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Articular Eminence Morphology of Temporomandibular Joint in Young Korean Adults

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Purpose: The aim of this study was to analyse and evaluate the morphology of the articular eminence of temporomandibular joint in young Korean adults using cone-beam computed tomography (CBCT).

Methods: One hundred seventy-one subjects (59 males, 112 females) in the 20s were examined using CBCT. Width and height of articular eminence, top-roof line angle, best-fit line angle, joint space were measured. For the group comparisons, independent t-test was used with the level of significance established at $p \leq 0.05$.

Results: In asymptomatic young Korean adults, average eminence width was 9.49±1.62 mm in males and 9.33±1.36 mm in females. Average eminence height was 7.23±1.81 mm in males and 6.82±1.31 mm in females. Average eminence inclination of measured by top-roof line angle was 37.09°±7.74° in males and 36.12°±5.65° in females. Average eminence inclination measured by best-fit line angle was 50.79°±11.49° in males and 48.43°±9.05° in females. Average joint space was 3.03±0.67 mm in males and 2.63±0.68 mm in females.

Conclusions: Increasing age did not affect the morphology of the articular eminence in asymptomatic young Korean adults. Males had slightly larger eminence width, height, top-roof line angle, best-fit line angle and joint space, but no statistical significance ($p>0.05$) was observed only in the joint space ($p=0.001$). There was no side-to-side difference in morphology ($p>0.05$).

Key Words: Articular eminence; Cone-beam computed tomography; Temporomandibular joint

INTRODUCTION

Articular eminence of the temporomandibular joint (TMJ) is the convex bony prominence, located anterior to the mandibular fossa of temporal bone [1]. Morphology of the articular eminence is one of the primary determinants of mandibular movement [2]. The steepness of articular eminence determines the pathway of the mandibular condyle as well as the degree of rotation of articular disc over the condyle [3]. Furthermore, it has been linked to temporomandibular disorders (TMDs), such as articular disc displacement [4-7] and subluxation [2].

A large number of studies have evaluated the morphology of the articular eminence. However, few researchers have conducted the on the Korean ethnicity [8-10] and had limitations, such as not considering the subjects' age [8,10], or not excluding pre-existing TMDs [10]. The inclination of articular eminence is however, highly variable between individuals [1]. It is also variable within an individual over time: both growth and ageing affect the morphology of articular eminence [3,11]. Therefore, there is still a need for the assessment of articular eminence morphology in homogenous asymptomatic population.

The purpose of this retrospective study was to analyse and evaluate the morphology of the articular eminence of TMJ in young Korean adults using cone-beam computed tomography (CBCT), with larger samples.

MATERIALS AND METHODS

1. Study Subjects

Study data were collected from patients aged between 20 and 29 years (mean 23.3±2.7 years) who underwent clinical examination and took CBCT in Wonkwang University Daejeon Dental Hospital (Daejeon, Korea) from January 2015 to June 2018. A total of 254 joints from 171 patients (59 males and 112 females) were subjected in the current study. Data were initially classified as two groups; bilateral subjects (whose TMJs were radiographically intact in both sides) and unilateral subjects (only one side of TMJ was radiographically intact).

In order to exclude other influencing factors, the following exclusion criteria were used: foreign patients; patients with a history of limitation of mouth opening or painful temporomandibular disorder before reaching 20 years old; patients with missing or unreplaced teeth; patient with degenerative joint disease in both sides of TMJ. The diagnosis of degenerative joint disease was made according to the diagnostic criteria for temporomandibular disorders (DC/TMD) [12], positive for at least one of the following radiographic sign: subchondral cyst(s), erosion, generalised sclerosis and osteophyte.

The study protocol was approved by the Institutional Review Board of Wonkwang University Daejeon Dental Hospital (W1807/003-001). Acquisition of informed consent was exempted by the Board.

