Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Original Article
J Morphol Sci 2023;40:317-323

A Panoramic Radiographic Evaluation of the Influence of Age and Edentulism on the Articular Eminence of the Temporomandibular Joint

Vasuki Krishnan[1], Vinutha. S P[2], Karthikeya Patil[3], Vidya. C S[4]

[1,2,4]Department of Anatomy, JSS Medical College, JSS Academy of Higher Education and Research, Mysuru, Karnataka, India
[3]Department of Oral Medicine and Radiology, JSS Dental college, JSS Academy of Higher Education and Research, Mysuru, Karnataka, India

Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: the temporomandibular joint's (TMJ) regenerative capability decreases as we age. Edentulism can also be a contributing factor. The aim of this study is to correlate the relationship of angle of the articular eminence of the TMJ with increasing age and edentulism.

Materials and Methods:

The Orthopantomogram (OPG) of 45 patients were collected from the archives of Department of Oral Medicine and Radiology, JSS Dental college. They were examined in three groups each group containing 15 OPG's based on age and presence or absence of maintained occlusion. The angle of the posterior slope of the articular eminence relative to the Frankfurt's horizontal plane was measured on both sides. Data was analysed statistically with the one-way ANOVA test (α=0.05).

Results: the highest value obtained in group 1 was (Right side 35.63±3.01º, left side 36.66±3.45º, mean 36.15±3.13º). The values in group 2 were (Right side 35.50±3.17º, left side 36.06±4.23º, mean 35.78±3.54º) were slightly lower than group 1. The Group 3 values (Right side 29.07±4.10º, left side 29.66±3.13º, mean 29.36±3.51º) were significantly lower compared to group 1 and group 2. Linear regression graph plotted between age and mean angles for each group showed a significant negative trend with increase of age within each group.

Conclusion: the flattening of the articular eminence was significant with the increase of age. The rate of flattening was more pronounced in older age groups. Age and edentulism play a major role in flattening of the posterior slope of the articular eminence.

Keywords: Temporomandibular joint; Edentulism; Articular eminence; Orthopantomogram.

Introduction

The temporomandibular joint (TMJ) is a bicondylar diarthrosis that facilitates a variety of mandibular movements, such as eating, chewing, swallowing, speaking, and expressing emotions. The TMJ is made of components from the temporal bone and the mandible. It is the articulation of the mandibular fossa and articular eminence of the temporal bone with the condyle of the mandible with an intervening articular disc[1]. An unusual feature of the joint is that unlike the other joints where the articular surface is covered by hyaline cartilage, the TMJ articular surfaces are covered with dense fibrocartilage, making it uniquely resistant to injury and able to heal more quickly[2].

The architecture of the different components of the TMJ varies in different age groups, sex, in degenerative changes due to diseases like osteoarthritis, in malocclusions or deleterious habits like bruxism. These changes can cause symptoms like TMJ pain and clicking or locking[1].

The temporomandibular remodelling is a process that occurs to adapt the TMJ to the various forces that it is subjected to. Even after growth has ceased, these parts of the TMJ still retain the ability to modify its structure and morphology [3]. In adulthood, the joint's adaptive and regenerative capability decreases significantly. Consequently, it is unable to cope with the changes and ends up being damaged and deformed[4]. The posterior slope of the articular eminence undergoes morphological changes such as flattening throughout life and is speculated to be affected by many factors such as age, edentulism, gender and deleterious habits [2].

Imaging of the TMJ involves examining the integrity and relationships of the hard and soft tissue elements such as the mandibular condyle, the glenoid fossa and articular eminence of the temporal bone, and the articular disc and its attachments[5]. In the present study the Ortho panto gram (OPG) has been used as the imaging modality. Although the OPG has many drawbacks such as superimposition of the zygomatic arch on the TMJ, no clear imaging of the soft tissues, but still, it is of great diagnostic value to assess the major changes of the articular eminence such as flattening of the posterior slope and presence of gross surface irregularities such as osteophytes[6].

DOI: 10.51929/jms.40.317.2023
ISSN 2177-0298

The Articular eminence inclination (AE) is the angle formed by the posterior slope of the articular eminence in relation to the Frankfort horizontal plane or any other level surface such as the occlusal or palatal plane[2,4,5,7,8,9,10,11]. In this study the Frankfurt's horizontal plane has been taken as the reference plane.

