Assessment of Articular Eminence Inclination (AEI) among the patients visited to the Dental Clinical Complex—A retrospective analysis through CBCT

Short Title: Articular Eminence Inclination (AEI) measurement through CBCT

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Abstract

Objective: The objective of present study is to assess the age and gender related changes in articular eminence inclination by top roofline method.

Material and Methods: Selected images were analyzed by using a digital image analysis software i-CAT DICOM (Digital Image Communication in Medicine). This software allowed the examination of section in the form of 0.1 mm slices. . On the selected axial image, lateral slices of the TMJ were taken perpendicular to the long axis of the condylar process with a thickness of 1mm, and coronal slices were taken parallel to the long axis of the condylar process with a thickness of 1mm. In this study, the AEI was measured by using top-roof line method.

Results: The articular eminence inclination was statistically significant in males and females in top roof line method. It was found that the AEI was highest (33.16 ± 7.44^0) in 21-30 years and lowest (31.58 ± 7.73^0) in 41-50years. It has been noted that the correlation between age groups and AEI was stastically not significant (p value-.92) and age is not having significant role on AEI. The unpaired t-test was performed to evaluate the comparison between AEI in both males and females. The articular eminence inclination was statistically significant (Male 34.71 ± 7.21^0 ; Female 31.42 ± 7.86^0 ; p=0.007).

Conclusion:

According to this study the AEI angulation is not influenced by age, but is influenced by the gender. The AEI difference between genders was statistically significant. Since this study based limited sample size, further studies with larger sample size with broader age range are required to evaluate this relation.

Keywords: Articular eminence, CBCT, Temporomandibular Joint, Top roofline method.
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Introduction

In comparison with other articulating joints in the human body the temporomandibular joint (TMJ), is a different type of articular joint. This is the only joint that is having capacity to move in all three dimensions. The articulation of the head of the condyle, the glenoid fossa, and the articular disk make this joint. On the inferior side of the squamous section of the temporal bone, the glenoid fossa and articular eminence are present (AE)[1]. The convex shaped articular eminence forms the anterior edge of the glenoid fossa. This AE governs the gliding path, movement, and degree of rotation of the condyle during mandibular movement. The degree, direction and route of disc rotation over the condyle are determined by the angle of inclination of the articular eminence, which varies from person to person[2].

The articular eminence inclination (AEI) is calculated by measuring the angle formed by the articular eminence with the Frankfort horizontal (FH) plane or any other horizontal plane, such as the occlusal or palatal plane. According to earlier studies in the adult population, AEI grows and develops at a rate of approximately around 1-1.3 % per year, achieves morphological maturity around the age of 20 years[3]. AEI ranges from 30^0 to 94^0, and several factors such as sex, facial profile, degenerative bone disease, condyle shape, altered condylar position and increasing functional stress on the dentition influences it. The depth of the fossa fluctuates as the articular eminence develops in response to a functional input from the condyle[4]. Based on the shape, AE has been divided into box, sigmoid, flattened and deformed. AE with steep posterior slope with a deep fossa is classified as box-typed and the slope of AE is gently tilted, it is called the sigmoid. If it is flat, it is known as flattened and not coming under any of these is known as deformed. During mouth opening, joints with steep articular eminence makes the posterior disc to rotate more than the less steep[5]. Increasing the steepness of the articular eminence makes the condyle to move inferiorly and anteriorly. This leads in increased vertical movement of the condyle and mandible. There were different types of techniques used to assess the inclination of the articular eminence and morphological changes, but cone-beam computed tomography (CBCT) provides accurate and reliable linear measures[6,7]. In comparison with CT it takes shorter scanning time and radiation dose[8]. The present study was carried out to estimate the average inclination angle of articular eminence among the patients reported to dental clinical complex of King Faisal University, KSA.

Materials& Methods

A cross-sectional retrospective study was conducted by using images captured with help of i-CAT (Imaging science international, Haffield, PA) in Dental clinical complex at King Faisal University for various treatment purposes.

After obtaining Institutional ethical committee approval **(KFU/CoD/R/10022/2019)** the retrospective analysis was done from the electronically archived images and followed all the recommendations of Helsinki Declaration (2013).

