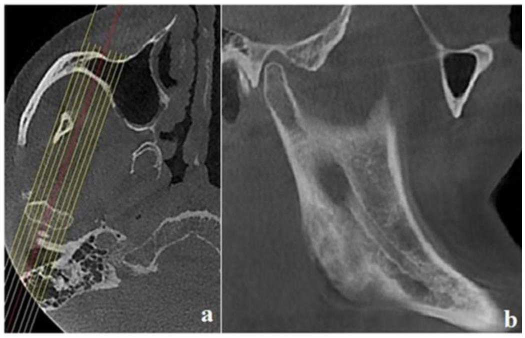

Figure 2. a. Axial section image showing the longest mediolateral length of the condyle. The red line shows the section chosen as reference for joint space and articular eminence measurements. **b.** Sagittal cross-sectional image corresponding to the shown red line.

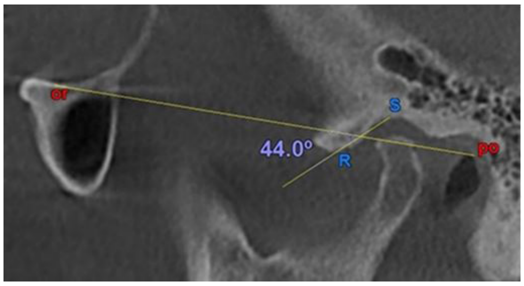

Figure 3. Articular eminence inclination measurement. **porion**: the highest point of the outer ear canal. **orbitale:** the lowest point of orbita. **S**: the deepest point of glenoid fossa. **R**: the peak point of articular eminence.

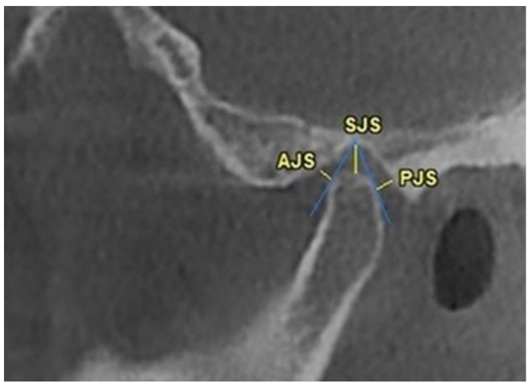

Figure 4. Sagittal section showing joint spaces. AJS: anterior joint space. SJS: superior joint space. PJS: posterior joint space.

For joint space measurement, two tangents were drawn from the S point of the glenoid fossa to the condylar head. Perpendiculars from the fossa to these tangents were measured as the anterior joint space and the posterior joint space. The distance of the S point to the condylar head was measured as the superior joint space (Figure 4).

Statistical analysis
The data obtained from this study were analyzed using IBM SPSS version 22. While examining the normality of the distribution of the variables, the Shapiro–Wilk test was used due to the number of units. When commenting on the results, the level of significance was accepted as 0.05, and $p < 0.05$ indicated that the variables were not normally distributed, while $p > 0.05$ indicated that they were normally distributed. Pearson's Chi-square was used to examine the relationships among the groups of nominal variables.

While examining the differences between the groups, Mann–Whitney U test was used when the variables were not normally distributed, while the independent samples t-test was used when the variables were normally distributed. When commenting on the results, the level of significance was accepted as 0.05, and $p < 0.05$ indicated a significant relationship, while $p > 0.05$ indicated no significant relationship.

Table 1. Comparison of mean age between edentulous and dentulous patients.

	Dentate				Edentulous				p
	Mean	Min	Max	SD	Mean	Min	Max	SD	
Age[a]	48.16	41	70	6.9	59.62	48	75	6.9	0.000

[a]Mann Whitney-U test

Table 2. Comparison of all TMJ measurements between edentulous and dentulous patients.

TMJ measurements	Dentate		Edentulous		p
	Mean	SD	Mean	SD	
Eminence inclination[a]	47.51	8.06	41.87	7.34	0.001*
Mediolateral width of condyle (mm)[b]	20.18	2.82	18.92	2.36	0.020*
Anteroposterior width of condyle (mm)[b]	8.28	1.41	7.10	1.30	0.000*
Posterior joint space (mm)[a]	2.16	1.17	2.36	1.63	0.803
Superior joint space (mm)[a]	4.08	1.20	4.53	5.73	0.067
Anterior joint space (mm)[a]	2.34	0.75	2.49	0.75	0.299

[a]Mann Whitney-U test [b]independent-samples t-test

RESULTS

The mean age of the edentulous patients was 59.62 (min 48, max 75, SD 6.77) years, while the mean age of the dentulous patients was 48.16 (min 41, max 70, SD 6.9) years. The mean age difference was statistically significant ($p < 0.05$; Table 1). Twenty-seven of the 48 patients were female, and 21 were male. Among the dentulous patients, 13 were female, and 11 were male. Among the edentulous patients, 14 were female, and 10 were male.

