ORIGINAL ARTICLE

Morphologic quantification of the maxilla and the mandible with cone-beam computed tomography

Toshio Deguchi, Sr,[a] Shinya Katashiba,[b] Toru Inami,[c] Kelvin W. C. Foong,[d] and Chan Yiong Huak[e]
Singapore, and Nagano and Kyoto, Japan

Introduction: The purpose of this pilot study was to use cone-beam computed tomography (CBCT) to determine the volumes of the maxilla and the mandible in subjects with skeletal Class I, Class II, and Class III malocclusions. Hypothesis 1 was that the volume (size) of a skeletal Class II maxilla is larger than those of Class I and Class III. Hypothesis 2 was that the volume of a skeletal Class III mandible is larger than those of Class I and Class II. **Methods:** Thirty women patients were classified into 3 groups according to their skeletal pattern: skeletal Class I ($0° \leq$ ANB $< 6°$), Class II (ANB $\geq 6°$) and Class III (ANB $< 0°$). The volumes of the maxilla and the mandible were measured with CBCT. CB MercuRay (Hitachi Medico, Tokyo, Japan) and CB works software (CyberMed, Seoul, Korea) were used to process the images. **Results:** There was a trend that skeletal Class III subjects might have significantly greater mandibular volume compared with Class II subjects ($P = 0.089$). The ratios of maxilla-to-mandible volumes between the skeletal Class II and Class III groups were significantly different ($P = 0.005$). Differences were observed in the ratios of maxillary and mandibular volumes across the 3 groups. **Conclusions:** Hypotheses 1 and 2 were rejected; there was no trend for Class III subjects to have larger mandibles ($P = 0.089$) compared with Class II subjects. The ratio of the maxilla and mandible volumes in skeletal Class III subjects was significantly larger ($P = 0.005$) compared with Class II subjects. (Am J Orthod Dentofacial Orthop 2010;137:218-22)

Conventional head film analysis of skeletal morphology (cephalometrics) has been used since the Broadbent era.[1] In the last 10 years, 3-dimensional (3D) imaging applications have been used in orthodontic studies, including asymmetry of skeletal abnormalities, localization of impacted teeth, growth modality of orthodontic treatment, implant bone thickness, and upper airway.[2] To better understand the 3D morphology of skeletal Class I, Class II, and Class III malocclusions, a study on the volumes of the maxilla and the mandible would be helpful. Two-dimensional analysis can measure only the angular and linear differences and be used to evaluate the components of dental and skeletal abnormalities. A skeletal Class II malocclusion could be a combination of a protrusive or large maxilla and a retrusive or small mandible.[3] In contrast, a skeletal Class III mallocclsuion could be characterized by a retrusive mandible, a protrusive mandible, or a combination.[4] Kau et al[2] reported that 3D CBCT imaging in orthodontics seems to be a paradigm shift from landmarks, lines, distances, and angles to surfaces, areas, and volumes.

The purpose of this study was to use CBCT to determine whether there are any differences in the volumes of the maxilla and the mandible in subjects with skeletal Class I, Class II, and Class III malocclusions. Hypothesis 1 was that the volume (size) of a skeletal Class II maxilla is greater than those of Class I and Class III. Hypothesis 2 was that the volume of a skeletal Class III mandible is greater than those of Class I and Class II.

MATERIAL AND METHODS

Informed consent was obtained from 30 women patients chosen randomly from a private orthodontic clinic in Kyoto, Japan. They were classified into 3 groups

