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ORIGINAL ARTICLE

Dental Arch Dimensions of Nigerian Children with Hypertrophied Adenoids

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ABSTRACT

Objective: The study objective was to assess the effect of adenoid hypertrophy on the dental arch dimensions of children in Ile-Ife, Nigeria.

Methods: Ninety patients aged 3-12 years attending the Otorhinolaryngology Clinic at Obafemi Awolowo University Teaching Hospital Ile-Ife diagnosed as having hypertrophied adenoids and 90 children from the Child Dental Health Clinic were recruited as adenoid and control subjects respectively. Arch and palatal vault dimensions, including total arch length; inter-canine, inter-premolar, and inter-molar widths; palatal length; and palatal heights measured at three levels and palatal volume were determined for both groups from dental casts.

Results: Maxillary arch dimensions were shorter in the adenoid group than the control group; however, only total maxillary arch length was significantly shorter ($p=0.049$). Mandibular arch dimensions with the exception of inter-molar width were significantly shorter in the adenoid group ($p<0.05$). Adenoid subjects had significantly increased palatal heights at canine, premolar, and molar levels and reduced palatal volume compared to the control subjects ($p<0.05$).

Conclusion: Adenoid subjects demonstrated shorter maxillary and mandibular arch dimensions compared with control subjects, with the differences being more evident in the lower arch. They also exhibited increased palatal heights at all levels and reduced palatal volume compared with control subjects.

Keywords: Adenoids, dental arch dimensions, mouth breathing, malocclusion

INTRODUCTION

Postnatal facial growth is a multifunctional and complex phenomenon that is influenced by both genetic and environmental factors. An increasing amount of evidence suggests that environmental influences may alter the growth of facial structures, and these structures show varying degrees of recovery when the abnormal stimulus is removed (1,2). Studies on the contribution of the environment to facial development have demonstrated an association between airway obstruction and undesirable variations in facial form (3,4). The effect of environmental factors such as enlarged adenoids, allergic rhinitis, choanal atresia, and enlarged tonsils on facial growth, although controversial, has been documented (5,6).

The adenoid, which is a conglomerate of lymphatic tissue in the posterior nasopharyngeal airway, is a normal mass or clump of lymphoid tissue whose size varies among children and in the same individual as he or she grows (7). This mass of lymphoid tissue decreases in size with growth of the nasopharynx, and the immunological activities of the adenoids follow a rhythm that decreases as the child grows (8). However, if these adenoidal lymphoid tissues become hypertrophied relative to the size of the nasopharynx, they produce harmful effects

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such as constriction of the airway, thereby leading to impairment of nasal respiration and hence altered respiratory pattern (9).

Studies have provided evidence for the role of breathing dysfunctions in abnormal dentofacial growth (10). Altered respiratory pattern leading to mouth breathing has been reported as a cause of abnormal craniofacial development, and this has been associated with the controversial "adenoid facie" also known as Long-face Syndrome or Respiratory Obstruction Syndrome (4,7,11). This syndrome is said to be characterized by various features, including a vertically long lower facial height, narrow alar bases, lip incompetence, narrow arch width dimensions, a narrow or v-shaped maxillary arch with high palatal vault, protruding teeth, and a post-normal relation between the upper and lower jaws (12).

Dental arch dimension is a function of several factors, including race, ethnicity, genetics, and environment, the knowledge of which plays an important role in orthodontic diagnosis and treatment planning (13). The ability to identify a suitable arch form and dimension is key to achieving a stable, functional, and aesthetic dental arch in orthodontic diagnosis and treatment. Failure to customize the arch form creates the probability of relapse and can lead to poor treatment prognosis or outcome (14).

