ORIGINAL ARTICLE CE AJO-DO

Three-dimensional evaluation of dentofacial transverse widths in adults with different sagittal facial patterns

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Introduction: The aim of this study was to evaluate the dentofacial transverse dimensions of subjects with different sagittal facial patterns using 3-dimensional cone-beam computed tomography images. **Methods:** Cone-beam computed tomography images of 63 men and 80 women were divided into skeletal Class I, Class II, and Class III groups. Skeletal and dental evaluations were made on frontal views and coronal cross-sections of the images. Independent 2-sample *t* tests and 1-way analysis of variance followed by post hoc Tukey tests were used for sex and group differences. Pearson correlation analysis was used to identify factors related to changes in ANB angle. **Results:** The Class II subjects did not show differences in maxillomandibular width and maxillary width compared with Class I subjects; however, their maxillary molars were more lingually tipped. The Class III subjects showed greater maxillomandibular width differences and smaller maxillary widths and maxillary buccolingual alveolar widths at midroot level compared with Class I subjects. The maxillary molars were buccally inclined, and the mandibular molars were lingually compensated in Class III subjects. The ANB angle showed positive correlations with jugal process width, maxillary width, and maxillary buccolingual alveolar width at midroot level as well as mandibular molar buccal inclination; negative correlations were found in maxillomandibular width difference, mandibular width at midroot level, and maxillary molar buccal inclination. **Conclusions:** A relative comparison of Class I, Class II, and Class III subjects showed that dental compensation had occurred to overcome the transverse skeletal discrepancies in the maxillary posterior segments of Class II and Class III subjects. This could escalate unidentified periodontal and functional problems in the long term. Future studies of transverse dentofacial dimensions, including periodontal evaluations and occlusal forces, would be useful for delivering proper orthodontic treatment for skeletal Class II and Class III subjects. (Am J Orthod Dentofacial Orthop 2018;154:365-74)

Transverse discrepancy is commonly assessed upon intraoral examination by a posterior crossbite, with prevalence rates from 8% to 22%.[1-4] The etiology of this malocclusion is complex and is associated with hereditary or environmental factors such as skeletal or dental abnormalities, congenital anomalies including cleft palate, nonnutritive sucking habits, mouth breathing, lowered tongue posture, and so on.[5-9] The early presence of a transverse discrepancy should not be overlooked since it could affect dentofacial growth in adverse directions because sagittal and vertical growth continues even after transverse dimensions are established.[10] Moreover, transverse coordination of the dental arches plays an important role in maintaining stable periodontal conditions and functional occlusion in the long term.[11]

In patients without apparent posterior crossbite, orthodontic diagnosis and treatment is generally focused on sagittal discrepancies, which are assessed with lateral cephalographs and study casts to categorize the subject into Class I, Class II, or Class III malocclusion on the basis of the anteroposterior position of the maxilla and mandible as well as first molar relationships. However, in complex malocclusion cases, additional posteroanterior radiographs or 3-dimensional (3D) cone-beam computed tomography (CBCT) images would aid in

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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 (2017R1D1A1B03030851) funded by the Korean government (Ministry of Science, ICT, and Future Planning; Ministry of Science, ICT, and Future Planning).
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Submitted, July 2017; revised and accepted, November 2017.
0889-5406/$36.00

https://doi.org/10.1016/j.ajodo.2017.11.041

detecting unidentified transverse discrepancies that may be clinically masked by the severity of the sagittal discrepancy and dental misalignment.

Previous studies have used 2-dimensional posteroanterior radiographs or study casts to compare the dental and skeletal components of transverse dimensions in subjects with different sagittal facial patterns.[12-14] These studies reported transverse discrepancy of deciduous molars in skeletal Class II subjects due to a narrow maxillary arch even with seemingly normal maxillomandibular width relationships that continued throughout the mixed dentition stage.[13-15] In skeletal Class III subjects, transverse discrepancies have been indirectly indicated by clinical studies that included rapid palatal expansion combined with facemask usage.[12,14]

To our knowledge, there have been no studies directly comparing dentofacial transverse dimensions using 3D images in adults with different sagittal facial patterns. Evaluations and comparisons of dentofacial widths of skeletal Class I, Class II, and Class III adults without apparent posterior crossbites would aid in identifying characteristics of the "hidden" transverse discrepancies that are difficult to diagnose clinically. Therefore, the aim of this study was to evaluate whether adults with different sagittal facial patterns show differences in dentofacial transverse dimensions and first molar inclinations using 3D CBCT images.

MATERIAL AND METHODS

In this study, we evaluated adults who visited Gangnam Severance Dental Hospital in Seoul, Korea, from January 2011 to February 2017. They had CBCT scans (Pax-Zenith 3D; Vatech, Gyeonggi-Do, Korea) taken in intercuspal occlusion for diagnostic purposes of impacted third molars. 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 analyze the subjects based on maxillomandibular sagittal and vertical discrepancies. The subjects were included if the vertical facial patterns were normodivergent, within the range of 28° to 37° measured by the angle between the sella-nasion line and the mandibular plane. This value represented about 1 SD from the mean mandibular plane angle of adults reported by Riedel.[16] Subjects were excluded from the study if they had posterior crossbite, facial asymmetry greater than 2 mm, dental crowding or spacing greater than 5 mm, prosthetic treatment of the first molars, missing or extracted permanent teeth excluding the third molars, prior orthodontic treatment, and significant medical or dental history such as cleft lip and palate, craniofacial syndromes, or trauma. The final sample included 143 adults (63 men, 80 women).

The sample was further divided into 3 groups depending on the maxillary and mandibular sagittal differences by evaluating the ANB angle followed by checking the first molar relationships: (1) skeletal Class I group, ANB angle between 0° and 4° and an Angle Class I molar relationship[17]; (2) skeletal Class II group, ANB angle greater than 4° and an Angle Class II molar relationship[17]; and (3) skeletal Class III group, ANB angle less than 0° and an Angle Class III molar relationship.[17] In the Class I group, the mesiobuccal cusp tip of the maxillary first molar was located at the buccal groove of the mandibular first molar. The mean ANB angles and ages of the subjects in the 3 groups are shown in Table I. This study was approved by the institution of research review board of Gangnam Severance Hospital (3-2017-0034).

Skeletal and dental evaluations were performed on the coronal cross-sections of the CBCT scans with OnDemand3D 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 molar on the same section. This was because a thinner section might show a portion of the maxillary root that could mislead the investigator as to the location of the furcation.[18] 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, which was the plane passing through the bilateral orbitales and the right porion; (2) the "first coronal plane" was perpendicular to the axial plane, passing the buccal groove of the maxillary right first molar; (3) the "second coronal plane" was perpendicular to the axial plane, passing the mesiobuccal groove of the mandibular right first molar; and (4) the sagittal plane was perpendicular to the axial and coronal planes passing the midpoint of the medial rims of the orbits. The first coronal plane was used to evaluate the dentoskeletal transverse measurements of all 3 groups, and the second coronal plane was used for additional evaluation of the mandibular skeletal parameters of the Class II and Class III groups (Fig 1).

From the frontal view of the CBCT scan, the transverse distances between the right and left jugal processes and the bilateral antegonial notches were measured. Maxillomandibular transverse dimensions were obtained on the first coronal plane using the following landmarks: (1) buccal alveolar crest point, (2) 7-mm apical point from the buccal alveolar crest, (3) lingual alveolar crest point, (4) 7-mm apical point from the lingual alveolar crest, and (5) most convex point on the buccal side of the first molar. Additionally, the mandibular skeletal transverse width was measured using the same