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Original Research Article

Relationship between malocclusion, soft tissue profile, and pharyngeal airways: A cephalometric study

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ABSTRACT

Background and objective: The recent years have been marked by a search for new interrelations between the respiratory function and the risk of the development of malocclusions, and algorithms of early diagnostics and treatment have been developed. The aim of the study was to evaluate the relationships between hard and soft tissues and upper airway morphology in patients with normal sagittal occlusion and Angle Class II malocclusion according to gender.

Materials and methods: After the evaluation of clinical and radiological data, 114 pre-orthodontic patients with normal or increased ANB angle, were randomly selected for the study. The cephalometric analysis was done by using the Dolphin Imaging 11.8 computer software.

Results: Comparison of the cephalometric values of soft tissue and airway measurements performed statistically significant negative correlation between the width of the upper pharynx and the ANB angle was found: the ANB angle was decreasing with an increasing width of the upper pharynx. The airways showed a statistically significant negative correlation between the width of the lower pharynx and the distance from the upper and the lower lips to the E line. Logistic regression analysis was performed to evaluate significant factors that could predict airway constriction. The upper pharynx was influenced by the following risk factors: a decrease in the SNB angle, an increase in the nose tip angle, and younger age; while the lower pharynx was influenced by an increase in the distance between the upper lip and the E line and by an increase in the upper lip thickness.

Conclusions: During critical period of growth and development of the maxillofacial system, the patients with oral functional disturbances should be monitored and treated by a multidisciplinary team consisting of a dentist, an orthodontist, a pediatrician, an ENT

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specialist, and an allergologist Cephalometric analysis applied in our study showed that Angle Class II patients with significantly decreased facial convexity angle, increased nasomental, upper lip-chin, and lower lip-chin angles, and upper and lower lips located more proximally to the E line more frequently had constricted airways.

1. Introduction

The functions of the maxillofacial system affect the growth of the face and jaws as well as tooth eruption [1]. Prolonged mouth breathing is associated with impaired speech, maxillofacial deformities, tooth malposition, abnormal posture, and even cardiovascular, respiratory, or endocrine dysfunctions [2,3]. The discussion on the relationship between maxillofacial morphology and upper airway size and resistance has been continuing over a century. Narrowing of the pharyngeal airway passage caused by various etiological factors – especially in the nasopharyngeal area – results in mouth breathing [2,4]. According to various authors, the main features of upper airway obstruction include: increased excessive anterior face height, narrowed upper dental arch, high palatal vault, steep mandibular plane angle, protruding maxillary teeth, and incompetent lip postures [2,5–7]. Basheer et al. found that the facial profile of patients who had mouth-breathing pattern was more convex than in those who were breathing through the nose [2]. Other authors determined a relationship between the size of the upper airways and the severity of malocclusion [6]. Obstruction of the upper airways is associated with Angle Class II malocclusion and vertical facial growth impairment [6,8]. Some studies have shown that in patients with Angle Class II malocclusion, the width of the upper pharynx is smaller than in those with Angle Class I or III malocclusion. However, other researchers provided contradicting conclusions and did not find any association between the width of the upper or lower pharynx and malocclusion [6,9,10]; some authors associate this with genetic and environmental factors [11].

The importance of lateral cephalometric radiographs in the evaluation of the morphology of soft and skeletal maxillofacial tissues and the diagnostics of airway pathology is unquestionable [1,12–14]. This cephalometric analysis is a simple, cheap, and sufficiently informative diagnostic technique, and the generated 2D images along with evaluation results are sufficiently reliable and may be an alternative to 3D imaging in the evaluation of soft tissue and upper airway morphology [1,15].

The recent years have been marked by a search for new interrelations between the respiratory function and the risk of the development of malocclusions, and algorithms of early diagnostics and treatment have been developed.

The aim of the study was to evaluate the relationships between hard and soft tissues and upper airway morphology in patients with normal sagittal occlusion and Angle Class II malocclusion according to gender.

2. Materials and methods

After the evaluation of clinical and radiological data, 114 pre-orthodontic patients (aged 14–16 years) were randomly recruited for the study from the Clinical Department of Orthodontics, Lithuanian University of Health Sciences. The study was conducted with the permission of the Kaunas Regional Biomedical Research Ethics Committee (February 9, 2015, No. BE-2-12). The inclusion criteria were the following: patients' age, sagittal jaw relationship angle ANB $> 1^{\circ}$, and no previous maxillofacial trauma or surgery, syndromes, clefts, or orthodontic treatment.

The study included 114 patients: there were 71 girls (62.3%), and 43 boys (37.7%). The subjects' mean age was 14.42 ± 0.58 years. The study sample was divided into two groups according to the ANB angle: the first group consisted of subjects with normal skeletal sagittal jaw relationship (ANB $2^{\circ} \pm 1^{\circ}$, Class I), and the second group consisted of patients with sagittal skeletal malocclusion, (ANB $> 4^{\circ}$, Class II). Group 1 consisted of 57 subjects, namely 37 girls (64.9%) and 20 boys (35.1%); group 2, 57 patients, namely 34 girls (59.6%), and 23 boys (40.4%).

Lateral cephalometric radiography was performed in fixed head position. To minimize radiation doze digital panoramic systems were used and ALARA radiation safety principle was followed. The analysis was done by using the Dolphin Imaging 11.8 (Dolphin Imaging and Management Solution) computer software. Soft tissue analysis was performed manually, using the ''Annotations and measurements'' function of the Dolphin Imaging software. Cephalometric parameters used for this study are shown in Fig. 1.

For the lateral cephalometric analysis, the error margin was determined by repeating the measurements of the variables on randomly selected 20 radiographic images at 2-week intervals with the same operator; the paired sample *t* test showed no significant mean differences in the two data sets.

2.1. *Statistical analysis*

Statistical data analysis was performed using the SPSS (IBM SPSS Statistics 22.0) software. Spearman correlation was applied in order to evaluate the strength of the relationship between two quantitative variables that did not meet the conditions of normal distribution. The mean values of quantitative attributes meeting the conditions of normal distribution in two independent sample groups were compared by applying the parametric Student *t* criterion, while the comparison of the medians was performed by applying the

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