Effect of Dentulous and Edentulous Status on Articular Eminence Inclination of Temporomandibular Joint in Adult Patients – A Cross-sectional Orthopantomogram Study

Madhura Barve, Ajay Bhoosreddy*, Chetan Bhadage, Kalyani Khairnar

Abstract

Introduction: The inclination of articular eminence (AE) varies across population. The AE dictates the path of condylar movement as well as the degree of rotation of the disc over the condyle. Mechanical conditions caused by aging and influenced by the loss of teeth might have some effect on remodulation and reshaping of the AE. **Aim and Objective:** The aim of the study was to compare the inclination of AE of temporomandibular joint (TMJ) in dentulous and edentulous elderly patients. **Materials and Methods:** Orthopantomogram scans fulfilling the inclusion criteria for dentulous and edentulous patients were included in the study. Patients with age range of 50–70 years were divided into two groups: Group A (dentulous) and Group B (edentulous). The inclination of AE was measured and compared. **Results and Conclusion:** Mean AE Inclination (AEI) value in dentulous and edentulous was 36.56 degrees and 30.16 degrees, respectively. The AEI was significantly increased in dentulous patients as compared to edentulous patients. The results of the current study are of great relevance as it suggests that maintenance of dentition is necessary to retain the proper physiologic function of TMJ.

Keywords: Articular eminence inclination, Dentition status, Temporomandibular joint

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Introduction

The temporomandibular joint (TMJ) is the complex articular system between the temporal bone and the mandible.[1] The articular eminence (AE) constitutes a portion of the temporal bone, serving as the surface along which the condylar process moves during mandibular motions. The angle of inclination of the AE determines both the trajectory of condylar movement and the extent of disc rotation over the condyle.[2]

The AE morphology undergoes remodeling throughout an individual's life.[3]

The angle between the AE and the Frankfort horizontal plane is known as AE inclination (AEI). Typically, AEI falls within the range of 30°–60° in adults without any abnormalities.[4]

Very few of the studies investigated the relation between edentulousness and changes in TMJ morphology and function.[5] Some authors have found a connection between the loss of teeth and the AEI.[6] In a study, it was suggested that tooth loss may cause harmful effects such as resorption of the AE.[7,8]

The present study aims to evaluate the AEI of the TMJ in dentulous and edentulous patients using orthopantomograph imaging.

Materials and Methods

This cross-sectional study was conducted at the Department of Oral Medicine and Radiology, Dental College in Nashik, Maharashtra, India, from October 2022 to January 2023 after the approval by the Institutional Ethical Clearance. MGVRESEARCH/14/2022.

The objectives of this study are as follows; to assess the AEI in dentulous patients through Orthopantomogram (OPG) imaging, to evaluate the AEI in edentulous patients using OPG imaging, and to compare the AEI between dentulous and edentulous elderly patients.

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Sample size estimation

Level of significance = 5%, Power = 80%, Type of test = two-sided. The formula of calculating sample size is:

$$n = 2\frac{S^2(Z1+Z2)^2}{(M1-M2)}$$

A power analysis was established by G*Power version 3.0.1 (Franz Faul universitat, Kiel, Germany). The total calculated sample size consists of 104 subjects, with n = 52 subject joints in Group A and n=52 subject joints in Group B, respectively. OPGs were being used as routinely advised investigations for various diagnostic purposes and can be utilized for assessment. It has been found to be more cost-effective than other advanced imaging techniques like computed tomography and magnetic resonance imaging. Various studies suggest that orthopantomographic image of sagittal inclination of AE consistently simulated the eminence inclinations; hence, OPG was used.[4,5]

The scans of patients who had undergone OPG examination for various reasons were randomly selected from the data stored in the OPG machine Sirona ORTHOPHOS XG 3D (Bensheim, Germany) with cephalometric attachment manufactured by SIRONA, Germany, with a standard exposure parameter 69 kVP, 15 mA, and 14.1 s. All radiographs were acquired with a standardized head position.

