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ORIGINAL ARTICLE

Comparison of craniofacial morphology, head posture and hyoid bone position with different breathing patterns

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Abstract *Objectives:* The aim of this study was to evaluate differences in craniofacial morphology, head posture and hyoid bone position between mouth breathing (MB) and nasal breathing (NB) patients.

Methods: Mouth breathing patients comprised 34 skeletal Class I subjects with a mean age of 12.8 ± 1.5 years (range: 12.0–15.2 years). Thirty-two subjects with skeletal Class I relationship were included in the NB group (mean 13.5 ± 1.3 years; range: 12.2–14.8 years). Twenty-seven measurements (15 angular and 12 linear) were used for the craniofacial analysis. Additionally, 12 measurements were evaluated for head posture (eight measurements) and hyoid bone position (four measurements). Student's *t*-test was used for the statistical analysis. Probability values <0.05 were accepted as significant.

Results: Statistical comparisons showed that sagittal measurements including SNA ($p < 0.01$), ANB ($p < 0.01$), A to N perp ($p < 0.05$), convexity ($p < 0.05$), IMPA ($p < 0.05$) and overbite ($p < 0.05$) measurements were found to be lower in MB patients compared to NB. Vertical measurements including SN-MP ($p < 0.01$) and PP-GoGn ($p < 0.01$), S-N ($p < 0.05$) and anterior facial height ($p < 0.05$) were significantly higher in MB patients, while the odontoid proses and palatal plane angle (OPT-PP) was greater and true vertical line and palatal plane angle (Vert-PP) was smaller in MB patients compared to NB group ($p < 0.05$ for both). No statistically significant differences were found regarding the hyoid bone position between both groups.

Conclusions: The maxilla was more retrognathic in MB patients. Additionally, the palatal plane had a posterior rotation in MB patients. However, no significant differences were found in the hyoid bone position between MB and NB patients.

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1. Introduction

Nasal obstruction, chronic allergic rhinitis and hypertrophic adenoids decrease capacity for nasal breathing (NB) and compensating for this by mouth breathing (MB) might be necessary (Oulis et al., 1994). Respiratory airway function influences facial morphology and both craniofacial (Gungor

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and Turkkahraman, 2009) and cervical functions (Huggare and Laine-Alava, 1997; McNamara, 1981). The breathing pattern may influence the development of the transverse relationship between the maxilla mandible, resulting in the development of a posterior cross bite (Rubin, 1980). MB can affect the form of the jaw or cause malocclusions (Hartsook, 1946), and it has been shown to lead to the so-called "adenoid face", which is characterized by a narrow upper dental arch, retroclined mandibular incisors, an incompetent lip seal, a steep mandibular plane angle and increased anterior facial height (Lessa et al., 2005; Peltomäki, 2007; Linder-Aronson, 1970). Ricketts (1968) suggested that head extension represents a functional response in MB patients to compensate for nasal obstruction.

MB has been reported to cause changes in human head posture (Cuccia et al., 2008). The treatment of hypertrophic adenoids (Linder-Aronson, 1970) and nasal obstruction (Vig et al., 1980) with a nasal clip has been shown to alter head posture. Children with MB who have enlarged tonsils can develop the extension of their head posture and the low position of hyoid bone position (Behlfelt et al., 1990a,b). However, some authors have concluded that the hyoid position is maintained in a stable position in children with MB (Bibby, 1984; Ferraz et al., 2007).

MB is associated with a low tongue posture and the absence of a contact surface between the tongue and soft palate; this latter factor was termed "posterior oral incompetence" by Ballard (1951). This problem is caused by enlarged adenoid tissue that reduces the airway space and leads to postural adaptations at the level of the oropharynx. The hyoid bone drops in relation to the mandible, and creates a relatively constant air-space diameter in the anteroposterior direction. This neuromuscular recruitment may cause changes in the mandibular resting position and neck extension (Tourné, 1991). Thus, the breathing pattern could represent a major factor that underlies the hyoid bone position (Graber, 1978).

