

The Effect of Age and Tooth Loss on Articular Eminence Slope: An Orthopantomographic Study

Yaş ve Diş Kaybının Eklem Eminens Eğimi Üzerindeki Etkisi: Ortopantomografik Bir Çalışma

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ABSTRACT

Objective: To investigate whether morphologic changes in the cranial component of the temporomandibular joint are associated with aging or tooth loss and, if so, whether articular eminence flattening is more associated with age or edentulism.

Methods: Orthopantomographs of patients admitted to the hospital for routine dental treatment were retrospectively analyzed. Patients were divided into 4 groups according to their age and edentulous status. Group1: 49 patients aged 18-35 years with occlusal support, Group2: 46 patients aged 36-59 years with occlusal support, Group3: 43 patients over 60 years with occlusal support, and Group4: 42 patients over 60 years with lost occlusal support. The Frankfort horizontal plane and the articular eminence slope were drawn on the radiographs and the angle between them was measured and the differences between the groups were analyzed.

Results: There was no significant correlation between age and flattening of the articular eminence angle ($P=.645$). A statistically highly significant difference was observed between Group 4 and all other groups in terms of articular eminence angles ($P=.01$).

Conclusion: Since there was no significant correlation between age and articular eminence angle, and since the articular eminence angle was significantly different in Group 4, which consisted of completely edentulous patients, compared to all other groups, it was concluded that AEA may be related to edentulism rather than age. Study emphasizes the importance of occlusion by identifying tooth loss as a possible cause of the decrease in AE slope.

Keywords: Age groups, dental occlusion, edentulous mouth, temporomandibular joint

Öz

Amaç: Temporomandibular eklem kranial bileşenindeki morfolojik değişikliklerin yaşlanma veya diş kaybı ile ilişkili olup olmadığını ve ilişki varsa artiküler eminens düzleşmesinin yaş ile mi dişsizlik ile mi daha fazla ilişkili olduğunu araştırmak.

Yöntemler: Hastaneye rutin diş tedavisi için başvuran hastaların ortopantomografları retrospektif olarak analiz edildi. Hastalar yaşlarına ve dişsizlik durumlarına göre 4 gruba ayrıldı. Grup 1: 18-35 yaş arası oklüzal desteği olan 49 hasta, Grup 2: 36-59 yaş arası oklüzal desteği olan 46 hasta, Grup 3: 60 yaş üstü oklüzal desteği olan 43 hasta ve Grup 4: 60 yaş üstü oklüzal desteği kaybolmuş 42 hasta. Radyograflar üzerinde Frankfort horizontal düzlemi ve artiküler eminens eğimi çizilerek aralarındaki açı ölçüldü ve gruplar arasındaki farklar analiz edildi.

Bulgular: Yaş ile artiküler eminens açısının düzleşmesi arasında anlamlı bir korelasyon yoktu ($P=.645$). Grup 4 ile diğer tüm gruplar arasında artiküler eminens açıları açısından istatistiksel olarak oldukça anlamlı bir fark gözlenmiştir ($P=.01$).

Sonuç: Yaş ile artiküler eminens açısı arasında anlamlı bir korelasyon bulunmadığından ve tamamen dişsiz hastalardan oluşan Grup 4'te artiküler eminens açısı diğer tüm gruplara kıyasla anlamlı derecede farklı olduğundan, AEA'nın yaştan ziyade dişsizlikle ilişkili olabileceği sonucuna varılmıştır. Çalışma, diş kaybını AE eğimindeki azalmanın olası bir nedeni olarak tanımlayarak oklüzyonun önemini vurgulamaktadır.