Linder-Aronson et al. (15) demonstrated varying degrees of recovery from steep mandibular plane angle, narrow maxillary arches, and retroclined mandibular incisors 5 years after adenoidectomy and a change from mouth to nose breathing. After adenotonsillectomy, Petraccone Caixeta et al. (5) also reported that mouth-breathing children showed greater maxillary transverse development than did the untreated controls. Patients with enlarged adenoids are likely to require orthodontic treatment to correct the dental irregularities that may be associated with their condition, and it is therefore imperative that a reference dataset for these patients among the Nigerian population be established. A search through the literature showed a paucity of information on the relationship between hypertrophied adenoids and dental arch dimensions in the Nigerian population (9). This study was therefore undertaken to assess the dental arch dimensions of subjects with hypertrophied adenoids in the primary and mixed dentition in Ile-Ife, Nigeria, and compare these with normal subjects without adenoid hypertrophy.

METHODS

This was a cross-sectional study carried out at the Obafemi Awolowo University Teaching Hospital Complex (O.A.U.T.H.C), Ile-Ife, Osun State, South Western Nigeria. The study population consisted of one hundred and eighty children in the primary and mixed dentition stage between the ages of 3 and 12 years. The experimental group consisted of ninety children attending the Ear, Nose and Throat Clinic of the hospital who had been diagnosed clinically and radiographically as having hypertrophied adenoid. The control group consisted of ninety children recruited from patients attending the Child Dental Health Clinic of the O.A.U.T.H.C. They were interviewed to rule out any clinical presentations of adenoidal hypertrophy.

A sample size of 174 subjects was required for the study in order to detect a statistically significant difference of 20% in arch dimensions between the study groups at 80% power and $p<0.05$. This was rounded up to 180. Other inclusion criteria included no previous history of orthodontic treatment or adenoidectomy and both parents being of Nigerian descent. Patients with developmental anomalies such as cleft lip/palate and patients not consenting to take part were excluded from the study. Participants were consecutively recruited into the study until the required sample size was attained.

Both of the study populations were divided into three age groups: 1) Primary dentition category consisting of 3–5 year olds, 2) Early mixed dentition category consisting of 6–8 year olds, and 3) Late mixed dentition/early permanent category consisting of 9–12 year olds.

Ethical approval was obtained from the Ethical Review Committee of O.A.U.T.H.C. Informed consent was obtained from the parents of study participants and assent from the children after duly explaining the study objectives, data collection procedure, confidentiality of data collected, benefits, risks, and discomfort of the procedure. Participants were informed of the voluntary nature of participation and that they had the freedom to withdraw from the study at any time.

Demographic and anthropometric data were collected for all participants, and impressions of the upper and lower arches of each participant were made by the investigator after clinical dental examination using appropriate-sized disposable trays to include all teeth present and the lingual and buccal sulci. Dental casts were thereafter fabricated immediately using dental stone. Each participant's bite was registered using a thin wax wafer.

Measurements on Dental Casts

Reference points for the arch measurements were made on the dental casts using sharpened pencils at the cusp tips of the primary canines and the mesio-buccal cusp tips of the primary first molars and primary second molars and on the canine tips, the tips of the buccal cusps of the first premolars, and on the mesio-buccal cusp tips of the first permanent molars. The dimensions of the maxillary and mandibular dental arches were measured using a dental caliper to the nearest 0.1 mm following the parameters described by Bishara et al. (16).

The following parameters were evaluated:

Arch length: The sum of the anterior and right and left posterior arch lengths for both the maxillary and mandibular dental arches.

Arch width

Inter-canine width: The distance between the right and left cusp tips of the primary and permanent canines for deciduous and permanent dentitions, respectively.

Inter-premolar width: The distance between the mesio-buccal cusps tips of the right and left first primary molar in the deciduous dentition and the buccal cusps of the first premolars in the permanent dentition.

Inter-molar width: The distance between the mesio-buccal cusps tips of the second primary molar and the first permanent molars in the deciduous and permanent dentitions, respectively.

Palatal length

The distance from the midpoint of the most labial point of the central incisors to the point bisecting the line joining the distal surfaces of the maxillary first permanent molars or second primary molars.