Criteria for the selection of panoramic radiographs included patients of age group 50–70 years old with maintained occlusion with full complement of teeth irrespective of third molars and completely edentulous upper and lower arches. The panoramic scans with the presence of anatomic landmarks such as the mandibular condyle, glenoid fossa and AE, inferior margin of orbit, and highest point of external auditory meatus, as well as no gross distortion of images of the maxilla and mandible were selected. The exclusion criteria were as follows: OPG scans with low image quality and radiographic artifacts scans with radiographic evidence of trauma, fracture, or pathologic lesions in the region of interest. All selected radiographs were reviewed with respect to the patient's dental status and were allocated to the following study groups:

1.   Group A: Dentulous
2.   Group B: Edentulous.

The measurements were performed on panoramic records of 208 joints of 104 patients who had previously visited the college. A maxillofacial radiologist measured the inclination of AE on selected OPG scans with the help of a dedicated measuring tool [Figures 1 and 2]. The data were visualized using, SIDEXIS Version 1.9.4497.23802(ID7) software. A caliper tool provided with the OPG scan software was used to measure the following.

1.   The left and right "orbitale" (the lowest point in the margin of the orbit) and the "porion" (the highest point in the margin of the auditory meatus) were identified and the Frankfurt horizontal plane was formed by joining the two landmarks on each side.
2.   The most superior point on the glenoid fossa (the crest of glenoid fossa) and the most inferior point on the AE (the crest of AE) were identified and a second line to represent the mean condylar path inclination (CPI) was drawn.
3.   The angle between the CPI plane and the Frankfort horizontal plane was recorded as the inclination of AE.

Statistical analysis was performed using Statistical Product and Service Solution (SPSS) version 21 for Windows (SPSS Inc, Chicago, IL).

Continuous quantitative data were expressed in mean and standard deviation, respectively. Data normality was checked by using Shapiro–Wilk test. Intergroup comparison between both groups in respect to study parameters was done using an unpaired t-test. Evaluation of scans was done by two independent observers. Intraclass correlation test was used as interobserver test.

All the data were gathered and inserted into Microsoft Excel file; Instat software was used for statistical analysis. The unpaired t-test was used in the analysis to test for the level of significance. *P* < 0.05 were considered significant.

Results

A total of 104 bilateral TMJ OPG scans, amounting to 208 joints, underwent assessment. In Group A (dentulous), the mean age was 58.8 (6.98) years, while in Group B (edentulous), the mean age was slightly higher at 62.65 (6.55) years. However, this variance in
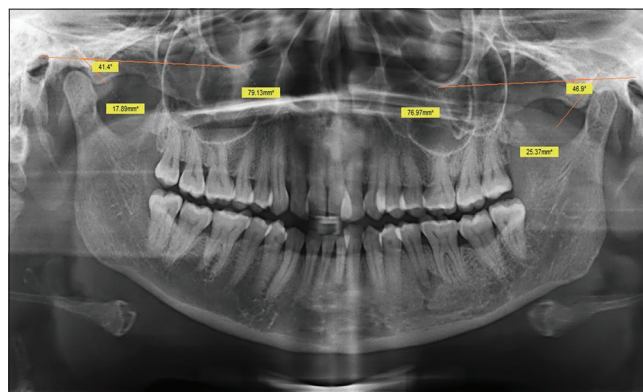

Figure 1: Panoramic radiograph of dentulous patient showing the tracing of the articular eminence inclination
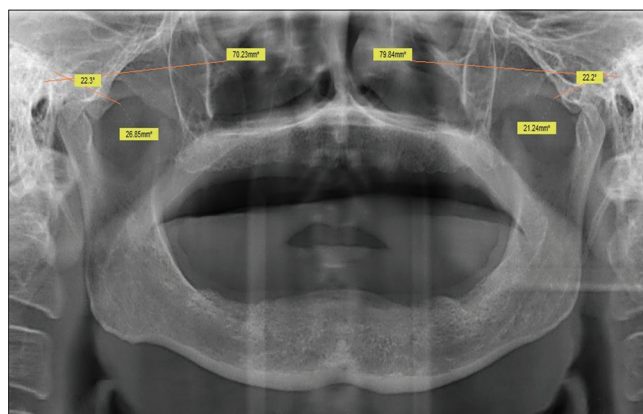

Figure 2: Panoramic radiograph of edentulous patient showing the tracing of the articular eminence inclination

mean age did not demonstrate statistical significance (*P* > 0.05). The study included an equal distribution of 52 men and 52 women. In Group A (dentulous), 21 (40.4%) subjects were male and 31 (59.6%) were female. Conversely, in Group B (edentulous), 31 (59.6%) subjects were male, and 21 (40.4%) were female. When comparing the gender distribution between Group A (dentulous) and Group B (edentulous), a statistically significant difference (*P* < 0.05) was observed.

