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Posterior slope of articular eminence of edentulous subjects in south Indian population: A retrospective cross sectional radiographic assessment

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Abstract
Background: The posterior slope of articular eminence of completely edentulous patients shows significant flattening as compared to patients with maintained occlusion.
Objective: To radiographically assess the posterior slope of articular eminence caused by edentulousness using orthopantomograph (OPG) and possible correlation between flattening of articular eminence and edentulousness.
Material and Methods: 90 OPGs, 30 each of completely dentulous, unilaterally edentulous, completely edentulous subjects in the age range of 30-70 years were selected. The angle of the posterior slope of articular eminence relative to Frankfort plane was measured on both sides on OPGs in Adobe photoshop 7. Data was analysed statistically with unpaired t test between groups and paired t test within group ($P < 0.05$). The linear regression test was used to perform the analysis of correlation between the angle and age, applying Pearson correlation coefficient.
Results: The highest angle values were measured in Group I, relatively lower in Group II and lowest in Group III. The correlation coefficient between age and flattening of articular eminence in Group I, II and III was -0.123, -0.161 and -0.101, on right side and 0.189, 0.133 and -0.088 on left side respectively.
Conclusion: The rate of deformation of articular eminence was significantly higher in edentulous patients than in patients with maintained occlusion. The flattening of articular eminence is significantly higher in completely edentulous patients than patients with maintained occlusion. However, there was no association between the increasing age and deformation of articular eminence.

Keywords: Edentulous jaws, orthopantomograph, posterior slope of articular eminence, temporomandibular joint

Introduction
Temporomandibular Joint (TMJ) is a unique joint system, as two (right and left) joints function as one unit, facilitating the mandibular functions by means of dynamic balance.[1] It is formed by the mandibular condyle fitting into articular or glenoid fossa of the temporal bone. The glenoid fossa forms the superior bone part while the mandibular condyle forms the inferior part. The convex bony eminence anterior to the fossa, the articular eminence, is a vital component in the biomechanics of TMJ and the entire masticatory system [1].
The amount of convexity of the articular eminence is extremely inconsistent but significant as the steepness of this surface guides the condylar pathway particularly, the slope of the posterior wall of the articular eminence also referred as articular eminence inclination, upon which the condyle-disk complex, glides during a range of mandibular movement [1].
The angle formed between the articular eminence & Frankfort horizontal (FH) plane or any other horizontal plane, such as occlusal or palatal plane is referred to as articular eminence inclination (AEI). AEI differs among subjects & ranges between 30º-60º in normal in adults [2]. Values lesser than 30º are described as flat, and greater than 60º are described as steep.However, this distinction has not been universally established [2].
Articular eminence despite belonging to cranium, is exposed to functional load from masticatory forces and these may inturn influence its morphology [3] it has been observed that extensive and early molar loss, would result in decrease in fossa depth and slope with increasing wear, especially on molars [4].
Articular eminence may strongly get altered as flattening by conditions such as osteophyte formation, anterior disc displacements, erosion etc.

This signifies an adaptation of joint system to the changes in loading.[4] Prolonged edentulousness may also result in numerous irreversible deformities [6].

Numerous means are available to measure the angulations of the posterior slope of the articular eminence. Few studies have considered the data from dry skulls [2, 7, 8], while others from imaging modalities, conventional radiographs [5, 9, 10], tomographs [1], computed tomograph [10], magnetic resonance imaging [11]. It was recently reported that the orthopantomographic image of the sagittal inclination of the articular eminence consistently simulated the eminence inclinations in 25 human skulls [11].

The present study aimed to assess the inclination of posterior slope of articular eminence of TMJ on Orthopantomographs (OPGs) in dentate, edentate and unilaterally edentate patients in the age group of 30-70 years and correlate changes with age.

Methodology

Following ethical clearance from Institutional Review Board, OPGs (Kodak 9000 Digital Panoramic System) were retrospectively analysed to assess the AEI. OPGs, fulfilling the criteria were selected from the database of Out Patient section of Oral Radiology. 90 OPGs belonging to 30 completely edentulous, 30 unilaterally edentulous and 30 dentulous subjects were selected.

