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Effects of tongue plate on the nasomaxillary complex of patients with unilateral cleft lip and cleft palate

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ABSTRACT

Background and Aim: Cleft lip and cleft palate are among the most common oro-facial abnormalities. Patients with these deformities commonly present with midface deficiency and need challenging treatment modalities that focus on improving the position of the maxilla. Tongue plate appliance is an intraoral device that has shown promising results in the treatment of growing patients with maxillary deficiency. Nonetheless, the effects of tongue plate on patients with cleft lip and cleft palate have not been evaluated yet. This study aimed to assess the effects of tongue plate on growing patients with cleft lip and palate.

Materials and Methods: Twenty-four growing patients (12 girls and 12 boys) with non-syndromic unilateral cleft lip and cleft palate between the ages of 6-12 years volunteered to participate in this quasi-experiment. All the patients had undergone the preliminary stages of lip and palate closure during infancy, but none of them had received bone grafts. They were treated with tongue plate appliance for 18±3 months. Lateral cephalograms were obtained and were analyzed at the beginning and at the end of the treatment. Paired t-test was used for statistical analysis of normally-distributed data; otherwise, Wilcoxon test was used.

Results: Paired t-test showed that the Sella-Nasion-Point A (SNA) angle was increased from 76.3±0.2 to 77.3±0.14 degrees, and the Point A-Nasion-Point B (ANB) angle was enhanced from -2.26±0.17 to 0.93±0.82 degrees (P<0.001).

Conclusion: Tongue plate appliance has shown favorable results in the treatment of class 3 malocclusion and maxillary deficiency in growing patients with cleft lip and cleft palate.

Case Report

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Introduction:

Cleft lip and cleft palate are among the most common types of congenital dentofacial deformities. The prevalence of these deformities is about one in every 500 to 550 births.[1]

These deformities are usually presented in a non-syndromic form, while many factors are involved in their development and therefore, the etiology is multifactorial.[2-5] Since the patients undergo surgical procedures for closure of the cleft lip and cleft palate early in life, the resultant scar tissue constricts the growth of their nasomaxillary complex in all dimensions.[6] These patients also have a characteristic retrognathic maxilla.[7] Therefore, the major focus of orthopedic treatments is to increase the dimensions of the nasomaxillary complex and protract the maxilla in order to improve the existing skeletal class 3 condition. Many modalities serve to correct the maxillary deficiency such as orthopedic treatments and orthognathic surgery and a combination of both. While orthognathic surgeries have the ability to correct the skeletal discrepancy, they are deferred until after the puberty and could potentially harm the velopharyngeal efficiency of the patients.[8] On the other hand, orthopedic treatments can enhance the skeletal relationship without compromising the patients' velopharyngeal capacity. However, they can only be applied during the growth period.[9]

Different modalities such as face mask, reverse chin cap and combination of rapid maxillary expansion protocols in conjunction with maxillary protraction have been used for correction of the maxillary deficiency in growing patients.[10-11] However, most of these devices are extraoral and bulky and impose the risk of a low patient compliance. Tongue plate is an intraoral maxillary protractor device, which has been proven useful in advancing the maxilla in growing class 3 patients with maxillary deficiency.[4,10]

The resting tongue pressure and also the pressure produced during swallowing are transmitted to the nasomaxillary complex via this device and exert a forward push force on the maxilla without directly affecting the mandible.[12-17] To date, no study has evaluated the effects of tongue plate on patients with cleft lip and cleft palate. Therefore, the aim of the present study was to evaluate the effects of tongue plate on the nasomaxillary complex of patients with unilateral cleft lip and cleft palate.

Methods and Materials:

This study received ethical approval from the Local Research Ethics Committee of Shahid Beheshti University of Medical Sciences, and all participants or their legal guardians signed informed consent forms.

