Comparison of Hyoid bone Position, Soft Palate Position and Head Posture in Class III Growing Patients with Maxillary Protraction treatment with or without Expansion.

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Abstract

Objective: To assess changes in hyoid bone position, soft palate angle, and head posture after maxillary protraction in class III Growing patients using lateral cephalograms between expansion group with facemask and the group without expansion.

Methods: The study was composed of 30 growing patients with Class III malocculsion treated in orthodontics department of the Faculty of Dentistry, Dental Clinic, and a number of private clinics in Hamadan, Iran. For data collection, lateral cephalograms were collected from each

of the patients before and after treatment, after which the patients exhibited positive overjet. After radiography scan (using Microtech Scan Maker 48bit color.i800) for patients without electronic radiographs (CD), the cephalograms were all resized at a certain dpi. The length of the ruler was considered to be the factor for resizing the scanned images. After collecting the electronic files of lateral cephalograms and the cephalometric scan for patients without the files, the images were traced using Orthosurger X software,Iran.. Statistical evaluation was performed using SPSS 23.

Result: Pm-U variable in control group increased after treatment.(P<0.05), downward movement of hyoid bone was significantly increased in both groups but there was no difference between two groups. No change happened in head posture during treatment in both groups

Conclusions: No difference was found between two groups and expansion seems to have no effect on airway size.

Keywords: class III malocclusion, hyoid, soft palate, maxillary protraction, expansion

Tob Regul Sci. ™ 2022;8(2): 418-433
DOI: doi.org/10.18001/TRS.8.2.26

INTRODUCTION

Class III malocclusion may present clinically as concave profile or straight profile with anterior divergence, midface deficiency resulting in sunken appearance, relative mandibular prognathism, prominent chin, with anterior cross-bite or edge-to-edge dental relationship, and narrow maxillary arch with or without posterior cross-bite(1). Treating class III malocclusion is one of the most difficult and most challenging orthodontic treatments. This malocclusion can be caused by the maxillary retrognathism or mandibular prognathism or a combination of both.32-63 % of patients with class III, have maxillary retrognathism (2). Based on studies, 75% of Cl III malocclusions are due to the retrognathism of the maxilla, or a combination of the back of the maxilla and mandibular forward. A large number of studies agree that the retrognathism of maxilla is the most common feature of this malocclusion(3, 4).

Maxillary protraction to treat Class III malocclusion induces large orthopedic effects in a short time period. Facemask treatment results in forward displacement of the maxilla mainly by enhancing sutural growth of circummaxillary sutures and changing maxillary tuberosity(5). Maxillary protraction headgear has been used in the treatment of Class III malocclusion with maxillary deficiency. However, loss of dental anchorage has been reported with tooth-borne anchorage appliances such as lingual arches and expansion devices(6).

face-mask therapy was first described more than a century ago, and since the late 1960s it has been used with increasing frequency for correction of Class III malocclusion(7).

Based on studies conducted in patients with skeletal class III, especially those with retrusion of maxilla, the use of protraction treatment with expansion will result in better treatment outcomes.(8)Although numerous studies have reported the maxillomandibular skeletal changes that occur after maxillary protraction, reports on the changes that occur in other surrounding tissues have mainly been limited to the airway dimensions. For instance, Sayinsu et al(9) reported that maxillary protraction also increases the oropharyngeal airway dimensions. The changes in the volume of the maxillary sinus and pharyngeal airway were evaluated by CBCT in a study and concluded that no significant change was observed in the size of the pharyngeal airway.(10) However, understanding the changes that occur in other structures, such as the hyoid bone and soft palate after maxillary protraction, is essential for ensuring treatment efficacy and good outcomes(11). The hyoid bone is distantly articulated to the surrounding bone and tissues via muscles and tendons(12). The position of the hyoid is important because muscles involving the tongue are attached to the mandible, hyoid, and hypopharyngeal space(13). the hyoid bone position of the protraction group remained unchanged in a study and indicated