Anahtar Kelimeler : Ağız dişsiz, oklüzyon, temporomandibular eklem, yaş grupları

INTRODUCTION

The temporomandibular joint (TMJ) is one of the most complex joints in the human body; some of its activities involve mastication and phonation.¹⁻⁵ Components such as the articular disc, capsule, ligaments, cartilage and masticatory muscles play an important role in the complex movements of the joint.⁶ In our study, possible age-related or tooth loss-related changes in the bone component, which is the joint's most difficult structure to be damaged,⁷ were examined. The morphometric characteristics of the TMJ's bone components play a crucial role in jaw movements involved in mastication, swallowing, and speaking.⁸ One



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of the bone components of the joint is the *caput mandibula* of the mandible.⁹ The mandibular component of the TMJ consists of an ellipsoid condylar head.¹⁰ Other component is the concave-shaped *fossa mandibularis* (glenoid fossa) and convex-shaped *eminentia articularis* of the temporal bone.¹⁰ In front of the fossa, there is a convex bone protrusion called the articular eminence (AE).⁹⁻¹¹ The bone thickness of the AE is thicker than the *fossa mandibularis*.¹² This is thought to be due to the fact that the loads in joint function are concentrated on the AE rather than the fossa.^{1,12,13}

TMJ morphology changes drastically during postnatal development.^{5,14} At birth, the temporal component of the joint is straight, while during primary dentition it starts to change into the characteristic "S" shape.^{5,14} In adults, the slope of the articular eminence becomes steeper, approaching 45 degrees relative to the occlusal plane.¹⁵ Alongside these physiological changes, pathological alterations in the bony surfaces may arise from various factors, such as irregularities in the TMJ, trauma, occlusal disorders, muscle hyperactivity, aging, and tooth loss that affects occlusion.^{5,16,17}

While the mandibular condyle is located in the *fossa mandibularis* at rest, its initial movement during mouth opening starts with rotation only.¹ In cases where the mouth needs to be opened further, rotation is followed by sliding of the condyle on the articular eminence slope (AES).^{1,18} The AES is the flat area posterior to the AE, anterior to the fossa mandibularis, followed by the condyle.¹⁹ The sliding of the condyle over the eminence increases the mobility of the TMJ. In order to reach the maximum opening, the condyle continues its movement and goes over the AES and onto the AE.¹⁹ Since the condyle is in a constant sliding state on this slope, this slope is of great clinical importance. For this reason, the AE slope has been the subject of many studies. The articular eminence angle (AEA) is often measured in the examination of the slope. The value of AEA indicates the steepness of the AE inclination (AEI). The 'S' shaped trajectory it follows is vital for the functionality of the joint, so a change in the slope of the AE can cause biomechanical variations of the TMJ.¹⁸ Factors such as the steepness of the slope, distance traveled and changes over time are important to understand TMJ irregularities and to effectively plan and implement prosthetic treatments in dentistry.

In light of all these observations, it is likely that functional impairments may arise in a joint with altered normal morphology. Therefore, the steepness of the joint's slope and any changes in this incline have become important topics of research and inquiry for clinicians and scholars alike.

Our research aims to examine the relationship between changes in the slope of the TMJ articular eminence and the loss of occlusion resulting from aging and edentulism. Additionally, the significance of occlusion in chewing biomechanics will be highlighted.

METHODS

Ethical approval

Ethical approval for the study was granted by Erzinan Binali Yıldırım University Clinical Research Ethics Committee with the decision dated 10.01.2022 and numbered 2022-14/15.

Study design

G*Power (Düsseldorf/Germany) was used to determine the sample size required for our study. Since the One-Way ANOVA test is applied in intergroup comparisons, the One-Way ANOVA test was selected from the F tests in G*Power. The 180-sample size requirement was obtained as a result of Cohen's effect size of 0.25 (medium size), 95% confidence interval and 0.80% power and selection of 4 groups.

Evaluation of radiographic parameters

The material of our study consisted of orthopantomographys (OPTG) of 180 patients divided into 4 groups according to age and occlusion status. In Group 1, 49 patients aged 18-35 years with occlusal contact on both sides of the jaw, in Group 2, 46 patients aged 36-59 years with occlusal contact on both sides of the jaw, in Group 3, 43 patients over 60 years with occlusal contact on both sides of the jaw, and in Group 4, 42 patients over 60 years with complete loss of occlusal contact on both sides of the jaw. All radiographs were randomly selected from OPTGs of patients who presented to Erzinan Binali Yıldırım University Oral and Dental Health Training and Research Hospital for routine dental treatment between 2015 and 2020. This study was planned as a retrospective radiologic study. Since there was no direct patient participation and all OPTGs were obtained for diagnostic purposes during routine dental treatment, written informed consent was not obtained from the patients. To standardize, all OPTGs were obtained with the same instrument (ProOne Planmeca, Finland). All radiographs obtained in this study were of adults only and the exposure parameters were 64 kV, 4 mA, 10 seconds.