The articular eminence outline can be studied in various methods. Some studies have used medical imaging techniques such as CBCT, MRI and OPGs[3-9,10,12,13,14]. Whereas some studies were conducted on dry skull[11,15 ,16,17,18] but, radiological studies have been more frequently conducted[19-23]. Clinical studies were also conducted using extraoral tracing methods such as facebow[24]. Autopsy studies have been undertaken on edentulous individuals to assess the changes in the TMJ[25].

Some authors have suggested that the dry skull method was more accurate keeping in mind the possible distortion and difference in positioning of the patients while taking radiograph and that minimal differences between right and left sides were not accurately recorded[12]. A study conducted by Gilboa *et al* has revealed that there was a significant correlation between the anatomical outline of the articular eminence measured in dry skulls and the corresponding OPG image suggesting that the OPG images can be used to determine gross differences in the articular eminence[17].

This study aims to determine the physiological changes that take place in the articular eminence and to determine whether age and edentulism play a role in the degree at which these changes occur. This will help the clinicians to come up with a treatment plan to restore the masticatory function of the edentulous patients and give them a comfortable and cosmetically superior dental treatment. This study will also help in understanding TMJ dislocations, degenerative changes causing pain and discomfort to patients.

The objectives of the present study are:

I) To measure the angle of the posterior slope of the articular eminence relative to the Frankfurt's horizontal plane.

II) To correlate the relationship of angle of the articular eminence of the temporomandibular joint with age and edentulism.

Materials and Methods:

This was a retrospective study conducted on the Orthopantomograms (OPGs) of 45 patients collected from the archives of Department of Oral Medicine and Radiology, JSS Dental College, Mysuru, Karnataka, India. The duration of the study was one year starting from January 2022 to December 2022. This study was approved by the Institutional Ethics Committee with the approval number JSS/MC/PG/04/2022-23.

The OPGs were divided into 3 groups each consisting of 15 persons.

Group 1: Patients 18-25 years of age with maintained occlusion

Group 2: Patients over 60 years of age with maintained occlusion

Group 3: edentulous patients over 60 years of age.

Keeping in mind the uniformity, all the patients were positioned in the same three-dimensional plane according to the median sagittal plane and Frankfurt's horizontal plane. The angle of the posterior slope of the articular eminence relative to the Frankfurt's horizontal plane was measured on both the right and left side of the OPG images.

To determine the FH plane, A line was drawn from the porion to the floor of the orbit. To determine the posterior slope of articular eminence a line was drawn from the point of maximum concavity of the mandibular fossa to the point of maximum convexity of the articular eminence.

The measurement of the angle between the posterior slope and the FH plane on both right and left side of each patient's OPG image was taken manually using a virtual protractor.

The mean ± standard deviation (SD) was calculated for each group and categorised according to side, age, and dental status. The statistical analysis was done on the software SPSS version 22. One-way ANOVA test was done to analyse the association between the variables mean angles and the age. The correlational analysis and a linear scatter graph were plotted to determine the correlation between increasing age and mean angles in each group. All statistical analyses were done at p value ≤0.05.

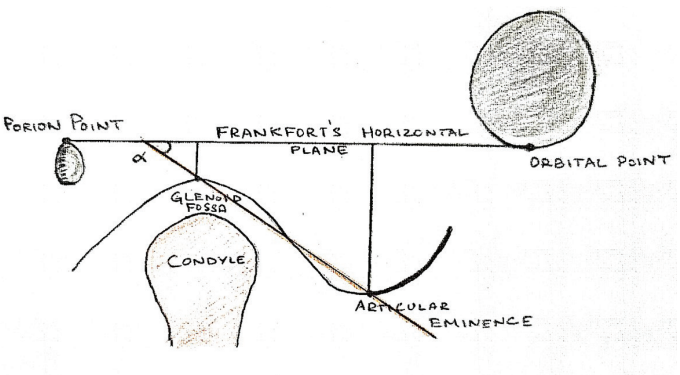

Figure 1. Diagrammatic representation of the reference line Frankfurt's horizontal plane – A line was drawn from the porion to the floor of the orbit. Posterior slope of articular eminence-A line was drawn from the point of maximum concavity of the mandibular fossa to the point of maximum convexity of the articular eminence. The measurement of the angle (α) between the posterior slope and the FH plane on both right and left side of each patient's OPG image was taken manually using a virtual protractor.