that the hyoid bone position remains consistent relative to the proximal structures, regardless of maxillary protraction.(11) simultaneously with the use of protractors, expansion is also considered an accepted treatment for this malocclusion(14). RPE in a growing patient, increase the distance between the canines and between the premolars more than the distance between the molars and the opening of midpalatal suture, makes it easy to move up and down the point A of the maxilla .(15-17). Nasopharyngeal and oral airway dimensions, changes after using Face Mask alone or with RPE(18). the relationship between the position of the hyoid bone and airway dimensions has been shown in several studies(12, 19-21). the changes in hyoid bone position may provide important information for conducting prognostic assessments.

Maxillary protraction for the treatment of such patients results in not only skeletal changes but also changes in the tongue position, depending on the correction of the maxillomandibular relationship. The position of the head is reported to be significantly related to the airway space, and changes in the inclination of the head towards the neck are due to changes in the pharyngeal airway(22). The oro-facial musculature is responsible for vital positional relationships that maintain a functionally adequate volume of oral, nasal and pharyngeal spaces, it is to be noted that soft tissue walls formed by lips, cheeks, floor of the mouth, tongue and soft palate, are determinants of these important functional spaces(23). The soft palate is moveable, consisting of muscle fibers sheathed in mucous membrane(24). The untreated Class III malocclusion patients with the craniofacial anomalies usually have the constriction of velopharynx and nasal cavity, nasal obstruction or choanal stenosis, which is caused by the severe maxillary hypoplasia (25, 26).

Hopefully expansion of maxilla will help expanding the velopharynx space.The present study aimed to Comparison of Hyoid bone Position, Soft Palate Position and Head Posture in Class III Growing Patients with Maxillary Protraction treatment with or without Expansion. the changes in the airway following the treatment of maxillary protraction have been studied in a quantitative study compared with palatal expansion in patients with class III patients.

Materials and methods

The study was composed of 30 growing patients(age=11.73±4.16,18 Female,12 Male) with Class III malocculsion treated in the orthodontics department of the Faculty of Dentistry, Dental Clinic, and a number of private clinics in Hamadan, Iran. there was not significant difference between control group (8 female and 7 male) and case group(10female 5 male) according to chi square test.(P=0.456).

For data collection, lateral cephalograms were collected from each of the patients before and after treatment, after which the patients exhibited positive overjet. Considering the study exclusion criteria (patients with syndrome, patients with cleft lip and palate, and history of sleep apnea), the initial sample consisted of 50 subjects, among which 20 patients were excluded due to bad quality of radiographs and different magnitude. and 30 patients were equally divided in two groups. control group (patients treated with maxillary protraction(petit face mask)) and case group (patients treated with maxillary protraction and rapid palatal expansion). Inclusion criteria was performed based on all patients had to be in the first and second stage of cervical vertebral growth(CS-1 or CS-2). All the subjects had exhibited Class III molar relationships, wits of -2 or smaller, anterior crossbite relationship, or end-to-end incisor relationship before treatment. In addition, the medical records of all patients were checked for the history of diseases such as syndromes and cleft palate. In most cases, the electronic file (CD) of radiographs, which had been provided for the patients, was used plus those available in their archives. After radiography scan (using Microtech Scan Maker 48bit color.i800) for patients without electronic radiographs (CD), the cephalograms were all resized at a certain dpi. The length of the ruler was considered to be the factor for resizing the scanned images. After collecting the electronic files of lateral cephalograms and the cephalometric scan for patients without the files, the images were traced using Orthosurger X software,Iran.

