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Maxillary transverse dimensions in subjects with and without impacted canines: A comparative cone-beam computed tomography study

Nicolas Arboleda-Ariza,[a] Juan Schilling,[b] Luis Ernesto Arriola-Guillén,[c] Gustavo Armando Ruíz-Mora,[d] Yalil Augusto Rodríguez-Cárdenas,[e] and Aron Aliaga-Del Castillo[f]

Lima, Perú, Bogotá, Colombia, and Bauru, São Paulo, Brazil

Introduction: The objective of this study was to compare the maxillary transverse dimensions between subjects with impacted maxillary canines and subjects without canine impactions, with similar vertical and sagittal features. **Methods:** In this retrospective study, 86 cone-beam computed tomography images of subjects with impacted maxillary canines (45 unilateral, 41 bilateral) and 67 images of subjects without dental impactions (control group) matched by similar vertical (NSAr, SArGo, ArGoMe) and sagittal (ANB, SNA, APDI) skeletal characteristics, were analyzed. The maxillary width was measured at 4 levels: first molar basal width, first molar alveolar width, first premolar basal width, and first premolar alveolar width. Group comparisons were performed with analysis of variance and post-hoc Scheffé tests. The influence of group features on the transverse dimensions was evaluated by a multiple linear regression analysis. **Results:** Groups with unilateral and bilateral impacted maxillary canines showed significantly smaller first molar basal widths, first molar alveolar widths, and first premolar alveolar widths compared with the control group ($P = 0.030$, $P < 0.001$, and $P < 0.001$, respectively). First premolar basal widths were not significantly different among the groups. **Conclusions:** Subjects with unilateral or bilateral impacted maxillary canines have smaller maxillary transverse dimensions than do subjects without impaction. Orthodontists should consider the relationship of maxillary width and canine impaction during diagnosis and treatment planning. (Am J Orthod Dentofacial Orthop 2018;154:495-503)

A common clinical finding in orthodontics is impacted maxillary canines. This dental eruption anomaly could be associated with morphologic variations in the maxillofacial and dentoalveolar structures.[1-3] The maxillary canine is the third most impacted tooth after the maxillary and mandibular third molars.[4] The prevalence of this condition varies depending on the evaluated population and has a range of 0.9% to 4.7%.[4-7] The etiology of palatally impacted canines is mainly associated with 2 theories: growth direction[8-10] and the genetic theory,[3,11-14] whereas the etiology of labially impacted canines appears to be dental crowding.[15]

Different studies have focused on evaluating the dental characteristics of subjects with impacted maxillary canines and have found that they are related to maxillary lateral incisor anatomy and agenesis, among other findings.[1-3,6-8,16-20] Other authors have studied the skeletal sagittal pattern of subjects with and without impacted maxillary canines and reported no significant differences between groups.[2,3,21] However, Cernochova and Izakovicova-Holla[1] found greater prevalences of Class I skeletal sagittal pattern in subjects with palatally displaced canines and Class III skeletal sagittal pattern in subjects with labially displaced

[a]Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Científica del Sur, Lima, Perú; Division of Orthodontics, Faculty of Dentistry, Universidad El Bosque, Bogotá, Colombia.
[b]Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Científica del Sur, Lima, Peru.
[c]Divisions of Orthodontics and Oral and Maxillofacial Radiology, School of Dentistry, Universidad Científica del Sur, Lima, Perú.
[d]Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Cientifica del Sur, Lima, Perú and Division of Orthodontics, Faculty of Dentistry, Universidad Nacional de Colombia, Bogotá, Colombia.
[e]Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Cientifica del Sur, Lima, Perú and Division of Oral and Maxillofacial Radiology, Faculty of Dentistry, Universidad Nacional de Colombia, Bogotá, Colombia.
[f]Department of Orthodontics, Bauru Dental School, University of São Paulo, Bauru, São Paulo, Brazil.
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Address correspondence to: Nicolas Arboleda-Ariza, Calle 147 # 14-69, Torre 2, Apartamento 501, Edificio Reservado 147, Bogotá D.C., Colombia; e-mail, arboledanicolas@gmail.com.
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canines. On the other hand, Basdra et al[19] associated canine impaction with Class II Division 2 malocclusion. Regarding the associated vertical pattern, some studies found a greater tendency of hypodivergence,[1,2] and other authors mentioned normal patterns.[3] In transverse measurements, there are differences among studies. McConnell et al[22] associated a transverse deficiency of the maxilla with palatally displaced canines, contrary to other studies reporting a relationship between greater maxillary transverse dimensions and canine impaction.[23,24] However, these studies did not match the groups to make true comparisons. Other authors did not find significant differences in maxillary width,[18,25-27] but these studies did not have an adequate control group. For these reasons, it seems necessary to clarify whether impacted maxillary canines have a relationship with the transverse skeletal dimensions of the maxilla.