Mean right AEI value in Group A and Group B was 34.79 (3.49) and 29.52 (3.05) degrees, respectively. On comparison of mean measurements using unpaired *t*-test, there was found to be a highly statistically significant (*P* < 0.001) difference where mean Right AEI was found to be higher in Group A (Dentulous) as compared to Group B (Edentulous) [Table 1 and Figure 3].

Mean left AEI value in Group A (Dentulous) and Group B (Edentulous) was 38.33 (4.4) and 30.8 (3.79) degrees, respectively. On comparison of mean measurements using unpaired t-test, there was found to be a highly statistically significant (*P* < 0.001) difference where mean left AEI was found to be higher in Group A as compared to Group B [Table 2 and Figure 4].

Mean AEI value in Group A (Dentulous) and Group B (Edentulous) was 36.56° and 30.16, respectively. On comparison of mean measurements using unpaired *t*-test, there was found to be a highly statistically significant (*P* < 0.001) difference where mean overall AEI was found to be higher in Group A as compared to Group B [Table 3 and Figure 5].

DISCUSSION

The TMJ is one of the most complex articular systems in human beings, which is formed by the glenoid fossa of the temporal bone and the mandibular condyle, and the two are separated by the articular disk.[9] The AE is exposed to functional load during chewing, and its shape is in a constant remodeling to match the movement of the condyle and joint disc. Therefore, the articular inclination reflecting the condylar path might also be influenced by the changing jaw movement and functional load. The AE forms the anterior limits for the movement of condyle and disc, thus, a deep glenoid fossa with a steep eminence means that both the condyle and disc have to move forward and downward further than the movement in a flat and shallow fossa during mouth opening.[10]

It is already known that the inclination of AE of TMJ is highly variable between individuals and is also variable within an individual over time.[11]

Radiographic methods allow the selection of specific reference points on radiograms resulting in reproducible and standardizable data.[12]

Mechanical conditions caused by aging and influenced by the loss of teeth might have some effect on remodulation and reshaping of the AE. It is usually thought that morphological changes may occur in the eminence structure with advanced age and this situation results in the differentiation of bone contours and flattening of the eminence in the long term.[13,14]

In this study, digital OPG scans of patients were selected. As evidenced by Gilboa *et al*.[7] the image of the sagittal inclination of the AE on panoramic radiographs consistently replicates the inclination measured on human skulls. Thus, we have considered this imaging modality for the evaluation of the morphology of the AE.

In this study, patients aged between 50 and 70 years were included and divided into groups based on dentition status. The mean right AEI and left AEI were found to be higher in dentate patients compared to edentulous patients. Similar results were found in studies by Jyothi *et al*.,[4] Erzurum and Celenk,[5] and Oruba *et al*.[7] On contrary Žabarović *et al*.[13] reported that there was no significant relationship between edentulousness and AEI. The author found that the AEI value had a wide range of distribution and showed individual differences.

Csado *et al*.[15] stated that the flattening of the AE could be correlated with age; however, the rate of deformation is significantly higher in completely edentulous patients than in patients with a maintained occlusion. Recent reports have emphasized the significant role that tooth loss has on the flattening of the AE. Although some articles have described the sex or age of the subjects as factors which could be associated with AEI variations, edentulism seems to be a significant factor impacting AEI values.[16]

The maintenance of the intercuspal position and the habitual vertical dimension of occlusion is essential from the viewpoint of the TMJ. Without a physiological occlusal vertical dimension, an irreversible deformation might occur. The flattening of the AE might cause severe maxillofacial discomfort for the patients and lead to further complications in prosthetic rehabilitation. The present results showed that edentulous patients had significantly lower AEI than dentate patients in both genders.
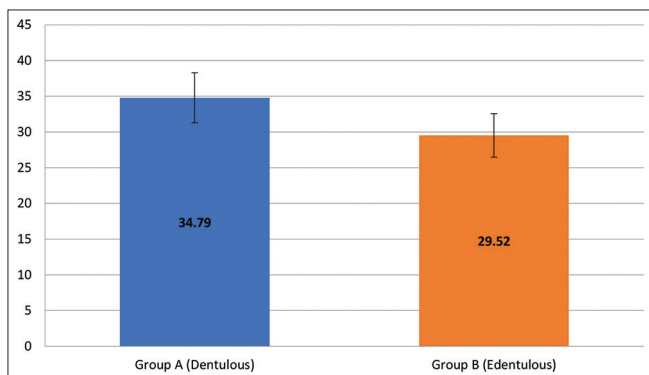

