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Evaluation of Glenoid Fossa Morphology in Different Facial Growth Patterns: A Cone Beam Computed Tomography Study

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Abstract

PURPOSE: The aim of current study was to assess the glenoid fossa morphology among different vertical skeletal patterns using cone beam computed tomography (CBCT).

MATERIALS AND METHODS: The CBCT images of 63 patients with Class I sagittal skeletal pattern were classified into three groups based on posterior facial height (PFH)/anterior facial height (AFH) ratio. Each group divided in to normal, horizontal, and vertical growth pattern groups. Depth, width, and inclination of glenoid fossa were measured and assessed on CBCT images. One-way analysis of variance (ANOVA) and Tukey post-hoc test were used to compare mean values of measured variables among the groups.

RESULTS: The width (28.76 ± 0.79) and depth (14.61 ± 0.514) of glenoid fossa were lower in horizontal in comparison to vertical and normal growth patterns (P-value < 0.05). Although steepness of glenoid fossa was higher in normal growth pattern (123.8 ± 16.68), no statistically significant differences were seen (P-value = 0.819).

CONCLUSION: The width and depth of glenoid fossa were significantly lower in horizontal growth pattern.

KEYWORDS: Glenoid Fossa; Growth Pattern; CBCT; TMJ

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Introduction

Temporomandibular joint (TMJ) is one of the most complex joints due to its anatomical, histological, and biomechanical characteristics [1]. TMJ is the joint between the mandible and the temporal bone of the skull that consists of mandibular condyle, glenoid fossa and articular eminence of the temporal bone [2]. Some previous studies showed association between the joint morphology and different facial patterns. Therefore, knowing about the articular eminence inclination could help clinician in the diagnosis, establishing more biological treatment modalities and treatment response between different facial types [3,4].

Several recent studies have investigated the association between joint morphology and sagittal craniofacial patterns [5-13]. Little is known about the association between the growth pattern and glenoid fossa morphology. To the best of our knowledge, there were only two studies that evaluated the association between the glenoid fossa morphology and vertical craniofacial morphology [14,15]. The study conducted by *Lin et al*. evaluated articular eminence angle

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using lateral cephalometry [14]. The other study assessed the position and morphology of the temporomandibular joint in skeletal Class II females using CBCT [15].

CBCT is a choice to evaluate TMJ structures because of several advantages including high-resolution images, short scanning times, reduced radiation dose and no magnification or distortion for accurate measurement of joint structure dimensions [16,17]. Therefore, the aim of present study was to assess the glenoid fossa morphology among different vertical skeletal patterns using CBCT.

Material and Methods

This cross-sectional study protocol was approved by institutional Research Ethics Committee of Shiraz University of Medical Sciences (SUMS) (*IR.SUMS.DENTAL.REC.1399.005*). Diagnostic CBCT images of 63 adult patients (17 verticals, 29 horizontals and 17 normal) who referred to Radiology Department of Dental School of SUMS for dental services such as impacted teeth, PNS, maxillofacial CBCT and etc. entered this study**.** The inclusion criterion follows: sufficient image sharpness and contrast to visualize the structure to be evaluated (glenoid fossa , articular eminence, sella turcica, mandible and nasion), and patients with skeletal Class I relationships on the basis of ANB angle, 0 to 4 degrees [18]. The exclusion criteria were symptoms of temporomandibular disorders, history of TMJ surgery and/or TMJ trauma, or fracture in the TMJ region, any congenital abnormalities or systemic diseases potentially affecting joint morphology. CBCT of patients presenting evidence of degenerative joint disease in the images were excluded from the study. All CBCT scans were taken by the same clinician using New Tom VGi. The exposure factors set at 120 kVp, 4.6 mA, exposure time of 20 s, and a field of view of 15 × 15 cm. The CBCT images were taken with the participants biting in maximum dental intercuspation and their heads positioned so that the Frankfort plane was parallel to the floor. The images divided into three groups according to growth pattern based on posterior facial height (PFH)/anterior facial height (AFH) ratio (Table 1).