The impact of MB in dentofacial growth remains unclear (Warren, 1990). The aim of this study was to evaluate differences in craniofacial morphology, head posture and hyoid bone position between MB and NB patients. The null hypothesis assumed that there were no significant differences in the craniofacial morphology, head posture and hyoid bone position between MB and NB children.

2. Materials and methods

This study was approved by the Regional Ethics Committee on Research of the Faculty of Dentistry, Erciyes University. A power analysis established by G*Power Ver. 3.0.10. (Franz Faul, Universität Kiel, Germany) software, based on 1:1 ratio between groups with a sample size of 33 patients would give more than 80% power to detect significant differences with an effect size of 0.33 [to detect a clinically meaningful difference of 1 mm (± 3 mm) for the distance of the A to N perp] between two groups and at a significance level of $\alpha = 0.05$.

In the present study, 155 MB and 50 NB skeletal Class I subjects were evaluated and 34 MB and 32 NB patients were selected by the sample selection criteria presented in Table 1. Sixty-seven pretreatment cephalometric radiographs of Class I patients taken by a standard technique formed the sample for this study. All children were admitted for orthodontic treatment to the Department of Orthodontics, University of Erciyes, with a Class I skeletal relationship (ANB: $2.2° \pm 1.5°$ and $2.9° \pm 0.9°$ in MB and NB, respectively). Prior to their participation in the study, written informed consent forms were signed by the parents of the patients.

Patients were divided into two groups according to their breathing pattern as follows: Group I, MB children as the experimental group and Group II, NB children used as the control group. Group I comprised 16 boys and 18 girls (mean age, 12.8 ± 1.5 years; range: 12.0–15.2 years). On clinical examination, MB patients showed lip incompetence, dry lips at rest, dental crowding in the upper arch, an 'adenoidal face' (Fig. 1) and a reduced maxillary transverse dimension with a unilateral or bilateral cross bite. These factors were consistent with the diagnosis of MB according to Moyers' criteria (1973). The evaluation of the breathing pattern was adapted from the study by Cuccia et al. (2008). MB was demonstrated by the presence of condensed water vapor on the surface of a mirror placed in front of the mouth Figs. 2–4).

Group II (NB-control) comprised eight boys and 24 girls (mean 13.5 ± 1.3 years; age range: 12.2–14.8 years). This group was chosen at random from a group of children according to inclusion criteria (Table 1) with various orthodontic problems, but who did not have a past history or any clinical signs of MB.

2.1. Craniofacial measurements

Twenty-seven measurements (15 angular and 12 linear) (Figs. 2 and 3) were used for craniofacial analysis (Table 2). Additionally, 12 measurements were evaluated to assess head posture (eight measurements) and the hyoid bone (four measurements) Fig. 4, as described in Table 2.

2.2. Statistical analysis

All statistical analyses were performed using the Statistical Package for Social Sciences v.13.0 (SPSS Inc., Chicago, Illinois, USA). The normality test of Shapiro–Wilks and Levene's variance homogeneity test was applied to the data. The data were found to be normally distributed, and there was homogeneity of variance between the groups. Arithmetic mean and standard deviation values were calculated for each measurement. Group differences were analyzed with Student's t-test.

To determine the errors associated with radiographic measurements, 15 radiographs were selected at random. Their tracings and measurements were repeated 8 weeks after the first measurements. A paired sample t-test was applied to the first and second measurements, and the differences between the measurements were insignificant (0.849). Correlation analysis applied to the same measurements showed the highest r-value (0.988) for the overbite and the lowest r-value (0.867) for servical vertebra and sella-nasion plane angle (CVT-SN) and insicor mandibular plane angle (IMPA) measurements. Probability values less than 0.05 were accepted as significant.

3. Results

The descriptive statistics and statistical comparisons of angular and linear craniofacial measurements are shown in Table 3. Statistically significant differences were found between Group I and Group II in 10 out of 27 measurements. SNA ($p < 0.01$),