Oral Breathing and Head Posture

Antonino Marco Cuccia[a]; Maurizio Lotti[b] Domenico Caradonna[c]

ABSTRACT

Objective: To determine the head posture and cephalometric characteristics in oral breathing children.

Materials and Methods: Lateral cephalograms taken in natural head posture of 35 oral breathing patients (OB) (mean age 8.8 $\pm$ 2.2 years SD; range 5–13 years) and of 35 patients with varied malocclusions and physiological breathing (PB) (mean age 9.7 $\pm$ 1.6 years SD; range 7–13 years) were examined.

Results: A Student's *t*-test showed that an increase in angles NSL/OPT ($P = .000$), NSL/CVT ($P = .001$), FH/OPT ($P = .000$), FH/CVT ($P = .005$), and NSL/VER ($P = .000$); a decrease in the distance MGP-CV1p ($P = .0001$); and a decrease in the angles MGP/OP ($P = .000$) and OPT/CVT ($P = .036$) were found in the OB group. A low position of the hyoid bone (H-MP, $P = .009$), a major skeletal divergence (ANS-PNS/Go-Me, $P = .000$), and an increased value of the ANB angle ($P = .023$) were present in OB patients. To ascertain if the changes in posture were connected with posterior obstruction of the upper respiratory airways, the OB group was divided into two subgroups based on the distance Ad2-PNS being greater than or less than 15 mm. No significant differences were found between these two groups.

Conclusions: Our data suggest that OB children show greater extension of the head related to the cervical spine, reduced cervical lordosis, and more skeletal divergence, compared with PB subjects.

KEY WORDS: Oral breathing; Head posture

INTRODUCTION

Oral breathing has been reported to cause changes in human head posture. The head position relative to the cervical spine is the result of integration at the central nervous system level of different external and internal inputs, including visual, cutaneous, musculotendinous, and vestibular receptors.

Breathing is one of the prime functions fulfilled by man, and it can have considerable effects on the morphology and on the craniofacial and cervical functions.[1–3] Ricketts[4] maintained that head extension represents a functional answer to facilitate oral breathing (OB) in order to compensate nasal obstruction. Tecco et al[5] studied the changes in head posture in mouth breathing girls after treatment with rapid maxillary expansion (RME). They reported that RME is able to increase the capacity of the nasopharyngeal airways and leads to significant changes in the craniocervical angles.

In a study undertaken on healthy young adults, OB was artificially induced by nasal obstruction. The authors evaluated the relationship between the true vertical and the nasion-tragus line as well the C7-tragus line, and found significant differences in extension of the neck as measured by the C7-tragus/vertical line angle, with the other (nasion-tragus/vertical line angle) showing greater variability.[6]

Another study evaluated the influence of total nasal obstruction and the absence of vision on head posture (singly and combined). The results indicate that total nasal obstruction, by the use of a nose clip, induces a change in head posture (head elevation).[7]

It has been noted that there are changes in the association between the nasopharyngeal resistance and

[a] Staff Scientist, Department of Dental Sciences and Department of Orthodontics and Gnathology, University of Palermo, Palermo, Italy.

[b] Research Assistant, Department of Dental Sciences, University of Palermo, Palermo, Italy.

[c] Professor, Department of Orthodontics and Gnathology, University of Palermo, Palermo, Italy.

Corresponding author: Dr Antonino Marco Cuccia, Department of Dental Sciences, University of Palermo, Via del Vespro 129 Palermo, 90127 Italy
(e-mail: cucciaam@odonto.unipa.it)

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the variations of the craniocervical parameters (with reduction in craniocervical angulation through head flexion) following a tonsillectomy or adenoidectomy,[8–10] rapid maxillary expansion (RME),[5] and after cortisone therapy in children with asthma and chronic rhinitis. In one study on children suffering from allergies, the use of a cortisone nasal spray (budesonide) reduced nasal resistance, thus causing an increased flexing of the head.[11] To approach the problem from another direction, no significant variation in airway resistance was seen after cranial extension obtained by manipulation.[12]

The existing correlations among OB, craniocervical posture, and craniofacial development indicate that further confirmation is needed in the morphogenetic consequences of bronchial asthma and of chronic allergic rhinitis.[13,14]

The aim of this research was to analyze the influence of OB, not necessarily connected to an upper airway obstruction, on head posture in children in order to establish possible postural alterations associated with OB, before the same might condition their development.

