

Original Article

Lower Arch Dimensions in Children with Anterior Open Bite and Normal Vertical Overbite: A Cross-sectional Study

Valentina Valderrama Rodríguez¹, Juliana Sánchez Garzón², Paola Botero-Mariaca¹

¹Department of Orthodontics, ²Department of Epidemiology, Universidad Cooperativa de Colombia, Envigado - Colombia

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ABSTRACT

Aim: Dental arch is a dynamic structure and its size depends on genetic and environmental factors. The aim of this study was to determine lower arch dimensions in children between 8 and 16 years with anterior open bite (AOB) and normal vertical overbite (NVO). **Materials and Methods:** A cross-sectional study was performed in 132 individuals with AOB and 132 with NVO between 8 and 16 years selected from public schools. Intercanine width, arch length, intermolar and interpremolar distances, and arch perimeter of the lower arch were measured in previously digitalized models using the GOM inspection program and an optical three-dimensional scanner. **Results:** Individuals with NVO presented smaller lower arch size with statistical differences in intercanine ($P = 0.024$, 95% confidence interval [CI]: 0.01, 0.02) and intermolar ($P = 0.000$, 95% CI: -1.76, -0.53) width and nonsignificant differences in the arch perimeter ($P = 0.239$, 95% CI: -1.57, 0.39) according to Mann-Whitney U -test. **Conclusion:** Individuals between 8 and 16 years of age with NVO showed smaller lower dental arch than individuals with AOB in most dimensions.

KEYWORDS: Dental arch, malocclusions, open bite, overbite

INTRODUCTION

Dental arch shape and size are established during growth and development, and their final structure is achieved based on several factors such as the supporting bone shape, dental eruption, perioral muscles, and intraoral forces.^[1] Dental arches are dynamic structures, which undergo different changes in the sagittal, transversal, and vertical planes, with a relatively rapid increase in their dimensions during deciduous and mixed eruption to accommodate the deciduous and permanent teeth. Once permanent functional dentition is established, the sagittal and transversal dimensions decrease, although to a lesser extent,^[2] due to dental position settlement.^[3] Dimensional arch changes depend on several factors such as genetics, race, function, and the presence of oral habits during development.^[4] Dental arch shape could affect bone development and teeth eruption angle, thereby resulting in multiple types of malocclusions.^[5]

An altered function of the tongue and lips during deglutition and breathing may cause changes in arch shape during development, resulting or exacerbating a preexistence malocclusion; for example, an increase in lower intercanine distance in the presence of thumb-sucking habit or a decrease in upper arch size in cases of oral breathing.^[6]

Individuals with anterior open bite (AOB) present lack of contact and vertical overlap between the upper and lower incisors. The incidence varies from 1.5% to 11% and differs according to race and dental age. This type of malocclusion is considered to be a combination of skeletal, dental, tissue factors, and habits reported as etiological factors in some studies;^[7] factors such as dental eruption, alveolar and skeletal growth

Address for correspondence: Dr. Paola Botero-Mariaca, Carrera 47# 37 Sur 18, Envigado, Medellín, Antioquia, Colombia.
E-mail: paola.botero@ucc.edu.co

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(hyperdivergent pattern), unproportioned muscle growth, airway obstruction, oral habits, and atypical neuromuscular function associated with lingual dysfunctions have been reported.^[8,9] Dimensional changes in the arches could contribute or aggravate AOB malocclusion,^[10] for example, the upper arch in individuals with AOB could be narrow compared with the arches from the individuals with normal vertical overbite (NVO).^[11]

In a previous study, upper dental arches of individuals with AOB and NVO were evaluated; significant statistical differences were noted in arch length, which was found to be bigger for AOB individuals.^[12]

Relationship between dental arch dimensions and facial phenotype has been proven using three-dimensional (3D) analysis. It could be interesting to perform stereophotogrammetry, which is considered a noninvasive gold-standard technique for the evaluation of the qualitative and quantitative effects on soft tissues of the orofacial region. In order to compare soft tissue changes with dental arch dimensions in both types of malocclusions because it can provide useful information for clinicians in order to achieve a good diagnosis and treatment.^[13,14]

Few studies in the literature have described lower dental arch size and shape in individuals with AOB; therefore, this study aimed to determine lower arch dimensions in children between 8 and 16 years of age with AOB and NVO.