Inclusion criteria:

Radiographs of people between the ages 18-60 dentulous and edentulous with asymptomatic TMJ and no history of temporomandibular disorders, fractures of the TMJ region and TMJ surgeries. Only digital OPGs were included in the study.

Exclusion criteria:

Radiographs of individuals with history of condylar fractures, surgeries, developmental anomalies affecting the TMJ region, degenerative diseases, arthritis, and tumours of the bone were excluded from the study.

OPGs where the Frankfurt's horizontal plane was not traceable, where the porion or the infra orbital point was not visible were excluded. OPGs with TMJ is not clearly visible, any foreign body present that prevented visualization of the anatomical area and motion artefacts present were excluded[5,13].

OPGs with incorrect Frankfort horizontal plane positioning, head rotated, head tilted, patient is not positioned in ski position, thyroid, or lead collar visible were excluded[13].

Results

The posterior slope of the articular eminence and the Frankfurt's horizontal plane was drawn and the angle between them were recorded.

The highest value was obtained in group 1, (Right side 35.63±3.01°, Left side 36.66±3.45°, Mean 36.15±3.13°)

The values in group 2 (Right side 35.50±3.17°, left side 36.06±4.23°, Mean 35.78±3.54°) were slightly lower than group 1.

The Group 3 values (Right side 29.07±4.10°, Left side 29.66±3.13°, mean 29.36±3.51°) were significantly lower compared to group 1 and group 2. (p value < 0.001)

The correlation coefficient between age and the flattening of the eminence in group 1, 2 and 3 was -0.79, -0.93 and -0.94, respectively.

OPGs from each group with the FH plane and line indicating posterior slope of articular eminence marked. The angle between the two lines were then measured. (The flattening is prominent to the naked eye in Fig 4.

Discussion

The TMJ undergoes constant remodelling due to the mechanical forces it sustains and change in physical demands. This study was conducted to analyse age and edentulism have a significant impact on the degree of remodelling of the TMJ and the importance of replacement of teeth to prevent further worsening of the flattening of the articular eminence[8].

A study conducted by Granados[11] on dry human skulls, found that those with attrition or total edentulism had osseous deformations such roughing, lipping, bone erosion, and low angulation of the articular eminence. This study did not find any difference in the articular eminence in relation to age or gender.

Chiang *et al* [15] in their study on patients, who had unilateral posterior edentulism observed that the inclination angle on the missing side was steeper compared to the non-missing side suggesting the importance of maintenance of occlusion for the integrity of the AE inclination. No relationship between age or gender and articular eminence angulation was observed.

Analysing the obtained results in the present study, it was observed that there is no significant difference in the mean angles of the right and left side. It was also noted that there was no significant difference in the mean angles of the posterior slope of articular eminence and Frankfurt's horizontal plane of the male and female radiographs.

Comparing the results of Group 1and Group 2 there was no difference in the mean angles of Group 1 and Group 2. In the correlational analysis, Group 2