The following selection criteria were employed based on the history and records of the patients.

Exclusion criteria:

Patients

--with a history of orthodontics treatment and signs or symptoms of TMD and TMD treatment

--with longstanding edentulism and prosthetic rehabilitation

--with history of a fracture or disease in the region of the articular eminence

--with local or systemic bone disease

--with history of systemic diseases like osteoarthritis, rheumatoid arthritis and uncontrolled diabetics, etc.,

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--with undergoing treatment for autoimmune disorders or taking steroids and other immunomodulators/suppressors

CBCT images

--with degenerative bone changes in the condyle or the glenoid fossa, fracture of the mandible and condylar region, missing teeth in affecting the vertical dimension, and/ or were of poor quality

Inclusion criteria:

--Patients above the age of 20 years with healthy medical records

A written informed consent was obtained individually from each patient at the time of CBCT scanning stating that taken image can be utilized for research purpose and obtained data will be published without revealing their identity.

Selected images were analyzed by using a digital image analysis software i-CAT DICOM (Digital Image Communication in Medicine). This software allowed the examination of section in the form of 0.1 mm slices. The exposure parameters were based on a Field Of View (FOV) according to the normal default values. On the lateral view patients were positioned to keep the Frankfort plane parallel to the horizontal plane. One of the axial images (**Fig:1**) with the widest mediolateral extent of the condylar processes was utilized as a reference view for secondary reconstruction. On the selected axial image, lateral slices of the TMJ (**Fig:**2) were taken perpendicular to the long axis of the condylar process with a thickness of 1mm, and coronal slices(**Fig:3**) were taken parallel to the long axis of the condylar process with a thickness of 1mm.To measure the inclination of articular eminence two proven methods named as Best-fit line and Top-roof line method are routinely used. Both of which are reliable and have already been used in various studies.

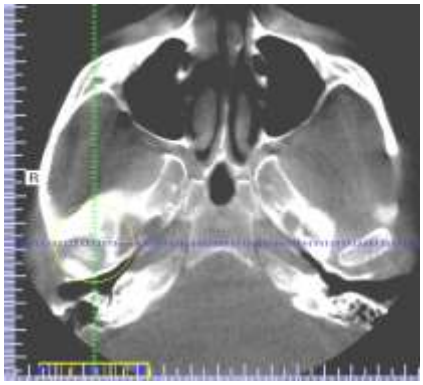

Fig:1 Axial section

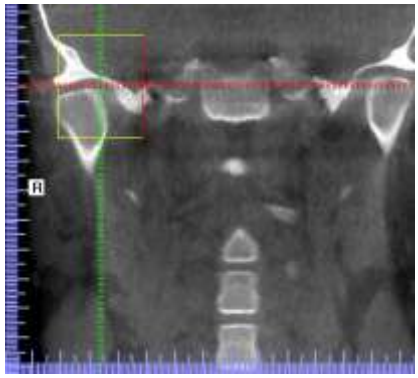

Fig:2 Coronal section

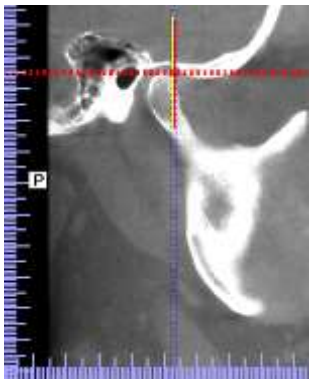

Fig:3 Sagittal section

In this study, the AEI was measured by using top-roof line method (**Fig: 4&5**) and following criteria used

--- the angle between Frankfort plane and the plane passing through the highest point(**HP**) in the roof of glenoid fossa and the lowest point at the crest of the articular eminence(**LP**).

--- the Frankfort plane (a line running horizontally from the top of the ear canal to the bottom of the orbital margin) was kept parallel to the horizontal plane in the side view.

