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Abdolreza Jamilian[1]*, Rahman Showkatbakhsh[2], Neda Borna[3] and Letizia Perillo[4]

[1]Associate Professor, Department of Orthodontics, School of Dentistry, Islamic Azad University, Tehran, Iran
[2]Professor, Department of Orthodontics, School of Dentistry, Shahid Beheshti University Tehran, Iran
[3]Department of Orthodontics, School of Dentistry, Islamic Azad University, Tehran, Iran
[4]Professor, Head of Post Graduate Orthodontic Program, Departments of Orthodontics, Second University of Naples, Naples, Italy

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***Corresponding author:** Prof Abdolreza Jamilian, No 2713, Jam Tower, Vali Asr St., Tehran, 1966843133, Iran, Tel: 0098-21-22011892; Fax: 0098-21-22022215; E-mail: info@jamilian.net

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Research Article

The Effects of Maxillary Protrusion on Pharyngeal Airway Dimensions

Abstract

Aim: The relationship between position of the maxillary structures caused by maxillary protraction therapy and airway dimensions has not been investigated as comprehensively as the skeletal changes. This study was conducted to evaluate the effects of treatment with a maxillary protraction appliance on upper airway dimensions.

Material and Methods: Twenty Five patients including 13 females, 12 males with the mean age of 10.66 years (range, +0.7, -0.8 years) with skeletal Cl III malocclusion due to maxillary deficiency were selected in this study. All of the patients were treated by using a maxillary protraction (Tongue Appliance) as the only treatment appliance. Lateral cephalograms were taken before and after treatment. Data were analyzed statistically by means of paired T-test.

Results: No significant increase in the width of upper and middle horizontal airway dimension was seen. Significant increases were observed in the length of vertical airway dimension (P<0.001).

Conclusion: These results demonstrated that Tongue Appliance doesn't affect sagittal airway dimensions but it increases vertical dimensions in the short time.

Introduction

The skeletal and dentoalveolar effects of orthopedic appliances in patients with Class III (Cl III) malocclusions and maxillary deficiency have been well documented in literature. Numerous appliance designs such as endosseous implants [1], ankylozed teeth [2], surgically assisted orthopedic protraction [3], distraction osteogenesis [4,5], Hybrid Hyrax appliance [6], reverse chin cup [7,8], face mask [9], tongue appliance [10-12], and tongue plate [13] have been used for treatment of skeletal Cl III malocclusions. Forward displacement of the maxilla, labial tipping of the maxillary incisors, counter clockwise rotation of the palatal plane, inhibition of anterior mandibular growth, increase of face height, clockwise rotation of the mandible and lingual tipping of the lower incisors have all been shown to take place [14-16]. Many studies have investigated the effects of the maxillary protraction appliance on nasomaxillary complex and the soft tissues of the face, but the relationship between these extreme changes in the position of the nasomaxillary complex and airway dimensions has not been investigated as comprehensively as the skeletal changes. Pharyngeal size is very important for all patients and particularly for the patient with sleep apnea. The size of the nasopharynx may be of particular importance in determining whether the mode of breathing is predominantly nasal or oral.

A few studies have investigated the relationship between extra oral maxillary protraction and pharyngeal size [17-19]. However, no research has ever been done to evaluate the relationship between pharyngeal airway space and tongue appliance.

Therefore, the purpose of this study was to examine the effects of an intra-oral maxillary protraction appliance named tongue appliance on the dimensions of the upper airway in patients with Cl III malocclusion and maxillary deficiency.

Materials and Methods

The study was done according to the ethical principles of the Declaration of Helsinki.

In this study 25 patients (13 females, 12 males) with mean age of 10.6 (SD 0.7) years who were treated with tongue appliance were selected. All samples had following inclusion criteria.

Presence of a skeletal Cl III malocclusion due to maxillary deficiency with SNA≤78. SNB ≤80. ANB ≤0

Edge to edge incisor relationship or anterior crossbite, flat or concave facial profile.

The patients were treated with tongue appliance alone.

4- No other congenital anomalies, endocrine, nasopharyngeal disorders, tonsillitis, adenitis, previous orthopedic, orthodontic treatment, and rhinoplasty were present.