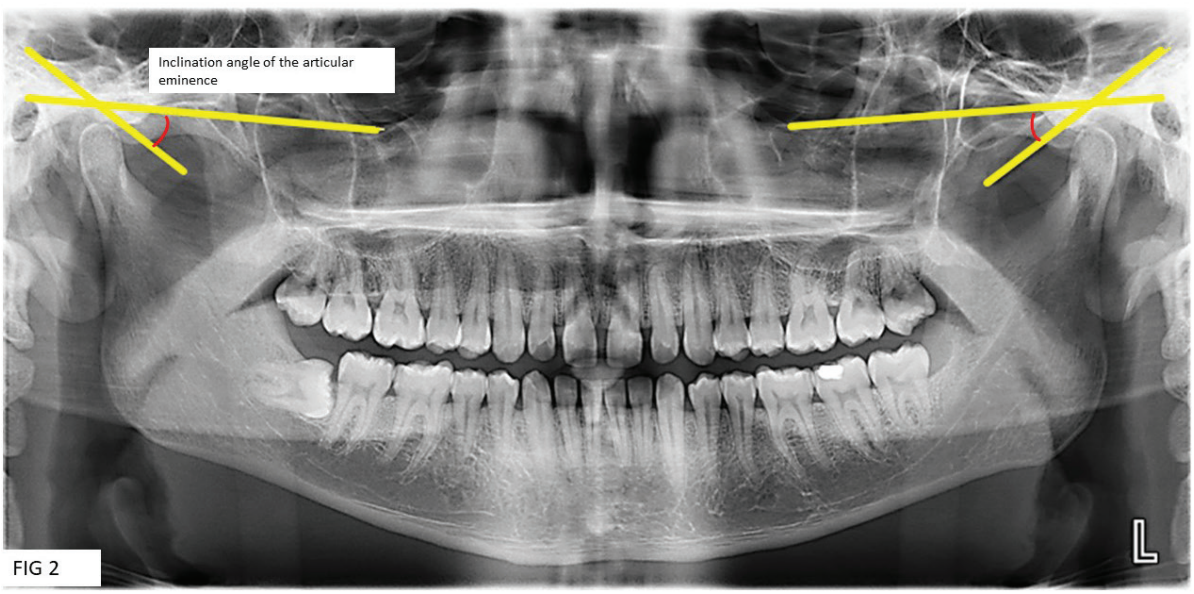

Figure 2. Group 1 (18-25 years with maintained occlusion).

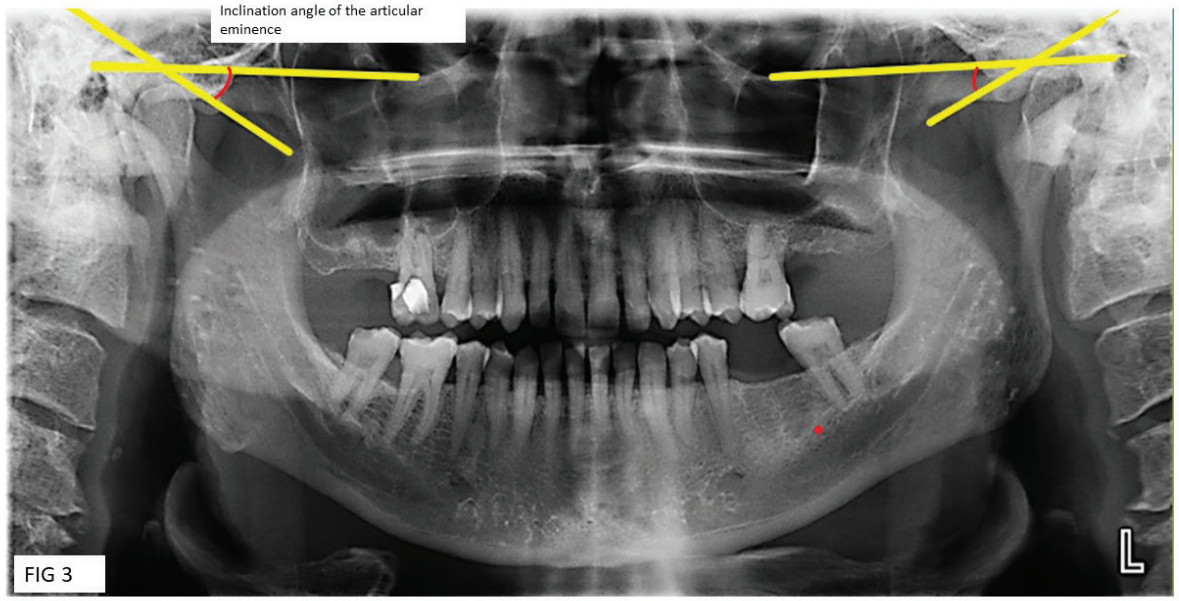

Figure 3. Group 2 (60 years and above with maintained occlusion).

