Asthma and Inhaled Corticosteroid Effect on the Dental Arch Morphology in Children

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ABSTRACT

Background: Asthma has an influence on craniofacial development. Recently evidences show that there is an association between oral health problems and chronic lung disease. The present study was designed to estimate the changes in arch dimension measurements among asthmatic children aged 12 years old who were collected from AL- Zahra Center Advisory for Allergy and Asthma and compare them with the non-asthmatic children of the same age and gender.

Material and Methods: Fifty children (25 asthmatic and 25 non- asthmatic children) were included for the odontometric measurement. For both upper and lower study models, photographs were taken using special photographic apparatus for each child, and the statistical analysis were done by using SPSS version 19. For permanent dentition, two liner measurements were utilized for each dental arch including width and length.

Results: The results of the current research revealed that the mean values of dental arch dimensions, width and length; for both maxillary and mandibular dental arches among asthmatic children were lower as compared to non-asthmatic children in both genders.

Conclusions: The findings of the present study showed that asthma and inhalation treatment in asthmatic children played an important role to minimize odontometric measurement including dental arch dimensions.

Keywords: Asthma, dental arch dimensions, inhaled corticosteroid. (J Bagh Coll Dentistry 2016; 28(3):159-166).

INTRODUCTION

The association between airways obstruction and dental malocclusion and abnormal development of the cranial-facial complex is still a matter of concern from about a century; asthma and allergic rhinitis are most common diseases which obstruct airways [(1)]. The airway patency is regarded as essential factor for the normal growth and development of the craniofacial and nasomaxillary structures [(2)]. Many studies had been done on the asthma effects on dentoalveolar arches; however the results of these studies were diverse to each other [(3-9)].

Bresolin et al. [(3)] found high prevelance of retrognathism of both upper and lower jaws among allergic children. Principato [(4)] reported that smaller and narrower maxilla were found among oral respiration.

Kairaitis et al. [(5)] Peltomaki [(8)] illustrated that asthmatic patients had narrowing of both upper and lower arches at the level of canines and first molars with a higher prevalence of posterior cross-bite. Solow and Sandham [(6)] observed that patients with chronic asthma symptoms could present with dysregulation in the growth and development of the orofacial structures, including narrowing of the maxilla and lower development of the mandible. Faria et al. [(7)] represented in their study the presence of association between dentofacial anomalies and asthma.

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Kumar and Nandlal [(9)] reported that asthmatic children under regular medication of inhaled corticosteroid (ICS) were observed to have narrower arches, deeper palate and higher frequency of cross bite as compared to those under irregular medication and also they found the same findings as compared the asthmatic to the non-asthmatics in 10 to 12 years old.

Gungor and Turkkahraman [(10)], found statistically significant differences between patients with airway problems and control groups in maxillary skeletal morphology that including shorter maxillary length in sagittal plane and narrower maxillary arch and higher palatal vault in transversal plane. On the other hand, contrary to this explanation, longer arches accompanied broader arches were the cases in the study conducted by Hojensgaard and Wenzel [(11)], Shanker et al [(12)], as they found there was no relationship between palatal arch width and respiratory function in asthmatic children.

The effects of the respiratory tract allergies on the dental occlusion in patients who diagnosed as having allergic rhinitis and /or asthma was studied by Bezzo [(13)], the results of this study revealed non-significant differences between the study and control groups in over jet and overbite, but higher percentages of anterior cross-bite (6.8%) as well as posterior cross-bite (9.5%) as compared to the control group (2.7%) and (4.4%) respectively.

The width of dental arch is determined by measuring distance between corresponding contra lateral teeth [(14)], which includes:

1-Inter-canine distance: It is the distance between cusp tips of the right to the left permanent canines in transverse dimension [15]. Generally, many researchers used cusp tip of canine as a landmark to measure the inter-canine distance [16-22].

Many studies observed that inter-canine distance did not change after age 13 and 16 years in both females and males respectively with a considerable individual variation [23-24].

2-Inter-molar distance of permanent first molar: It is the distance between mesio-buccal cusp tips of the right permanent first molars to the left one in transverse direction, many researchers used inter-molar distance to determine growth as well as effects of genetic and environmental factor on dental arch dimension, it is also used for gender differentiation [25].

Different landmarks had been used to measure inter-molar distance; some studies used the disto-buccal cusp tip [26-27], while central fossa was employed by Mohammad [25]. Some researchers used the mesio-lingual cusp tip [28-29]. Other investigators utilized the mesio-buccal cusp tip [30-32], and other investigators utilized central fossa in upper arch and disto-buccal cusp tip in the lower arch [33].