Palatal Height Dimensions

The height of the palate was recorded at three different levels on the maxillary models using a profile gage to record the cross-sectional shape of the palate at the canine and first and second primary molar regions for the deciduous dentition and the first premolar and first permanent molar regions in the permanent dentition (17). The corresponding palatal heights were measured off the profile gauge with a steel ruler.

Palatal Volume

Palatal volume was calculated using the formula:
V=M/D.
V=volume occupied by the silicone within the stone model.
M=mass of the silicone within the palatal vault
D=density of the silicone; given by the manufactures as 1.45.

Very high viscosity condensation-type silicone impression material (Silibest; BMS dental, Pisa, Italy) was used. To obtain the mass of the silicone material, the upper model was sliced distal to the first permanent upper molar or the second primary molar, the end of the cast was blocked with wax, and the cast was weighed using an electronic professional laboratory scale. The silicone impression material was placed in the palatal cavity of the model, limited by the palate, teeth, posterior dental wax, and the occlusal plane. The occlusal plane was found by pushing the stone model filled with the soft putty silicone impression material down onto a glass slab until the glass slab touched the incisal edges of the maxillary central incisors and the mesiopalatal cusps of the molars (17). The maxillary model with the silicone material was then weighed. The initial weight of the model was subtracted from the final weight of the model with the silicone to obtain the silicone mass. The volume for each palate was then calculated as the mass of the silicone divided by the density (18).

Reliability of the Study

All measurements on the dental casts were carried out using a dental caliper calibrated to the nearest 0.1 mm. A professional laboratory electronic scale was used to determine the mass of the silicone impression material. This scale had been calibrated to the nearest 0.01 g.

To reduce measurement errors, only the principal investigator carried out the measurement and assessment of all required parameters. The study models were assessed twice, and individual measurement that differed by more than 0.1 mm were measured a third time to resolve the discrepancy.

Ten dental casts were randomly selected after a two-week interval from the first round of measurement, and the same measurements were made to determine the intra-observer error. The test-retest reliability was calculated for the investigator, and the correlation coefficient was found to be 0.85.

Data Analysis

Statistical analysis was carried out with IBM SPSS Statistics for Windows Version 20.0 (IBM Corp.; Armonk, NY, USA). Frequencies and mean values (with their standard deviations) of variables were generated. Association between discrete variables was tested using the chi-square test. The association between continuous variables was tested using the independent samples *t*-test and analysis of variance (ANOVA). Statistical significance was inferred at $p<0.05$.

RESULTS

A total of one hundred and eighty children participated in this study, including 93 (51.7%) boys and 87 (48.3%) girls. The age range was 3-12 years with a mean age of 6.89±2.43 years. There was no statistically significant difference between the mean ages of boys and girls in either the adenoid or control groups. The demographic characteristics of the study populations are shown in Table 1. The 3–5 years age group constituted 35% of the total population, the 6-8 years group constituted 40.56%, and the 9-12 year group constituted 24.44%.

Dental Arch Dimensions of the Adenoid and Control Groups

Comparisons of maxillary and mandibular arch dimensions in adenoid and control subjects are presented in Table 2. Maxillary arch dimensions in the adenoid group were consistently shorter compared to the control group, but only the difference in total

Table 1. Demographic characteristics of the study population

	Adenoid group				Control group					
Age group	Male		Female		Male		Female		Total	
(years)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%0)
3-5	26	(14.44)	15	(8.33)	14	(7.78)	8	(4.44)	63	(35.0)
6-8	21	(11.67)	13	(7.22)	12	(6.67)	27	(15.0)	73	(40.56)
9-12	8	(4.44)	7	(3.99)	12	(6.67)	17	(9.44)	44	(24.44)
Total	55	(30.56)	35	(19.44)	38	(21.11)	52	(29.0)	180	(100)