The inclusion criteria consisted of non-syndromic patients with unilateral cleft lip and cleft palate who showed growth potential based on the cervical vertebrae stage on lateral cephalograms,[18] whereas the patients with bilateral clefts, syndromic patients and those who had received alveolar grafts were excluded from the study. All the patients had class 3 malocclusion due to maxillary deficiency. The patients also had anterior and bilateral posterior crossbite prior to appliance therapy. No abnormal mandibular asymmetry was observed clinically. None of these subjects had a history of orthodontic treatment, and all of them were non-syndromic

The sample size consisted of 24 growing patients with non-syndromic unilateral cleft lip and cleft palate (12 girls and 12 boys) between the ages of 6-12 years who had volunteered to participate in this study.

All patients had undergone the preliminary stages of lip and palate closure during infancy, but none of them had received bone grafts.

Tongue plate was constructed consisting of Adams clasps for first upper molars and C clasps for anterior teeth in order to increase the retention. A screw was mounted in the midpalatal area to correct the bilateral posterior crossbite. The screw was activated at weekly intervals by the patient. The tongue plate was incorporated in the palate, in the canine-to-canine area. The plate was long enough to cage the tongue and was adjusted in the clinic to avoid traumatizing the floor of the mouth. This appliance was used for 20 hours a day, and each patient was evaluated at monthly intervals. The duration of the treatment

with tongue plate appliance was 18±3 months. Panoramic and lateral cephalometric radiographs, dental casts and photographs of the face were obtained from all subjects. Pre- and post-treatment lateral cephalograms were analyzed. These cephalograms had been taken with the teeth in occlusion. The magnification factor was recorded for each radiograph. All radiographs were traced on acetate paper by the same investigator. Figures 1 to 4 show pre-treatment intraoral and extraoral images of a patient with class 3 malocclusion.

Figure1: Pre-treatment extraoral image

Figure2: Pre-treatment intraoral image (lateral view)

Figure3: Pre-treatment intraoral image (frontal view)

Figure4: Pre-treatment intraoral image (lateral view)

Figure5 :Tongue plate in situ

The tongue plate in situ can be seen in figure 5. Data were analyzed by an orthodontist at the beginning and at the end of the treatment. The

following variables were measured: Sella-Nasion-Point A (SNA) angle, Sella-Nasion-Point B (SNB) angle, Point A-Nasion-Point B (ANB) angle, Anterior Nasal Spine to Posterior Nasal Spine (ANS-PNS) length, Gonion to Gnathion (GoGn) length, the angle formed by GoGn and Sella-Nasion lines (GoGn-SN or mandibular plane angle), inclination angle, the angle formed by upper incisor inclination and SN line (U1-SN) and Incisor Mandibular Plane Angle (IMPA).

The intra-examiner reliability was tested by randomly selecting 10 lateral cephalograms and having the examiner recalculate the measurements at a 4-week interval. The level of statistical significance was set at P<0.05. In order to compare the differences before and after the intervention, paired t-test was used for normally-distributed data, while Wilcoxon test was applied when the distribution of data was not normal.

Results:

In the present study, a total of 24 growing patients with non-syndromic unilateral cleft lip and cleft palate (12 girls and 12 boys) with the mean age of 10.4±4 years were treated with tongue plate appliance for 18±3 months.

Paired t-test showed that the SNA and ANB angles were respectively increased by 1±0.6 and 3.17±0.5 degrees (P<0.001, Table 1).

Table 1. Mean and standard deviation (SD) of pre- and post-treatment measurements (statistical significance was set at P<0.05

Cephalometric variable	Pre-treatment Mean±SD	Post-treatment Mean±SD	P-value
SNA	76.3±0.2	77.3±0.14	<0.001
SNB	78.66±0.59	78.68±0.94	0.5
ANB	-2.26±0.17	0.93±0.82	<0.001
Inclination angle	76.53±7.79	74.88±5.72	0.26
MPA	42.21±5.07	44.55±4.35	0.83
ANS-PNS	44.12±2.3	46.71±2.5	<0.001
Go-Gn	63.33±5.3	66.21±7.2	<0.001
U1-SN	79.33±8.2	85.15±9.82	<0.001
IMPA	88.73±1.73	88.69±2.99	0.018

No statistically significant differences were found with regard to the MPA and inclination angle before and after the treatment. The U1 increased significantly (P<0.001). No significant changes were observed in the inclination of lower incisors (L1). Figures 6 to 8 show extraoral and intraoral images of the same patient after the treatment. Figures 9 and 10 show the pre- and post-treatment lateral cephalograms, respectively.