The following cephalometric points and measurements were used to assess skeletal and soft tissue changes.(Figure 1)

Pm-U:distance between from tip of Uvula and the most posterior point of palate

NL/Pm-U: angle between Nasal line(ANS-PNS) and line crossing from tip of Uvula and the most posterior point of palate(soft palate angle)

h-S: vertical distance between the most anterior point of hyoid bone and sella turcica

h-ML: vertical distance between hyoid bone and mandibular line(Go-Me)

h-FH: vertical distance between hyoid bone and Frankfort plane h-C3: horizontal distance between hyoid and the most posterior and inferior point of third cervical vertebrae

NSL/Ref ML:the angle between sella -nasion line and mandibular line

Rl/ML: Gonial angle

NL-ML: angle between palatal plane(ANS-PNS) and mandibular plane

Ref cranial base/Ref ML: angle between cranial base refrence plane and mandibular refrence plane

Opt-FH: Odontoid process tangent-frankfurt plane angle

OPt-NSL: the angle formed by sella nasion line and Odontoid process tangent

Opt-HRP: the angle formed by horizontal reference plane and Odontoid process tangent

Opt-HRP: the angle formed by palatal plane and Odontoid process tangent

NSL-CVT angle: the angle formed by the intersection of Sella-Nasion line with CVT line (the line between the most inferoposterior point of the second cervical vertebra and that of the fourth cervical vertebra).

CVT-FH: angle between Frankfort plane and CVT line

CVT-HRP: angle between horizontal reference plane and CVT line

CVT-NL: angle between palatal plane and CVT line

NSL/VRP: angle of sella nasion line and vertical reference plane

FH-VRP: angle of Frankfurt plane and vertical reference plane

NL/VRP angle of palatal plane and vertical reference plane

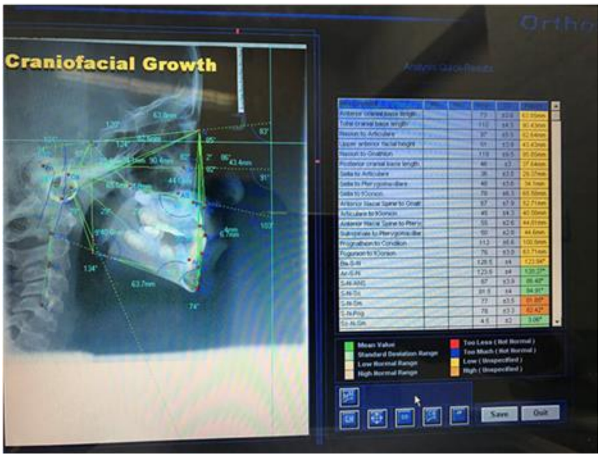

Figure1,cephalometric points on software

Statistical analysis

Statistical evaluation was performed using SPSS 23. The effects of the facemask therapy(maxillary protraction) and rapid palatal expansion(RPE) compared with maxillary protraction group (control) on head posture, soft palate and hyoid bone position were investigated by means of Independent sample T-test, Wilcoxon-Mann-Whitney-Test, and ANCOVA(analysis of covariance).in addition paired T-test was done for investigating changes before and after treatment in each group. To determine the error of measurement, 10 radiographs were remeasured that showed all the results. The reliability of the measurements was high, with significant intraclass correlation coefficients (ICC). (p < 0.001).

Results

Reliability of reference planes

No change was occurred in reference planes before and after treatment and all of them were constant and reliable. The changes of SN, FH and NL angle with a Vertical reference plane, was not significant between case and control group (p=0.290, p=0.168, p=0.473 respectively).

		Control		Case				
		Mean	Std. Error Mean	Mean	Std. Error Mean	P (Mann-Whitney)	P (ANCOVA)	p (T-test)
NSL/VRP	T0	83.3020	6.35315	83.0533	7.16739	0.116	0.290	---
	T1	84.3167	5.13818	82.6553	3.08367			---

p (T-test)		.233		.173		---		---
FH-VRP	T0	88.7467	4.40890	87.7773	7.02527	0.202	0.168	---
	T1	89.6947	2.73502	88.2227	2.76008			---
p (T-test)		.387		0.233		---------		---
NL/VRP	T0	93.3833	5.59065	93.9340	7.67122	0.325	0.473	---
	T1	94.7553	3.95142	93.3473	6.26074			---
p (T-test)		0.428		0.281		---------		---