$\chi2=16.02$; df=6; $p=0.013$

Table 2. Comparison of arch dimensions of adenoid and control subjects

Arch dimensions	Adenoid group (n=90) mean±sd (cm)	Control group (n=90) mean±sd (cm)	t-test	p
Maxillary arch				
Total arch length	6.61±0.75	6.82±0.68	-1.98	0.049*
Inter-canine width	3.25±0.36	3.29±0.46	-0.68	0.497
Inter-premolar width	3.77±0.35	3.81±0.32	-0.92	0.360
Inter-molar width	4.44±0.40	4.47±0.41	-0.62	0.535
Mandibular arch				
Total-arch length	5.84±0.69	6.18±0.62	-3.56	0.005*
Inter-canine width	2.65±0.32	2.80±0.40	-2.79	0.006*
Inter-premolar width	3.29±0.35	3.39±0.31	-1.99	0.048*
Inter-molar width	4.02±0.46	4.06±0.46	-0.47	0.639
Palatal vault dimensions				
Palatal length	3.92±0.52	3.94±0.43	-0.33	0.740
Height at canines	0.59±0.15	0.50±0.15	4.06	<0.001*
Height at premolars	1.42±0.22	1.24±0.18	5.71	0.001*
Height at molars	1.43±0.26	1.28±0.19	4.53	<0.001*
Palatal volume	5.00±1.37	5.66±1.80	-2.77	0.006*

*Statistically significant

maxillary arch length reached statistical significance (p=0.049). All of the mandibular arch dimensions with the exception of inter-molar width were significantly shorter in the adenoid group compared with the control (p<0.05). Palatal vault measurements showed that the adenoid subjects had shorter palatal length; increased palatal heights at the canines, premolars, and molars; and reduced palatal volume compared to the control subjects. These differences were significant for palatal heights at all levels of measurement and palatal volume (p<0.05).

Age Groups and Arch Dimensions

Age group comparisons of arch dimensions between adenoid and control subjects are shown in Tables 3 and 4. All maxillary and mandibular arch dimensions were shorter in the adenoid group compared to the control group with the exception of maxillary inter-molar width in the 3-5 year age group and the total maxillary arch length and mandibular inter-premolar width in the 9-12 year age group. However, none of the differences reached statistical significance in the various age groups (p>0.05) (Table 3). Palatal lengths were greater in the adenoid group compared with control subjects in the 3–5 year and 9–12 year age groups, but the difference was significant only in the 9-12 year groups (Table 4). Palatal heights at all levels were significantly greater in adenoid subjects compared to control subjects in all age groups except at the canine level in the 3-5 year age group. The palatal volume was consistently lower in adenoid subjects in all age groups, but the differences were not statistically significant (p>0.05).

ANOVA comparing all arch dimensions in different age groups in adenoid subjects showed statistically significant increases in all arch dimensions across the three age groups, and the increases

Table 3. Comparison of arch dimensions of adenoid and control subjects by age groups