Table 1. Distribution of subjects according to different growth patterns

Variables	Growth pattern group (Valid percent)		
	Vertical (N= 17)	Normal (N=17)	Horizontal (N=29)
PFH/AFH	< 62	62- 65	> 65

On the axial view, the section of the condylar process that had the widest mediolateral diameter on the left and right sides was chosen as the reference view for reconstruction of the sagittal slices. In this section, a line parallel to the long axis of the condylar process was drawn and sagittal images were reconstructed as 0.5 mm slice interval/thickness. The measurements were establishing on the central sagittal section of the condyle. The glenoid fossa depth was established by measuring the perpendicular distance between the highest point of fossa and the line passing through the most inferior point on the articular eminence and the posterior glenoid process (Figure 1.b). The glenoid fossa width defined as the distance between the most inferior point on the articular eminence and the posterior glenoid process (Figure 1.b). The articular eminence inclination was measured by top-roof line method, i.e., the angle between Frankfort plane and the plane passing through the highest point in the roof of glenoid fossa and the lowest point at the crest of the articular eminence (Figure 1.c).

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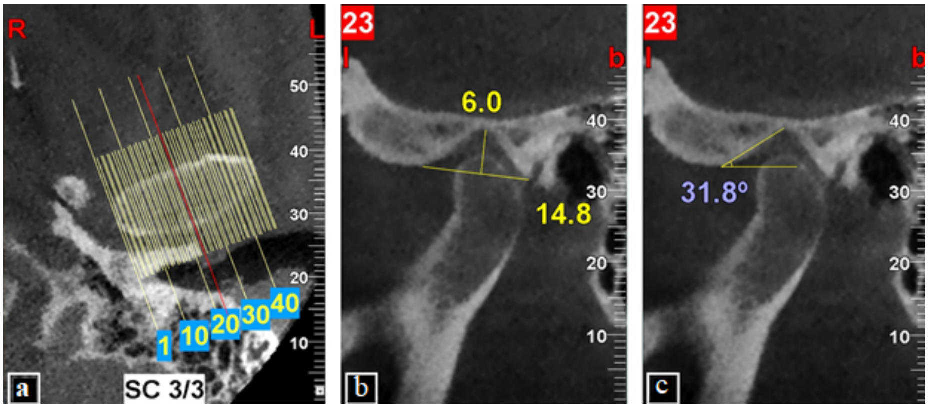

***Figure 1.** Axial view of the condylar process (a); linear measurements of depth and width of glenoid fossa (b); inclination of glenoid (c).*

Statistical analysis

Data were analyzed using SPSS software package V.18 (version 18, SPSS Inc, Chicago, IL, USA). All CBCT images were re-measured by the same examiner after a 2-week interval to confirm intra-observer reliability. Intra-Class correlation coefficient was used to assess the reliability of the measurements. One-way analysis of variance (ANOVA) and Tukey post-hoc test were used to evaluate the association between different growth patterns and glenoid fossa morphology. P-value less than 0.05 was considered significant.

Results

A total of 63 adult patients were included in this study. Distribution of glenoid fossa morphology based on the width, depth and inclination is shown in Table 2. The width (28.76 ± 0.79) and depth (14.61 ± 0.514) of glenoid fossa in horizontal growth pattern were the least of all groups (P-value < 0.05). Although not statistically significant, the inclination of glenoid fossa was highest in normal growth pattern (123.8 ± 16.68).

Table 2. Distribution of glenoid fossa morphology based on the width, depth, and inclination of glenoid fossa

	Growth pattern group			
Variables	**Normal** Mean ± SD*	**Vertical** Mean ± SD	**Horizontal** Mean ± SD	**P-value**
Width	32.11 ± 0.79	30.33 ± 0.79	28.76 ± 0.79	0.017
Depth	15.34 ± 0.514	16.49 ± 0.514	14.61 ± 0.514	0.043
Inclination	123.8 ± 16.68	114.66 ± 16.68	109.013 ±16.68	0.819

*Standard Deviation

Discussion

Sagittal and vertical facial disharmonies can affect the relationship of the mandible to the cranial base. Therefore, glenoid fossa position is likely to play an important role in the establishment of different craniofacial patterns and orthopedic/orthodontic therapies [19-21]. In current study we determined the association between glenoid fossa morphology and different growth patterns using CBCT images.