Figure 6: Post-treatment extraoral image (frontal view)

Figure7:Post-treatment extraoral image (lateral view)

Figure8: Post-treatment intraoral image (lateral view)

Figure9:Pre-treatment lateral cephalogram

Figure10: Post-treatment lateral cephalogram

Discussion:

This study evaluated the effects of 18±3 months of treatment with tongue plate on 24 growing patients with non-syndromic unilateral cleft lip and cleft palate. This study showed that the SNA and ANB angles were increased significantly, which indicate the forward movement of the maxilla. In the current study, the U1 has also increased significantly, but no forward movements of the mandible or mandibular incisors were detected.

Maxillary protraction by means of face mask is one of the most common treatment methods for growing patients with cleft palate. This protocol has multiple variations and can be simultaneously used with different types of maxillary expansion devices. [9,19-21]

Face mask therapy has become a common technique for correction of the maxillary deficiency. However, this appliance is bulky, which makes it a discouraging choice for children. Patients who wear glasses experience more discomfort. This discomfort and the embarrassment caused by the large size of the device, especially at school, reduce the patient's compliance.

Due to the above-mentioned disadvantages, we decided to use the tongue plate intraoral appliance for treatment of this malocclusion. Placing the tongue plate in the mouth transmits considerable pressure to the deficient maxilla. This pressure is constant during rest position and intermittent during swallowing and functional activity.

Tongue plate is an intraoral device, which can be tolerated rather easily and therefore, can be used for longer durations. In terms of the point of force application, face mask directly exerts the force on both maxilla and mandible. In the mandible, the force vector leads to counterclockwise rotation, which can contribute to the improvement of the class 3 discrepancy, and

also it increases the vertical dimensions of the patient's lower facial height. This effect, in theory, can be avoided by the use of tongue plate appliance since this device has no direct effect on the mandible.[21] However, since the rotation of the palatal plane can occur with tongue plate, this can, in turn, lead to clockwise rotation of the mandible. However, this effect has been minimal and insignificant in the present study.

No significant changes were observed in the L1, which can be explained by the mechanism of tongue plate appliance, which only exerts direct force to the maxilla and maxillary dentition, and not on the mandible. The current study showed that tongue plate is successful in the treatment of growing patients with class 3 malocclusion and maxillary deficiency due to unilateral cleft lip and cleft palate. Similarly, in another study, it has been shown that tongue plate is effective in the treatment of class 3 malocclusion with maxillary deficiency.[16] The difference between the latter article and current study is that the present study has been performed on patients with cleft palate. In both studies, forward movement of the maxilla and maxillary dentition was observed.

Forward movement of lower incisors was not detected in the present study. Tongue plate removes the tongue pressure on lower incisors, therefore the IMPA will be decreased.

The reason behind the exclusion of patients with the bilateral cleft is that the premaxilla in these patients tends to be rather protruded. This can, in turn, distort the results of the study. We suggest recalling the patients after the retention period to determine which effects of the device have been stable. Also, designing a clinical trial to compare the results achieved by the use of tongue plate to the results obtained by another appliance such as face mask is the next step.

Conclusions:

Tongue plate appliance has shown promising results related to maxillary protraction in patients with cleft lip and cleft palate. Due to the simple intraoral design of the appliance, we recommend tongue plate for maxillary protraction in patients presenting with cleft lip and cleft palate.

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