Three-dimensional evaluation of morphologic tooth symmetry in various malocclusions

Furkan Dindaroğlu,[a] Gökhan Serhat Duran,[b] and Işıl Aras[a]
İzmir and Ankara, Turkey

Introduction: The aim of this study was to evaluate the morphologic symmetry of the maxillary and mandibular teeth between the left and right quadrants in 3 dimensions using advanced engineering software. **Methods:** The total sample comprised 120 dental casts of 60 patients with dental and skeletal Class I, Class II, and Class III malocclusions. They were divided into 3 groups of 40 dental casts (20 maxillary, 20 mandibular) belonging to 20 patients. The dental casts were digitized with an intraoral 3-dimensional scanner (TRIOS; 3Shape, Copenhagen, Denmark). Segmentation and superimposition procedures were carried out using Rapidform software (Inus Technology, Seoul, Korea). Teeth in the left and right quadrants (except for the second molars) in both jaws were superimposed using 3-point registration followed by surface-based registration; 3-Matic software (Materialise, Leuven, Belgium) was used for deviation analysis. **Results:** The maximum mean deviations observed in the positive and negative directions were 0.14 ± 0.10 mm in the maxilla (for the Class I group) and 0.16 ± 0.09 mm for the Class III group. The differences of the maximum deviation amounts among the malocclusion groups were 0.47 ± 0.08 mm in negative direction in the maxillary teeth and 0.79 ± 0.17 mm in the mandibular arch. **Conclusions:** In the 3 malocclusion groups investigated, morphologic deviations were low and clinically insignificant. Symmetry of tooth morphology did not differ among Class I, Class II, and Class III malocclusions. (Am J Orthod Dentofacial Orthop 2016;150:459-66)

Facial appearance, specifically the lower third of the face and particularly the mouth, has been deemed to play a vital part in social interactions, expressions of emotions, and physical attractiveness.[1,2] Subsequent to the many studies of concerned with evaluation of facial symmetry, the big picture concerning the oral environment has been scrutinized into so-called microelements from macroelements to mini-elements[3] over the years, and 1 such component is morphologic tooth symmetry. Montero et al,[4] in a study of 548 subjects, observed that tooth symmetry was graded to be the main element for a beautiful smile in a third of the population.

Several techniques have been used in assessing tooth size and shape, such as linear measurements in various directions either manually[5] or with computer software.[6,7] However, these methods have inherent incapabilities of depicting variations in tooth shape, form, and surface topography and are limited to providing mainly tooth size. Considering the complex 3-dimensional (3D) morphology of teeth, merely measuring in designated landmarks is insufficient to depict the true picture. On the other hand, the data acquired with surface laser scanners in x, y, and z coordinates and analyzed with reverse engineering technology enables us to observe morphologic differences precisely based on biologically meaningful structures in acquiring 3D superimpositions.

Although few studies have evaluated tooth symmetry even with linear measurements, there is yet no study that assessed both maxillary and mandibular teeth in 3 dimensions. We hypothesized that symmetry between the left and right posterior and anterior teeth in both jaws is different among Class I, Class II, and Class III malocclusions. The aim of this study was to evaluate the morphologic symmetry of maxillary and mandibular teeth in the left and right quadrants in 3 dimensions using advanced engineering software in the context of Class I, Class II, and Class III malocclusions.

MATERIAL AND METHODS

Ethical approval for the study was granted by the ethics committee of the School of Medicine, Ege University, İzmir, Turkey.

This study was conducted on 120 dental casts of 60 patients (mean age, 13.9 years; range, 12-15 years) having