The variability and complexity of the TMJ make it difficult for accurate radiographic examination and clinical diagnosis [22]. Different radiographic methods have been used in previous studies to examine the TMJ morphology, such as computed tomography [23], magnetic resonance imaging [24], conventional tomography [25], and CBCT [26-28]. Standard 2D radiographs of the TMJ have several limitations including superimposition of overlying structures, magnification and distortion that limit the ability to evaluate TMJ [29,30]. CBCT, a recently developed imaging technology, has been used for 3D imaging of the TMJ and has been shown to delineate the joint

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structures with high accuracy [26]. Therefore, in our study we used CBCT images for evaluation of joint morphology.

There are two methods for measuring articular eminence inclination [4,31,32]. The first method is to measure the angle between FH plane and the line of deepest point of the roof of the fossa and the top of the articular eminence. The second method defines articular eminence inclination as the angle between the best fit line drawn along the posterior slope of articular eminence and FH plane. It should be noted that both angles really show the eminence inclination; the first method focuses on the location of eminence crest relative to the fossa roof, whereas the second method focuses on the posterior surface of eminence. The second method represents the actual condylar path, whereas the first method depicts the morphology of articular eminence better. In the present study the former method has been used the same *as Katsavrias et al.* [4] , *Sümbüllü et al.* [31] and *Kranjčić et al.* [32].

Inclination is defined as an angle between posterior slope of the articular eminence and any other horizontal plane such as FH plane, occlusal plane, and palatal plane [4,32]. The line frequently used is FH plane [31-34]. *Cohlmia et al*. used the superior border of a tomographic film [35], whereas Keller and Carano used the angle between the posterior surface of the articular eminence and the posterior occlusal plane [34]. Since some other previous studies selected the FH plane as the reference plane. We also used FH plane as the reference plane in the present study like *Sümbüllü et al.* [31], *Kranjčić et al.* [32] , *Wu et al.* [33] and *Gökalp et al*. [34].

There were different concepts about the depth and width of the glenoid fossa. Our results showed that the depth and width of glenoid fossa in horizontal growth pattern was significantly smaller than other groups in skeletal Cl I. Lower depth seems to be in accordance with clockwise rotation of anterior and posterior cranial bases [36]. *Lin et al*. [15] and *Katsavrias et al.* [37] expressed that the depth of the glenoid fossa in high-angle was significantly smaller than control and the low-angle groups but there were no statistical differences between three groups in regard to width of glenoid fossa. The differences might be due to different case selections; skeletal Cl I in current study vs skeletal class II female cases and different sagittal skeletal patterns in *Lin*'s and Katsavrias' respectively.

The inclination of the glenoid fossa was lower although not statistically significant in the horizontal compared with vertical and normal growth pattern groups. On the other hand, *Lin et al.* [15] and *Widman et al.* [14] demonstrated that inclination of articular eminence and mandibular plane angle were inversely related. The variation in the results from these studies might be due to different radiographic methods and the index for growth pattern classification with varying accuracy. Current study analyzed CBCT images of Class I adult patients and adopted Jaraback's as a reliable index to represent the growth pattern. *Widman et al.* [14] and *Lin et al.* [15] examined the angle of articular eminence with lateral cephalometry and adopted mandibular plane angle to classify patients. We assumed that unlike SN-MP and FMA, representing the relation of the mandibular base to cranial base, Jaraback's is a special index to classify patients according to their growth patterns.

Conclusion

Due to the importance of muscular function on the TMJ it is recommended further studies focusing on the relationship of muscle function and glenoid fossa morphology.

The width and depth of glenoid fossa were significantly lower in horizontal growth pattern. No statistically significant differences were found between inclinations of glenoid fossa among three groups.