MATERIALS AND METHODS

Subjects

The sample included 35 oral breathing (OB) children and 35 physiological breathing (PB) children, consecutively admitted in the Department of Orthodontics, University of Palermo, who needed orthodontic treatment. The first group of OB subjects comprised 14 (40%) boys and 21 (60%) girls (age 5–13 years, average 8.8 years, SD ± 2.2 years). All patients had a history of OB, confirmed by their parents and the medical history. On clinical examination these patients showed lip inefficiency at rest, dental crowding in the upper arch, "adenoidal facies," and reduced maxillary transverse dimension with unilateral or bilateral crossbite.

Evaluation of the breathing pattern for most of this group showed a diaphragmatic mode of inhalation with underexpansion of the thorax and a reduced mobility of the nostrils suggesting a reduced patency of the upper airway. OB was shown by water vapor condensed on the surface of a mirror placed outside the mouth. The cause of OB was not established.

The second group of PB subjects comprised 16 (46%) boys and 19 (54%) girls (age 7–13 years, average 9.7 years, SD ± 1.6 years). These children were chosen at random from a group of children who had varied orthodontic problems, but who did not have a past history or any clinical signs of OB.

Exclusion criteria for both groups included previous or ongoing orthodontic treatment, vestibular or equilibrium problems, visual, hearing or swallowing disorders, and facial or spinal abnormalities (ie, torticollis, scoliosis, or kyphosis). A teleradiograph was taken of each subject (70 in total) in the natural head position (NHP), and all teleradiographs were evaluated cephalometrically. The parents of all patients gave informed consent for participation in the study.

Craniofacial Measurements

Fourteen angular and three linear measurements that formed the basis of the postural and craniofacial analysis and airways dimension[15–17] were measured by hand for each subject. A ruler and a protractor accurate to 0.5 mm and 0.5° were used. The Ad2-PNS value was measured in all subjects in the OB group. On the basis of the obtained data the group was divided into two subgroups of 12 and 23 patients: subjects with values ≥15.5 mm and subjects with values ≤15 mm. The association between the increases in the nasopharyngeal resistance, using an active anterior rhinomanometer, and Ad2-PNS values ≤15 mm, encouraged the choice of this measurement in order to differentiate between the patients.[18] The cephalometric points, lines, and angles used in the study are shown in Figures 1 and 2.

Method Errors

In the postural recording method, the radiographs were taken with the subject standing in NHP as described by Şahin Sağlam and Uydas.[19] Duplicate determinations were also carried out for all the linear and angular variables measured on the lateral cephalometric radiographs by two orthodontists. The measurements were undertaken 2 weeks apart and no significant differences were found for any of the craniofacial and airway variables in the two data sets (paired *t*-test).

The measurement error was calculated using 20 radiographs (10 randomly chosen from OB and 10 from PB) and Dahlberg's formula. For linear distances the error varied from 0.4 mm (H-MP) to 0.75 mm (H-CV3ia-RGN) with a mean of 0.52 mm, while for angles the error varied from 0.40° (CVT/HOR) to 0.80° (OPT/NSL) with a mean of 0.65°.

Statistical Method

Cephalometric variables are presented as mean, standard deviation (SD), and the lowest and highest values. The Student's *t*-test was used to determine if significant cephalometric differences existed between the OB and the PB children.

Three subgroups representing those with normal values, increased values, and reduced values com-

