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Radiographic cephalometry analysis of head posture and craniofacial morphology in oral breathing children

Radiografsko-kefalometrijska analiza položaja glave i kraniofacijalne morfologije kod dece koja dišu na usta

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Abstract

Background/Aim. Nasal breathing plays an important role in overall physical growth and mental development, as well as in the growth of the craniofacial complex. Oral breathing over a long period of time, can cause changes in position of the head relative to the cervical spine and jaw relationship. It can cause an open bite and the narrowness of the maxillary arch due to increased pressure of strained face. The aim of this study was to analyze the position of the head and craniofacial morphology in oral breathing children, and compare the values obtained compared with those of the same parameters in nasal brething children. **Methods**. We analyzed the profile cephalometric radiographs of 60 patients who had various orthodontic problems. In the first group there were 30 patients aged 8–14 years, in which oral breathing is confirmed by clinical examination. In the second group there were 30 patients of the same age who had orthodontic problems, but did not show clinical signs of oral breathing. The analyses covered the following: craniocervical angle (NS/OPT), the length of the anterior cranial base (NS), anterior facial height (N-Me), posterior facial height (S-Go), the angle of maxillary prognathism (SNA), angle of mandibular prognathism (SNB), difference between angles SNA and SNB (ANB angle), the angle of the basal planes of the jaws (SpP/MP), cranial base angle (NSB), and the angle of facial convexity (NA/Apg). **Results**. The average value of the craniocervical angle (NS/OPT) was significantly higher in OB children (p = 0.004). There were significantly different values of SNA (p < 0.001), ANB (p < 0.001), NA/APg (p < 0.001) and length of the anterior cranial base (NS) (p = 0.024) between groups. **Conclusion**. Oral breathing children have pronounced retroflexion of the head in relation to the cervical spine compared to nasal breathing children, and the most prominent characteristics of the craniofacial morphology of skeletal jaw relationship of class II and increased facial convexity.

Key words:
mouth breathing; craniofacial abnormalities; child.

Apstrakt

Uvod/Cilj. Disanje na nos ima važnu ulogu u celokupnom telesnom rastu i psihičkom razvoju, pa i u rastu kraniofacijalnog kompleksa. Kod dece koja dišu na usta u dugom vremenskom periodu može se promeniti položaj glave u odnosu na vratnu kičmu, kao i odnos vilica. Može se javiti otvoren zagrižaj i uskost maksilarnog zubnog luka zbog povećanog pritiska zategnutih obraza. Cilj ove studije bio je da se analizira položaj glave i kraniofacijalna morfologija dece koja dišu na usta i dobijene vrednosti uporede sa vrednostima istih parametara kod dece koja dišu na nos. **Metode**. Analizirani su profilni telerendgen snimci kod ukupno 60 pacijenata koji su imali različite ortodontske probleme. U prvoj grupi je bilo 30 pacijenata starosti 8–14 godina, kod kojih je kliničkim pregledom utvrđeno disanje na usta. U drugoj grupi je bilo 30 pacijenata iste starosti koji su imali ortodontske probleme, ali nisu pokazivali kliničke znake disanja na usta. Analizirani su: kraniocervikalni ugao (NS/OPT), dužina prednje kranijalne baze (NS), prednja visina lica (N–Me), zadnja visina lica (S–Go), ugao maksilarnog prognatizma (SNA), ugao mandibularnog prognatizma (SNB), razlika između uglova SNA i SNB (ugao ANB), ugao osnovnih ravni vilica (SpP/MP), ugao baze lobanje (NSBa) i ugao konveksiteta lica (NA/Apg). **Rezultati**. Prosečna vrednost kraniocervikalnog ugla- (NS/OPT) bila je značajno veća kod dece koja dišu na usta (p = 0,004). Ustanovljena je značajna razlika u vrednosti uglova (SNA) (p < 0,001), ANB (p < 0,001), NA/Apg (p < 0,001), kao i dužine prednje kranijalne baze (p = 0,024) između ispitivanih grupa. **Zaključak**. Deca koja dišu na usta imaju izraženiju retrofleksiju glave u odnosu na vratnu kičmu u poređenju sa decom koja dišu na nos, a najupadljivija karakteristika njihove kraniofacijalne morfologije jeste skeletni odnos vilica II klase i povećan konveksitet lica.

Ključne reči:
disanje na usta; kraniofacijalne anomalije; deca.