	Adenoid group (n=90) mean±sd (cm)	Control group (n=90) mean±sd (cm)	t-test	p
3-5years	**(n=41)**	**(n=22)**		
Maxillary arch				
Total arch length	5.14±0.56	6.08±0.56	0.93	0.356
Inter-canine width	2.88±0.52	3.05±0.27	1.72	0.089
Inter-premolar width	3.63±0.27	3.65±0.40	-0.23	0.815
Inter-molar width	4.19±0.29	4.10±0.40	1.02	0.313
Mandibular arch				
Total arch length	5.23±0.42	5.33±0.32	-0.43	0.671
Inter-canine width	2.50±0.28	2.55±0.45	-0.61	0.547
Inter-premolar width	3.19±0.27	3.20±0.29	-0.07	0.943
Inter-molar width	3.67±0.28	3.78±0.35	1.28	0.204
6-8 years	**(n=34)**	**(n=39)**		
Maxillary arch				
Total arch length	6.94±0.59	7.00±0.65	0.51	0.610
Inter-canine width	3.32±0.41	3.38±0.34	-0.81	0.418
Inter-premolar width	3.81±0.33	3.82±0.23	-0.14	0.890
Inter-molar width	4.49±0.32	4.58±0.39	1.04	0.300
Mandibular arch				
Total arch length	6.17±0.56	6.29±0.40	-1.14	0.259
Inter-canine width	2.74±0.28	2.90±0.34	-1.88	0.064
Inter-premolar width	3.29±0.32	3.37±0.27	-1.09	0.278
Inter-molar width	4.08±0.49	4.18±0.49	0.83	0.410
9-12 years	**(n=15)**	**(n=29)**		
Maxillary arch				
Total arch length	7.32±0.53	7.25±0.40	0.47	0.638
Inter-canine width	3.49±0.38	3.63±0.45	1.09	0.283
Inter-premolar width	3.93±0.33	4.07±0.37	1.19	0.241
Inter-molar width	4.74±0.32	4.79±0.29	0.53	0.600
Mandibular arch				
Total arch length	6.58±0.19	6.68±0.28	-1.18	0.244
Inter-canine width	2.85±0.32	2.86±0.26	-0.02	0.964
Inter-premolar width	3.57±0.49	3.57±0.28	-0.02	0.984
Inter-molar width	4.32±0.28	4.36±0.27	0.04	0.688

*Statistically significant

were greater with increasing age (p≤0.001). However, Duncan post hoc tests showed that there was no significant difference in inter-canine widths or palatal volume between the 6-8 year group and the 9-12 year group.

Gender comparisons of arch dimensions among adenoid and control subjects showed that arch dimensions were shorter among both male and female adenoid subjects compared to their counterpart control subjects (Table 5). The differences in arch dimensions did not reach statistical significance among the male subjects (p>0.05). Among female subjects, significant differences were observed in total maxillary arch length and in all

Table 4. Comparison of arch dimensions of adenoid and control subjects by age groups

	Adenoid group (n=90) mean±sd (cm)	Control group (n=90) mean±sd (cm)	t-test	p
3-5years	**(n=41)**	**(n=22)**		
Palatal length (cm)	3.60±0.37	3.47±0.33	1.50	0.137
Height at canine (cm)	0.57±0.16	0.50±0.12	1.82	0.074
Height at premolar (cm)	1.38±0.20	1.18±0.16	4.13	<0.001*
Height at molar (cm)	1.38±0.24	1.25± 0.18	2.01	0.031*
Palatal volume (cm3)	4.43±1.65	4.47±1.31	0.08	0.938
6-8 years	**(n=34)**	**(n=39)**		
Palatal length (cm)	3.99±0.43	4.07±0.29	-1.03	0.306
Height at canine (cm)	0.59±0.10	0.50±012	2.84	0.005*
Height at premolar (cm)	1.42±0.23	1.27±0.19	3.10	0.003*
Height at molar (cm)	1.44±0.26	1.30±0.20	2.48	0.016*
Palatal volume (cm3)	5.30±1.31	5.76±1.62	-1.32	0.192
9-12 years	**(n=15)**	**(n=29)**		
Palatal length (cm)	4.63±0.26	4.13±0.41	4.29	<0.001*
Height at canine (cm)	0.66±0.18	0.49±0.20	2.73	0.009*
Height at premolar (cm)	1.49±0.27	1.26±0.17	3.56	0.001*
Height at molar (cm)	1.55±0.24	1.27±0.19	4.34	<0.001*
Palatal volume (cm3)	5.77±1.17	6.47±1.70	-1.39	0.171

*Statistically significant

mandibular dimensions with the exception of inter-molar width (p<0.05).

Intra-group gender comparisons of maxillary and mandibular arch dimensions of adenoid subjects showed that all dimensions were shorter in female adenoid subjects compared to male adenoid subjects, and these differences were statistically significant in the maxillary and mandibular inter-premolar widths and maxillary inter-molar widths (p<0.01).