2. Imaging process and Measurement

Image data were gained by either Alphard-3030 (Asahi Roentgen Ind., Kyoto, Japan) or Green-21 (Vatech, Hwaseong, Korea) CBCT device. Using imaging solution software (OnDemand 3D ver. 1.0; Cybermed, Seoul, Korea), raw data were processed. Images were rotated so that the Frankfort horizontal plane is parallel to the floor of the image on the sagittal slices. Then the image, where the mandibular condyle was seen with its widest mediolateral dimension on axial view, was used for a reference view. Finally, images were rotated perpendicular to the long axis of the condylar process in sagittal view and parallel to the long axis of the condylar process on coronal slices (Fig. 1).

Measurement was performed using the method previously described by other studies [3,5,9,10,13]. The measurement points and planes used in this study are described in Fig. 2. The length was measured with a precision of hundredths of a millimetre, and inclination was measured with a precision of tenths of a degree. All measurements were measured twice by a single observer (H.N.) except for the best-fit line angle, which was done three times. Mean of measured values were used for the statistical analysis.

3. Statistical Analysis

The collected data were analysed using PASW Statistics for Windows, Version 18.0 (SPSS Inc., Chicago, IL, USA). The independent samples t-test was applied for group comparisons. Normality of the distribution was verified by Kolmogorov-Smirnov test. Homogeneity of variances was verified by Levene's test. Two-tailed tests with the level of significance established at $p \leq 0.05$ for all statistical analyses. The Pearson correlation coefficient was used for the verify

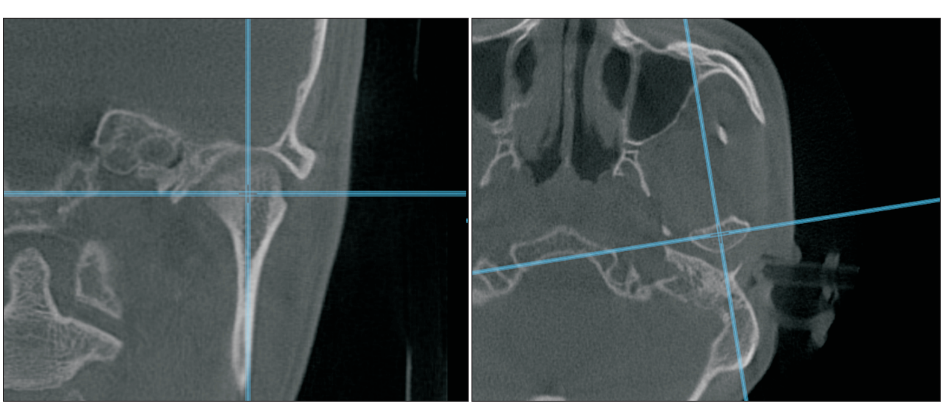

Fig. 1. Imaging reconstruction process in the imaging solution software (OnDemand 3D ver. 1.0; Cybermed, Seoul, Korea).

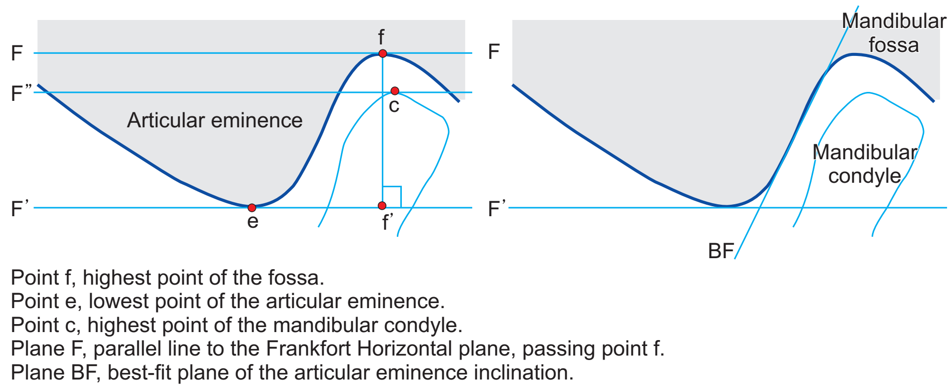

Fig. 2. Measurements used in the study. Eminence width, distance between point e and f'. Eminence height, distance between point f and f'. Top-roof line angle, inclination of articular eminence calculated by trigonometry, using eminence width and eminence height (arctan $\frac{\text{eminence height}}{\text{eminence width}}$). Best-fit (BF) line angle, inclination of articular eminence measured by the angulation between the BF plane of the articular eminence inclination and plane F”. Joint space, distance between plane F and plane F”.