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Introduction

The head position is associated with the growth and morphology of the craniofacial complex, but also with certain non-physiological and pathological conditions such as respiratory problems and sleep problems. Breathing is the first vital function that can be approached immediately after birth. It is, above all, the nasal function, but during the life, there are shorter or longer periods when there is breathing through the mouth in some pathological (chronic respiratory infection), or physiological (increased need for oxygen during body activity) conditions. Nasal breathing (NB) during the growth period plays an important role in the overall physical growth and mental development, as well as the growth of the craniofacial complex. Breathing is largely determined by the position of the head, mandible and tongue. Breathing through the mouth requires descending mandible and tongue and throwing the head back. Therefore, it is logical that the change of breathing from nasal to oral may lead to a change of the position of the jaws, tongue and head.

Oral breathing (OB) can affect the form of the jaws, and it has been shown that it leads to the so-called ''adenoid face'', which is characterized by a narrow face, proclination maxillary incisors, lips apart at rest, retroclined mandibular incisors, and increased anterior facial height [1–3].

Children, who breathe through their mouth for a long period of time can change the position of the head relative to the cervical spine, as well as the relationship between the upper and lower jaw [4]. The anterior face height can be increased [5] and an open bite can appear [4, 5] as well as the narrowness of the maxillary arch due to increased pressure of strained face.

The position of the head is connected to the cervical spine, and the position (posture) of the entire body, is under the control of the conditioned and unconditioned reflexes. No conditioned reflexes are formed on the basis of the sense of sight, sense of balance nor a sense of proprioceptive organs and muscles of the body. Conditioned reflexes develop under the influence of environmental factors, and, therefore, posture of each individual is different.

The head posture is assessed on the basis of the craniocervical angle forming the main plane of the anterior cranial base (NS) and tangent odontoid process (OPT) passing through the most inferior and posterior point on the second cervical vertebra corpus [6]. It was found that in children aged 7–13 years, without diseases of muscles and joints, and obstruction of the upper airways, the average value of this angle is 94.6° [7]. Higher values indicate retroflexion or extension, and less anteflexion of the head in relation to the cervical spine.

It is considered that nasal obstruction which causes retroflexion of the head is a consequence of this obstruction compensation [8]. This is confirmed by studies which have noted that there has been a reduction of craniocervical angulation after interventions such as tonsillectomy, adenoidectomy, rapid maxillary expansion (RME) or cortisone therapy for children with asthma and chronic rhinitis [3, 9, 10].

Examining changes in the head position after RME in girls who had to breathe through their mouths, it was found that after RME the capacity of nasopharyngeal tract increased, leading to a significant change in the value of the craniocervical angle that reflected the position of the head relative to the cervical spine [11].

Many studies have shown that there is a connection between head posture, craniofacial morphology and obstruction of the upper airways [12–15]. It was found that narrow and long faces in persons with reduced nasopharynx correspond to the position of head of extensions to the cervical spine, while broad faces in persons with well-developed nasopharynx correspond to the flexion of the head from the spine. Oral breathing, caused by artificial obstruction of the nasal passages, leads to changes in head position so that it comes to extensions [16].

Examining the position of the head in OB children, Antonino et al. [4] concluded that oral breathing leads to an extension of the head in relation to the cervical spine, as well as changes in the craniofacial morphology. They also concluded that the change of breathing from oral to nasal, if occurs during early adolescence, may lead to normalization of craniofacial dimensions during further growth.

Comparing craniofacial morphology, head posture and hyoid bone position with different breathing patterns it has been found that the maxilla is more retrognathic, and palatal plane has a posterior rotation in patients who breath through their mouth. No significant differences are found in the hyoid bone position between the two groups of patients [5].

The aim of this study was to analyze the position of the head and craniofacial morphology in children who breathe through their mouths and to compare the values obtained with those of the same parameters in children who breathe through their nose.

Methods

We analyzed the profile cephalometric radiographs of 60 patients of the Department of Orthodontics, Faculty of Medicine, University of Pristina, with the headquarters in Kosovska Mitrovica.

The sample was divided into two groups of patients. The first group consisted of 30 children aged 8–14 years (16 girls and 14 boys), in which the clinical examination confirmed oral breathing. When a mirror was put in front of the mouth of these children, there was a condensation of exhaled air at the surface of it. Also, when these children were given a sip of water and were instructed to keep it in their mouths and not to swallow it, they could not keep it longer than 10 seconds. In clinical examination with these patients, the existence of "facies adenoidea" is confirmed, and it is characterized by a narrow face, proclination maxillary incisors and lips apart at rest. In the second group there were 30 children of the same age (19 girls and 11 boys), which had different orthodontic problems, but showed no clinical signs of mouth breathing. For each patient lateral cephalogram was made at standard shooting conditions on the appliance brand "Siemens" output of 90 KV and the exposure of 1 s (standard shooting conditions imply that each participant shot in the standing position, with the head oriented so that the Frankfort plane is parallel with the floor). Distance from the source of X-rays to the film was 150 cm. Mid-sagittal plane of the patient's head was parallel to cassette with the film. X-ray film cassette was in distance of 15 cm from the mean sagittal plane of the patient's head. Central X-ray falls in the middle of the opening of the outer skin of the ear canal. At the time of recording the teeth were in centric occlusion and lips relaxed and at rest. Each lateral cephalogram had to satisfy that, in addition to other structures, the first two cervical vertebrae are clearly visible. The parents of all patients gave informed consent for their participation in the study.