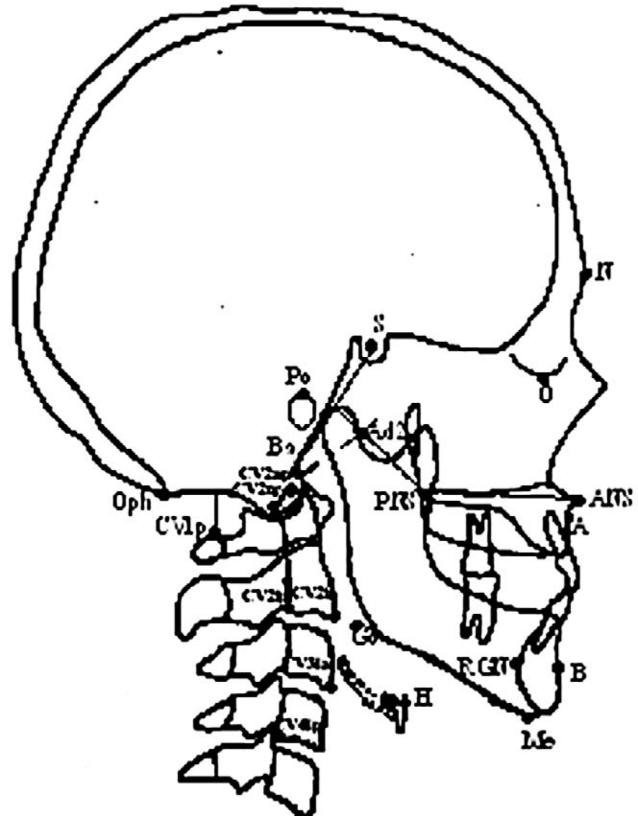

Figure 1. Diagrammatic representation of the anatomic points used to identify craniofacial parameters on lateral cephalometric radiographs. Point A: most posterior point on the anterior contour of the upper alveolar process; Point ANS: anterior nasal spine, the tip of the bony anterior nasal spine of the maxilla; Point B: deepest point on the anterior contour of the lower alveolar process; Point Ba: Basion, the median point of the anterior margin of the foramen magnum; Point Go: Gonion, the constructed point of the intersection of the ramus plane and the mandibular plane; Point RGN: Retrognation, most posterior point of the mandibular symphysis; Point N: Nasion, the most anterior point of the frontonasal suture in the median plane; Point PNS: Posterior nasal spine, the tip of the bony posterior nasal spine; Point S: Sella, the midpoint of the pituitary fossa; Point O: Orbitale, the most inferior point on the inferior margin of the orbit; Point Me: Menton, the most inferior point on the symphysis of the mandible. Point Po: Porion, the most superior point of the external auditory meatus; Point Oph: Ophisthion, the most anterior point on the posterior border of the foramen magnum in the sagittal plane; Point Ad2: Superior adenoidal point, on perpendicular from point PNS to S-Ba line; Point CV1p: the most posterior and superior point of the spinous process of atlas (the first cervical vertebra); Point CV2ap: the most superior point of the odontoid process; Point CV2tg the tangent point at the superior, posterior extremity of the odontoid process of the second cervical vertebra; Point CV2ip: most inferior and posterior point on the second cervical vertebra corpus; Point CV2ia: most anterior and inferior point of body of the second cervical vertebra; Point CV3ia: most anterior and inferior point of body of third cervical vertebra; Point CV4ip: most inferior and posterior point on the fourth cervical vertebra corpus; Point H: most superior and anterior point on the body of the hyoid bone.