References

1. Temporomandibular joint anatomy assessed by CBCT images. Caruso S, Storti E, Nota A, Ehsani S, Gatto R. BioMed Res Int. 2017;2017.
2. Skin doses on the lens for temporomandibular joint exam in cone beam computed

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Vol 11 No 1 (2023) DOI 10.5195/d3000.2023.172

tomography. Oliveira MVLd, Andrade MEA, Batista WO, Campos PSF. Brazil Arch Biol Technol. 2015;58(6):886-90.
3. Comparison of condylar position in hyperdivergent and hypodivergent facial skeletal types. Girardot Jr RA. Angle Orthodontist. 2001;71(4):240-6.
4. Changes in articular eminence inclination during the craniofacial growth period. Katsavrias EG. Angle Orthodontist. 2002;72(3):258-64.
5. Condyle and fossa shape in Class II and Class III skeletal patterns: a morphometric tomographic study. Katsavrias EG, Halazonetis DJ. Ame J Orthodont Dentofac Orthoped. 2005;128(3):337-46.
6. Three-dimensional evaluation of TMJ parameters in Class II and Class III patients. Krisjane Z, Urtane I, Krumina G, Zepa K. Stomatologija. 2009;11(1):32-6.
7. Condylar volume and condylar area in class I, class II and class III young adult subjects. Saccucci M, D'Attilio M, Rodolfino D, Festa F, Polimeni A, Tecco S. Head Face Med. 2012;8(1):34.
8. Correlation between condylar position and different sagittal skeletal facial types. Paknahad M, Shahidi S, Abbaszade H. J Orofacial Orthoped. 2016;77(5):350-6.
9. Computed tomography evaluation of the temporomandibular joint in Class II Division 1 and Class III malocclusion patients: condylar symmetry and condyle-fossa relationship. Rodrigues AF, Fraga MR, Vitral RWF. Am J Orthodont Dentofac Orthoped. 2009;136(2):199-206.
10. Computed tomography evaluation of temporomandibular joint alterations in patients with class II division 1 subdivision malocclusions: condyle-fossa relationship. Vitral RWF, de Souza Telles C, Fraga MR, de Oliveira RSMF, Tanaka OM. Am J Orthodont Dentofac Orthopedic. 2004;126(1):48-52.
11. Three-dimensional cone-beam computed tomography based comparison of condylar position and morphology according to the vertical skeletal pattern. Park IY, Kim JH, Park YH. Korean J Orthodont. 2015;45(2):66-73.
12. Association between condylar position and vertical skeletal craniofacial morphology: A cone beam computed tomography study. Paknahad M, Shahidi S. Int Orthodont. 2017;15(4):740-51.
13. Comparison of Glenoid Fossa Morphology Between Different Sagittal Skeletal Pattern Using Cone Beam Computed Tomography. Khademi B, Karandish M, Paknahad M, Farmani S. J Craniofac Surg. 2020;31(8):e789-e92.
14. Functional and morphologic considerations of the articular eminence. Widman DJ. Angle Orthodont. 1988;58(3):221-36.
15. Comparative Cone-Beam Computed Tomography Evaluation Of Temporomandibular Joint Position and Morphology in Skeletal Class II Females. Lin YXM, Wu H, Zhang H, Wang S, Qi K. J Int Med Res 2020;48(2):300060519892388. doi: 10.1177/0300060519892388.
16. Clinical applications of cone-beam computed tomography in dental practice. Scarfe WC, Farman AG, Sukovic P. J Canada Dent Associat. 2006;72(1):75.
17. Cone beam computed tomography 3D reconstruction of the mandibular condyle. Schlueter B, Kim KB, Oliver D, Sortiropoulos G. Angle Orthodont. 2008;78(5):880-8.
18. Cephalometrics for you and me. Steiner C. Am J Orthodontic. 1953;39(10):729-55. http://dx.doi.org/10.1016/0002-9416(53)90082-7
19. The cranial base as an aetiological factor in malocclusion. Hopkin G, Houston W, James G. Angle Orthodontist. 1968;38(3):250-5.
20. Some relationships between the glenoid fossa position and various skeletal discrepancies. Droel R, Isaacson RJ. Am J Orthodontic. 1972;61(1):64-78.
21. Tissue reactions in the temporomandibular joint resulting from anterior displacement of the mandible in the monkey. Stöckli PW, Willert HG. Am J Orthodontic Dentofacial Orthopedic. 1971;60(2):142-55.
22. Cone-beam CT evaluation of temporomandibular joint in permanent dentition according to Angle's classification. Song J, Cheng M, Qian Y, Chu F. Oral Radiol. 2020;36(3):261-6.
23. Characteristics of articular fossa and condyle in patients with temporomandibular joint complaint. Okur A, Ozkiris M, Kapusuz Z, Karaçavus S, Saydam L. Eur Rev Med Pharmacol Sci. 2012;16(15):2131-5.
24. Condylar position assessed by magnetic resonance imaging after various bite position registrations. Kandasamy S, Boeddinghaus R, Kruger E. Am J Orthodontic Dentofacial Orthopedic. 2013;144(4):512-7.
25. Tomographic assessment of temporomandibular joint osseous articular surface contour and spatial relationships associated with disc displacement and disc length. Major PW, Kinniburgh RD, Nebbe B, Prasad NG, Glover KE.