Table 1. Eminence morphology according to the age

	20-24 y (n=175)	25-29 y (n=79)	p-value
Eminence width (mm)	9.27±1.58	9.22±1.54	0.821
Eminence height (mm)	6.97±1.58	6.82±1.21	0.472
Top-roof line angle (°)	36.84±6.96	36.63±5.66	0.812
Best-fit line angle (°)	48.96±10.40	49.27±8.97	0.422
Joint space (mm)	2.73±0.73	2.64±0.62	0.341

Values are presented as mean±standard deviation.
*p<0.05.

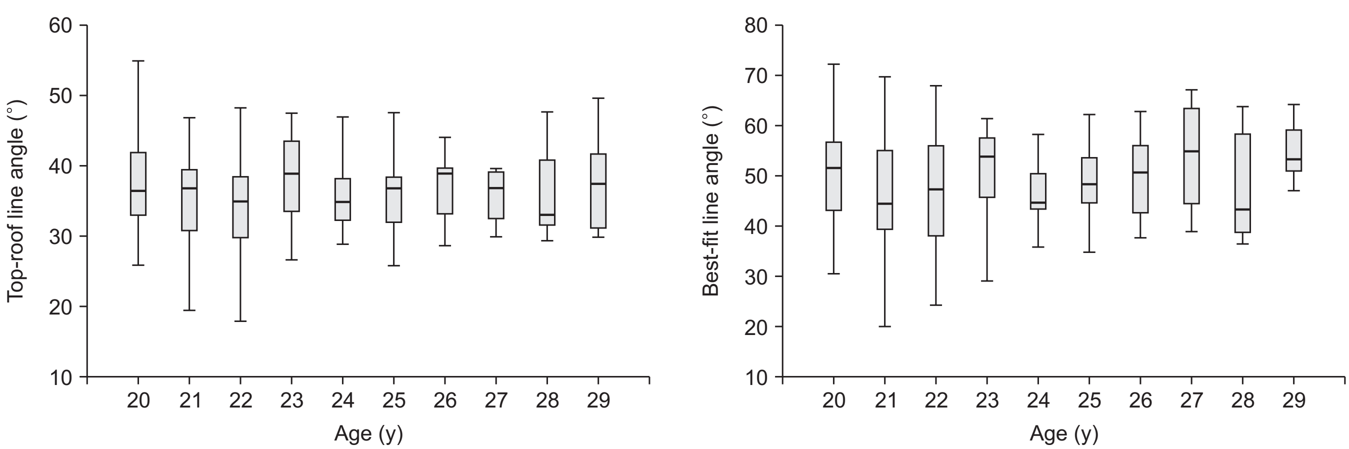

Fig. 3. Distribution of the top-roof line angle and best-fit line angle according to the age.

the intra-observer repeatability [14].

RESULTS

1. Eminence Morphology according to the Age

No significant difference was found between subjects aged 20-24 and 25-29 (Table 1). Fig. 3 depicts the distribution of top-roof line angle and best-fit line angle according to the age. Still, no significant relationship could be found between increasing age and the inclination of articular eminence.

2. Eminence Morphology according to the Sex

Overall, males had slightly larger eminence width, height, top-roof line angle, best-fit line angle and joint space. However, statistical significance was observed only in the joint space (Table 2). Since there was no significant sex difference in eminence morphology, analyses on the difference of eminence morphology according to the side.

3. Eminence Morphology according to the Side

Difference between left and right side of the joint were assessed only in the bilateral joint group. There was a statically significant difference in eminence width between the right and left joint (Table 3). However, other measurements did not show any significant difference. Therefore, other analyses were conducted regardless of the side of the joint.