MATERIALS AND METHODS

A cross-sectional study was performed in 264 individuals, 132 with AOB and 132 with NVO from five different public schools. The sample size was determined using the same methodology as a study previously described,^[12] considering a 2% prevalence of AOB with a confidence interval (CI) of 95% and a margin of error of 7% based on a population of 22,955 inhabitants.

The inclusion criteria consisted of previously selected children between 8 and 16 years of age with AOB and upper and lower incisors fully erupted without posterior crossbite. The exclusion criteria consisted of children with mental disabilities and facial and/or skeletal malformations, individual with caries or dental agenesis, individuals who received or were under interception and/or correction treatment, and those who sucked their thumbs or lips.

Dental impressions were obtained in alginate with liquid and powder ratio mixed according to the manufacturer's instructions and poured in type-III

plaster (the water and powder ratio was obtained by dividing the volume of water with the weight of the powder). The models were taken by the same previously calibrated operator (Kappa index of 95%) to avoid possible biased measures. Models were digitalized using the GOM's inspection program with a 3D optical scanner created by the company i3D [Figure 1] (ATOS Core Kinematics, Philadelphia, Pennsylvania USA and Toronto, Ontario Canada). The optical scanner used lens with a 440mm distance, a 300 × 230 × 230mm measuring volume, and a scanner with a precision of 15 microns.

All measurements were independently made by two professionals at two different times with a two-week interval. An intra- and interobserver error was determined by selecting 10 virtual 3D models, reproducibility was evaluated for all the variables using Dahlberg error. Reproducibility results showed values between 0.005 - 0.06 mm for each variable.

Digital measurements were made in millimeters and were as follows: intercanine width, straight-line measurement from the canine cuspid tip from both sides, and in cases of canine wear, the distance was measured at the middle of the facet. Intermolar distance, measured from the center of mesial fossa of the first right permanent molar to the first left permanent molar; arch perimeter, measured from mesial of the first permanent molar and going around the arch over contact points and the borders of the incisors in a gradual curve until reaching the mesial side of the first permanent molar of opposite side. Interpremolar width was from first right premolar fossa to first left premolar fossa. Finally, arch length was as a linear distance from the midpoint of the lingual aspect between the central incisors up to a tangent to mesial sides of second deciduous molars [Figure 2].



Figure 1: Model of the inferior arch taken and scanned from one of the individuals of this study

This study was approved by the Bioethics Committee of the Cooperative University of Colombia (Act 0800-00200). Written informed consents were obtained by individuals' legal tutor before starting the study.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) program, version 21.0, Armonk, New York - USA Markham, Ontario, Canada. For this analysis, information was summarized from the continuous variables using averages with their corresponding standard deviation and the categorical variables with proportions. To determine the statistical differences between the response variable and the co-variables, the quantitative variables were compared in both groups using the parametric (Student's *t*-test) and nonparametric (Mann–Whitney *U*-test) tests, with variables that did not follow a normal distribution a Shapiro–Wilk test was performed. To measure the association between the categorical variables, we used the chi-squared test of independence. In all cases, a 5% significance level was used.

RESULTS

A total of 264 models from individuals with and without AOB were measured, with an age ratio of 11.62 ± 2.58 years, 132 were males and 132 females, respectively [Figure 3]. The average intermolar distance was 42.12 ± 2.54 mm (minimum: 33.50 mm, maximum: 47.76 mm), interpremolar distance was 31.81 ± 2.30 mm, and intercanine distance was 26.93 ± 1.98 mm, whereas arch perimeter was 70.79 ± 3.98 mm (minimum: 51.44 mm, maximum: 83.55 mm). Similarly, the average for arch length was 21.80 ± 3.91 mm (minimum: 14.80, maximum: 74.76 mm).

