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Posttreatment evaluation of maxillary canine positions in 15-year-old subjects

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Introduction: Esthetic improvement is a primary reason that people seek orthodontic treatment. The maxillary canine is considered by many to have great importance for both function and esthetics. Limited information is available about the position of the maxillary canine in relation to skeletal landmarks and whether the position can influence esthetic perceptions. The purposes of this study were to evaluate the normal maxillary canine position in relation to skeletal landmarks, to determine posttreatment 3-dimensional maxillary canine position with cone-beam computed tomography images, and to see whether maxillary canine position influences esthetic perceptions. **Methods:** The Bolton standard template was used as the control sample, and the maxillary canine position was determined by implementing a Cartesian coordinate system. The right and left maxillary canines of 96 treated patients (48 boys, 48 girls; 15 years old) were analyzed by digitization of the cone-beam computed tomography volumes. The subjects' posttreatment smile photographs were ranked and quantified by 9 orthodontic residents who completed a Q-sort. Correlations were determined between canine positions and esthetic outcomes. **Results:** The only difference between the right and left canine positions was the anteroposterior position of the root apex. Statistically significant sex differences were found for the superoinferior position of the right and left canine cusp tips, the mediolateral right and left canine root apices, and the mediolateral left canine cusp tips. No correlation was determined between the maxillary canine position and the esthetic perception. **Conclusions:** The maxillary canine position in relation to skeletal landmarks was determined and does not appear to significantly impact the esthetic perception, according to this study. (Am J Orthod Dentofacial Orthop 2016;149:481-90)

A large body of orthodontic literature exists on the subject of dental esthetics. Esthetic factors such as a high degree of facial symmetry, an upper lip line upon smiling that fully displays the maxillary incisors, and well-proportioned dental and gingival architecture have been consistently found to improve esthetic perceptions.[1-6] Conversely, esthetic factors such as smile-arc consonance, buccal corridors, and the golden proportion in soft and hard tissues are highly contentious in the orthodontic literature.[7-10] This stems from the difficulty in objectifying and quantifying esthetics, a topic that is greatly affected by cultural and personal influences.[1,11]

Orthodontic diagnosis has focused primarily on the positions of the incisors and the molars in relation to the other teeth, the skull, and the supporting soft tissues. Interestingly, little information is available about maxillary canine position in both normal and abnormal dental and skeletal relationships, even though the canine is considered by many to be of great importance to occlusion and function.[12,13]

In the early 20th century, the German orthodontist Simon[14] developed a method of diagnosis and treatment planning based on the maxillary canine's position to the orbital plane. He reported that the orbital plane passed through the maxillary canine and the embrasure between the mandibular canine and the first premolar in most subjects. Simon's theory was reevaluated by Oppenheim in 1928 with conflicting results.[15] Oppenheim found that the maxillary canine angle was not perpendicular to the Frankfort horizontal as reported by Simon but was more procumbent with an average of 104.5°. Both studies were completed before the advent of cephalometrics. A review of the literature did not yield a

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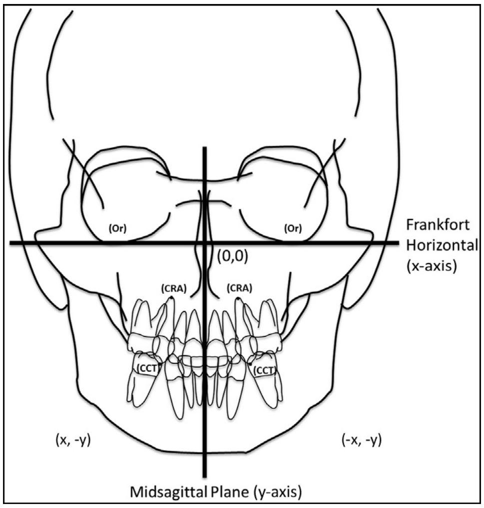

Fig 1. Orientation and landmarks of the control sample posteroanterior tracing. *Or*, Orbitale; *CRA*, canine root apex; *CCT*, canine cusp tip.