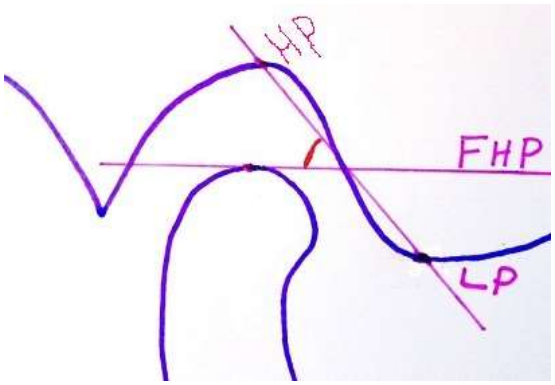

Fig: 4 Top-roof line method

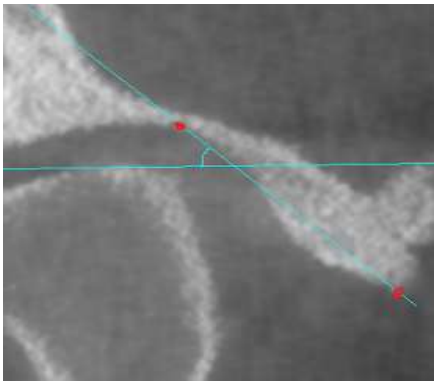

Fig:5 AEI measurement

Statistical Analysis:

Collected data analysed with SPSS 24.0, (SPSS for Windows; SPSS Inc., Chicago, IL, USA). Cohen's KAPPA variability test was done with and scored at 0.8 to rule out intra examiner variables. The unpaired t-test was used to determine correlation between AEI in both males and females and one-way analysis of variance (ANOVA) test was used to determine correlation between the AEI and age groups. P-value of 0.05 was considered statistically significant.

Results:

From the archive around 200 images randomly searched and among them based on the selection criteria 50 patient's images were selected. Both male and female grouped according to their age as 21- 30, 31-40, 41-50, 51-60 and >60 years. For each age group 5 patients selected and their mean age was 38±7.2 years.

The unpaired t-test was performed to evaluate the comparison between AEI in both males and females. The articular eminence inclination was statistically significant (Male 34.71 ± 7.21^0 ; Female 31.42 ± 7.86^0 ; p=0.007 : **Table 1**).

Table 1: AEI comparison between male and female

Gender	AEI (in degrees)
Male	34.71±7.21
Female	31.42±7.86
p-value	0.007*

*p- value is significant

By using ANOVA, the AEI was compared between the age groups (**Table 2**). It was found that the AEI was highest (33.16 ± 7.44^0) in 21-30 years and lowest (31.58 ± 7.73^0) in 41-50years. It has been noted that the correlation between age groups and AEI was stastically not significant (p value-.92) and age is not having significant role on AEI.

Table 2: Comparison of AEI between age groups

Age (in years)	AEI (in degrees)
21-30	32.92±7.44
31-40	32.50±7.32
41-50	31.58±7.73
51-60	32.46±8.51
>60	32. 62±7.59
p-value	0.92*

*p-value is not significant

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Discussion

For correct measurement of AE inclination, it is important to choose a correct method as well as TMJ imaging technique. Since TMJ is difficult to view with conventional techniques because of superimposition of the adjacent dense temporal bone, CBCT offers a dose and cost effective alternative to CT[9,10].To measure the AE inclination two types of techniques namely the best-fit line approach and the top-roof line method were used in previous literatures. Both of them are reliable and standardized by previous studies. The angle between one of the lines passing through the AE and the Frankfort horizontal plane or any other horizontal plane, such as the occlusal plane or the palatal plane (formed between the anterior nasal spine and posterior nasal spine), is known as the inclination of the AE[11,12] . The Frankfort horizontal plane, which is formed by a line connecting the porion to the infra orbital foramen, was employed in this work as the reference plane, much like it was in studies by Maryam Paknahad et al.,[13] Shahidi et al., Estomaguio et al.,[14] Csadó et al., [15] and Sümbüllü et al.,[16]. However, Saione Cruz SA et al.,[17] employed the palatal plane in a different investigation. Kikuchi et al.,[18] used best-fit line method in which the eminence inclination was measured as the angle between the best-fit line on the posterior slope of articular eminence and the Frankfort horizontal plane. Maryam Paknahad et al.,[13] and Shahidi et al.,[14] used top-roof line method to measure AEI. In this method the angle measured between the plane passing through the superior most point in the roof of glenoid fossa and the inferior most point of the crest of the AE and Frankfort Horizontal (FH) plane. Whereas Sumbullu M A et al., [16] and Ilguy et al., [19] was used both the methods to measure the AE inclination. According to the previous studies, top roof line method useful to identify the location of the eminence crest in relation to the glenoid fossa and the best fit line method useful to study the eminence's posterior surface. As a result, the best fit line technique accurately portrays the condylar path and the morphology of the articular eminence is better depicted by the top roof line method. Because the aim of this study was to evaluate TMJ morphology, it used the top roof line method.