Evaluating the relationship between age and occlusion type, no statistically significant differences ($P = 0.117$, 95% CI: 0.10, 0.11) with Mann–Whitney *U*-test were noted. While comparing the intermolar distance and arch perimeter between groups, we determined that in the first measurement, individuals with AOB had larger arches than those with NVO ($P = 0.000$, 95% CI: $-1.76, -0.53$), whereas

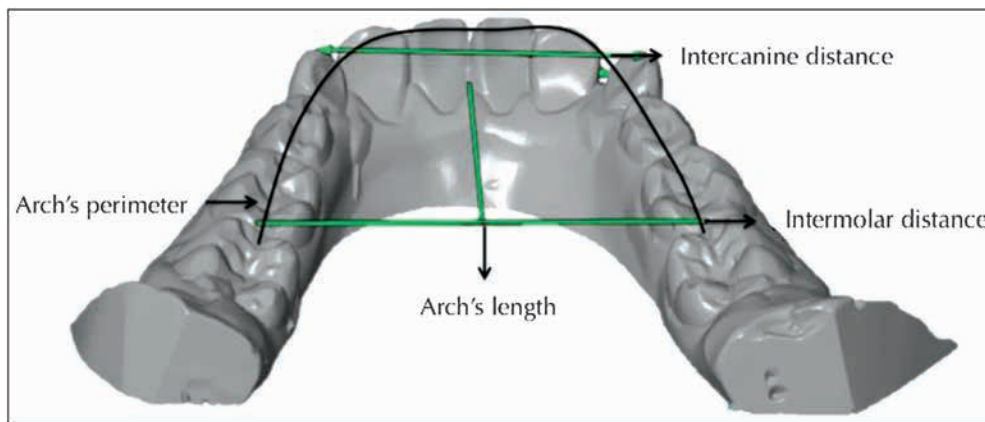


Figure 2: Scanned model showing the lines corresponding to the ones reported in this study

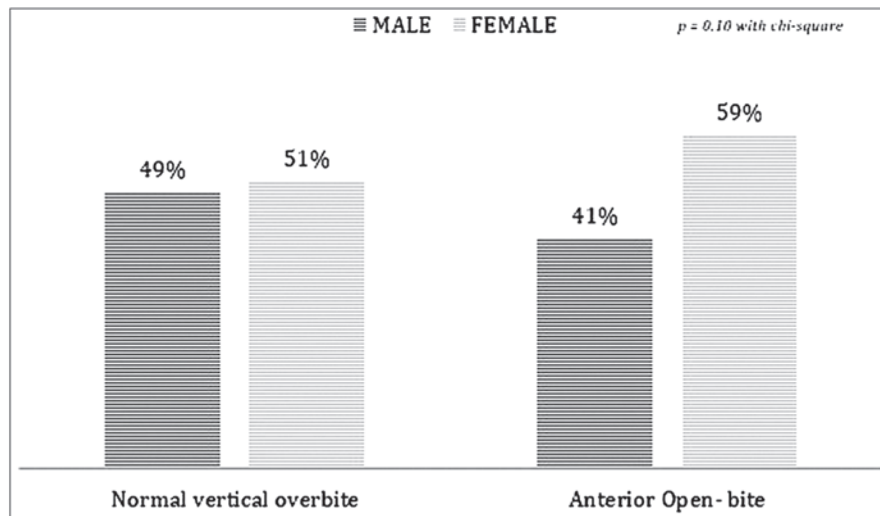


Figure 3: Types of occlusion according to sex

no significant difference was noted for the arch perimeter ($P = 0.239$, 95% CI: $-1.57, 0.39$) by Student's t -test.

No significant differences were found for the interpremolar distance ($P = 0.055$, 95% CI: $0.055, 0.059$) and total arch length ($P = 0.121$, 95% CI: $0.01, 0.02$) between the occlusion groups described. Conversely, significant differences were noted for the intercanine distance ($P = 0.024$, 95% CI: $0.01, 0.02$) with Mann–Whitney U -test [Table 1]), with this distance being smaller in individuals with NVO.