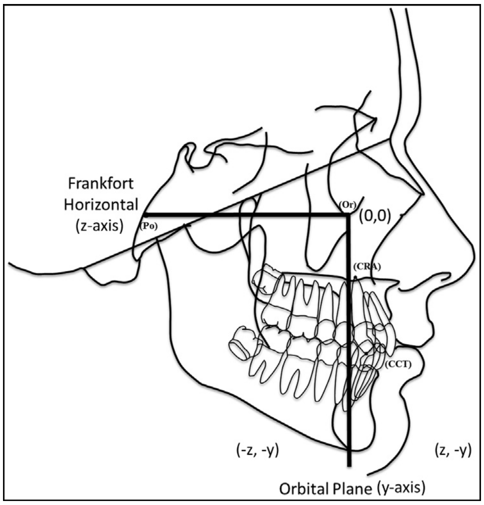

Fig 2. Orientation and landmarks of the control sample lateral tracing. *Po*, Porion; *Or*, orbitale; *CRA*, canine root apex; *CCT*, canine cusp tip.

current study examining the relationship between the maxillary canine positions and skeletal landmarks.

The purposes of this study were threefold. First, the normal maxillary canine position in relation to skeletal landmarks was determined. Second, a posttreatment 3-dimensional (3D) assessment of the maxillary canine position using cone-beam computed tomography (CBCT) volumes of white male and female subjects was completed. Finally, the effect of the maxillary canine position on the esthetic perceptions of frontal smiling photographs was determined.

MATERIAL AND METHODS

The control sample was composed of the Bolton standard cephalometric template of 15-year-old boys and girls. The Bolton standard template was created as a composite average of 32 male and 32 female subjects selected from the Bolton-Brush Longitudinal Growth Study. The subjects in the Bolton standard group never had orthodontic treatment and were previously deemed to have excellent facial esthetics, dental esthetics, and occlusal relationships.

A Cartesian coordinate system was used to uniformly orient the posteroanterior and lateral tracings (Figs 1 and 2). The x-axis of the posteroanterior tracing was established through the left and right orbitales. The y-axis of the posteroanterior cephalogram was constructed through the facial midline perpendicular to x-axis. The intersection of the x- and y-axes marked the 0,0 point. The Cartesian coordinate system for the lateral cephalogram was established with the Frankfort horizontal as the z-axis (horizontal). The orbital plane, as defined by Simon,[14] was constructed by a perpendicular plane from the Frankfort horizontal through orbitale and represented the y-axis (vertical). The 0,0 mark on the lateral cephalogram was at the intersection of the Frankfort horizontal and the orbital plane (Fig 1).

The landmarks identified on the lateral cephalogram were canine cusp tip, canine root apex, orbitale, and porion. The landmarks identified on the posteroanterior cephalogram were maxillary right canine cusp tip, maxillary right canine root apex, maxillary left canine cusp tip, maxillary left canine root apex, right orbitale, left orbitale, right ear rod, and left ear rod.

Maxillary right and left canine cusp tips and apices were identified, and the x- and y-coordinates were recorded on the posteroanterior cephalogram. The z- and y-coordinates were recorded on the lateral cephalograms of the canine cusp tip and the root apex. The z- and y-coordinates from the lateral tracing were applied to the right and left canines even though only the right canine is drawn on the Bolton standard template.

The experimental sample was composed of the posttreatment CBCT scans of 48 boys and 48 girls who had received orthodontic treatment at Case Western Reserve University in Cleveland, Ohio. They were selected based on the following criteria: white ethnicity; availability of a posttreatment CBCT volume; availability of a high-quality posttreatment photograph that showed the frontal smile; age, 15 years; presence of both maxillary right and left canines; no maxillary canine substitution treatment; and no significant restorative needs after orthodontic treatment.