Inclusion criteria

a) Maintained occlusion (full complement of teeth irrespective of third molars).
b) Unilaterally edentulous in either of the arches or both without occlusal stop.
c) Completely edentulous upper and lower arches.

Exclusion criteria

1. Osteoarthritis, Rheumatoid arthritis, Septic arthritis
2. Trauma of TMJ & mandible.
3. Developmental anomalies - Condylar hypo/hyperplasia, bifid condyle.

OPGs fulfilling the inclusion criteria were categorized as-

- Group I: maintained occlusion.
- Group II: unilateral edentulousness in either of the arches or both without occlusal stop.
- Group III: complete edentulousness in both arches.

The images were saved in jpeg format & AEI measurements were carried out on both sides on Adobe Photoshop 7 software. (Fig-1)

Statistical Analysis: Data tabulated on MS Excel was statistically analysed by software SPSS 20.0 (SPSS Inc, Chicago, IL, USA) by descriptive statistics, and differences of arithmetic means were tested for significance by Student's t-test. Paired t test was employed for intra-group comparison. Linear regression test was used for correlation between AEI and age. The statistical significance was set at $P<0.05$. Difference in proportion between normal AEI and flattened AEI was noted with Z value >1.986 to be significant within the groups.

Results

The age of subjects ranged between 30 to 70 years. The mean of AEI was $33.68^0 \pm 7.01^0$ ranging from 15.6^0 to 50^0. There was also difference between right and left inclination between males and females in group III. (Table 1)

The inclination was significantly higher in Group I compared to Group III on both sides. (Table 2) There was negative correlation between age and AEI between Group I and III, similarly in group II when categorised as dentulous and edentulous side. (TABLE 3). The AEI was in normal range in Group I but predominantly flattened in Group III, & statistically significant. 40 out of 90 patients revealed fattening of posterior slope. (Table 4).

Table 1: Genderwise AEI measurements in three groups.

Group	Gender	Mean RT AEI	Mean Left AEI
I	Male	$35.78^0 \pm 7.06^0$	$36.96^0 \pm 6.94^0$
	Female	$35.36^0 \pm 6.53^0$	$35.93^0 \pm 5.43^0$
	P value	0.44	0.319
II	Male	$36.23^0 \pm 7.21^0$	$34.30^0 \pm 7.90^0$
	Female	$34.13^0 \pm 7.69^0$	$31.66^0 \pm 7.69^0$
	P value	0.22	0.18
III	Male	$30.67^0 \pm 6.52^0$	$29.99^0 \pm 7.00^0$
	Female	$33.27^0 \pm 2.45^0$	$33.27^0 \pm 6.19$
	P value	0.4	0.02^*

Table 2: Comparison of AEI among the groups.

	RT AEI	LT AEI	P value
Group I	35.570±6.680	36.450±6.150	0.007*
Group III	31.540±5.590	30.510±6.680	0.0003*
Group I	$35.57^0 \pm 6.68^0$	$36.45^0 \pm 6.14^0$	0.4
Group II	$35.11^0 \pm 7.42^0$	$32.89^0 \pm 7.77^0$	0.02*
Group II	$35.11^0 \pm 7.42^0$	$32.89^0 \pm 7.77^0$	0.019*
Group III	$31.54^0 \pm 5.59^0$	$30.51^0 \pm 6.68^0$	0.103

Table 3: Negative correlation of age with AEI.

Groups	Right AEI		Left AEI	
	PC	P- Value	PC	P- Value
Group I	-.123	0.517	.189	0.316
Group III	-.161	0.396	.133	0.484
Group II	AEI Edentulous side		AEI Dentulous side	
	-0.101	0.596	-0.088	0.644

Table 4: Proportion of flattening and normal AEI among three groups.

Group	Sample		Difference	Z- Value	P-Value
	Normal	Flattened			
I	23	7	0.53	7.86*	0.000
II	17	13	0.13	1.89	0.029
III	10	20	0.33	-4.74*	1.000

Fig 1: Angle measured between the posterior slope of articular eminence and the Frankfort horizontal plane.

Discussion

The health of TMJ plays an important role in maintaining occlusion and oral health. The present study, measures the articular eminence inclination using the angle between FH

plane and a line connecting the roof of fossa with the highest point of eminence as this method denotes the eminence height. OPGs was used as they are routinely advised investigation for various diagnostic purposes, & can be employed for assessment [11].