Table 1. *Changes of reference planes*

Changes of soft palate

The changes occurred in soft palate angle and Pm-U measurements before and after treatment between two groups were not significant. But the Pm-U variable in control group increased after treatment.(P<0.05) (Table 2)

		Control		Case				
		Mean	Std. Error Mean	Mean	Std. Error Mean	P (Mann-Whitney)	P (ANCOVA)	p (T-test)
NL_Pm-U	T0	125.3027	2.04821	121.9500	2.14530	0.902[b]	0.380	
	T1	122.6647	2.10584	114.1733	5.23963	---	---	---
p (T-test)		0.191		0.195		---------		-------
Pm_U	T0	30.4173	0.81464	31.9747	1.44302	0.202[b]	0.730	---
	T1	28.8760	0.99258	32.9873	1.63470			---
p (T-test)		**0.030***		0.516		---------------		

Table 2. *Changes of soft palate*

The position of the mandible plane relative to the fixed reference

The mandibular rotation in this study is a confounding factor. Table 3 showed that the Mandibular Plane has not changed during treatment in control group. however, in the group who received rapid palatal expansion rotation of mandible was statistically significant, however comparison between two groups showed that, it can not affect our treatment outcomes.

		Control		Case				
		Mean	Std. Error Mean	Mean	Std. Error Mean	P (Mann-Whitney)	P (ANCOVA)	p (T-test)
NSL/Ref ML	T0	34.3467	1.68397	33.8087	1.17014	0.412[b]	0.763	---
	T1	32.8300	1.80894	31.1647	0.99506			---
p (T-test)		0.294		**<u>0.031*</u>**		---		---
NL/ML	T0	23.9080	1.24215	23.1160	1.59857	0.481	0.933	---
	T1	22.7067	1.82899	20.2847	1.36613			---
p (T-test)		0.538		**<u>0.042*</u>**		---------		---
Rl/ML	T0	126.4333	1.71706	131.0027	1.80951	0.161[b]	0.058	---
	T0	126.9967	2.07134	127.7580	2.81078			
p (T-test)		0.615		0.273		---------		

Table 3. The Slope of mandibular plane Compared with Reference Planes

Hyoid bone positions

With regard to the hyoid bone position only C3-H was significantly increased at T1 compared with that at T0 in control group. (p = 0.004. h-FH and h-Sella variables that show downward movement of hyoid bone was significantly increased in both groups but there was no difference between two groups(table4).

		Control		Case				
		Mean	Std. Error Mean	Mean	Std. Error Mean	p (T-test)	P (Mann-Whitney)	P (ANCOVA)
C3-h (mm)	T0	41.7867	1.06389	41.6293	1.05456	0.056	---	0.198
	T1	37.9673	1.08583	40.8060	1.65511			

P			**0.004**		0.438			
hyoid-Frankfurt plane (mm)	T0	73.3767	2.31429	65.8033	1.84385	0.322	---	0.304
	T1	70.6887	1.73684	66.1627	1.76826			
P			**0.08***		**0.022***			
h- ML(mm)	T0	12.0407	1.25059	12.3193	1.09681	0.195	---	0.278
	T1	12.3373	1.18081	10.8633	.82268			
			0.799		0.077			
h- Sella Turcica \ (vertical distance)	T0	93.0007	2.72088	82.9220	2.80850	0.358	---	0.388
	T1	90.9147	2.29777	84.2973	2.78325			
P			**0.006***		**0.006***			

Table 4. Hyoid bone positions

position of head (craniocervical angulation):

No change happened in head posture during treatment in both groups and no difference between two group occured. (P=NS)