DISCUSSION

The TMJ is a synovial joint where the mandibular condyle articulates at cranium with the squamous portion of the temporal bone [1]. This concave-shaped, squamous portion of the temporal bone is called mandibular fossa (or articular or glenoid fossa) [1], and articular eminence is located anterior to the mandibular fossa. The morphology of articular eminence not only dictates the pathway of the mandibular condyle while the mandible is moving forward (or translating) [2], it also determines the degree of rotation of disc over the condyle [3]. Steeper articular eminence makes the condyle to move more inferiorly while it translates; resulting in more vertical movement of the mandible [3].

Numerous studies using various imaging methods were used for the evaluation of the morphology of articular eminence including tomographic radiographs [9,15], panoramic radiographs [8,16], cephalometric radiographs [17], CBCT [10,18] and magnetic resonance imaging [5,16,19]. CBCT has various advantages including cost-effectiveness, dose-effectiveness, high spatial resolution [11] so this study used CBCT image.

It is already known that the inclination of articular eminence of TMJ is highly variable between individuals and is also variable within an individual over time [1,3,9]. Katsavrias [3] reported that the inclination of articular eminence reaches 92% of its final value by the age of 20 and the remaining 10% during the subsequent ten years in Asian Indian. Choi et al. [9] found sex differences in growth of eminence height and inclination. Using tomographic radiograph, they concluded that female subjects reach their 82.2% of maximal inclination by the age of 7.9 and 103.3% of maximal inclination by the age of 13.7 whereas male subjects reach 69.3% by the age of 8.1 and 83.3% by the

Table 2. Eminence morphology according to sex

	Male (n=84)	Female (n=170)	p-value
Eminence width (mm)	9.49±1.62	9.33±1.36	0.504
Eminence height (mm)	7.23±1.81	6.82±1.31	0.152
Top-roof line angle (°)	37.09±7.74	36.12±5.65	0.429
Best-fit line angle (°)	50.79±11.49	48.43±9.05	0.159
Joint space (mm)	3.03±0.67	2.63±0.68	0.001*

Values are presented as mean±standard deviation.
*$p<0.05$.

Table 3. Eminence morphology according to the side

	Right (n=83)	Left (n=83)	p-value
Eminence width (mm)	9.60±1.49	9.15±1.36	0.041*
Eminence height (mm)	6.94±1.48	6.95±1.50	0.944
Top-roof line angle (°)	35.69±5.59	37.14±6.98	0.142
Best-fit line angle (°)	48.77±9.44	49.51±10.32	0.632
Joint space (mm)	2.67±0.68	2.83±0.71	0.143

Values are presented as mean±standard deviation.
*$p<0.05$.

age of 14.2. Meanwhile, Sümbüllü et al. [13] reported that eminence the highest value of eminence inclination and height can be seen in the 21-30 age group and decrease afterwards. The result of the current study (Table 1, Fig. 3) is consistent with Sümbüllü et al.'s [13] findings. No statistically significant difference was observed ($p>0.05$) in subjects aged 20-24 and 25-29. In addition, no correlation was found with increasing age and both top-roof line angle and best-fit line angle (Fig. 3).

No significant sex difference was observed in the current study (Table 2). The angles measured by two different methods were higher in male than female, but it was not statistically significant. Some previous literature [20-22] has suggested that there is a sex difference in the morphology of articular eminence. However, others [5,13,19,21] found no such difference exists. The result of the present study is almost identical to the report by Sümbüllü et al. [13], who suggested that male subjects had higher width, height, and inclination on average but did not have any statistical significance ($p>0.05$).

Difference between left and right joint were assessed only in the bilateral joint group, because subjects who have degenerative change in one side of the joint may affect the result. The difference between the left and right side of the joint was observed only in eminence width ($p=0.041$). However, other measurements did not show statistically significant difference ($p<0.05$), and it is consistent with the previous results [5,19].

In conclusion, increasing age did not affect the morphology of the articular eminence in asymptomatic young Korean adults. Males had slightly larger eminence width, height, top-roof line angle, best-fit line angle and joint space, but no statistical significance was observed only in the joint space. There was no side-to-side difference in morphology.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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