3-Inter-molar distance of permanent second molar: It is the distance between the right and the left permanent second molars in transverse direction, different landmarks used to determine this distance, some studies used mesio-lingual cusp tip [34], while others used mesio-buccal cusp tip [16]. Many researchers used disto-buccal cusp tip [18, 19, 31].

Lindstron [35] reported minimal increases in the permanent inter-molar width occur between ages 9-19 years. On the other hand, Ward et al. [36], reported that the inter-molar widths decreased between 11 and 14 years old among United King Dom children.

The Dental arch length includes:

1. Anterior arch length: the definitions of this distance vary between different studies depending on different landmarks. Some investigators defined it as a vertical distance from the foremost point of the central incisor to the straight line between the distal surfaces of the canine [17]. Other investigators define it as a distance from mid way between the incisal edges of central incisors to the inter-canine distance at the cusp tip [37-39].

2. Molar vertical distance: Merz et al. [40], defined it as the shortest distance from a line connecting the distal surfaces of the first permanent molars to the labial surfaces of the most anterior teeth in the arch, different anatomical landmarks had been used for anterior teeth, many researchers used midpoint of line joining the mesial edges of central incisors or midpoint between the two central incisors [17, 32, 38, 41]. For posterior teeth landmarks, some researchers used the distal surface of first permanent molar [42], and some other studies utilized the mesio-buccal cusp tip of first permanent molar [19, 43].

3. Total Arch Length: It is defined as a distance between the mid-incisal edges to the midpoint of a line joining the disto-buccal cusps of the second molars [17-18], while other researchers defined it as a distance between the inter–incisal point to the mid distance of the maxillary and mandibular inter–second molar width at the mesio-buccal cusps [16,39]. Louly et al. [44], found a significant increase in the maxillary anterior segment length from 10-12 years, while an insignificant increase in maxillary arch total length from 9 to 12 years and a little decrease in mandibular arch total length.

Measurement methods of dental arch dimensions:

Direct method; Indirect method; Travel Microscope; Wax print; Photosteriometry; Occlusogram; The Reflex Metrograph Optical Plotter; Steriolethography; Dental cast; Radiographs; Holography; Laser scanner and Photography of study models [21].

MATERIALS AND METHODS

This study was conducted among asthmatic children in comparison to non- asthmatic children matching with age and gender in Baghdad city, examination started at the 20 of December 2013 till the end of March 2014. The sample of this study involved one age groups 12 years). The samples were collected from Al-Zahra Center Advisory for Allergy and Asthma, while the non-asthmatic children were randomly selected from different Baghdad's school.

The criteria for selecting the samples for the odontometric measurements included [45]:

All the permanent teeth might erupt, with exception of the third molar.

<u>The odontometric measurements include:</u>

<u>1-Production of the dental casts</u>:

The Upper and lower impressions were taken to every child [46].

<u>2-Pouring the cast</u>:

A suitable amount of dental stone was used immediately to pour the impressions to avoid any dimensional changes [47].

3-Standardization of dental casts photographs:

Photographic apparatus was used for standardization; this photographic apparatus was designed by Hasan [21].

4-Dental cast photographic technique

Certain selected tooth-related points in an occlusal view were carefully marked bilaterally with a pen in the maxillary and mandibular study casts to facilitate the identification of the landmarks that would be used for measuring dental arch dimensions [21].

- **Dental cast landmarks**

According to Hasan [21], Ali [22], the dental cast landmarks include:

1. Incisal point: the point in the midway between the incisal edges of the two central incisors.
2. Canine point: the cusp tips of the right and left permanent canines.
3. Mesio-buccal cusp tips of the permanent first molars point: the mesio-buccal cusp tips of the right and left permanent first molars.
4. Disto-buccal cusp tips of the permanent second molars point: the disto-buccal cusp tips of the right and left permanent second molars.

- **Cast orientation**

This procedure was performed by putting the dental cast in surveyor base then the cast put on a movable horizontal plate of the apparatus and adjusted to attach the translucent plastic plate in a way through which the incisal or occlusal surface segment plane attached to translucent plastic plate and parallel to the arm of the camera container.

- **Taking dental cast captures**:

After identifying landmarks and orientation of each dental cast, the photographic capture views of cast were produced as follow: Occlusal surfaces of whole arch view was standardized by overlapping of the two cross lines; lines A and B, whereas line A should overlap along the median palatal raphe of cast; Median Palatal Line {MPL} for the maxilla. In addition, the mirror image of MPL was transferred to the mandibular cast and line B should overlap to transverse line that was tangent to the distal edges of the two second molars for maxilla and mandible respectively [21].