[a]Research assistant, Department of Orthodontics, School of Dentistry, Ege University, İzmir, Turkey.
[b]Research assistant, Department of Orthodontics, Dental Sciences Centre, Gülhane Military Medical Academy, Ankara, Turkey.
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Address correspondence to: Furkan Dindaroğlu, Ege Üniversitesi, Diş Hekimliği Fakültesi, Ortodonti Anabilim Dalı, Bornova-İzmir 35100, Türkiye; e-mail, furkan.dindaroglu@ege.edu.tr.
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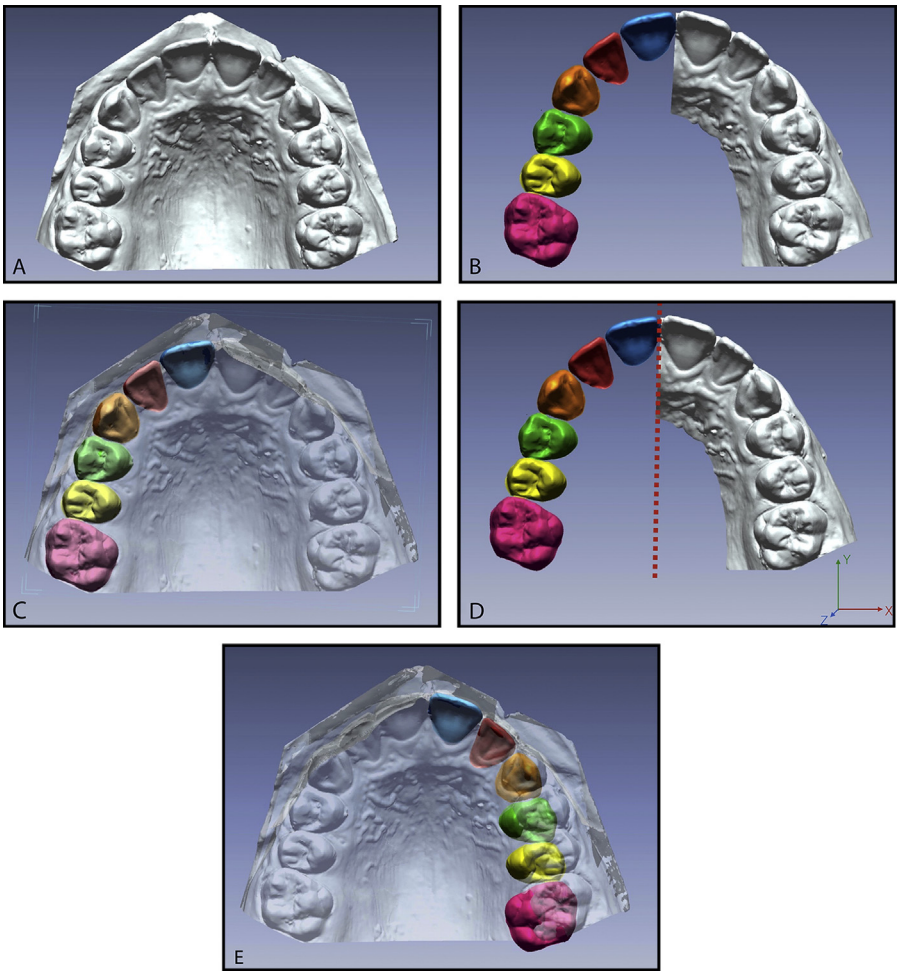

Fig 1. A-C, Segmentation of the maxillary anterior and posterior tooth crowns in the right quadrant of the jaw at the gingival margin; **D** and **E,** the mirror images of the segmented teeth acquired relative to the median palatine suture.

Class I, Class II, and Class III malocclusions. The mean ages of the patients in malocclusion groups were 13.7 ± 1.5, 14.2 ± 1.9, and 13.5 ± 1.1 years, respectively. Forty maxillary and mandibular dental casts belonging to 20 patients were included in each malocclusion group. The dental malocclusions were determined as Class I, Class II, and Class III according to the maxillomandibular molar relationship. ANB angle and Wits appraisal were used for assessing the skeletal anomalies. Subjects having an ANB angle of 2° ± 2° were identified as skeletal Class I, whereas ANB angles greater 4° and less than 0° were determined as skeletal Class II and Class III, respectively.[8] Subjects exhibiting a Wits appraisal of −1 ± 2 mm were categorized as Class I, whereas discrepancies more than 1 mm and less than −3 mm were identified as Class II and Class III, respectively.[9] Only those showing consistency between the ANB angle and the Wits appraisal were included in the study to overcome the effects of occlusal plane inclination and vertical growth pattern on the measurements. Additional selection criteria of the casts were (1) a fully erupted permanent dentition except for the second molars in both jaws; (2) no tooth agenesis or extractions; (3) no restorations, abrasions, or tooth anomalies; (4) no clinically visible discrepancies on the gingival margins of collateral teeth; (5) maximum of 3 mm of crowding; and (6) no evident facial and dentoalveoler asymmetry. Records of patients with genetic disorders such as syndromes were not included in the study.

Dental casts were digitized using an intraoral 3D scanner (TRIOS; 3Shape, Copenhagen, Denmark). Segmentation and superimposition procedures on casts converted to digital data were carried out using engineering software (Rapidform; Inus Technology, Seoul, Korea). Before the 3D deviation analysis, the teeth were superimposed twice using point-based and surface-based registrations. First, the crowns of anterior and posterior teeth in the