The mean articular eminence inclination was 47.51° in the dentulous patients and 41.87° in the edentulous patients. The difference in the mean articular eminence inclination was statistically significant (Table 2). The mean anterior joint space was 2.34 mm in the dentulous patients and 2.49 mm in the edentulous patients. The mean superior joint space was 4.08 mm in the dentulous patients and 4.53 mm in the edentulous patients. The mean posterior joint space was 2.16 mm in the dentulous patients and 2.36 mm in the edentulous patients. No statistically significant differences were found between the dentulous and edentulous patients in terms of joint space (Table 2). The mean mediolateral length of the condylar head was 20.18 mm in the dentulous patients and 18.92 mm in the edentulous patients. The mean anteroposterior length of the condylar head was 8.28 mm in the dentulous patients and 7.1 mm in the edentulous patients. Both the mediolateral and anteroposterior lengths of the condylar head differed significantly between the two groups (Table 2).

DISCUSSION

The articular eminence inclination is an important element in the biomechanics of the temporomandibular joint. The articular eminence in humans is completely straight at birth and develops thereafter.[4] Since the fossa glenoidalis and articular eminence are remodeled by mastication, various masticatory forces and dental attrition affect the articular eminence inclination.[4]

Several studies have measured the articular eminence inclination. Aggarwal et al. compared the bone density of mandibular condyles between age-matched dentulous and edentulous patient groups.[5] The cortical and medullary bone densities of the condyles were higher in dentulous patients, suggesting that impaired masticatory function due to tooth loss affects the bone density of the condyles. Csado et al. compared the posterior slope of the articular eminence on radiographic images between young adults (18–25 years of age) and two elderly patient (>60 years of age) groups—dentulous and edentulous—and found that the mean slope angle was narrower in the dentulous elderly patients than in the young adults and even narrower in the edentulous elderly patients.[6] Interestingly, only the edentulous patient group differed significantly from the other two, suggesting that the rate of deformation is likely aggravated by the loss of natural teeth rather than by aging. Oruba et al. found that the slope of the articular eminence remained unchanged from early adulthood to old age as long as the occlusal support zones were preserved.[7] No change in the articular eminence inclination was noted, even in elderly patients in whom at least one occlusal support zone was preserved on each side. Conversely, in elderly patients with loss of all occlusal support zones, significant eminence flattening was evident. These findings suggest that it is the loss of occlusal support rather than aging itself that causes changes in the morphology of the articular eminence. Similarly, Chiang et al. studied patients with unilateral posterior edentulism and observed a decreasing trend in the degree of inclination on the lacking side, which was not associated with age or gender.[8] Likewise, Levartovsky et al. found that decreased molar support was the main etiological factor for changes in the bone morphology of the mandibular condyles and that age had a negligible effect on these changes.[9] Erzurumlu et al. conducted measurements on panoramic radiography images and found a higher articular eminence inclination in dentulous patients than in edentulous patients.[10] Similarly, in this study, conducted using CBCT, the articular eminence inclination differed significantly between the dentulous group (47.51°) and the edentulous group (41.87°).

Many studies have used panoramic radiography to measure the articular eminence inclination.[6–8,10] However, panoramic radiography for TMJ imaging has several disadvantages. One disadvantage is the superimposition of the zygomatic arch and the base of the skull, which allows only the assessment of the lateral part of the condyle. Another disadvantage is the distortion effects of panoramic radiography, which may impede data interpretation.[11] For these reasons, we used CBCT, which can clearly show bone changes without superimposition.

No previous studies have compared the Ajs, Pjs, and Sjs between dentulous and edentulous patients, as was done in this study. However, similar studies have been conducted.[6,12–14] Dalili et al. reported mean anterior joint spaces of 1.9 mm on the left side and 2.1 mm on the right side, mean superior joint spaces of 3.4 mm on the left side and 3.2 mm on the right side, and mean posterior joint spaces of 2.4 mm on the left side and 2.1 mm on the right side.[15] In this study, the mean anterior joint space was 2.34 mm in the dentulous patients and 2.49 mm in the edentulous patients, the mean superior joint space was 4.08 mm in the dentulous patients and 4.53 mm in the edentulous patients, and the mean posterior joint space was 2.16 mm in the dentulous patients and 2.36 mm in the edentulous patients. The differences between the two groups were not statistically significant.

Likewise, although no previous studies have evaluated joint width differences between dentulous and edentulous patients, similar studies have been conducted.[12–14] Al-koshab et al. reported mean anteroposterior condyle lengths of 7.08 mm on the left side and 7.31 mm on the right side and mean mediolateral lengths of 17.17 mm on the left side and 17.27 mm on the right side.[12] In this study, the mean mediolateral length of the condylar head was 20.18 mm in the dentulous patients and 18.92 mm in the edentulous patients, while the mean anteroposterior length was 8.28 mm in the dentulous patients and 7.1 mm in the edentulous patients. Both the anteroposterior and mediolateral lengths of the condyle were significantly higher in the dentulous patients than in the edentulous patients.

Certain limitations of this study should be noted. First, the study groups were relatively small. Second, the age difference between the dentulous and edentulous patients may also have been associated with the observed morphological changes in the TMJ. Third, factors such as systemic health, nutritional status, race, duration of tooth loss, and type of prosthetic restoration can influence the process of articular eminence inclination flattening. Further research is needed to investigate the influence of these factors.

CONCLUSION

The results of this study suggest that edentulism causes reductions in the articular eminence inclination and in the mediolateral and anteroposterior lengths of the condylar head.

CONFLICT OF INTEREST

None declared.

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