All the lateral cephalograms were analysed manually. The corresponding craniometric points and planes were labeled 3 linear and 7 angular measurements were hand made (Figures 1 and 2). The following points were labeled: 1) nasion (N) – the most anterior point of the frontonasal suture in the frontonasal suture; 2) sella (S) – the midpoint o the pituitary fossa; 3) basion (Ba) – median point of the anterior margin of the foramen magnum; 4) spina nasalis anterior (Sna) – the tip of the bony anterior nasal spine of the maxilla; 5) spina nasalis posterior (Snp) – the tip of the bony posterior nasal spine; 6 subspinale (A) – the most posterior point on the anterior contour of the upper alveolar process; 7) supramentale (B) – deepest point on the anterior contour of the lower alveolar process; 8) menton (M) – the most inferior point on the symphysis of the mandible; 9) pogonion (Pg) – the most forward point on the anterior surface of the chin; 10) gonion (Go) – the constructed point of the intersection of the ramus plane and the mandibular plane; 11) most inferior and posterior point on the second cervical vertebra corpus – (CV2ip).

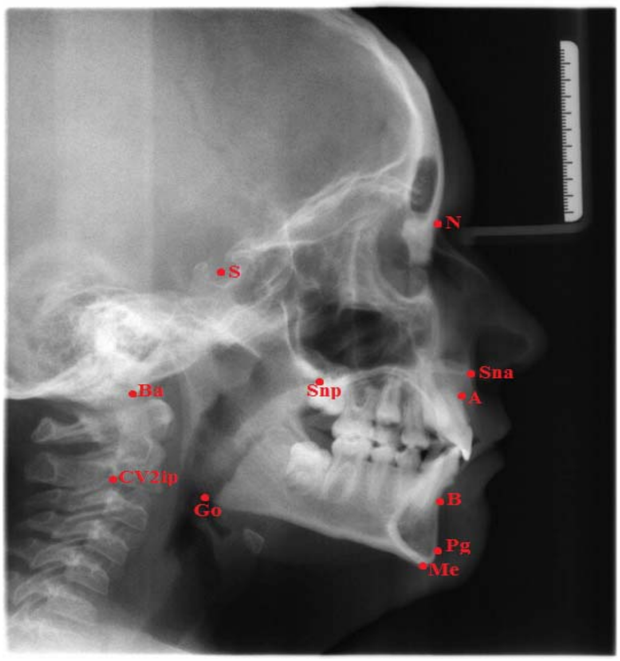

Fig. 1 – The cephalometric and craniocervical points.

The following linear measures were analyzed: 1) anterior cranial base lenght – (N-S); 2) anterior facial height – (N-Me); 3) posterior facial height – (S-Go);

The following angles were analyzed: 1) craniocervical angle – (NS/OPT); head position in relation to the second cervical vertebra, intersection of NS with odontoid process tangent through CV2ip point – (OPT); 2) angle of maxillary prognathism; formed by the connection of the sella, nasion, and A point – (SNA); 3) angle of mandibular prognathism; formed by the connection of the sella, nasion – (SNB) and B point; 4) difference between angles SNA and SNB (ANB); indicating sagittal relation of maxilla and mandible to each other; 5) basal plane angle (SpP/MP); formed by basal plane of the maxilla (SpP) and mandible (MP); indicating vertical relation of maxilla and mandible to each other; 6) angle of basis cranii; formed by the line joining nasion to sella to basion – (NSBa); 7) facial convexity angle; formed by NA and APg line – (NA/Apg).