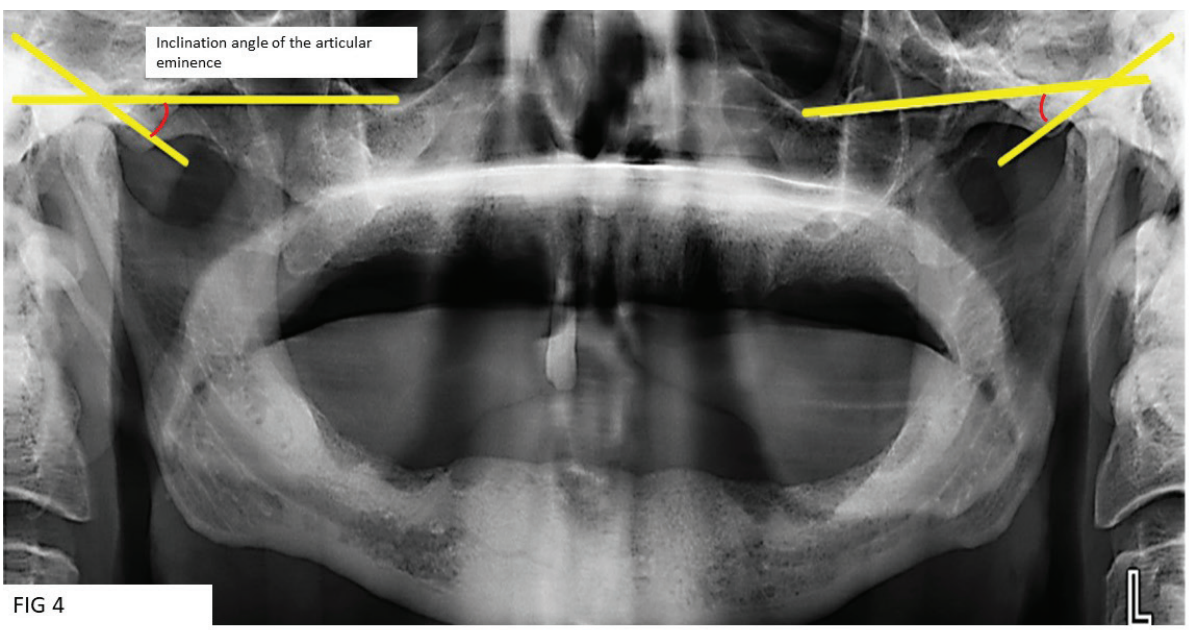

Figure 4 : Group 3 (60 years and above edentulous).

Table 1. Showing mean angles of inclination of the articular eminence and correlation coefficient of the three groups.

Group	Right side mean angle	Left side mean angle	Mean angle of right and left side	Correlation coefficient	P-value
Group 1 (18-25 with occlusion)	35.63±3.01º	36.66±3.45º	36.15±3.13º	-0.79	< 0.001
Group 2 (60 and above with occlusion)	35.50±3.17º	36.06±4.23º	35.78±3.54º	-0.93	
Group 3 (60 and above edentulous)	29.07±4.10º	29.66±3.13º	29.36±3.51º	-0.94	

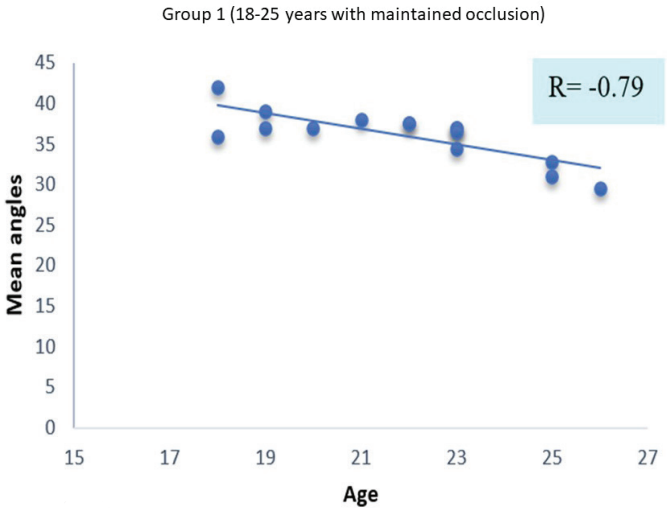

Figure 5. Scatter graph plotted for Group 1 (18-25 years with maintained occlusion).

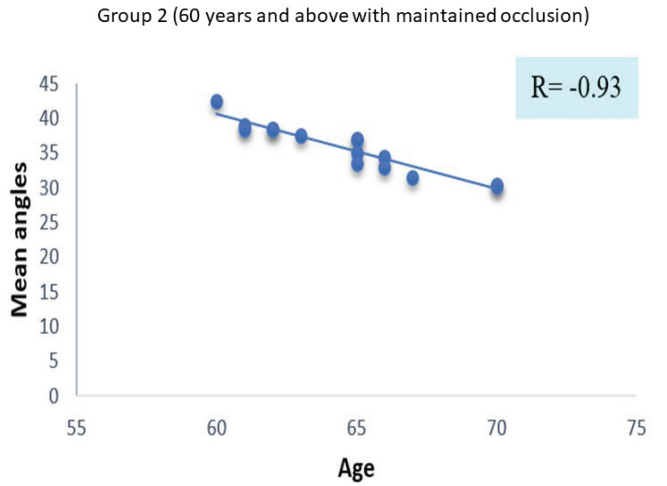

Figure 6. Scatter graph plotted for Group 2 (60 years and above with maintained occlusion).