[a]Professor, Orthodontic Postgraduate Program, Faculty of Dentistry, National University of Singapore; professor emeritus, Graduate School, Matsumoto Dental University, Shiojiri, Nagano, Japan.
[b]Postgraduate student, Matsumoto Dental University, Shiojiri, Nagano, Japan.
[c]Private practice, Kyoto, Japan.
[d]Associate professor and director, Orthodontic Postgraduate Program, Department of Preventive Dentistry, Faculty of Dentistry, National University of Singapore.
[e]Head, Biostatistics Unit, Yong Loo School of Medicine, National University of Singapore.
The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.
Reprint requests to: Toshio Deguchi, Orthodontic Postgraduate Program, Department of Preventive Dentistry, Faculty of Dentistry, National University of Singapore, 5 Lower Kent Ridge Rd, Singapore 119074; e-mail, pndtd@nus.edu.sg.
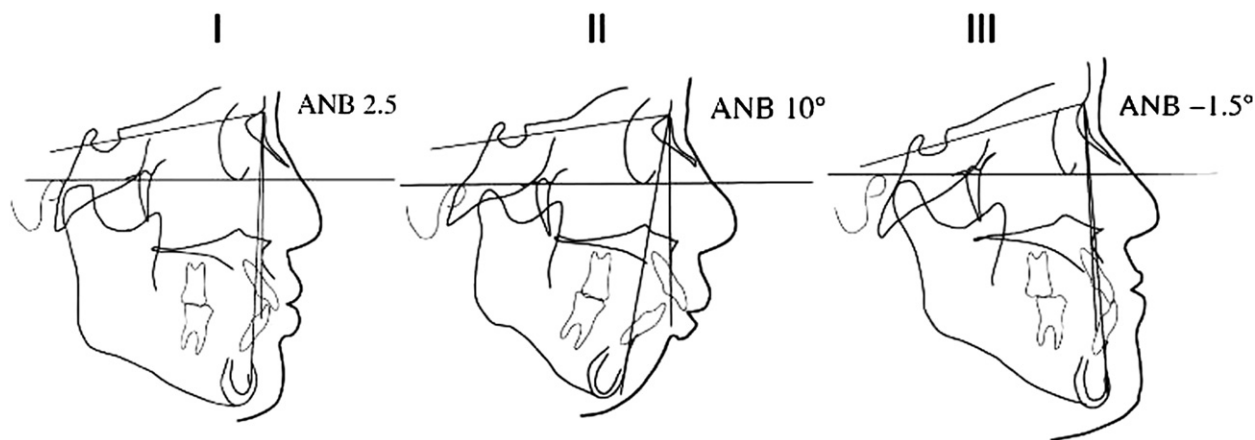
Fig 1. Tracings of typical skeletal malocclusions: Class I, Class II, and Class III. The ANB angle indicates the horizontal jaw relationship.

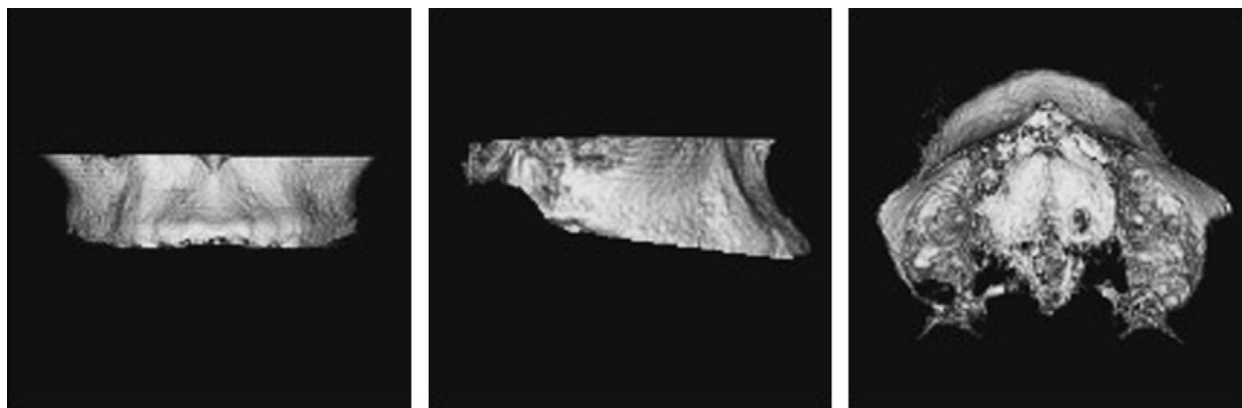**Fig 2.** Coronal, sagittal, and axial views for setting the boundaries of the maxillary bone.

according to skeletal pattern: skeletal Class I ($0° \leq$ ANB $<6°$; n = 10), Class II (ANB $\geq 6°$; n = 10), and Class III (ANB $<0°$; n = 10) as shown in Figure 1. The CBCT images in the pretreatment records were studied. All patients had no history of orthodontic treatment and congenital diseases.

Imaging was performed with the CB MercuRay (Hitachi Medico, Tokyo, Japan). The device was operated at 15 mA and 100 kV with 1 scan time of 10 seconds. Each field of view mode was 12 in. Then the image was processed with CB works software (CyberMed, Seoul, Korea). With a threshold set by an operator, the best images of the maxilla and the mandible were obtained. A 3D image was obtained by rendering the 3D volume. The upper reference line to the volume of the maxilla is the lower side of the palatal plane (anatomic posterior nasal spine-anterior nasal

spine line) that does not contain a tooth crown. The volume of the mandible without a tooth crown is the whole bone, including the condyle. The boundaries of alveolar bone and tooth crown were hand-drawn.

The coronal, sagittal, and axial views for setting the boundaries of the maxilla volume are shown in Figure 2. There were lateral and frontal 3D skeletal images of the maxilla and the mandible in skeletal Class I, Class II, and Class III malocclusions (Fig 3).

Measurement accuracy was verified. Although CBCT images are not standard, there are reference points when a CBCT image is taken: (1) the patient's head is fixed with a head holder, (2) the lateral line of light of the floodlight projector is parallel to the Frankfort plane, and (3) the frontal line of light is parallel to the orbital line, and the perpendicular line of light is perpendicular to the midline of the face.