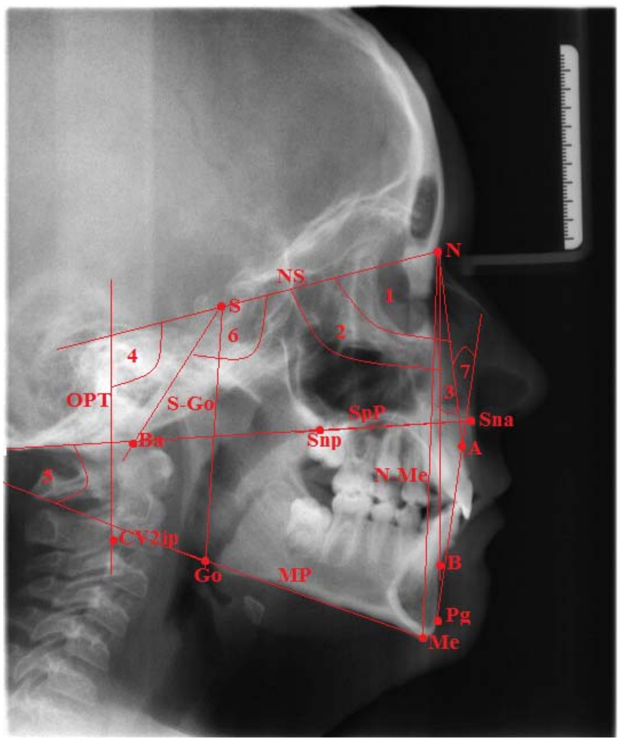

Fig. 2 – The cephalometric angular (1-SNA, 2-SNB, 3-ANB, 4-NS/OPT, 5-SpP/MP, 6-NSBa, 7-NA/APg) and linear (N-Me, S-Go, NS) parameters.

SNA° – angle of maxillary prognathism; SNB – angle of mandibulary prognathism; ANB – difference between angles SNA and SNB; NS/OPT – craniocervicale angle; NS – anterior cranial base lenght; SpP/MP – basal plane angle; NSBa – angle of basis cranii; Na-Apg – facial convexity angle; N–Me – anterior facial height; S-Go – posterior facial height.

The values of angular measure are expressed in degrees, and linear in millimeters.

Craniocervical angulation was evaluated on the basis of the value of the craniocervical angle NS/OPT. Other variables examined were indicators of craniofacial morphology.

The analysis of primary data was conducted by using descriptive statistical methods and methods for testing statistical hypotheses. Descriptive statistical methods included measure of central tendency (mean and median) and measures of variability (standard deviation, and range). Testing statistical hypotheses was performed by using *t*-test and Mann-Whitney test. Data analysis was done by using Software package SPSS 21 Differences between groups were considered statistically significant at a level of $p < 0.05$.

Results

The results of the study are shown in Table 1. It can be seen that there were differences in the values of the examined parameters between the two study groups. The average value of the craniocervical angle (NS/OPT) in children who breathed through their mouth was 101.5° which was significantly higher than the average value of this angle in children who breathed through their nose (p = 0.004). Significantly different values were also found in maxillary prognathism angle (SNA) ($p < 0.001$) and ANB ($p < 0.001$). Anterior (N-Me) and posterior (S-Go) face height, and basal plane angle of the jaws (SpP/MP) did not differ significantly regardless of breathing through the nose or mouth. The length of the anterior cranial base (NS) was significantly higher in patients who breathed through their mouth (p = 0.024), while the values of the angle of the cranial base (NSB) did not differ significantly between the two groups of patients. The facial convexity angle (NA/APg) was significantly higher in patients who breathed through their mouth ($p < 0.001$).

Disscusion

The mouth breathing in a large number of children is a bad habit, which may occur due to the disturbed anatomical relationships and bad features of circumoral muscles. It is usually a consequence of frequent respiratory infections. On the other hand, the mouth breathing causes a change in the balance of pressure on the jaw and teeth, and the reasons for its occurence are orthodontic anomalies such as the narrowness of the maxillary arch, open bite and distal position of the mandible because of an extreme rotation down and back.

In this study, it was assumed that there was a difference in craniocervical angulation and craniofacial morphology between OB and NB pearsons, as other authors have found in their studies [1–4, 11, 17].

The research confirmed that in the OB children there is a difference in the position of the head to the cervical spine in relation to the NB children [4]. The difference is reflected in significantly higher average value of the craniocervical angle NS/OPT (p = 0.004) in the OB children. Increasing of this angle points to the increased extension of the head in relation to the cervical spine, which is probably a compensation for nasal obstruction [8].

The value of the maxillary prognathism angle (SNA) is significantly higher in children who breathe through their mouths, with its average value of 81.6°, implying mild retrognathism of upper jaw [5], which could be explained by pressing the soft tissue due to the extension of the head and limiting growth in advance [18].

The values of the angle of mandibular prognathism did not differ significantly between the two study groups of children, which is not in accordance with the findings of some previous studies that speak in favor of a reduced SNB angle and length of the mandible in people who breathe through their mouths [19, 20].