Radiographs had to meet the following selection criteria to be selected for the study:

- The outlines of all anatomical structures must be visible.
- The Frankfort horizontal plane (FHP) must be parallel to the ground and the sagittal plane must coincide with the vertical guide line of the device.
- In Groups 1 and 2, X-rays of patients with all teeth in the mouth were preferred.
- Group 3 patients had to maintain occlusal contact with at least two teeth on each side.
- Group 4 patients were preferred to have no extraction sockets indicating recent tooth loss.
- There should be no fracture or pathologic lesion in the AE region that would interfere with the measurement.
- OPTGs that were considered to have an elongated image due to possible positioning error by the technician were excluded.

Calculation of data

In our study, the AEA was calculated using the "Top-roof line" method. AEA was found by measuring the angle between the articular eminence slope (AES) and the FHP (Figure 1).

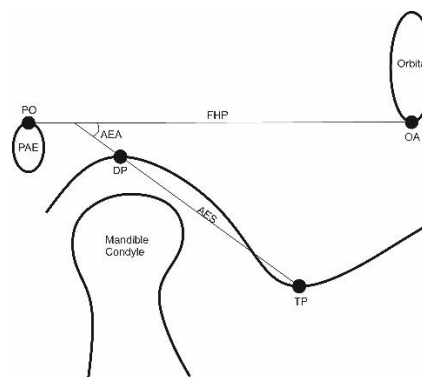


Figure 1. Calculation of Articular Eminence Angle with Top-roof line Method
Abbreviations: AEA: Articular Eminence Angle, AES: Articular Eminence Slope, DP: Deepest point of fossa mandibularis, TP: Top point of articular eminence, OA: Bottom point of Orbita, PAE: Porus acusticus externus, PO: Top point of PAE.

All drawings and measurements were made with Corel Draw (2021, Austin, USA). When calculating the AEA, the lower point of the Orbita (OA) and the upper point of the Porion (PO) were marked on the OPTGs. FHP was determined by drawing a line between these two points. The deepest point on the fossa mandibularis (DP) and the highest point of the articular eminence (TP) were then marked. AES was determined by drawing a line connecting the DP and TP points. The angle formed between the AES and FHP lines was measured and recorded as AEA. These measurements were made separately for each side TMJ and the angles obtained were recorded (Figure 2). For the reliability of the measurements, the values were checked by measuring again 2 months after the first recording dates.

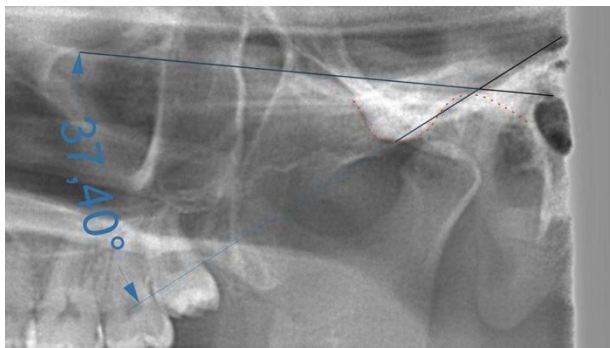


Figure 2. Measuring the AEA Value on a Sample OPTG

Statistical analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) for Windows software, version 16.0 (SPSS Inc., Chicago, IL, USA). The conformity of the values to normal distribution was determined by analyzing normality with Shapiro Wilks Test, examining the histogram, evaluating the skewness and kurtosis values and examining the coefficients of variation. Comparisons between more than two normally distributed groups were made with One-Way ANOVA. In case of a significant difference, homogeneity of variances was analyzed with Levene's Test. In the case of unequal distribution of variances, Tamhane's Post Hoc test was applied. Descriptive statistics were expressed as mean $\pm$ standard deviation for quantitative or numerical variables and as number and (%) for nominal variables.

Nominal variables were evaluated with Pearson Chi-Square test. Spearman Brown Rank Difference Correlation Test was used to determine the relationship between age and AEA values. Angle measurements of the right and left articular eminence slopes were visualized graphically. Results were considered statistically significant for $P < .05$.