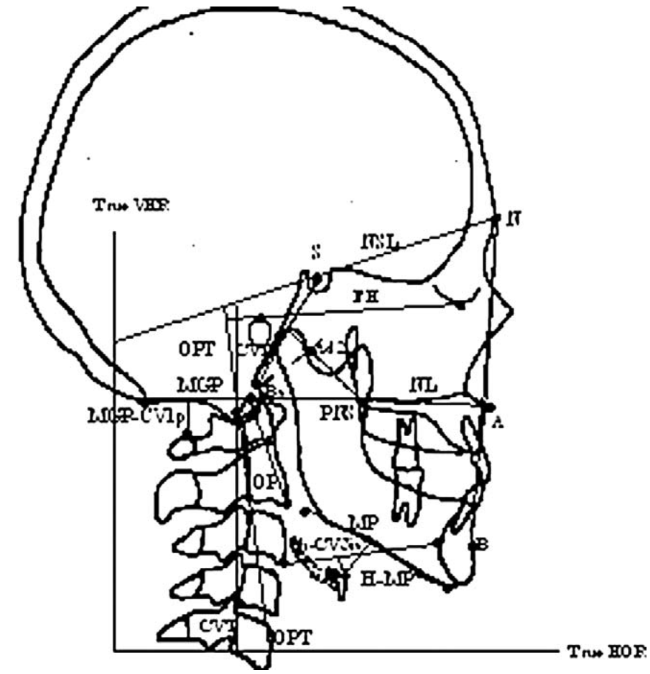

Figure 2. Linear and angular measurements of cephalometric analysis. MGP (McGregor plane): line connecting point PNS to Oph; OP (odontoid plane): line connecting points CV2ap to CV2ia; OPT: line connecting the tangent point at the superior, posterior extremity of the odontoid process of the second cervical vertebra (CV2tg) and the most inferior/posterior point on the second cervical vertebra corpus (CV2ip); CVT (posterior tangent cervical): an extended line from CV2tg to CV4ip; FH (the Frankfurt horizontal plane): line connecting Porion (Po) and Orbitale (O); NL (palatal plane): extended line from ANS to PNS; MP: (mandibular plane) extended line from Me to Go; NSL (anterior cranial base): extended line from nasion to sella; VER: the gravity determined vertical; HOR the perpendicular to VER; Ad2-PNS (the rhinopharyngeal airway dimension): distance in millimeters between PNS and the nearest adenoidal part on the perpendicular to the line S-Ba; H-MP: distance to the hyoid bone measured perpendicular to the mandibular plane; H-CV3ia: distance to the hyoid bone measured perpendicular from the line RGN-CV3ia; MGP-CV1p: distance in millimeters between MGP and CV1p; NSL/VER: the angle between NSL and VER; NSL/Ba: inner angle formed by the connection of N, S, and Ba in that order; MGP/OP (craniovertebral angle): posterior inferior angle comprised of the intersection of McGregor plane and the odontoid plane; NSL/OPT: head position in relation to the second cervical vertebra, intersection of NSL with OPT; NSL/CVT (head position in relation to the second and the fourth cervical vertebrae): angle between NSL and CVT; FH/OPT: angle created by extension of the Frankfurt horizontal plane and OPT; FH/CVT: angle created by extension of the Frankfurt horizontal plane and CVT; OPT/HOR (the cervical inclination): the angle between OPT and HOR; CVT/HOR (the cervical inclination): the angle between CVT and HOR; OPT/CVT (the cervical curvature): the angle between CVT and OPT; NL/MP: angle between NL and MP; SNA: angle formed by the connection of the sella, nasion, and A point; SNB: inner angle formed by the connection of the sella, nasion, and B point; ANB: difference between angles SNA and SNB.

Table 1. Variables Studied[a]

	Oral Breathing (n = 35)				Physiological Breathing (n = 35)				Student's *t*-test	
	Mean	SD	Max	Min	Mean	SD	Max	Min	*t*	*P*
NSBa, degrees	133.8	±6.66	154	119	132.79	±5.00	144.7	122.5	0.717	NS
MGP/OP, degrees	93.45	±10.9	115	66	103.77	±9.05	120.5	82	−4.309	0.000
NSL/VER, degrees	102.4	±6.68	125	81	93.25	±5.63	105	81	6.196	0.000
NSL/OPT, degrees	108	±9.96	133	92	98.14	±8.64	116.5	80	4.424	0.000
NSL/CVT, degrees	111.79	±9.60	134	91	103.64	±9.41	126.5	86	3.332	0.000
FH/OPT, degrees	97.61	±10.80	123.5	84	88.15	±8.84	106.5	75	4.010	0.000
FH/CVT, degrees	100.71	±10.54	124.5	80	93.65	±9.59	116.5	78	2.931	0.005
OPT/HOR, degrees	83.00	±9.24	62	101	84.42	±8.79	101	71	−0.470	NS
CVT/HOR, degrees	79.21	±8.24	67	00	78.92	±8.08	101	61	0.364	NS
OPT/CVT, degrees	3.79	±3.79	14	−4	5.5	±2.83	12	−3	−2.139	0.036
MGP-CV1p, mm	6.84	±3.99	20	1	9.84	±2.54	14.5	3.5	3.752	0.000
H-MP, mm	14.78	±6.30	31	4	10.07	±8.14	31	−7	2.707	0.009
H-CV3ia-RGN, mm	3.8	±5.05	13	−10	7.15	±8.73	31	−7	−1.965	NS
SNA, degrees	81.74	±4.45	90	75	80.92	±4.29	90	73	0.785	NS
SNB, degrees	77.1	±3.90	84	70	77.55	±3.94	87	67.5	−0.480	NS
ANB, degrees	4.65	±2.17	10	1.5	3.37	±2.43	7.5	−3	2.324	0.023
ANS-PNS/Go-Me, degrees	30.64	±5.41	40	20	23.97	±5.83	39.5	14	4.961	0.000

[a] Max indicates maximum; Min, minimum; NS, not significant.