Sumbullu M A et al., [16] stated that Mean±SD of eminence inclination in males by best fit line method is estimated as58.46 ± 8.13^0 and for females is 56.13 ± 13.95^0 and by top roof line method, Mean ± SD of eminence inclination in males is 38.67 ± 5.12^0 and in females is 37.30 ± 7.71^0. Jasine vicious et al., and Csadó et al., [6,15] found that there were no differences in eminence inclination by gender. Gilboa et al., [20] stated that the eminence inclination values usually vary from 21^0 to 64^0. Ilguy et al., [19] suggested that Mean±SD of eminence inclination in males by best fit line method is estimated as 49.66 ± 6.88^0 and for females is 47.58 ± 6.75^0. By top roof line method, Mean±SD of eminence inclination in males is 40.19 ± 6.58^0 and in females is 37.99 ± 6.0^0. Maryam Paknahad et al., [15] used top roof line method and found that Mean±SD of eminence inclination in males was 34.56 ± 6.21^0 and for females it was 38.10 ± 7.01^0 . Akhilanand C et al., [21] study the Mean±SD best fit line method was 53.37^0 and for females48.8^0 and by top roof line method, Mean±SD of eminence inclination in males is 33.77^0 and in females is 30.58^0. Where as in this study the AEI difference between genders was statistically significant (Male 34.71 ± 7.21^0; Female 31.42 ± 7.86^0 ; p=0.007 : **Table 1**).

Correlation between the age and AE inclination

Katsavrias and Dibbets et al., [22] mentioned that the AEI completed approximately 45% of its development with the completion of primary dentition and reaching 70–72% of its adult value around the age of 10years and by the age of 20 years it was 90–94%complete. Sumbullu MA et al., [16] stated that the value of AEI was lower in patients aged 16–20 years reached its highest value in patients aged 21–

30 years and decreased in patients aged over 30 years. Akhilanand C et al., [21] study it was found that mean value of AEI in best fit line method is50.69^0in10-20years which gradually increases to 52.31^0 in 31-40 years and it is lower into 41-50 years aged persons and its mean value is 49.02^0. In top roof line method mean value of eminence inclination is 32.96^0 in 10-20 years aged persons which increases upto 33.16^0 in 21-30years and it is lower in 41-50 years of life and mean value is 31.58^0. Wu et al., [23] who found a moderate correlation between age and AEI angulation in males, and also observed a positive correlation in women. Saione Cruz SA et al., [17] there was no positive correlation in between AEI and age. Whereas in this study it was found that the AEI was highest (33.16 ± 7.44^0) in 21-30 years and lowest (31.58 ± 7.73^0) in 41-50years. The relation between age groups and articular eminence inclination by top roof line method was stastically not significant (p value-.92). It has been noted that age is not playing significant role AEI. According to Ilguy et al., [20] males have significantly higher AEI angle values than women in older age groups. As confirmed by Wu et al., [23] in men there was a trend for the AE angle to rise with age, but there were no statistical differences in the means of the angles when comparing the right and left sides in females and males.

Therefore, changes in the morphology of the AE's posterior slope have been linked in earlier research more to tooth loss/loss of occlusal support zones than to the physiological processes of aging, which are often present in the TMJ of older individuals. The reasons for the variances in the results could be related to elements like various measuring techniques, sample size, age range, and other demographic variables.

Conclusion

According to this study the AEI angulation is not influenced by age, but is influenced by the sex. Since this study has some limitations such as number of patients and age ranges included were smaller, further studies with larger sample size with broader age range are required to evaluate this relation.

Funding

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Conflicts of Interest

No conflicts of interest.

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