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Three-dimensional computed tomography analysis of mandibular morphology in patients with facial asymmetry and mandibular retrognathism

Kug-Ho You, Kyung-Ho Kim, Kee-Joon Lee, and Hyoung-Seon Baik
Seoul, Korea

Introduction: The purpose of this study was to analyze the morphologic features of skeletal units in the mandibles of patients with facial asymmetry and mandibular retrognathism using cone-beam computed tomography. **Methods:** The subjects consisted of 50 adults with facial asymmetry and mandibular retrognathism, divided into the symmetry group (n = 25) and the asymmetry group (n = 25) according to the degree of menton deviation. Three-dimensional computed tomography scans were obtained with cone beam computed tomography. Landmarks were designated on the reconstructed 3-dimensional images. Linear and volumetric measurements were made on the mandibles. **Results:** In the asymmetry group, the lengths of condylar, body, and coronoid units were shorter, and condylar width was narrower on the deviated side than on the nondeviated side (P <0.01). The lengths of angular and chin units were not significantly different between the deviated and nondeviated sides (P >0.05). Hemimandibular, ramal, and body volumes were less on the deviated side than on the nondeviated side (P <0.01). **Conclusions:** Condylar, body, and coronoid units contribute to mandibular asymmetry in patients with facial asymmetry and mandibular retrognathism. (Am J Orthod Dentofacial Orthop 2018;153:685-91)

Facial asymmetry is defined as inconsistency in size, shape, and arrangement of 1 side of the face from the opposite side when viewed in relation to the midsagittal plane.[1] Facial asymmetry is important in the esthetic evaluation of the craniofacial region. Facial asymmetry within limits is recognized as normal, but severe asymmetry of the facial features is not acceptable.[2] Facial asymmetry is a common finding. It was reported that 34% of patients who visited the University of North Carolina for orthodontic evaluation had facial asymmetry, and 75% of those had deviation of the chin.[3]

Two-dimensional (2D) x-ray films such as posteroanterior cephalograms, submentovertex views, and panoramic views have been used as diagnostic methods for facial asymmetry. However, the reliability of these 2D films is limited in the diagnosis of facial asymmetry.[4] Using 3-dimensional (3D) computed tomography (CT) imagings, clinicians can observe the outer and inner structures of an object precisely. Also, it enables volumetric measurement of craniofacial structures. In dentistry, cone-beam CT (CBCT) has been used widely because of lower radiation doses and lower costs. Also, because CBCT ensures high dimensional accuracy in measurements of facial structures, CBCT is an excellent method for evaluation of facial asymmetry.[5]

Previous 2D studies have reported that facial asymmetry is more prominent in the lower part of the face.[6,7] Likewise, previous 3D studies in patients with mandibular prognathism paid attention to the morphology of the mandible such as ramal height, body length, and ramal inclination, and showed that the mandible is a dominant factor in facial asymmetry.[8,9] Therefore, assessment of mandibular asymmetry is needed for understanding the characteristics of facial asymmetry.

Because the mandible might be a composite of relatively independent skeletal units including the condylar process, coronoid process, angular process, alveolar

From the Department of Orthodontics, College of Dentistry, Yonsei University, Seoul, Korea.
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Address correspondence to: Hyoung-Seon Baik, Department of Orthodontics, College of Dentistry, Yonsei University, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea; e-mail, baik@yuhs.ac.
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process, body, and chin, analysis of the mandible by skeletal units might help to understand the etiology of mandibular asymmetry.[10,11] You et al[12] examined the mandibles of patients with facial asymmetry and mandibular prognathism, and concluded that both condylar and body units contribute to mandibular asymmetry, with a more central role of the condylar unit. However, in a review of the literature, we found no studies that evaluated mandibular asymmetry by skeletal units in the retrusive mandible. Therefore, the purpose of this study was to analyze the morphologic features of skeletal units in the mandibles of patients with facial asymmetry and mandibular retrognathism using CBCT.