		Control		Case				
		Mean	Std. Error Mean	Mean	Std. Error Mean	p (T-test)	P (Mann-Whitney)	P (ANCOVA)
CVT- FH	T0	96.9627	2.49195	96.8693	2.00370	-	0.273	0.107
	T1	98.1840	2.45923	93.4993	2.81084			
p (T-test)		0.334		0.108				
CVT -HRP	T0	96.6580	2.33875	95.0913	1.85135		0.595	0.777
	T1	96.8580	2.31708	93.0767	2.72056			
p (T-test)		0.820		0.337				
CVT-NL	T0	91.9020	2.25066	91.7453	2.54067	-	0.272	0.061
	T1	94.1780	2.96356	87.3380	2.93879			
p (T-test)		0.398		0.66				
CVT-NSL	T0	102.3413	2.40875	102.4380	2.07657		0.232	0.65
	T1	103.8987	2.50893	98.2240	2.84113			
p (T-test)		0.360		0.050				

OP tangent -FH	T0	89.6947	0.70618	88.2227	0.71265	0.155	---	0.589
	T1	88.7467	1.13837	87.7773	1.81392			
p (T-test)		0.387		0.233				
OPt-HRP	T0	95.3947	1.96954	92.0267	2.00900	0.428	---	0.789
	T1	95.6520	2.67635	90.0093	00001			
p (T-test)		0.894		0.352				
OPt- NL	T0	90.6380	1.91379	88.6800	2.72571	-----	0.029b	0.615
	T1	92.9667	3.52627	84.2740	3.33345			
p (T-test)		0.484		0.081				
OPt - NSL		101.0780	2.04174	99.3727	2.32911	0.091		0.488
		102.6480	2.91452	95.1553	3.19059			
p (T-test)		0.268		0.050				

Table 5. Head and neck positions

The success of the treatment

The Witz variable shows the success of the treatment (table 6). In case and control group, witz was significantly increased at T1 compared with that at T0 (p = 0.001).

There was no significant difference between the mean of SNA in the control group (p = 0.085) and case group (p = 0.479) before and after the intervention.

In control group, SNB was significantly shorter at T0 compared with that at T1 (p = 0.031). But ANB was significantly in both groups at T1 larger than T0(p=0.003).

According to the table 6, OVERJET in case and control groups was significantly larger at T1 compared with that at T0.

		Control		**Case**				
		Mean	**Std. Error Mean**	**Mean**	**Std. Error Mean**	**p (T-test)**	**P (Mann-Whitney)**	**P (ANCOVA)**
witz	T0	-1.8000	0.22254	-1.90000	0.21381	0.106	---	0.261
	T1	-4.7000	0.37733	-4.0667	0.36471			
p (T-test)		0.001		0.000		---	---	---
SNA	T0	79.3707	0.94807	114.8307	3.29668	0.494	---	0.965
	T1	78.0233	1.06166	108.6973	3.04805	---		
p (T-test)		0.085		0.479		---	---	---

SNB	T0	78.6427	1.00301	80.3527	0.67277	0.322	---	0.304
	T1	79.4633	1.02084	81.3747	0.93177			
p (T-test)		0.031	---	0.114		0.775	---	0.680
ANB	T0	0.7080	0.41500	0.4860	0.53236	0.195	---	0.278
	T1	-1.4373	0.49553	-1.1280	0.71281			
p (T-test)		0.003		0.012		0.477		0.533
OVERJET	T0	2.7240	0.28669	2.4613	0.29426	0.003	---	0.105
	T1	-3.5240	0.58438	-1.7720	0.33437			
p (T-test)		0.000		0.000		---	---	---

Table 6. success of the treatment

Discussion

In order to understand the relationship between the induced skeletal soft and tissue changes in class III patients traeted with maxillary protractor (face mask) with or without expansion and the size of the sagittal airway dimensions related to the position of head,soft palate and the hyoid bone, after radiographic examination before and after the treatment, found that hyoid bone has been moved downward in both groups, but there is no difference between the two groups. Also, in the control group that did not receive expantion, Hyoid moved forward significanly.($P<0.05$) the soft palate position and angle didn't show any difference . The change in the position of the tongue causes a change in the soft plate position, which ultimately leads to an increase in width of Upper airway, but in our study no difference was found before and after treatment between two groups in position of foft palate.