RESULTS

There was no significant difference between male and female in terms of AEA values ($P = .465$). It was observed that the age distribution of the patients participating in the study did not conform to the normal distribution. Age distribution of 180 patients according to groups is given in Right AEA left AEA and right-left average AEA mean values were analyzed separately and the mean and standard deviation values of all AEA values are given in Table 1 and Table 2.

AEA values were statistically evaluated with age and groups. Correlation test was performed to determine the relationship between age and AEA and the results are presented in Table 3.

Table 1. Age Distribution by Groups

	Group 1 (N: 49)	Group 2 (N: 46)	Group 3 (N: 43)	Group 4 (N: 42)
Age				
Mean $\pm$ Sd	26.20 $\pm$ 5.10	45.59 $\pm$ 7.18	68.62 $\pm$ 5.30	69.58 $\pm$ 6.21
Median (min-max)	26 (19-35)	45 (36-59)	67 (61-80)	69 (61-82)
Gender				
Female	30/49 (61%)	23/46 (50%)	19/43 (%44)	22/42 (%52)
Male	19/49 (39%)	23/46 (50%)	24/43 (%56)	20/42 (%48)

Abbreviations. Group1: Patients aged between 18-35 with intact occlusion. Group2: Patients aged between 36-59 with intact occlusion. Group3: Patients over 60 years old with intact occlusion. Group4: Patients Over 60 Years old with Loss of Occlusion Support. Sd: Standart deviation, N: Number of patients, min: Minimum, max: Maximum

Table 2. AEA Mean and Sd Values According to Groups

	Group 1 (N: 49)	Group 2 (N: 46)	Group 3 (N: 43)	Group 4 (N: 42)
Right AEA				
Mean $\pm$ Sd	36.95 $\pm$ 4.84	38.71 $\pm$ 5.53	36.18 $\pm$ 4.74	32.23 $\pm$ 6.24
Left AEA				
Mean $\pm$ Sd	37.22 $\pm$ 4.45	38.33 $\pm$ 5.34	36.91 $\pm$ 5.38	33.58 $\pm$ 6.44
Right-Left Average AEA				
Mean $\pm$ Sd	37.08 $\pm$ 4.63	38.29 $\pm$ 5.09	36.57 $\pm$ 5.08	32.91 $\pm$ 6.31

Abbreviations. Group 1: Patients aged between 18-35 with intact occlusion. Group 2: Patients aged between 36-59 with intact occlusion. Group 3: Patients over 60 years old with intact occlusion. Group 4: Patients Over 60 Years old with Loss of Occlusion Support. Sd: Standart deviation, N: Number of patients, AEA: Articular Eminence Angle.

Shapiro-Wilk test was applied for the selection of the test to be used in the comparison of AEA values between groups ($P = .142$ for right AEA, $P = 0.227$ for left AEA, $P = 0.498$ for right-left mean AEA). One-way ANOVA test was applied due to the results obtained in accordance with the normal distribution. Since a significant difference was detected, Tamhane's Post Hoc test was also applied and the results of the difference between the groups are given in Table 4. Group IV showed a significant difference with the other three groups ($P < .05$). The other three groups did not show a significant difference ($P > .05$).

Table 3. Correlation Test of Age and AEA Values

		Right AEA	Left AEA	Right-Left Average
Age	Correlation coefficient (r)	-0.058	-0.020	-0.040
	Signification (2-tailed)	0.501	0.817	0.645

Abbreviations. AEA: Articular Eminence Angle.

Table 4. Intergroup Comparison of Right, Left and Average AEA Values

	Groups	P
Right AEA	Group 1	Group 2 .464
		Group 3 .926
		Group 4 .001
	Group 2	Group 3 .179
		Group 4 .000
	Group 3	Group 4 .010
Left AEA	Group 1	Group 2 .804
		Group 3 .994
		Group 4 .019
	Group 2	Group 3 .676
		Group 4 .001
	Group 3	Group 4 .049
Right-Left Average AEA	Group 1	Group 2 .739
		Group 3 .976
		Group 4 .004
	Group 2	Group 3 .502
		Group 4 .000
	Group 3	Group 4 .019

Abbreviations. Group 1: Patients aged between 18-35 with intact occlusion. Group 2: Patients aged between 36-59 with intact occlusion. Group 3: Patients over 60 years old with intact occlusion. Group 4: Patients Over 60 Years old with Loss of Occlusion Support. p: Significance, AEA: Articular eminence angle

The graphical representation of the distribution of right AEA according to the groups, including minimum and maximum values, is shown in Figure 3. The graphical representation of the distribution of left AEA according to the groups, including minimum and maximum values, is shown in Figure 4.