Tongue appliance [10] used for the treatment of the samples was constructed by Adams clasps for first upper molars and c clasps in the anterior teeth in order to increase the retention. Three to five separate spurs incorporated in the palatal between canine to canine areas. These spurs were as long as to cage the tongue and they were adjusted in clinic to avoid traumatizing the floor of the mouth. This appliance was used for approximately 22 hours a day. The average treatment time of patients was 12±1.4 months. Pre and Post treatment lateral cephalograms of the subjects were analyzed. The following variables of airway dimensions were studied:

SPPS (Superior pharyngeal space)

The width of the pharynx measured between the posterior pharyngeal wall and the dorsum of the soft palate on a line parallel to the palatal plane that runs through the middle of the line from PNS to the tip of the soft palate (P).

MPS (middle pharyngeal space)

The width of the pharynx measured between the posterior pharyngeal wall and the dorsum of the tongue on a line parallel to the palatal plane that runs through P.

IPS (inferior pharyngeal space)

The width of the pharynx measured between the posterior pharyngeal wall and the dorsum of the tongue on a line parallel to the palatal plane that runs through the most anterior inferior point on the second vertebra (C2).

PNS-Eb

The distance between posterior nasal spine and the inferior part on epiglottis (Eb).

SN-CVT

The angle formed by the SN plane and CVT (The line through C2 and C4).

The cephalogram were traced by one trained and calibrated dentist. The magnification factor of the lateral cephalometric radiographs were measured separately and corrected. Statistical Package for the Social Sciences (SPSS) was used for evaluation of the data and the data were analyzed statistically by means of paired t-test.

Results

Table 1 shows the changes caused by tongue appliance in the width and area measurements of airway space. SPPS and MPS showed insignificant increase and IPS showed insignificant decrease. PNS-Eb increased significantly from 52.7±5.2 to 59.2±7.9. (P<0.001) SN-CVT also showed an insignificant increase.

Discussion

In this study, no significant changes were found between pre and post treatment airway parameters in horizontal dimension but there was significant increase in vertical dimension. Similarly, Hiyama et al. [17] found that there were no significant changes between pre and post treatment airway parameters. They carried out a multiple regression analysis which revealed that greater forward maxillary growth was associated with a greater increase in the superior upper airway dimension.

A possible explanation as to why in this study and that of Hiyama there wasn't any difference between pre and post treatment airway parameters may be that upper airway measurements (SPPS, MPS, IPS) were mainly at the back of the tongue and very minimally related to maxillary structures. This might be happen due to increase the length of maxilla not changing the position of it anteroposteriorly.

As previously mentioned, in this study only the vertical airway dimension was increased. Since Y-axis was increased during treatment, the mandible had a clockwise rotation, which might have influenced the tongue posture and Eb. Due to the backward and downward rotation of the mandible, Eb can move in downward direction and vertical dimension of pharyngeal space is increased.

In similar studies, Fransson et al. [20] evaluated the influence of a mandibular protruding device (MPD) after 2 years of nocturnal use on the upper airway and its surrounding structures and found an increase in the pharyngeal airway resulting from the mandibular protrusion. Ackam et al. [21] studied the relationship between the soft palate and the nasopharyngeal airway in different mandibular growth rotation and found a decrease in the upper airway dimensions of the patient having posterior mandibular rotation. This reveals that there is a close relationship between the airway dimension and the positioning of the jaws especially lower jaw.

One of the most critical limitation of this study might be that the upper airway dimension was evaluated based on a 2-dimensional cephalometric measurement [22-24]. Therefore it is still unknown whether changes in respiratory function could be induced following the increased maxillary growth during maxillary protraction appliance treatment.

Table 1: Pre and post cephalometric data based on pharyngeal airway dimensions [a].

	T_1	T_2	Changes	Values
SPPS	9.6 ± 2.9	10.5 ± 4.9	0.8 ± 0.4	0.41
MPS	10.3 ± 2.9	10.5 ± 3.9	0.2 ± 4.3	0.82
IPS	11.04 ± 4.1	11 ± 4	-0.04 ± 3.3	0.96
PNS-EB	52.7 ± 5.2	59.2 ± 7.9	6.5 ± 8.5	0.001*
SN-CVT	94.2 ± 6.1	94.5 ± 5.9	0.3 ± 0.9	0.21

Level of significance was set at 0.05.

Conclusion

This study evaluated the effect of tongue appliance on the sagittal dimension of the upper airway space in 25 growing patients with maxillary deficiency.

1. Upper (SPPS) and middle (MPS) horizontal airway dimension was increased insignificantly
2. inferior horizontal airway dimension was decreased insignificantly
3. Vertical airway dimension was increased significantly.

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