As a result, Hyoid bone stability changed after treatment. So, oropharyngeal dimensions showed no significant increase at the upper and middle pharyngeal levels. The findings differ from previous results reported by Sayınsu et al and Oktay and Ulukaya, who reported that maxillary protraction with or without rapid maxillary expansion induced statistically significant increments in the airway dimensions, and consistant with those of Mucedero et al and Baccetti et al, who demonstrated that no significant changes for the oropharyngeal and nasopharyngeal sagittal airway dimensions were induced by maxillary protraction(9, 27-29).

The head posture, hyoid bone position, and airway dimensions are known to be interrelated, and the head posture should be consistent while obtaining each lateral cephalogram. Yagci et al reported that maxillary protraction induces not only structural changes of the maxillofacial complex but also face-down effects on the natural head position. Nevertheless, in the current study, no significant difference in the head posture was identified between T0 and T1, and head postures of the two groups were not different,so the possibility of the head posture contributing to the changes in the hyoid bone position and airway dimensions can be eliminated. This discrepancy between the present study and that of Yagci et al. may be because they measured the dynamic natural head position using an inclinometer attached to the head, whereas the current study used an ear rod to fix the patients' heads during taking lateral cephalograms. (30-32).

Sayinsu et al and Kaygisiz et al. [17] reported that maxillary protraction only increases the nasopharyngeal dimensions. In contrast, Kilinc et al. [3] and Oktay and Ulukaya [18] reported that maxillary protraction expands both the nasopharyngeal and oropharyngeal airway dimensions. However, few reports explaining this contradictory data, exist.(9, 27, 33).

Kawasaki et al., The oropharyngeal airway was evaluated by CBCT. Patients with class III deformation significantly had higher oropharyngeal airway than the class I patients. oropharyngeal airway region was positively correlated with Class III severity (34). In the study of Hiyama et al., Titled "Magnetic protrusion effect" on craniofacial and upper airway structures, 25 patients with an average age of 9.8 years lateral cephalometric were prepared before and after treatment with face masks. Significant changes in the anterior maxillary growth, inhibition of mandibular growth And rotation in the mandibular clockwise direction. The results of this study showed that maxillary growth has a clear and positive effect on the upper airway(22). Klinic and colleagues entitled "The Study of the Effect of Rapid Palatal Extension Therapy and Maxillary Prostration on Sagittal Aperitonia, the comparison of lateral cephalometrics before and after treatment showed a significant increase in the size of the nasopharyngeal region(25). In a study, Alovfi et al. Reviewed the effects of Rapid Maxillary Expansion on the upper and lower airways. The findings indicated that the upper airway sagittal dimensions significantly increased, while no clear change was observed in the dimensions of the lower airway(35). In a study by Chen et al., Airway dimensional changes in class III children undergoing maxillary protrusion with RME were investigated. After collecting CBCTs before and after treatment and reconstructing their three-dimensional models, the results showed that by class III treatment, simultaneously with maxillary protrusion and RME, the dimensions of the airways of the nasopharyngeal and velopharyngeal significantly increased(36). The study by Macedo et al. Compared airway dimensional changes in class III patients treated with Face Mask alone and in combination with RME. Their results showed that all patients had skeletal maturation in the prepubertal stage. Examination of cephalometric results before and after treatment showed that skeletal changes and maxillary protrusion in both groups did not significantly change the airway dimensions, and Overall, it is concluded that growth modification treatments in class III patients do not affect the airway dimension(37).Radiography with lateral cephalometry before and after treatment showed an increase in the size of the upper airway in addition to maxillary changes(27). Finally, it was concluded that Bone anchor maxillary protraction did not prevent the growth of the airway(38).

Conclusion

Maxillary protraction did not improved head posture and soft palate in growing patients with skeletal Class III malocclusion. Hyoid bone moved downward after treatment in both groups. Further, the nasopharyngeal airway dimensions did not change after protraction with or without expansion.

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