Table 2. Ratio for Each Variable of Altered Values[a] With Regard to Normal Values in Oral and Physiological Breathing

		Oral Breathing			Physiological Breathing		
Variables	Normal Values (±SD)	Value Altered, %	a.e., %	a.d., %	Value Altered, %	a.e., %	a.d., %
NSBa, degrees	131 ± 4.5	42.85	73.34	26.66	40.00	71.42	28.58
MGP/OP, degrees	102 ± 5	57.10	0.05	0.95	57.10	65.00	35.00
NSL/OPT, degrees	91 ± 6	85.70	100.00	0.00	62.85	90.90	0.90
NSL/CVT, degrees	97 ± 6	80.00	100.00	0.00	60.00	85.71	14.29
OPT/CVT, degrees	5 ± 2	54.28	0.26	0.74	34.28	66.66	33.34
MGP-CV1p, mm	7 ± 2	51.42	0.38	0.62	77.14	92.59	7.41
SNA, degrees	80 ± 2	62.80	68.18	31.82	48.57	52.94	47.06
SNB, degrees	78 ± 2	65.71	30.43	69.57	45.71	43.75	56.25
ANB, degrees	2 ± 2	62.85	100.00	0.00	40.00	85.71	14.29
ANS-PNS/Go-Me, degrees	25 ± 6	48.57	100.00	0.00	31.42	36.36	63.64

[a] a.e. indicates altered on excess; a.d., values altered on defect.

pared with the standard values,[20] were created within each group (OB and PB). A chi-square test was used to analyze the data. The purpose was to see if the different value of a craniocervical parameter, in both groups, was due to an excessive flexion on PB or an exaggerated extension on OB. Within the OB group, two further subgroups were created with Ad2-PNS values less than 15 mm and greater than 15.5 mm. A Student's *t*-test was used to compare the values between these two subgroups.

Statistical significance was set at the value $P = .05$. Data were analyzed using the Primer of Biostatistics for Windows (version 4.02).[21]

RESULTS

When OB children were compared with PB children, the following craniocervical angles were significantly greater: NSL/OPT ($P < .0001$), NSL/CVT ($P < .0001$), FH/OPT ($P < .0001$), FH/CVT ($P = .005$), and NSL/VER ($P < .0001$). The distance MGP-CV1p was significantly smaller ($P < .0001$) as was angle MGP/OP ($P < .0001$) and angle OPT/CVT ($P = .036$).

A lower position of the hyoid bone, as measured by a greater distance H-MP ($P = .009$) was present in OB children. An increase in the maxillomandibular plane angle (ANS-PNS/Go-Me, $P < .0001$) and an increase in angle ANB ($P = .023$) were seen in the OB group (Table 1).

Tables 2 and 3 show the ratio and number distribution for each variable as well as the normal, increased, and decreased values for the OB and PB groups. In particular, PB patients present a greater proportion of children with an increased value for MGP/OP ($P = .012$) and MGP-CV1p ($P < .001$), and a smaller proportion of children with decreased value for OPT/CVT ($P = .022$) and increased values for an-

Table 3. Number of Patients With Normal, Increased, And Reduced Values of Cephalometric Variables Oral Breathing (OB) and Physiological Breathing (PB) Compared Using a Chi-Square Test

	Normal Values		Reduced Value		Increased Value		Normal vs Reduced		Normal vs Increased	
	OB	PB	OB	PB	OB	PB	χ^2	*P*	χ^2	*P*
MGP/OP	15	15	19	7	1	13	2.580	0.108	6.313	0.012
NSL/OPT	5	13	0	2	30	20	0	1	4.287	0.038
NSL/CVT	7	14	0	3	28	18	0.260	0.611	3.348	0.067
OPT/CVT	16	23	14	4	5	8	5.280	0.022	0.027	0.870
MGP/CV1p	17	8	11	2	7	25	0.512	0.474	10.43	0.001
SNA	13	18	7	8	15	9	0	0.989	1.540	0.122
SNB	12	19	16	9	7	7	2.601	0.107	0.147	0.701
ANB	13	21	0	2	22	12	0.113	0.736	3.768	0.052
ANS-PNS/Go-Me	18	24	0	7	17	4	3.077	0.079	6.758	0.009
NSBa	20	21	4	4	11	10	0.105	0.746	0	1

Table 4. Comparison of Cephalometric Variables Between the Two Subgroups of Oral Breathing (Mean ± SD)[a]