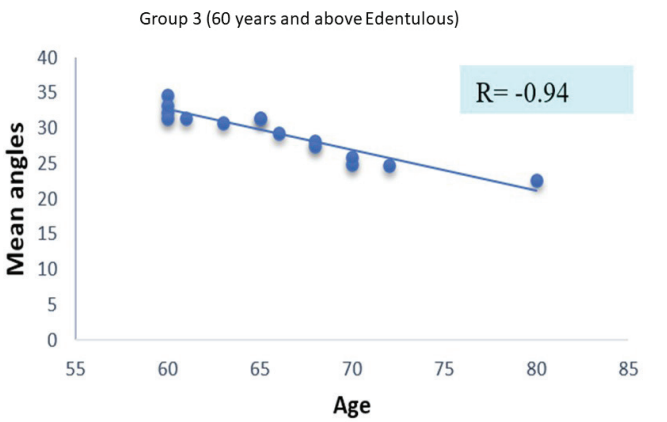

Figure 7. Scatter graph plotted for Group 3 (60 years and above edentulous).

showed a steeper slope than Group 1 indicating that the rate of progression of flattening is more in Group 2 individuals. This indicates that as the age progresses the rate of progression of flattening also increases.

Comparing the results of Group 2 and Group 3,

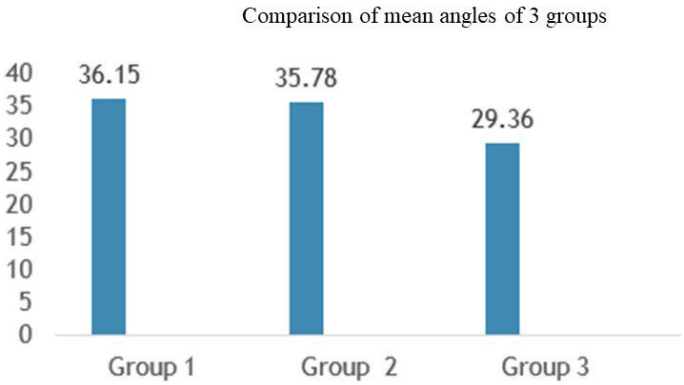

Figure 8. Comparison of mean angles of 3 groups

there was a significant reduction in the mean angles in Group 3 compared to Groups 1 and 2. This indicates that in edentulous individuals the flattening of the AE slope was more eminent. The correlational analysis showed that the rate of progression of flattening in Group 2 and Group 3 was similar indicating that although the flattening is more in edentulous patients the rate of progression of flattening correlated more with age rather than edentulism.

In the study conducted Kinga Csado *et al*[4] there is a reduction in mean angle as the age increases and the edentulism played a role in further reduction of the angle.

In the correlational analysis of Kinga Csado *et al*'s study, a different observation was obtained. The difference in value of correlation coefficient of Group 1, Group 2 and Group 3 indicates that the progression of flattening of AE slope was not affected by age significantly but it progressed more rapidly in edentulous individuals.

On the contrary, in the present study the Group 2 showed a steeper slope than Group 1 indicating that the rate of progression of flattening is more in Group 2 individuals but Group 3 was similar to Group 2. This indicates that the rate of progression of flattening of AE slope greatly increased as age increased but edentulism did not change the rate significantly.

Oruba *et al*[8] studied the relationship between the slope of articular eminence and the maintenance of Occlusal Contact Zones (OCZ). They observed that elderly patients with no occlusal contact zone have more evident flattening compared to those with maintained occlusion. This indicates that loss of occlusal contact had a greater impact than ageing.

In the present study it was observed that there is not much difference in the angle of the slope articular eminence in the early ages and in subjects that are between the age group of 18 to 25 years with maintained occlusion. This shows that articular remodelling is minuscule in the early adulthood[4]. As with increasing age, there is more correlation with flattening of the AE. The mean angle of the articular eminence slope is reduced significantly in edentulous patients but there

is no difference in the rate of progression of flattening between dentulous and edentulous patients above the age of 60.