Comparisons of palatal vault dimensions in male and female adenoid and control subjects are as shown in Table 6. Palatal heights at all levels were significantly greater in male and female adenoid subjects compared to control subjects (p<0.005). Palatal volume was significantly lower in female adenoid subjects compared with female control subjects (p=0.02). Intra-group gender comparison of palatal vault dimensions in adenoid subjects showed that palatal vault dimensions were generally lower in female adenoid subjects compared with male subjects. However, the differences were not statistically significant.

DISCUSSION

The effect of mode of breathing on the craniofacial structures has been a widely debated and controversial issue in orthodontics (19). This study was carried out to evaluate the arch dimensions in patients with hypertrophied adenoids and to compare the findings with normal subjects. It was found that maxillary arch widths, although shorter, were not significantly different

Table 5. Gender comparison of arch dimensions in adenoid and control subjects

Palatal vault dimension	Adenoid group (n=90) mean±sd (cm)	Control group (n=90) mean±sd (cm)	t-test	p
Male	**(n=55)**	**(n=38)**		
Maxillary arch				
Total arch length	6.63±0.87	6.97±0.74	0.94	0.349
Inter-canine width	3.27±0.21	3.29±0.52	0.01	0.997
Inter-premolar width	3.85±0.37	3.89±0.33	-0.51	0.608
Inter-molar width	4.50±0.31	4.57±0.41	0.09	6.928
Mandibular arch				
Total arch length	5.85±0.72	6.08±0.66	-1.54	0.127
Inter-canine width	2.69±0.32	2.77±0.30	-1.18	0.213
Inter-premolar width	3.38±0.36	3.43±0.34	-0.61	0.543
Inter-molar width	4.10±0.43	4.10±0.40	-0.04	0.967
Female	**(n=35)**	**(n=52)**		
Maxillary arch				
Total arch length	6.54±0.53	6.85±0.65	-2.00	0.049*
Inter-canine width	3.19±0.28	3.30±0.42	-1.28	0.203
Inter-premolar width	3.64±0.26	3.76±0.31	-1.85	0.067
Inter-molar width	4.31±0.36	4.45±0.42	-1.62	0.109
Mandibular arch				
Total arch length	5.81±0.64	6.26±0.57	-3.40	0.001*
Inter-canine width	2.59±0.31	2.83±0.46	-2.64	0.010*
Inter-premolar width	3.15±0.30	3.36±0.29	-3.41	0.001*
Inter-molar width	3.92±0.48	4.03±0.50	-1.03	0.306

*Statistically significant

between adenoid and control subjects. This is in line with the reports of previous studies that did not find a significant relationship between maxillary dental morphology and mouth breathing due to enlarged adenoids (20). Conversely, some studies have also reported a significant relationship between narrow upper arch and oral breathing due to enlarged adenoids (5,14). They observed that children with obstructive adenoids had narrower maxillary arch and increased incidence of posterior cross bites but had a significant maxillary transverse width gain compared to the control groups after adenotonsillectomy.

The possible reason for this result for maxillary arch widths in this study might be due to differences in the degree of obstruction of the nasopharynx by the enlarged adenoids. That is, the size of adenoids varies from child to child and even in the same child as he or she grows (7). This difference in size and thus the degree of obstruction has been shown to impact significantly on dental development in these patients (21).