Before taking a picture, it was necessary to set a reference millimetric scale in correspondence to the occlusal surface of the tooth (for each capture), by means of this metric scale, the calibration of each image dimension could be prepared [21]. Figure (4)

Measurements on the photographs were performed with the AutoCAD software to calculate linear measurements; the linear measurements were divided by scale to overcome the magnification [22].

Dental cast photograph analysis:

Measurements of dental cast according to Al-Hadithy [19], Hasan [21] were involved: Figure (1).

1-Dental arch width: the dental arch width includes:

-Inter-canine distance (ICD).
-Inter-first molar distance (IFMD).
-Inter-second molar distance (ISMD).

2-Dental arch length: the dental arch length includes:

-Anterior arch length (AAL).
-Molar-vertical distance (MVL).
-Total arch length (TAL).

Figure 1: Linear measurements of dental arch width and length.

The statistical analysis was performed by using SPSS version 19. The descriptive statistics was used including mean and SD (standard deviation). The independent samples t-test was performed to analyze and determine the differences of the measurement values between the study and control groups.

RESULTS

The maxillary dental arch width for asthmatic and non- asthmatic children is illustrated in Table (1). Concerning ICD and IFMD, data showed that the mean values were found to be highly significantly lower among asthmatic than non-asthmatic children (P<0.01).

Concerning ISMD, results revealed that the mean value among asthmatic children was found to be lower than non-asthmatic children with statistically significant difference (P<0.05).

Concerning gender differences in asthmatic group, data analysis of the mean values of all ICD, IFMD and ISMD were found to be higher among boys than girls, with statistically not significant difference for ICD (P>0.05), while for IFMD the difference was significant (P<0.05) and for ISMD the difference was highly significant (P<0.01). Similar results were noticed concerning gender differences in non-asthmatic group except for IFMD the difference was not significant (P>0.05).

The mandibular dental arch width for asthmatic and non-asthmatic children is illustrated in Table (2). Concerning ICD and IFMD, data showed that the mean values were found to be highly significantly lower among asthmatic than non- asthmatic children (P<0.01). Concerning ISMD, results revealed that the mean values among asthmatic children were found to be lower than non-asthmatic children with statistically significant difference (P< 0.05).

Concerning gender differences in asthmatic children, data analysis reported that the mean values of all ICD, IFMD and ISMD were found to be higher among boys than girls with statistically highly significant difference for ICD and IFMD (P<0.01), while for ISMD the difference was not significant (P>0.05). Similar results were noticed concerning gender differences in non-asthmatic children except for IFMD the difference was not significant (P>0.05) and for ISMD the difference was statistically significant (P<0.05). The maxillary dental arch length for asthmatic and non-asthmatic children is illustrated in Table (3). Concerning AAL, results reported that the mean value was found to be highly significantly lower among asthmatic than non- asthmatic children (P<0.01). For MVD, data revealed that the mean value among asthmatic children was found to be lower than non-asthmatic children group with statistically non-significant difference (P>0.05). Concerning TAL, results revealed that the mean value among asthmatic children was found to be lower than non-asthmatic children with statistically highly significant difference (P<0.01).

Concerning gender differences in asthmatic and non-asthmatic children, data analysis reported that the mean value of all AAL, MVD and TAL were found to be higher among boys than girls, with statistically

Highly significant difference (P<0.01), except MVD in asthmatic children, the difference was not significant (P>0.05). The mandibular dental arch length for asthmatic and non-asthmatic children is illustrated in Table (4).

The results of AAL showed that the mean value was found to be lower among asthmatic than non- asthmatic children with statistically non -significant difference (P>0.05). For MVD data revealed that the mean value among asthmatic children was found to be lower than non-asthmatic children with statistically highly significant difference (P<0.01).

The results of TAL, results revealed that the mean value among asthmatic children was found to be lower than non-asthmatic children with statistically highly significant difference (P< 0.01). Comparison between genders, the results illustrated that the mean values for all AAL, MVD and TAL were found to be higher among boys than girls among asthmatic children with statistically highly significant difference (P<0.01). While among non-asthmatic children the results reported statistically non-significant difference (P>0.05).

Table 1 Maxillary arch width (mm) among asthmatic and non-asthmatic children by genders.

