# Three-dimensional evaluation of dentofacial transverse widths of adults with various vertical facial patterns

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**Introduction:** The purpose of this study was to investigate maxillomandibular transverse widths and molar inclinations of adults with hypodivergent, normodivergent, and hyperdivergent facial patterns using cone-beam computed tomography. **Methods:** We evaluated Class I subjects (55 men, 66 women) who were divided into hypodivergent (<27°), normodivergent (28°-37°), and hyperdivergent (>38°) groups by their mandibular plane angles. Frontal and coronal views of the images were analyzed. Sex differences, vertical facial pattern differences, and related factors were assessed with independent 2-sample *t* tests, 1-way analysis of variance followed by post hoc Tukey tests, and Pearson correlation analysis. **Results:** The hypodivergent group had greater maxillary alveolar widths 7 mm apically from the alveolar crest. The intermolar widths and molar inclinations showed no significant differences among the groups. As the mandibular plane angles increased, interjugular widths, transverse mandibular widths, and buccolingual maxillary alveolar widths at the midroot level decreased, whereas the maxillomandibular width differences and palatal heights increased im both sexes. **Conclusions:** An increase in the mandibular plane angle is associated with tendencies of narrow mandibular arches, thinner maxillary alveolar bones at the midroot level, and higher palatal arches in both sexes. Intermolar widths and molar inclinations were not significantly affected by vertical facial patterns. (Am J Orthod Dentofacial Orthop 2018;153:692-700)

A balance between maxillary and mandibular transverse dimensions in the dental arches is considered one of the most important features for maintaining a functional and stable occlusion.[1] When this balance is disrupted, a transverse discrepancy in the dentofacial region generally occurs, with single or multiple posterior teeth in a crossbite state with an abnormal buccolingual relationship in 1 jaw or both jaws when in occlusion.[2] The prevalence of posterior crossbite shows wide variations among studies with rates between 8% and 22%.[3-5] The etiology of this malocclusion is often multifactorial including factors such as arch deficiencies, prolonged or early loss of deciduous teeth, deleterious oral habits such as thumb sucking, cleft palate, and so on.[2,6] In the long term, a transverse discrepancy that may adversely affect dentofacial esthetics.[1]

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All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Supported by the National Research Foundation of Korea grant funded by the Korea government (Ministry of Science, ICT and Future Planning) (2017R1D1A1B03030851).
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Submitted, May 2017; revised and accepted, August 2017.
0889-5406/$36.00

https://doi.org/10.1016/j.ajodo.2017.08.026

Dental arch parameters have been related to vertical facial types in many studies.[7-9] The mandibular plane has been used as a standard to divide the subjects into hypodivergent, normodivergent, and hyperdivergent growth patterns.[10,11] Subjects with hypodivergent growth patterns have short lower anterior facial height, small mandibular plane angle, and a tendency of deepbite. Subjects with hyperdivergent growth patterns often have increased lower anterior facial height, high mandibular plane angle, short ramus, and clockwise mandibular rotation. Some authors have suggested that in subjects with increased vertical dimensions, the maxillary dental arch is narrower, the palates have higher arches, and the posterior teeth are buccally inclined, whereas those with decreased vertical dimensions have the opposite characteristics such as lingually inclined molars.[12-14] However, Ross et al[9] found no differences in molar inclinations and facial types. Furthermore, Tsunori et al[15] argued that, although subjects with hyperdivergent growth patterns have narrow arches, strong pressure of the tongue against the teeth allowed uprighting of the molars. These aforementioned studies using 2-dimensional radiographs or study casts reflect the diversity of opinions on transverse dimensions and the relationship to various facial types in the vertical dimensions.

If the transverse width of the dental arch and the molar inclinations have correlations to vertical facial types, patients would benefit from treatment plans that include differentiated approaches for facial patterns to improve the transverse discrepancy to achieve an ideal functional and esthetic occlusion. Thus, the aim of this study was to investigate whether subjects with different vertical facial patterns vary in maxillomandibular transverse widths and first molar angulations using 3-dimensional cone-beam computed tomography (CBCT) images.