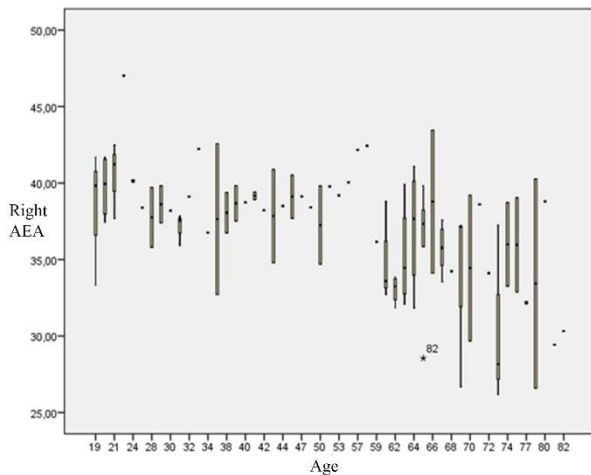


Figure 3. Distribution of Right Articular Eminence Angle by Age

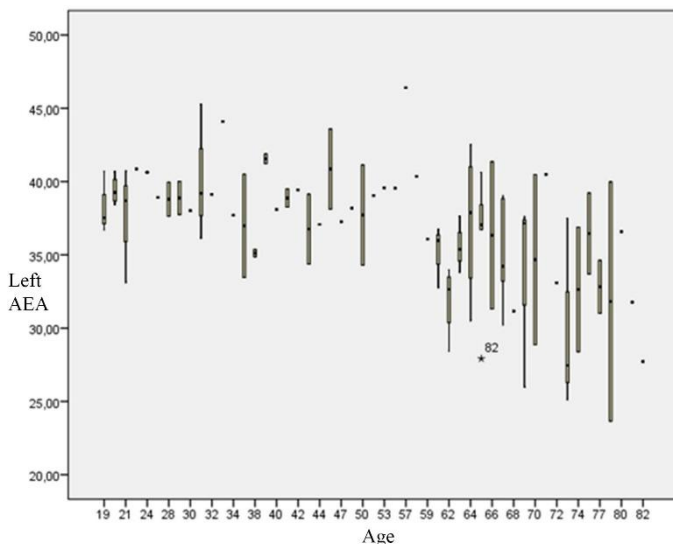


Figure 4. Distribution of Left Articular Eminence Angle by Age

DISCUSSION

The temporal bone articular surface, one of the bony components of the TMJ, continues to remodel throughout life. Studies show that there are differences in AEA in patients and that a wide variety of factors affect the AEA. Data from a review of the medical literature shows that the AE inclination can be influenced by a variety of factors such as gender, facial profile, degenerative bone disease, condyle shape, altered condyle position, dentition, increased functional stress.^{18,20-23}

In our study, no significant difference was found in the mean AEA values of male and female. There are other studies showing that AEA is steeper in men than in women,²³⁻²⁶ and similar to the result in our study, there are also studies that did not detect a significant difference.²⁷

In our study, it was observed that the angle first showed a statistically insignificant increase and then a decrease with increasing age among the first three groups. Over 60 years of age, unlike younger individuals, increased tooth loss and change in natural masticatory biomechanics, age-related TMJ dysfunctions and TMJ disorders come to mind as possible causes of eminence flattening. As a result of the emergence of these factors, there may be a negative correlation between aging and EEA that is not statistically significant.^{28,29} In our study, a negative but not significant correlation was found between age and AEA angle values ($P=.645$). The effect of edentulism on AE flattening came to the forefront with the determination that the AEA values of Group 4 patients were significantly different compared to the other patient groups ($P=.001$). Especially since the age range of Group 3 and Group 4 patients was the same and the difference between these two groups was only occlusion status, it strengthens the thesis that the flattening of the AE slope is related to impaired occlusion as a result of tooth loss rather than age. Similarly, there are many studies in the literature that have found that tooth loss plays an important role in AE flattening.^{5,18,24,27,28,30}