Variables	Genders	Asthmatic			Non-asthmatic			Statistical Difference		
		N	Mean	S.D.	N	Mean	S.D.	t-test	df	p-value
ICD	Boys	12	32.34	1.06	12	34.73	1.13	5.32	22	0.000 **
	Girls	13	31.99	0.63	13	34.44	1.44	5.57	24	0.000**
	Total	25	32.16	0.86	25	34.58	1.29	7.78	48	0.000 **
IFMD	Boys	12	49.32 ▲	1.98	12	51.37	1.44	2.91	22	0.008**
	Girls	13	47.67	1.68	13	51.32	1.86	5.25	24	0.000**
	Total	25	48.46	1.98	25	51.35	1.64	5.62	48	0.000**
ISMD	Boys	12	53.92 ▲▲	1.78	12	55.40 ▲▲	0.65	2.70	22	0.013**
	Girls	13	51.26	0.46	13	51.93	0.91	2.37	24	0.026 *
	Total	25	52.54	1.84	25	53.39	1.93	1.98	48	0.050 *

(Non Sig. at P>0.05;*S: Sig. at P<0.05; ** HS: Highly Sig. at P<0.01 between asthmatic and non- asthmatic children), (▲P<0.05 between boys and girls; ▲▲P<0.01 between boys and girls), N =number.

Table 2: Mandibular arch width (mm) among asthmatic and non-asthmatic children by genders

Variables	Genders	Asthmatic			Non-asthmatic			Statistical Difference		
		N	Mean	S.D.	N	Mean	S.D.	t-test	df	p-value
ICD	Boys	12	25.75 ▲▲	1.47	12	27.58 ▲▲	1.51	3.01	22	0.006 **
	Girls	13	24.17	1.08	13	25.70	0.77	4.17	24	0.000 **
	Total	25	24.93	1.49	25	26.60	1.50	3.95	48	0.000 **
IFMD	Boys	12	42.69 ▲▲	1.82	12	46.28	1.83	4.81	22	0.000 **
	Girls	13	40.54	0.56	13	45.74	1.05	15.80	24	0.000 **
	Total	25	41.57	1.70	25	46.00	1.47	9.85	48	0.000 **
ISMD	Boys	12	50.01	2.75	12	51.32 ▲	1.80	1.38	22	0.182
	Girls	13	49.20	1.58	13	50.13	0.97	1.80	24	0.084
	Total	25	49.59	2.21	25	50.70	1.53	2.06	48	0.044 *

(Non Sig. at P>0.05;*S: Sig. at P<0.05; ** HS: Highly Sig. at P<0.01 between asthmatic and non- asthmatic children).

Table 3: Maxillary arch length (mm) among asthmatic and non-asthmatic children by genders

Variables	Genders	Asthmatic			Non-asthmatic			Statistical Difference		
		N	Mean	S.D.	N	Mean	S.D.	t-test	df	p-value
AAL	Boys	12	8.50 ▲▲	0.99	12	9.29 ▲▲	0.45	2.50	22	0.020 *
	Girls	13	6.85	0.53	13	8.55	0.47	8.69	24	0.000 **
	Total	25	7.65	1.14	25	8.91	0.59	4.93	48	0.000 **
MVD	Boys	12	27.01	1.73	12	28.88 ▲▲	2.02	2.44	22	0.023 *
	Girls	13	26.07	1.24	13	26.12	0.95	0.12	24	0.907
	Total	25	26.52	1.54	25	27.45	2.08	1.79	48	0.080
TAL	Boys	12	43.42 ▲▲	2.41	12	44.32 ▲▲	1.32	1.13	22	0.272
	Girls	13	40.88	0.71	13	43.25	0.33	10.98	24	0.000 **
	Total	25	42.10	2.15	25	43.76	1.07	3.47	48	0.001 **

(Non Sig. at P>0.05;*S: Sig. at P<0.05; ** HS: Highly Sig. at P<0.01 between asthmatic and non- asthmatic children.

Table 4: Mandibular arch length (mm) among asthmatic and non-asthmatic children by genders

Variables	Genders	Asthmatic			Non-asthmatic			Statistical Difference		
		N	Mean	S.D.	N	Mean	S.D.	t-test	df	p-value
AAL	Boys	12	6.30 ▲▲	0.66	12	6.32	1.08	0.07	22	0.946
	Girls	13	5.28	0.49	13	6.11	0.71	-3.46	24	0.002 **
	Total	25	5.76	0.76	25	6.21	0.89	-1.88	48	0.081
MVD	Boys	12	23.40 ▲▲	1.49	12	24.59	1.22	2.14	22	0.044 *
	Girls	13	21.20	0.75	13	24.26	0.64	11.15	24	0.000 **
	Total	25	22.26	1.60	25	24.42	0.96	5.81	48	0.000 **
TAL	Boys	12	39.17 ▲▲	1.88	12	40.38	1.33	1.83	22	0.081
	Girls	13	37.08	1.39	13	39.83	1.19	5.42	24	0.000 **
	Total	25	38.08	1.93	25	40.10	1.26	4.37	48	0.000**

(Non Sig. at P>0.05; *S: Sig. at P<0.05; ** HS: Highly Sig. at P<0.01 between asthmatic and non- asthmatic children).