Figure 3: Comparison of mean Right Articular Eminence Inclination values between Group A (Dentulous) and Group B (Edentulous), respectively

Table 1: Comparison of mean Right Articular Eminence Inclination values between Group A (Dentulous) and Group B (Edentulous), respectively

Right AEI	Mean	SD	Mean difference±SE	Unpaired t-test	P-value, Significance
Group A (Dentulous)	34.79	3.49	5.26±0.64	t=8.178	P<0.001**
Group B (Edentulous)	29.52	3.05			

**P<0.001-Highly statistical significant difference

Table 2: Comparison of mean Left Articular Eminence Inclination values between Group A (Dentulous) and Group B (Edentulous), respectively

Left AEI	Mean	SD	Mean Difference±SE	Unpaired t-test	P-value, Significance
Group A (Dentulous)	38.33	4.4	7.53±0.80	t=9.352	P<0.001**
Group B (Edentulous)	30.8	3.79			

**P<0.001-Highly statistical significant difference

Table 3: Comparison of mean overall (right+left) Articular Eminence Inclination values between Group A (Dentulous) and Group B (Edentulous), respectively

Overall AEI	Mean	SD	Mean Difference±SE	Unpaired t test	P-value, Significance
Group A (Dentulous)	36.56	4.33	6.4±0.54	t=11.729	P<0.001**
Group B (Edentulous)	30.16	3.48			

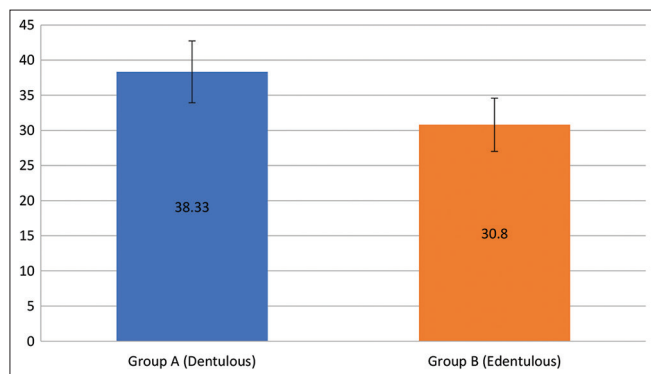**P<0.001-Highly statistically significant difference

Figure 4: Comparison of mean Left Articular Eminence Inclination values between Group A (Dentulous) and Group B (Edentulous)
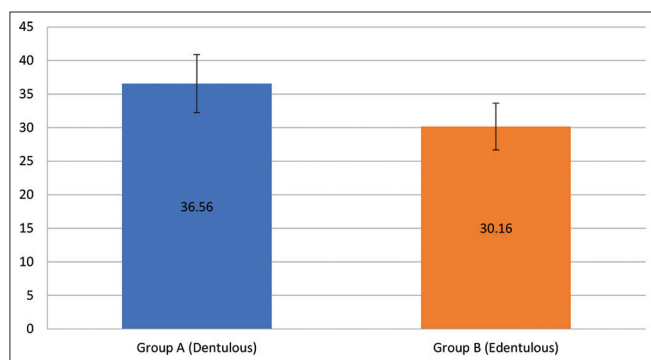

Figure 5: Comparison of mean overall (right+left) Articular Eminence Inclination values between Group A (Dentulous) and Group B (Edentulous)

Limitation of Study

The sample size was small. Furthermore, due to the limited information on patient's history such as the time since tooth loss, a longitudinal study is necessary to investigate whether the long-term effects of tooth loss have a different association with the AEI.

Future Scope of the Study

To determine the effect of dentulous and edentulous status on the inclination of AE of TMJ, future prospective study with a larger sample size is recommended.

CONCLUSION

The results of the current study are of a great clinical relevance, as they suggest that the maintenance of natural dentition may be necessary to retain proper anatomical relations and function of the TMJ. Thus, in a case of tooth loss, the prosthetic rehabilitation should be done as soon as possible to restore the physiological occlusal relations. OPG can be used as routinely imaging modality in diagnosis and treatment planning as it is cost-effective and provides a low radiation dose compared to CBCT.

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