Majority of the investigations conducted on the osseous changes of the TMJ have pointed out that age and edentulism plays a role in the flattening of the posterior slope of the articular eminence[1,4,7,8,11,15,16,26].

The knowledge of the degree of flattening of the articular eminence with age and absence of teeth help the clinicians in preventing further damage to the joint, reduce its progress into TMJ disorders and in providing the patients with a conservative treatment plan.

The analysis of rate of progression of flattening within the physiological limit helps the clinician identify any exaggerated changes in the patient which can be indicative of an underlying pathological degenerative disease or deleterious habits like bruxism, tobacco chewing etc. Malocclusion can also play a major role in degenerative changes of the TMJ which should be corrected at an early stage in life to prevent chronic degeneration.

It is important to make the patient understand the detrimental effect of edentulism and convince the patient to undergo prosthetic treatments like dentures or implants to restore the occlusal contact reducing the load on the TMJ.

Conclusions

There was no significant difference in mean angle of the AE slope with the FH plane between the right and left side. There was no significant difference in mean angles of the AE slope with the FH plane in gender. The mean angle of the AE slope with the FH plane decreased with age and was less in edentulous patients when compared to those with maintained occlusion (p value < 0.001). The rate of flattening was more pronounced in those patients who were above 60 years of age when compared to between 18-25 years of age. Edentulous patients had a lesser mean angle but edentulism did not impact the rate of progression of flattening of the AE slope. Age and edentulism plays a major role in the flattening of the Articular eminence.

References

1. Ramdhan RC, Iwanaga J. Anatomy and Variations of the Temporomandibular Joint. Anatomical Variations in Clinical Dentistry. 2019:187-202.
2. Vîrlan MJ, Păun DL, Bordea EN, Pellegrini A, Spînu AD, Ivașcu RV, Nimigean V, Nimigean VR. Factors influencing the articular eminence of the temporomandibular joint. Experimental and Therapeutic Medicine. 2021 Oct 1;22(4):1-5.
3. Mathew AL, Sholapurkar AA, Pai KM. Condylar changes and its association with age, TMD, and dentition status: a cross-sectional study. International Journal of Dentistry. 2011 Oct 31; Article ID 413639.
4. Csado K, Marton K, Kivovics P. Anatomical changes in the structure of the temporomandibular joint caused by complete edentulousness. Gerodontology. 2012 Jun;29(2):111-16.
5. Brooks SL, Brand JW, Gibbs SJ, Hollender L, Lurie AG, Omnell KÅ, Westesson PL, White SC. Imaging of the temporomandibular joint: a position paper of the American Academy of Oral and Maxillofacial Radiology. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 1997 May 1;83(5):609-18.
6. Kumarihami AM, Heshani SD, Sathyathas P, Illeperuma RP. Development of Brief Image Quality Evaluation Criteria for Digital OrthoPantomography (OPG) Images in Dental Radiography. Journal of Health Science. 2018;6:139-47.
7. Al-Nakib LH. Flattening of the posterior slope of the articular eminence of completely edentulous patients compared to patients with maintained occlusion in relation to age using computed tomography. Journal of Baghdad College of Dentistry. 2015;27(2):66-71.
8. Oruba Z, Malisz P, Sendek J, Aardal VE, Kopycińska N, Krzystyniak K, Darczuk D, Kaczmarzyk T. Flattening of the articular eminence is associated with the loss of occlusal support: Radiological study. Australian Dental Journal. 2020 Mar;65(1):53-7.
9. Unal Erzurumlu Z, Celenk P. A radiological evaluation of the effects of edentulousness on the temporomandibular joint. Journal of Oral Rehabilitation. 2020 Mar;47(3):319-24.
10. Sa SC, Melo SL, MELO DP, Freitas DQ, Campos PS. Relationship between articular eminence inclination and alterations of the mandibular condyle: a CBCT study. Brazilian oral research. 2017 Mar 30;31:1-8.
11. Granados JI. The influence of the loss of teeth and attrition on the articular eminence. The Journal of Prosthetic Dentistry. 1979 Jul 1;42(1):78-85.
12. Ruf S, Pancherz H. Is orthopantomography reliable for TMJ diagnosis? An experimental study on a dry skull. Journal of Orofacial Pain. 1995 Oct 1;9(4).
13. Muir CB, Goss AN. The radiologic morphology of asymptomatic temporomandibular joints. Oral surgery, oral medicine, oral pathology. 1990 Sep 1;70(3):349-54.
14. Matsumoto MA, Bolognese AM. Bone morphology of the temporomandibular joint and its relation to dental occlusion. Brazilian Dental Journal. 1995 Jan 1;6(2):115-22.
15. Chiang MT, Li TI, Yeh HW, Su CC, Chiu KC, Chung MP, Huang RY, Shieh YS. Evaluation of missing-tooth effect on articular eminence inclination of temporomandibular joint. Journal of Dental sciences. 2015 Dec 1;10(4):383-87.
16. Hinton RJ. Changes in articular eminence morphology with dental function. American Journal of Physical Anthropology. 1981 Apr;54(4):439-55.
17. Gilboa I, Cardash HS, Kaffe I, Gross MD. Condylar guidance: Correlation between articular morphology and panoramic radiographic images in dry human skulls. The Journal of prosthetic dentistry. 2008 Jun 1;99(6):477-82.
18. Yamada K, Tsuruta A, Hanada K, Hayashi T. Morphology of the articular eminence in temporomandibular joints and condylar bone change. Journal of oral rehabilitation. 2004 May;31(5):438-44.
19. İlgüy D, İlgüy M, Fişekçioğlu E, Dölekoğlu S, Ersan N. Articular eminence inclination, height, and condyle morphology on cone beam computed tomography. The Scientific World Journal. 2014 Jan 1; Article ID 761714.
20. Rabelo KA, Melo SL, Torres MG, Campos PS, Bento PM, de Melo DP. Condyle excursion angle, articular eminence inclination, and temporomandibular joint morphologic relations with disc displacement. Journal of Oral and Maxillofacial Surgery. 2017 May 1;75(5):938-e1.
21. Da Costa ED, Peyneau PD, Roque-Torres GD, Freitas DQ, Ramírez-Sotelo LR, Ambrosano GM, Verner FS. The relationship of articular eminence and mandibular fossa morphology to facial profile and gender determined by cone beam computed tomography. Oral

Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2019 Dec 1;128(6):660-66.
22. Sümbüllü MA, Çağlayan F, Akgül HM, Yilmaz AB. Radiological examination of the articular eminence morphology using cone beam CT. Dentomaxillofacial Radiology. 2012 Mar;41(3):234-40.
23. Bäck K, Ahlqwist M, Hakeberg M, Dahlström L. Occurrence of signs of osteoarthritis/arthrosis in the temporomandibular joint on panoramic radiographs in Swedish women. Community dentistry and oral epidemiology. 2017 Oct;45(5):478-84.
24. Jasinevicius TR, Pyle MA, Nelson S, Lalumandier JA, Kohrs KJ, Sawyer DR. Relationship of degenerative changes of the temporomandibular joint (TMJ) with the angle of eminentia. Journal of oral rehabilitation. 2006 Sep;33(9):638-45.
25. Grunert I, Grubwieser GJ, Ulmer H. Bilateral investigation of the temporomandibular joint. An autopsy study of edentulous individuals. Journal of Oral Rehabilitation. 2000 Aug;27(8):671-81.
26. 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. 2020 Dec 26;11(1):29.

Mini Curriculum and Author's Contribution

1. Dr. Vasuki Krishnan - BDS, MSc Medical Anatomy. Contribution: Data Acquisition and data interpretation, preparation of manuscript. ORCID ID: 0009-0000-2356-232X

2. Dr. Vinutha S.P - MD, Ph. D. Contribution: Design of the study, Critical review and Final approval. ORCID ID: 0000-0002-6993-6566

3. Dr. Karthikeya Patil - BDS, MDS. Contribution: Guidance, Critical review and Final approval. ORCID ID: 0000-0002-7941-2467

4. Dr. Vidya C. S - MD, Ph. D. Contribution: Guidance, Critical review and Final approval. ORCID ID: 0000-0003-4876-7326

Received: March 2, 2023
Accepted: May 7, 2023

Corresponding author
Vinutha. S. P
E-mail: vinuthasp@jssuni.edu.in