This study found significantly shorter lower arch dimensions in the adenoid subjects compared with the control group, which is similar to previous reports (3). Children with large adenoids and tonsils have been reported to have somatic growth impairment. Decreased mandibular growth (growth in width, length, and

Table 6. Gender comparison of palatal vault dimensions in adenoid and control subjects

Palatal vault dimension	Adenoid group mean (cm) ±sd	Control group mean (cm) ±sd	t-test	p
Male	**(n=55)**	**(n=38)**		
Palatal length (cm)	3.96±0.51	3.87±0.49	0.63	0.410
Height at canine width (cm)	0.59±0.13	0.51±0.15	2.43	0.001*
Height at premolar width (cm)	1.44±0.22	1.27±0.19	3.98	0.001*
Height at molar width (cm)	1.45±0.26	1.31±0.20	2.40	0.001*
Palatal volume (cm^3)	5.01±1.36	5.41±1.76	-1.23	0.227
Female	**(n=35)**	**(n=52)**		
Palatal length (cm)	3.85±0.53	3.99±0.36	-1.43	0.156
Height at canine width (cm)	0.60±0.17	0.43±0.45	3.12	0.003*
Height at premolar width (cm)	1.37±0.23	1.23±0.17	3.47	0.001*
Height at molar width (cm)	1.41±0.25	1.25±0.19	3.00	0.003*
Palatal volume (cm^3)	4.97±1.42	5.84±1.84	-2.38	0.020*

*Statistically significant

height) occurs as a result of the decreased nocturnal growth hormone (GH) secretion seen in this group of patients (19). GH is released in a pulsatile fashion over a 24-h period, with the highest GH values being associated with the onset of slow-wave sleep. It has been shown that a reduced amount of slow-wave sleep occurs in children with adenoid hypertrophy and that this results in a decrease in sleep-associated GH secretion (22). Other studies, however, found larger mandibular widths and larger mandibular arch lengths in adenoid subjects (5).

Palatal vault dimensions were also evaluated in this study, and palatal morphology differed between the adenoid and control subjects. Significant differences were observed in the palatal volume and palatal height at the three levels studied between adenoid and control groups, which is similar to previously published data (3). This finding of increased palatal heights in adenoid subjects is similar to what has been documented in the literature about mouth-breathing subjects diagnosed with obstructive sleep apnea syndrome (OSAS) (23). Diouf et al. (6) also found that maxillary depth was significantly and positively correlated to tonsillar grade.

Children with OSAS are known to have craniofacial characteristics similar to those with large adenoids and tonsils such as increased palatal heights and lengths and shorter lower dental arch and an increased prevalence of posterior cross bites when compared to healthy normal subjects (24). The first treatment of choice for OSAS children is removal of the adenoids and tonsils (23).

This increase of the vertical dimension can be due to the increased pressure in the oral cavity due to mouth breathing. Mouth breathing can cause long-term changes in the posture of the head, mandible, and tongue. These alter the equilibrium of pressures on jaws and teeth affecting both jaw growth and tooth position (11). On the other hand, there is the distinct possibility that patients with genetic tendency for a pattern of vertical facial growth and deep palate can develop mouth breathing (25).

Palatal volume was found to be significantly lower in the adenoid subjects. This is similar to the finding of reduced palatal volume in subjects with posterior cross bites who exhibit mouth breathing or sucking habits (26). A recent report has shown increased palatal volume following the correction of the posterior cross bites in these patients (27). Reduced palatal volume connotes a corresponding reduction in tongue space on the palate. The clinical implication of this is that because it has been established that palatal volume decreases following orthodontic treatment requiring extractions, caution should be exercised in the prescription of extraction for these patients during comprehensive orthodontic therapy. The option of maxillary expansion, which has been shown to produce increase in palatal volume, might be more appropriate.

After categorization into age groups, the mandibular and maxillary arch lengths and widths of adenoid subjects showed no significant differences when compared to control subjects. This is different from what was documented by Shiva et al. (2) who reported shorter upper inter molar arch width dimensions in mouth-breathing subjects when compared to healthy control subjects among 8-12-year-old children. However, subjects in their study with mouth breathing from aetiological factors other than hypertrophied adenoids were also assessed. The maxillary inter-canine, inter-premolar, and inter-molar widths were found to be significantly and negatively correlated to tonsillar grade in a cross-sectional study of a group of children by Diouf et al. (6).