The difference between the minimum and maximum values of AEA in patients in group 4 was greater than in the other groups. It has been observed that in some patients over 60 years of age with no teeth, the AEA value can remain close to the AEA values of younger patients with natural occlusion. Although it is not possible to understand the reason for this situation with the available data, it may be related to the duration of edentulism or the extent to which the prostheses used mimic the patient's natural occlusion. In order to explain this situation, it is necessary to determine the extent to which the prostheses made to replace tooth loss mimic the patient's natural occlusion. In order to make these determinations, it would be more meaningful to conduct prospective studies covering a long period of time.

CONCLUSION

As a result of a significant change in dental function, the glenoid fossa is remodeled to maintain the functional existence of the joint. For this reason, this remodeling may be more as the duration of edentulousness increases. In future studies on the subject, the inclusion of data such as the duration of edentulism of the patients and whether the prostheses made to the patients were made in accordance with the occlusion rules in order to make the results of our study more meaningful will contribute more to the literature.

In dental faculties, there are intensive trainings on occlusion in both theoretical and practical courses. The importance given to occlusion in education has once again become evident as a result of our study. After the loss of occlusion support, restoration of occlusion with prosthetic applications without wasting time can prevent structural changes in the TMJ, which is one of the most important components of the masticatory system.

Ethics Committee Approval: Ethics committee approval was obtained from Erzincan Binali Yıldırım University Clinical Research Ethics Committee (Date: 10.01.2022, Number: 2022-14/15).

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Use of Artificial Intelligence: AI tools (ChatGPT, OpenAI, San Francisco, USA) and (DeepL SE, Germany) were used solely for language correction and to enhance the narrative of the text. All content has been reviewed, verified, and approved by the authors, who are responsible for the scientific integrity of the work.