Individuals were divided into two groups according to dental age, mixed dentition between 8 and 12 years of age, and permanent dentition between 13 and 16 years. When evaluating the comparison between the type of dentition and arch size, statistical differences were found in arch perimeter ($P = 0.023$) with Student's t -test and intercanine width ($P = 0.017$) with Mann–Whitney U -test, showing smaller arch size for permanent dentition group, whereas intermolar distance had no statistical difference.

DISCUSSION

This study showed that individuals with AOB have a significant greater intercanine and intermolar distance and a greater arch perimeter than those with NVO possibly owing to the functional disruption due to etiological factors that have been related with AOB taking in consideration that the sample did not present posterior crossbite. A study performed by Doto *et al* (2015) suggested that the tongue position and size influence dental arch structure,^[15] and Yu *et al.* (2019) showed that the alveolar bone responds to tongue functional stimuli, which influences dental arch form and appearance in a constant and dynamic way.^[16] The relationship between the tongue and the dental arch size was also studied by Bandy and Hunter,^[17] who determined that arch diameter increases along with tongue volume. A study performed on similar individuals found a higher tongue position during deglutition, making contact with the lingual

surface of upper teeth, which can cause a narrower lower arch.^[18] Likewise, mouth-breathing individuals who underwent adenoidectomy showed a greater length and width of the lower arch after the procedure.^[19] However, the study by Scott^[20] suggested that both form and shape of the dental arch are determined more by alveolar process growth regardless of the pressure applied by the adjacent soft tissue.

While evaluating the data of this study, significant differences were noted in both types of dental relationship, female individuals showed smaller measurements in both types of occlusions than males; similarly, Alvaran *et al.*^[21] reported in their study that male individuals presented wider arches, especially in the posterior area, that study was performed on 473 individuals between 5 and 17 years of age, who did not present AOB;^[4] and the findings were controversial to the findings of another study performed in 2008 where Caucasian and Asian populations were compared.^[22]

The present evidence supports the idea that changes in dental arch can be related with normal growth and development process due to the decrease in lower arch length during late adolescence, which is consistent with the findings suggested by Jonsson *et al.* (2009) and Moorrees and Reed.^[22-24]

A study published in 2018 compared the results of upper arch in individuals with AOB and NVO and showed statistically significant differences in upper arch length, individuals with AOB showed a greater length (26.99 ± 2.67 mm) than those with NVO. However, no significant differences were noted while evaluating the intercanine and intermolar distance between same individuals.^[12]

Something that should be noted when comparing this study with the existent literature is that there were differences in the reference points used to measure the intercanine distance, which makes the comparison difficult to analyze. In the present study, the intercanine

Table 1: Measurements of the arches according to occlusion type

Variable	Normal vertical overbite				Anterior open bite			
	N = 132				N = 132			
	8–11 years		12–16 years		8–11 years		12–16 years	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Intermolar distance of the arch	40.56	2.42	40.54	2.50	42.23	2.59	41.18	2.41
Interpremolar distance of the arch	31.26	2.16	32.11	2.13	32.08	2.46	32.12	2.35
Intercanine distance of the arch	26.56	1.92	26.92	1.92	26.95	2.19	27.43	1.81
Arch perimeter	70.71	3.79	69.96	4.34	72.04	4.09	70.16	3.75
Total length of the arch	22.10	1.98	21.06	2.12	22.70	7.04	20.93	1.95

SD = standard deviation; X = Average

distance was measured as the straight line between the cuspal vertices of the canines in both sides and in those cases in which wear facets were found, the distance was measured from the middle of the facet. Other studies consider this measurement to be the distance between cuspal vertex of the right canine and cuspal vertex of the left canine;^[21,25-29] whereas some other articles determine the intercanine distance starting at the most protuberant part of the center of the lobe of the canine's clinical crown (FA point);^[30] yet another way of measuring this distance is that reported by Ling and Wong,^[28] who measured it from interproximal contact point between the lateral and the canine of each side.^[28]

It can be concluded that individuals between 8 and 16 years with NVO have a shorter intercanine and intermolar distance as well as a smaller inferior arch perimeter than that of individuals with AOB; however, etiology was not determined by this study; therefore, further analytic and exploratory studies should be performed.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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