The arch dimensions of adenoid subjects followed the normal and expected pattern of dental development and increased from one dental age group to the next. However, no significant difference was found in inter-canine widths or palatal volume between 6–8 years and 9–12 years. Inter-canine width in the mandible might remain unchanged from mixed dentition to permanent dentition because growth cessation in the three planes of space follows a definite sequence in which growth declines to a slow rate as age increases. Growth in width is completed first, followed by growth in length, and finally growth in height. Completion of growth in the transverse plane tends to occur before the adolescent pubertal growth spurt and is therefore minimally affected by this (11). In the maxilla, the narrowing of the maxillary arch due to enlarged tonsils and mouth breathing may have contributed to this observation.

If inter-canine widths are established as early as the age of 8 years, attempts to change inter-canine width may ultimately lead to relapse. Previous studies on relapse have shown that post-orthodontic occlusal stability is enhanced through maintenance of the original mandibular inter-canine width and preservation of the original arch form (28,29).

Palatal length was evaluated and found to be significantly different only between adenoid and control subjects in the 9-12 year age group and across different age groups in adenoid subjects. Normal growth changes could account for the latter observation. Gender comparisons also showed that male and female adenoid subjects had shorter maxillary and mandibular arch dimensions compared to their normal counterparts. These differences reached statistical significance in the mandibular dimensions in female subjects, and palatal volume was also significantly reduced among female adenoid subjects when compared with female control subjects. The possible reason for this finding is that although the skeletal airway is larger in males, the lymphoid tissue on the posterior pharyngeal wall is smaller in males compared to females (30). Hence, the same degree of obstruction by enlarged adenoids will produce more profound effects in females.

Intra-group comparisons found that female adenoid subjects generally had shorter arch dimensions than male adenoid subjects, and this is similar to what has been previously reported among normal Nigerian children and has been documented in other races (13,14,29). Girls are known to have greater susceptibility to incisor crowding, especially mandibular incisor crowding during the early mixed dentition stage, because of smaller arch widths (11).

This study was not without limitations. Subjects selected for this study had their dental arch dimensions evaluated, but their naso-respiratory function, age of occurrence of nasal obstruction, and degree of obstruction were not evaluated, and each of these could also affect the degree to which the dental arch is altered (1). The current practice in the determination of the arch dimensions is the use of digitized casts with 3-dimensional computerized electromagnetic instrumentation, which have been shown to be the most accurate because subtle differences can be registered. The majority of study participants were also under the age of 9 years, and because adenoid tissue volume decreases as a child grows this may have affected our results (8).

From this study, it can be deduced that perhaps a simple cause and effect relationship between enlarged adenoids and peculiar arch characteristics might not exist, and thus that the dental characteristics seen in patients with enlarged obstructive adenoids might result from a complex interaction between environmental, genetic, and hormonal influences. An increasing amount of evidence supports this (1,2,12).

CONCLUSION

Based on the findings in this study, the following conclusions can be drawn:

The arch widths of adenoid subjects were shorter compared to normal subjects, and this difference between adenoid and control subjects was most obvious in the mandibular arch and among females.

The adenoid subjects showed increased palatal heights at canines, premolars, and molars and reduced palatal volume compared to the control subjects. These differences were significant for palatal heights at all levels of measurement and palatal volume ($p<0.05$)

There was no significant difference in inter-canine widths and palatal volume between the 6–8 year and 9–12 year age groups.

Gender comparisons showed that arch dimensions (dental arch and palatal vault) were generally smaller in female adenoid subjects compared to male adenoid subjects, and these differences were most apparent in the maxillary and mandibular inter-premolar widths and the maxillary inter-molar width.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of the Obafemi Awolowo University Teaching Hospitals Complex Ile-Ife.

Informed Consent: Written informed consent was obtained from the parents of the patients and the patient who participated in this study.

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