	Ad2-PNS ≥ 15.5 mm (n = 12)	Ad2-PNS ≤ 15 mm (n = 23)	
	n = 12	n = 23	t
NSBa	130.79 ± 6.5	134.89 ± 6.42	−1.78
MGP/OP	94.87 ± 10.30	92.71 ± 11.05	0.56
NSL/OPT	107.87 ± 9.76	108.06 ± 10.28	−0.05
NSL/CVT	112.16 ± 9.41	110.71 ± 9.87	0.41
FH/OPT	97.58 ± 10.15	97.63 ± 11.34	0.013
FH/CVT	101.87 ± 9.76	100.10 ± 11.09	0.46
OPT/CVT	4.29 ± 3.25	3.53 ± 4.09	0.55
MGP-CV1p, mm	6.45 ± 2.70	7.04 ± 4.57	0.41
H-MP, mm	14.41 ± 3.87	14.97 ± 7.53	−0.24
H-CV3ia-RGN, mm	2.37 ± 5.00	4.54 ± 5.02	−1.21
SNA	82.83 ± 5.03	81.17 ± 4.13	1.04
SNB	78.45 ± 4.60	76.39 ± 3.37	1.51
ANB	4.37 ± 2.29	4.80 ± 2.07	−0.56
ANS-PNS/Go-Me	30.62 ± 5.47	30.65 ± 5.50	−0.01

[a] *P* value is not significant.

gle ANS-PNS/Go-Me ($P = .009$). In OB patients an increased number of children with an increased value of NSL/OPT ($P = .038$) was always evident.

Table 4 shows the measurements of all craniocervical variables in the two subgroups: Ad2-PNS ≥15.5 mm and Ad2-PNS ≤15 mm. No statistical differences were found for any of the cephalometric parameters between the two subgroups.

DISCUSSION

Oral respiration alters the muscle forces exerted by the tongue, cheeks, and lips upon the maxillary arch. Intraorally, the dentist might expect to find a narrow maxillary arch with a high palatal vault, a posterior crossbite, a Class II or III dental malocclusion, and an anterior open bite.[22]

The purpose of this study was to assess whether there was a relationship between OB and variables of head posture in children before these same variables might influence their development. An abnormal posture of the head changes the load in several joints of the craniovertebral region, resulting in unfavorable dentofacial and craniofacial growth.[23]

Our main finding is that in OB patients a well-defined postural picture is often evident: reduction of cervical lordosis and increased extension of the atlanto-occipital joint to maintain the Frankfurt plane horizontal. Further analysis of the data with the chi-square test confirms this result. Only MGP/OP and MGP-CV1p suggest an excessive craniocervical flexion in the PB subjects.

Several studies have shown that OB is connected with a variation in the head posture and with a increased craniocervical extension[1] in order to increase the dimension of the airway[24,12] and the oropharyngeal permeability[4] with mandibular and lingual postural modifications, and of the soft palate as well.[25]

Some authors have evaluated the patency of the upper airways using cephalometric techniques and established a connection between the reduction of the nasopharyngeal space and the increase of the craniocervical angle.[26,27]

Even if no association emerges between obstruction of nasopharyngeal space and craniocervical extension, we cannot conclude that craniocervical extension does not depend on the superior airway obstruction, owing to the absence of information about the nasal resistances in this study. In fact, the OB subdivision in Ad2-PNS ≥15.5 mm and ≤15 mm only underlines the different adenorhinopharyngeal conditions of these patients, without revealing any details about nasal resistance.

However, there are studies which have demonstrated, by rhinomanometric tests, a significant relationship between a smaller distance Ad2-PNS or impaired nasal breathing and a wide craniocervical angulation and forward inclination of the cervical spine.[1,28]

In our analysis, the ANB angle and the intermaxillary divergence (ANS-PNS/Go-Me) are present and prevailing in OB patients, which agrees with other studies.[29] These skeletal measurements indicate a tendency for OB children to present a dolichofacial Class II skeletal pattern.

The hyoid bone is located in a lower position in OB patients. Other studies found a correlation between a lower hyoid bone position in relation to the mandibular plane and increase in craniocervical extension.[30,31] However, Bibby[32] supported the stability of the hyoid position which should not be influenced by the postural anomalies of oral breathers.

CONCLUSIONS

- OB causes an increase in head elevation and a greater extension of the head related to the cervical spine and influences hyoid bone position and intermaxillary divergence.
- OB during growth may alter NHP, as well as craniofacial morphology.
- Changing the mode of breathing from oral to nasal early in adolescence may promote a tendency towards normalization of the craniofacial dimensions with growth.

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