## MATERIAL AND METHODS

In this retrospective study, we evaluated subjects who visited Gangnam Severance Dental Hospital from January 2011 to February 2017 with CBCT scans (Pax-Zenith 3D; Vatech, Gyeonggi-Do, Korea) taken for diagnostic purposes of impacted third molars. The subjects were asked to relax the tongue and lip positions and maintain an intercuspal occlusion while the images were taken with a scan time of 24 seconds, tube voltage of 105 kV(p), and 0.3-mm voxel size. Pretreatment cephalograms were generated from the CBCT scans to classify the subjects based on their maxillomandibular sagittal discrepancies. The final sample included 121 adults (55 men, 66 women) with Class I molar relationships and ANB angles between 0° and 4°, classified as skeletal Class I subjects according to the classification of Steiner.[16,17] Subjects were excluded if there was facial asymmetry greater than 2 mm measured by a menton deviation from the midsagittal plane,[18] dental crowding greater than 5 mm, posterior crossbite, prosthetic treatment of the first molars, missing or extracted permanent teeth excluding prior extractions of third molars, previous orthodontic treatment, and a significant medical or dental history such as cleft lip or palate, craniofacial syndrome, or trauma. This study was approved by the research review board of Gangnam Severance Hospital (3-2017-0034) in Seoul, Korea.

The sample was divided into 3 groups of skeletal divergence by the sella-nasion line angle to the mandibular plane (SN-MP angle) measured from the generated cephalograms: less than 27° (hypodivergent), between 28° and 37° (normodivergent), and greater than 38° (hyperdivergent). These SN-MP values represented about 1 SD from the mean SN-MP angle of adults reported by Riedel[19] and were based on previous studies.[20,21] The mean SN-MP angle and demographics for the 3 groups are shown in Table I.

Skeletal and dental evaluations were performed on the coronal cross-sections of the CBCT scans by the On-Demand3D imaging software (CyberMed, Seoul, Korea). Cross-sections of 5-mm thickness were used to visualize both the mesiobuccal and palatal roots of the maxillary first molars on the same section. This was because a thinner section might show a portion of the maxillary root and mislead the investigator as to the location of the furcation.[22] The following reference planes were used to ensure consistent orientation of the 2-dimensional coronal slices: (1) the axial plane was defined as the Frankfort horizontal, the plane passing through the bilateral orbitales and the right porion; (2) the coronal plane, perpendicular to the axial plane, passing the buccal groove of the maxillary right first molar; and (3) the sagittal plane, perpendicular to the axial and coronal planes passing the midpoint of the medial rims of the orbits.

From the frontal view of the CBCT scan, the transverse distance between the bilateral jugular process and the bilateral antegonial notches were measured. The following measurements were made in the coronal plane. The transverse measurements were obtained by measuring the transverse width using the following bilateral landmarks on the maxilla and the mandible: (1) buccal alveolar crest point, (2) apical point 7 mm from the buccal alveolar crest, (3) lingual alveolar crest point, (4) apical point 7 mm from the lingual alveolar crest, and (5) most convex point on the buccal side of the first molar. The apical point 7 mm from the alveolar crest landmark was used to represent the midpoint of the first molar root length because the average maxillary and mandibular first molar root lengths have been reported to be 13 and 14 mm, respectively.[23] The angulations of the maxillary first molars were obtained by measuring the angles formed by the long axes of the molars and the Frankfort horizontal plane. The angulations of the mandibular first molars were obtained by measuring the angles formed by the long axes of the molars and the line connecting the mandibular inferior borders. Palatal depth was assessed by measuring the distance between the functional occlusal plane and the most superior point on the palate.[24]

For further evaluations, the following width differences were calculated: (1) maxillomandibular width difference, (2) maxillary buccolingual alveolar width at the alveolar crest and 7 mm apically from the alveolar crest, and (3) mandibular buccolingual alveolar width at the alveolar crest and 7 mm apically from the alveolar crest.