Reports suggest [11] that orthopantomographic image of sagittal inclination of articular eminence consistently simulated the eminence inclinations, hence OPG was utilised.

Subjects less than 30 years of age were excluded due to developmental implications, as reports suggest that AEI is approximately 45% developed at completion of primary dentition, reaching 70-72% of its adult value around the age of 10 years and 90-94% complete by the age of 20years. It then continues to grow, at a reduced rate, until the age of 30years [2].

The mean inclination was 35.75°±6.68^0 (range 24.9°- 47.7°) on the right side and 36.45^0±6.15^0 (range 26^0 - 45^0) on the left side in Group I, 35.11°±7.42^0 (range 16.80 - 49.0^0) on the right side and 32.89^0±7.77^0 (range of 22.50^0 - 50.0^0) on the left side in Group II and 31.54°±5.59^0 (range 22.0^0 - 41.70^0) on the right side and 30.51^0±6.68^0 (range 15.60^0 - 41.10^0) on the left side in Group III. The highest values was observed in Group I, values were lower in group II and were the lowest in group III.

The mean of AEI in the present study was 33.68^0±7.01^0 with a range varying of 15.6^0 to 50^0. In right side it was 34.08^0±6.79^0 and left side it was 33.39^0±7.25^0. These results were consistent with the previous studies [5, 9]. However the mean values were much lower compared to few other studies [8, 12].

The present study shows that the right slope has slightly higher value in Group II & Group III, and the left slope has slightly higher value in Group I considering the mean values of respective groups. The observations obtained in Group II and III were in agreement with other reports [8, 12, 13].

The data from the present study supports the previous theory of the asymmetry of the articular eminence inclination (posterior slope) of the left and right joint. This asymmetry of the articular eminence could be attributed to the predominant usage of one side of the dental arches during chewing, and consequently the distribution of the biomechanical forces is not similar in both joints. Chewing side preference may generate unequal mechanical loading of the TMJ and it has been suggested that joint loading in the nonworking side is heavier during function than the working side [14].

The mean of AEI was significantly higher among dentate group (Group I) compared to edentulous group (Group III). Also when Group II (unilaterally edentulous) was categorized as dentulous and edentulous sides, it was found that the mean of inclination was statistically significant between the sides. The results comply with the concept of other study [14], that joint loading in nonworking side is heavier during function than in working side. The results were similar to recent studies [5, 12]. On the contrary, previous studies [8, 9] infer that loss of teeth has no effect upon AEI.

In the present study, although the age range was wide, there was only a negative correlation between age and articular eminence inclination but there was no significant association between the increasing age and changes in AEI. Similar results were observed in other studies [5, 9]. The temporal part of the TMJ is under the influence of remodeling forces throughout life [10]. This remodeling is characterized by regressive changes in the articular eminence and progressive remodeling on its upper posterior slope of the articular eminence. Thus it seems that the location of the posterior wall is mainly related to morphologic factors of condyle whereas the eminence is more under functional influence [10]. but few reports [9] suggest that as age advances morphological changes may occur in eminence, resulting in differentiation of bone contours and flattening of eminence. Thus, to address the long-term effects of aging on TMJ and AEI, a longitudinal study is necessary.

The correlation coefficients obtained within the groups according to the dentition status of the patients, infers that the association between dentition status and the flattening of the eminence is present in every group but, was more evident in edentulous group (Group III), suggestive of flattening of articular eminence being directly proportional to the loss of teeth, and males being predominantly affected.

Present study obtained a wide range of measured inclination values among the study population indicating that the average values can be used as preliminary data. The temporomandibular components, apart from dentition depends on other factors like chewing side preference, diet, parafunctional habits, masticatory stress, and craniofacial growth requiring clinical assessment. So, further studies are needed with clinical consideration to confirm the association of dependent cofactors. Also a longitudinal study is necessary to address the long-term effects of aging on the TMJ and AEI.

Conclusion

It was evident that loss of teeth showed significant correlation with AEI, with asymmetry between two sides of joint. Sexual dimorphism was evident with higher value of eminence inclination in males.

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