Dentistry 3000
Vol 11 No 1 (2023) DOI 10.5195/d3000.2023.172

Am J Orthodontic Dentofacial Orthopedic. 2002;121(2):152-61.
26. Assessment of optimal condylar position with limited cone-beam computed tomography. Ikeda K, Kawamura A. Am J Orthodontic Dentofacial Orthopedic. 2009;135(4):495-501.
27. Cone beam computed tomography imaging in the evaluation of the temporomandibular joint. Barghan S, Merrill R, Tetradis S. J California Dent Associat. 2010;38(1):33-9.
28. Assessment of condyle and glenoid fossa morphology using CBCT in South-East Asians. Al-koshab M, Nambiar P, John J. PloS one. 2015;10(3):e0121682.
29. Spatial analysis of condyle position according to sagittal skeletal relationship, assessed by cone beam computed tomography. Arieta-Miranda JM, Silva-Valencia M, Flores-Mir C, Paredes-Sampen NA, Arriola-Guillen LE. Progress Orthodontic. 2013;14(1):36.
30. Imaging of the temporomandibular joint: a position paper of the American Academy of Oral and Maxillofacial Radiology. Brooks SL, Brand JW, Gibbs SJ, Hollender L, Lurie AG, Omnell K-Å, et al. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol. 1997;83(5):609-18.
31. Radiological examination of the articular eminence morphology using cone beam CT. Sümbüllü M, Cağlayan F, Akgül H, Yilmaz A. Dentomaxillofacial Radiol. 2012;41(3):234-40.
32. Differences in articular-eminence inclination between medieval and contemporary human populations. Kranjčić J, Vojvodić D, Žabarović D, Vodanović M, Komar D, Mehulić K. Arch Oral Biol. 2012;57(8):1147-52.
33. Assessments of inclinations of the mandibular fossa by computed tomography in an Asian population. Wu C-K, Hsu JT, Shen YW, Chen JH, Shen WC, Fuh LJ. Clin Oral Invest. 2012;16(2):443-50.
34. Correlation between eminence steepness and condyle disc movements in temporomandibular joints with internal derangements on magnetic resonance imaging. Gökalp H, Türkkahraman H, Bzeizi N. Europ J Orthodontic. 2001;23(5):579-84.
35. Tomographic assessment of temporomandibular joints in patients with malocclusion. Cohlmia JT, Ghosh J, Sinha PK, Nanda RS, Currier GF. Angle Orthodontist. 1996;66(1):27-36.
36. Graber T, Vanarsdall R, Vig K. Current principles and techniques1994. 685 p.
37. Condyle and fossa shape in Class II and Class III skeletal patterns: a morphometric tomographic study. Katsavrias EG, Halazonetis DJ. Am J Orthod Dentofacial Orthop. 2005;128(3):337-46. http://dx.doi.org/10.1016/j.ajodo.2004.05.024 www.ncbi.nlm.nih.gov/pubmed/16168330