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REFERENCES

- Wilkie G, Al-Ani Z. Temporomandibular joint anatomy, function and clinical relevance. *Br Dent J.* 2022;233(7):539-546.
- Thomas DC, Singer SR. Temporomandibular Disorders: The Current Perspective, An Issue of Dental Clinics of North America, E-Book: Temporomandibular Disorders: The Current Perspective, An Issue of Dental Clinics of North America, E-Book. Elsevier Health Sciences; 2023.
- Baskan S, Zengingul A. Temporomandibular Joint, Disorders and Approaches. *Biotechnol Biotechnol Equip.* 2006;20(2):151-155.
- Ingawale S, Goswami T. Temporomandibular Joint: Disorders, Treatments, and Biomechanics. *Ann Biomed Eng.* 2009;37(5):976-996.
- Oruba Z, Malisz P, Sendek J, et al. Flattening of the articular eminence is associated with the loss of occlusal support: radiological study. *Aust Dent J.* 2020;65(1):53-57.
- Agbulut N, Delilbasi C. The Anatomy of the Temporomandibular Joint. In: Keyhan SO, Bohluli B, Fallahi HR, Khojasteh A, Fattahi T, eds. *Handbook of Oral and Maxillofacial Surgery and Implantology.* Springer International Publishing; 2024:1-12.
- Sindelar BJ, Herring SW. Soft Tissue Mechanics of the Temporomandibular Joint. *Cells Tissues Organs.* 2005;180(1):36-43.
- Ayyıldız E, Orhan M, Bahşi İ, Yalçın ED. Morphometric evaluation of the temporomandibular joint on cone-beam computed tomography. *Surg Radiol Anat.* 2021;43(6):975-996.
- Ahmed J, Sujir N, Shenoy N, Binnal A, Ongole R, Nithin. Morphological Assessment of TMJ Spaces, Mandibular Condyle, and Glenoid Fossa Using Cone Beam Computed Tomography (CBCT): A Retrospective Analysis. *Indian J Radiol Imaging.* 2021;31:78-85.
- Yolaçan E, Demircan NE, Ercikti N, Kocabiyik N, Yalçın B. Temporomandibular Joint and Artificial Intelligence. *Romanian J Funct Clin Macro Microsc Anat Anthropol Rev Rom Anat Funct Si Clin Macro Si Microsc Si Antropol.* 2022;21(2):112-120.
- Al-koshab M, Nambiar P, John J. Assessment of condyle and glenoid fossa morphology using CBCT in South-East Asians. *PLoS One.* 2015;10(3):e0121682.
- Görürgöz C, Kurt H, Şeker Ç, İçen M, Aksoy S, Orhan K. Relationship Between the Degenerative Changes in the Mandibular Condyle and Articular Eminence Inclination, Height, and Shape: A Cbct Study. *Cumhuriyet Dent J.* 2022;24(4):403-414.
- Okeson JP. Management of Temporomandibular Disorders and Occlusion.; 1998.
- Gupta DrS, Baghel DrNS, Narula DrJ. Milestones of temporomandibular joint. *Int J Appl Dent Sci.* 2021;7(2):493-495.
- Dibbets JM, Dijkman GE. The postnatal development of the temporal part of the human temporomandibular joint. A quantitative study on skulls. *Ann Anat Anat Anz Off Organ Anat Ges.* 1997;179(6):569-572.
- Fan XC, Singh D, Ma LS, Piehslinger E, Huang XF, Rausch-Fan X. Is there an association between temporomandibular disorders and articular eminence inclination? A systematic review. *Diagnostics.* 2021;11(1).
- Melis M, Di Giosia M. The role of genetic factors in the etiology of temporomandibular disorders: A review. *Cranio - J Craniomandib Pract.* 2016;34(1):43-51.
- Virlan M, Păun D, Bordea E, et al. Factors influencing the articular eminence of the temporomandibular joint (Review). *Exp Ther Med.* 2021;22(4).
- Cohen A, Sela MC, Shooraki N, Alterman M, Casap N. The influence of articular eminence morphology on temporomandibular joint anterior dislocations. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2021;131(1):9-15.
- Costa ED da, Peyneau PD, Roque-Torres GD, et al. The relationship of articular eminence and mandibular fossa morphology to facial profile and gender determined by cone beam computed tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2019;128(6):660-666.
- Hinton RJ. Changes in articular eminence morphology with dental function. *Am J Phys Anthropol.* 1981;54(4):439-455.
- RauStia, Pirttiniemi, Salonen, Pyhtinen. Effect of edentulousness on mandibular size and condyle-fossa position. *J Oral Rehabil.* 1998;25(3):174-179.
- SA SC, Melo SLS, Melo DP de, Freitas DQ, Campos PSF. Relationship between articular eminence inclination and alterations of the mandibular condyle: a CBCT study. *Braz Oral Res.* 2017;31(0).
- Chiang MT, Li TI, Yeh HW, et al. Evaluation of missing-tooth effect on articular eminence inclination of temporomandibular joint. *J Dent Sci.* 2015;10(4):383-387.

25. Zabarović D, Jerolimov V, Carek V, Vojvodić D, Zabarović K, Buković D. The effect of tooth loss on the TM-joint articular eminence inclination. *Coll Antropol.* 2000;24 Suppl 1:37-42.
26. İlgüy D, İlgüy M, Fişekçioğlu E, Dölekoğlu S, Ersan N. Articular eminence inclination, height, and condyle morphology on cone beam computed tomography. *ScientificWorldJournal.* 2014;2014:761714.
27. Unal Erzurumlu Z, Celenk P. A radiological evaluation of the effects of edentulousness on the temporomandibular joint. *J Oral Rehabil.* 2020;47(3):319-324.
28. Csadó K, Márton K, Kivovics P. Anatomical changes in the structure of the temporomandibular joint caused by complete edentulousness. *Gerodontology.* 2012;29(2):111-116.
29. Sümbüllü M, Çağlayan F, Akgül H, Yılmaz A. Radiological examination of the articular eminence morphology using cone beam CT. *Dentomaxillofacial Radiol.* 2012;41(3):234-240.
30. Fang TH, Chiang MT, Hsieh MC, Kung LY, Chiu KC. Effects of unilateral posterior missing-teeth on the temporomandibular joint and the alignment of cervical atlas. *PloS One.* 2020;15(12):e0242717.