MATERIAL AND METHODS

This study was reviewed and approved by the ethics committee at Yonsei University, Seoul, Korea. We examined CBCT images of 50 patients who visited Yonsei University for orthodontic and orthognathic treatments from 2011 through 2016. The inclusion criteria were as follows: (1) older than 19 years of age; (2) ANB, $>4.0°$; (3) Pog to N perpendicular, < -6.0 mm; (4) $32.0° <$ SN-GoMe $< 40.0°$; (5) no systemic disease; (6) no osteoarthritis in the temporomandibular joint; and (7) no history of trauma in the craniofacial region.

The horizontal reference plane was established parallel to the Frankfort hoizontal plane, which was constructed on both sides of porion (highest midpoint on the roof of the external auditory meatus) and left of orbitale (lowest point on the infraorbital margin of each orbit). The midsagittal plane was drawn perpendicular to the horizontal plane passing through nasion (most posterior point on the curvature between the frontal and nasal bones in the midsagittal plane) and the prechiasmatic groove (vertical and transverse midpoint of the prechiasmatic groove).[13] The patients were divided into 2 groups according to the degree of menton deviation (MD) from the midsagittal reference plane. The symmetry group consisted of 25 adults (13 men, 12 women), whose MDs were less than 2 mm from the midsagittal reference plane. The asymmetry group included 25 adults (11 men, 14 women), whose MDs were more than 4 mm from the midsagittal reference plane. The characteristics of the patients in both groups are shown in Table I.

All patients underwent CBCT examinations (Alphard 3030; Asahi Roentgen, Kyoto, Japan) as part of diagnostic record gathering. CBCT scanning of the maxillofacial regions was performed for 17 second scans with a voxel size of 0.39 mm, a field of view of 20×17.9 cm, 80 kVp, and 5 mA. The patients were seated in an upright position and were biting in centric occlusion during exposure. The CBCT scan data were converted into DICOM format. Craniofacial 3D images were reconstructed from the DICOM data using the In-Vivo dental software program (version 5.1; Anatomage, San Jose, Calif). In volume-render mode, soft tissues were removed from the hard tissues with the function of threshold (226-3071 HU) of the software program. The mandibles were separated from the reconstructed 3D images, and the teeth above the alveolar bone in the mandible were removed.

Table I. Characteristics of subjects in the symmetry and asymmetry groups

Variable	*Mean*	*SD*	*Minimum*	*Maximum*
Symmetry group (n = 25)				
Age (y)	22.8	4.2	19.0	35.0
ANB (°)	7.7	2.4	5.3	13.5
Pog to N perpendicular (mm)	−7.9	3.3	−15.0	−6.1
MD (mm)	1.2	0.5	0.4	2.0
SN-GoMe (°)	37.0	3.3	32.0	39.8
Asymmetry group (n = 25)				
Age (y)	22.7	6.3	19.0	38.0
ANB (°)	7.2	1.9	5.1	10.3
Pog to N perpendicular (mm)	−8.0	3.2	−14.0	−6.0
MD (mm)	6.9	2.9	4.0	11.3
SN-GoMe (°)	36.2	3.4	32.5	39.9

Landmarks and measurements were selected according to the study of You et al.[12] Landmarks were designated on the surface of reconstructed 3D images and were verified on the axial, coronal, and sagittal views. All landmarks are shown in Figure 1 and Table II. Linear and volumetric measurements are shown in Figure 1. The mandibular volume was divided into 2 hemimandibular volumes by the plane connecting menton, point B, and G. Hemimandibular volume was divided into ramal and body volumes by the plane connecting Go_{mid}, J_{lat}, and J_{med}. The data were measured in increments of 0.01 mm for linear measurements, and 0.01×10^3 mm^3 for volumetric measurements.

Statistical analysis

Two weeks after the first measurements, all measurements were made again in 30 randomly selected subjects to examine intraobserver and interobserver errors by 3 observers. The 2 assessments by each observer were analyzed with intraclass correlation coefficiants for intraobserver reliability. The first and second assessments of the 3 observers were compared for interobserver reliability. Method errors were calculated with the Dahlberg formula.[14] The Shapiro-Wilk test showed that all measurements were normally distributed. The 2-sample *t* test was used to determine possible statistically significant differences between the male and female groups, and between the symmetry and asymmetry groups.