DISCUSSION

The index age twelve years was selected in the present study as it is still a proper time for prediction of arch dimension and they are also considered as a static stages as the width in the region of the permanent first molars gradually increase and attain a stable condition about 12 years of age [48], and the width in the inter canine region of both arches gradually decrease between the ages of 10 and 12 with no change after that [49]. The current study didn't depended in the odontometric analysis on the traditional casts by using dental vernier particularly due to problems of casts storage in terms of space and cost, and the risks of damage. Thus instead of, an alternative method to record the study models in a digital format was needed as an integral part of the modern dentistry practice through which data could be saved on a personal computer [43]. Therefore digital photography was used in this study, because the resolution of the software program in this study could reach up to more than 0.001mm as compared to the measurement of the manual and digital calliper that reaches up to only to 0.1 mm and 0.01mm respectively, additionally the particular software program facilitates the ability to enlarge the digital models without changing the real size of teeth. Furthermore, the measurements on the digital casts are also expected to be generally reliable and more precise, especially when reaching each point on the digital casts seemed to be easier to do [21].

The clinical findings of the current study concluded that the mean values of dental arches width and length for both maxillary and mandibular dental arches among asthmatic children were lower as compared to non-asthmatic children in both genders. These results were in agreement with Principato [4], Kairaitis et al. [5], Solow and Sandham [6], Faria et al. [7], Peltomaki [8], Kumar and Nandlal [9], Gungor and Turkkahraman [10], and in disagreement with Hojensgaard and Wenzel [11], Shanker et al. [12].

These findings could be explained by the fact that patients with chronic asthma symptoms could appear with resistance elevation of the airways lower part with gas-trapping in the chest [50], the different mechanism of breathing which correlated with these changes could lead to cervical respiratory muscles shortening which might change head and cervical spine posture [51, 52], as a result this relationship between head posture and breathing difficulties might cause dysregulation in the growth and development of the orofacial structures, including narrowing of the maxilla and lower development of the mandible [6, 53], this abnormal development had been explained by changes in head and tongue position and muscular balance [6], because the extended head posture, soft tissue stretching and the tongue lowered from contact with the palate and protruded to provide a greater oral airway as seen in response to an obstructive resistant airway, all of these factors might cause slight backward and downward forces exerted by the soft tissue layer on the facial skeleton thereby restraining the forward and increasing the downward component of the maxillary and mandibular growth relative to the cranial base [54], so asthma cause functional changes of the oral-maxillary muscles that can alter the normal development of dental occlusion [55].

The change in the dentoalveolar morphology which seen in asthmatic children can be summarized as result of a complex combination of the disease, medication and associated mouth breathing [56].

Mouth breathing in allergic individuals is believed to be the primary factor in development of class 2 division 1 malocclusion. However, in this study all asthmatics were observed to have class 1 molar relation, this result was in agreement with Kumar and Nandlal [9], that could be explained by the fact that the mouth breathing might associated with all classes of malocclusion, however the occurrence of various types of malocclusion in allergic and mouth breathing subjects does not indicate mouth breathing itself as a primary cause [3, 9].

The outcome of the present study showed that the maxillary dental arch is larger in all dimensions of the width and length than the mandibular dental arch in both gender among asthmatic and non-asthmatic children which confirm the accepted view that the maxillary dental arch is larger in all dimensions than the mandibular counterpart and this is consistent with the principle that the maxillary dental arch overlaps the mandibular dental arch [19, 22, 57].

The results in the present study reported larger mean values of both maxillary and mandibular arches width at IFMD, ISMD in addition to mandibular ICD in boys than in girls, these findings are in line with those obtained in other studies [21, 24, 58, 59].Furthermore this study revealed that the length of maxillary and mandibular dental arches among boys were larger in all dimensions mean values than girls, this in accordance with other studies [17, 60]. This might be attributed to the smaller and smoother bony ridge and alveolar processes in girls than in boys and due to physical characteristics and strongest musculature in males which play role in facial development [19,60]. While the findings of the current study were in disagreement with other studies which concluded that there were no such differences between genders in the dental arches [36,61], this disagreement could be due to ethnic differences, sample size and /or selection criteria.

In conclusion, the findings of this research demonstrated the clear need to establish health programs for early diagnosis and management of airway obstructive disorders in order to avoid certain complications such as the changes in the development of the dentoalveolar morphology.

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