Currently, cone-beam computed tomography (CBCT) is the most complete and efficient imaging tool for diagnosis and planning of impacted tooth treatment.[28] By applying the ALARA principle,[29-31] the analysis can be carried out in 3 dimensions, with a minimal dosage and high precision. The size, position, and potential effects of this eruptive anomaly can be analyzed with greater advantages over 2-dimensional images.[28,32]

Measurement of the maxillary transverse dimension is still controversial.[33] There are no studies comparing these dimensions between subjects with unilateral and bilateral impacted maxillary canines and subjects without dental impactions, with similar vertical and sagittal characteristics, using CBCT. Therefore, the objective of this study was to compare the maxillary transverse dimensions of subjects with unilateral and bilateral impacted maxillary canines and a control group without dental impactions, with similar vertical and sagittal characteristics, using CBCT. The null hypothesis was that there are no differences in the maxillary transverse dimensions in subjects with impacted maxillary canines compared with a matched control group without impaction.

MATERIAL AND METHODS

This retrospective study was approved by the institutional ethics committee of Universidad Científica del Sur, Lima, Perú. The sample consisted of CBCT images of subjects from 2 private diagnostic centers in Lima, Perú. Sample size was calculated considering a mean difference of 3.6 mm in the intermolar distance as a clinically relevant difference between the bilateral impacted maxillary canine group and the control group, using a standard deviation of 5.5 (obtained from a previous pilot study) with a 2-sided significance level of 0.05 and power of 80%. Although a minimum of 37 subjects per group was required, pretreatment records of 86 subjects with at least 1 impacted maxillary canine (45 unilateral, 41 bilateral; Fig 1) were used for the study groups, and 67 subjects with similar vertical and sagittal characteristics but without dental impactions were used as the control group. The selection criteria required that subjects have 2 mm or less of anterior dental crowding (measured between the central and lateral incisors). Subjects with previous orthodontic treatment, cleft lip or palate, craniofacial anomalies, head and neck syndromes, tumors, trauma or history of trauma, absence or dental agenesis, or other maxillary lesions were excluded.

CBCT scans were acquired with Picasso Master 3D (Vatech, Hwaseong, South Korea) set to 8 mA, 90 Kv, and exposure time of 20 seconds, with a flat panel detector 25 × 20 cm, and a field of view of 20 × 19 cm. CBCT synthesized cephalograms were obtained to match the groups by vertical and sagittal characteristics. Vertical growth pattern (mesofacial, brachyfacial, dolichofacial) was evaluated by measuring the nasion-sella-articulare angle (NSAr), sella-articulare-gonion angle (SArGo), and articulare-gonion-menton angle (ArGoMe).[34] Skeletal sagittal relationship (Class I, Class II, Class III) was evaluated by ANB and APDI angles. Maxillary sagittal position (normal, retrusive, protrusive) was evaluated by measuring sella-nasion-A point angle (SNA), palatal plane (PP)/anterior cranial base (ACB), and ratio (PP/ACB) (Table 1; Fig 2).

For maxillary width measurements, DICOM files were imported into OnDemand 3D software (version 1.0; Cybermed, Seoul, South Korea) that was used to orient the CBCT scans and measure all data, based on the method of Podesser et al.[35] Maxillary transverse dimensions were measured at 4 levels: first molar basal width (MBW), first molar alveolar width (MAW), first premolar basal width (PMBW), and first premolar alveolar width (PMAW) (Fig 3). The measurements were made on slices showing the maxillary first premolars and first molars. Molar measurements were made on the most anterior coronal slice showing the buccal root furcation with the palatal plane horizontal in the CBCT scan. Landmarks were placed at the most inferior point on the right and left nasal floor to draw a nasal floor reference plane passing through these 2 landmarks. Premolar measurements were made on the coronal slice showing the center of the root canal, with the same landmark placement and reference lines considered for molar measurements. The definitions of the cephalometric and CBCT measurements are shown in Table 1.

Twenty records were reanalyzed by the same examiner (N.A-A.) after a 30-day interval. Intraexaminer reliability was assessed by the intraclass correlation coefficient. Additionally, random error of reproducibility was calculated with Dahlberg's formula.[36]

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