The difference in angles of the maxillary and mandibular prognathism, the angle of ANB, was also significantly higher in the OB children. This finding suggests that in the OB children, mainly, there is a relationship of the skeletal jaw of class II, which is consistent with findings from the previous studies [4, 20].

The results of our study indicate that the angle of the basal planes of the upper and lower jaw (SpP/MP), is not significantly different regardless whether a person breathes

Table 1

Variables of craniofacial morphology and craniocervical angulation in patients with oral breathing (OB) and nasal breathing (NB)

Variables	NB group (n = 30)	OB group (n = 30)	p
SNA°, x̄ ± SD	79 ± 3	81.6 ± 2	< 0.001
SNB°, x̄ ± SD	75.9 ± 2.8	75.9 ± 1.7	0.856
ANB°, median (range)	3 (2–4)	5.6 (3–9.2)	< 0.001
NS/OPT °, x̄ ± SD	93.6 ± 10.3	101.5 ± 10.1	0.004
N-Me (mm), x̄ ± SD	103.9 ± 6.7	103 ± 7.5	0.619
S-Go (mm), x̄ ± SD	66 ± 4.9	65 ± 6	0.505
SpP/Mp °, x̄ ± SD	28 ± 4.5	26.8 ± 3.9	0.244
N-S (mm), x̄ ± SD	65.9 ± 5.2	63.3 ± 3.4	0.024
NSBa°, x̄ ± SD	131.6 ± 4.5	132.4 ± 4.6	0.491
NA/APg°, median (range)	5.2 (1.2–11)	10.6 (5.3–15.5)	< 0.001

SNA° – angle of maxillary prognathism; SNB° – angle of mandibulary prognathism; ANB° – difference between angles SNA and SNB; NS/OPT ° – craniocervicale angle; NS – anterior cranial base lenght; OPT – odontoid process tangent through CV2 ip point; CV2ip – most inferior and posterior point on the second cervical vertebra corpus; N–Me – anterior facial height; S-Go – posterior facial height; SpP/Mp – basal plane angle; NSBa – angle of basis cranii; NA/Apg ° – facial convexity angle;
x – arithmetic mean;
SD – standard deviation.

through the nose or the mouth. In accordance with these results are values of anterior (N-Me) and the posterior (S - Go) face height in the OB children, which do not differ significantly in relation to the values in the NB children. Munoz and Orta [21] have found increased anterior facial height in the OB children. The values of these three parameters (SpP/MP, N-Me and S-Go) suggest that oral breathing does not lead to significant changes in the vertical dimension of the face. In contrast to this, Antonino et al. [4] in their analysis of the position of the head in the OB, have found significantly larger angle of the basal planes of jaw in OB children. Based on the increased value of this parameter, as well as the ANB, the same author suggests that people who breathe through the mouth are predominantly dolichofacial, with skeletal jaw relation of the class II.

The length of the anterior cranial base (N-S) was significantly higher in the OB children. This finding differs from the results of Ang et al. [22], and Shrivastava and Thomas [23] who found no significant difference in the length of the anterior cranial base, regardless someone breathes through the nose or mouth.

The value of cranial base angle (NSB) was not significantly different between the two study groups in our study. Similar results have been reported by Ang et al. [22] and Antonino et al. [4]. In contrast, Solow and Tallgen [24] and Solow and Greve [25] have found that the increased craniocervical angle is followed by the bigger angle of the cranial base.

The facial convexity (NA/APg) was significantly higher in OB children, which can be linked to the fact that in these children, skeletal jaw relationship of class II, characterized by a convex profile was dominant.

Different results in the literature have been discussed by Viveros [26] who believes that although there were many researches that have attempted to resolve the influence of breathing patterns on the facial growth, the direct relation between obstruction of the respiratory tract and facial malformations is not established. The author suggests, that in order to explain these dependences, the genetic and environmental influences should be considered. The author, also suggests that well-controlled studies on large population should be carried out in order to clarify the connection between facial growth and breathing through the nose or mouth.

Conclusion

The long-term oral breathing, especially if it appears in the period of growth, can lead to changes in head position and disorders in the growth of the craniofacial complex. Children who breathe through their mouths have pronounced retroflexion of the head in relation to the cervical spine. The most striking characteristic of craniofacial morphology of children who breathe through their mouth is skeletal jaw relationship of class II and increased facial convexity. The vertical craniofacial morphology parameters were not significantly changed.

It is necessary to reveal and remove the cause of oral breathing in its early stage, and thus create conditions for modifying breathing from oral to nasal that can prevent adverse effects on the growth of craniofacial structures.

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