Journal of Research in Medical and Dental Science
2018, Volume 6, Issue 5, Page No: 335-342

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Therapeutic Effect of Face Mask with Two Different Retention Plaques in Class III Children

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ABSTRACT

Statement of Problem: The effects of simultaneous using of facemask with removable appliance and facemask with modified TPA Nance are not been compared till now. The aim of this study was to evaluate the therapeutic effect of facemask-modified TPA Nance and Facemask-Y- expander plate and comparison of these two appliances in 8-10 years old children with maxillary deficiency CLIII malocclusion by protraction the maxilla to forward.

Purpose: This study performed to evaluate the therapeutic effect of facemask-modified TPA Nance and Facemask-Y-expander plate and comparison of those two appliances in 8-10 years old children with maxillary deficiency CLIII malocclusion.

Materials and Methods: In this analytical retrospective study, 25 children who were referred to Dental Faculty and its clinics were selected by census sampling. All children had CLIII malocclusion and had been treated by two orthodontists. According to the treatment method the patients were divided into 2 groups: treated by facemask-modified TPA Nance (group A) and Y-expander plate (group B). Lateral cephalometric radiography of the patients were hand-traced and before-after data were analyzed by SPSS22 Ver. Using Mann Whitney test for comparison of two methods and Wilcoxon to compare before-after effects (α=0.05).

Results: SNA angel, ANB angel, Co-A distance, Witts angle, A-B Difference, Upper1-SN distance, Upper1-PP distance and Overjet in group A and SNA, ANB, Maxilla to cranium distance, witts angle, Anterior facial height Co-A distance A-B difference in group B were increased (P<0.05) and Insior Mandibular Plane Angle in both groups was decreased (P<0.05). In comparison of the two groups there is no difference in any of the parameters (P<0.05).

Conclusion: Both treatment methods bring maxilla forward effectively therefore both methods are useful treatments. Skeletal vertical changes are low and acceptable in both groups. According to total superimpositions upper incisor and first molars in both groups have been extruded.

Key words: Facemask, Class III, Maxillary deficiency, Y-expander plate, TPA-nance, Concave face, Orthopedic therapy

HOW TO CITE THIS ARTICLE: Majid Heidarpour, Amin Aminian, Amir Siadat, Elahe Shafei Rad, Mahjube Entezar-e-Ghaem*, Therapeutic effect of face mask with two different retention plaques in class III children, J Res Med Dent Sci, 2018, 6 (5):335-342

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Received: 25/09/2018
Accepted: 17/10/2018

INTRODUCTION

There are two direct and indirect contributing factors lead to maxillary deficiency. Direct factor is deficiency of maxilla in anteroposterior and vertical dimensions. Indirect factor is Upward and forward mandibular rotation, producing an appearance of mandible prognathism. In order of their effectiveness, there are three possible approaches to maxillary deficiency: Frankel's FR-III functional appliances, reverse-pull headgear (facemask) to a maxillary split or skeletal anchors and class III elastic to skeletal anchors [1]. Facemask is an appliance that enters force to posterior sutures of maxilla by some kinds of maxillary splint and moves that forward through making growth stimulation in posterior maxillary sutures but only if it was done at

an early age. The Age of the patients is critical parameter and is easier and more effective to move the maxilla forward at young ages. The probability of success reduces after 10-11 years old [1,2]. Due to the fact that the teeth transfer the force applied on them, to skeleton and sutures; movement of these teeth is inevitable. Furthermore, the effects of this treatment including clockwise rotation of mandibular plan are complicated [1,3]. Some of the clinicians use the facemask and palatal expander simultaneously and some of them apply the facemask after expander. Palatal expander is applied as a splint for facemask in both conditions [1]. Many studies have been done on facemask and proved its success in the treatment of the patients with maxillary deficiency including a systematic review study that has reported the effectiveness of facemask on treatment of the maxillary deficiency at a short time in 2014 [4]. Also many studies have reported the effectiveness of this appliance if used at the right age. Facemask has been used with different splits such as rapid maxillary expansion [3-8], skeletal anchorage [9-12], labiolingual appliance [5] and removable appliance with or without posterior bite plane [3-8]. Removable appliances with anterior-posterior expansion screw with or without facemask have been used to treat CLIII disorder in few case report [13] or case series [14], studies with no control groups and unification of treatment biomechanics. Anterior-posterior movement by rapid maxillary expansion is observed in some studies [15-19]. In another study, this kind of movement is not observed but inferior and posterior rotation of mandibular plan has been reported in these patients [20].

Therefore, applying facemask for pulling, growth stimulation and ossification of posterior sutures of maxilla is a common method that valid studies have confirmed its effectiveness but in few of them, a kind of splint that is able to expand maxilla anterior-posteriorly (Y-Plate splint) has been applied with facemask at the same time. Furthermore, these few studies have not used unification in designing of their appliances and they have been as case reports and case series with no control groups. Therefore, they are not valid. This study performed to evaluate the therapeutic effect of facemask-modified TPA Nance and Facemask-Y- expander plate and comparison of those two appliances in 8-10 years old children with maxillary deficiency CLIII malocclusion.

MATERIALS AND METHODS

In this analytical retrospective study, the sample included 25 eight-ten years old CLIII children with maxillary deficiency and less than 4 mm reverse jet that had been treated by two orthodontists in Dental University and two dependent clinics. All of the children were between 8 and 10 years old when the treatment had been started. Their orthodontists had prescribed 2 cephalometric radiographies before treatment (to diagnose) and after treatment (to complete medical record and ensure proper treatment) and we did not expose patients to X-ray any more to observe ethics in this study. The selection of their pre-post treatment cephalometric radiography in their medical files was based on census.

The study was performed from June 2014 to January 2017.

Inclusion criteria: 8-10 years old children, Class III disorder with maxillary deficiency, less than 4 mm reverse jet and Patients with pre-post cephalometric radiographies.

Exclusion criteria: Patients with the history of previous orthodontic treatment, Uncooperative patient, Children with cleft lip/palatal or both disorder and Patients with history of surgical maxillofacial treatment.

According to treatment method the patients were divided to two groups named A (a modified Trans Palatal Appliance-Nance with facemask) (Figures 1-4) and B (removable Y-expander plaque with facemask) (Figure 1, Figure 5). Group A included 5 boys and 8 girls with the average age of 8 years and 7 months. Treatment duration for this group was 7 months. Group B included 5 boys and 7 girls with the average age of 8 years and 4 months. Treatment duration for this group was 8.5 months. A force of 350-450 grams was applied to each side of maxilla. The patients were instructed to wear the appliance approximately 12-14 hours a day. In group A, U loops were designed in way that the tongue applies a kind of constant pressure on its rest position, that is, transverse bar of the appliance has 2 mm distance to hard palate. Bite blocks (The thickness of 5-6 mm that is 2-3 mm over freeway space) to removing the occlusal interference and allowing the maxilla for anterior translocation was considered in group B. Two cephalometric radiographies had been taken from each patient at the beginning and the end of the treatment period (reaching at least 1.5 mm overjet and getting clinical favorable result depending on the clinician opinion) by their clinicians to complete medical records of patients. For evaluation the overjet, distance between incisal of the upper and lower incisor was measured by the clinician.

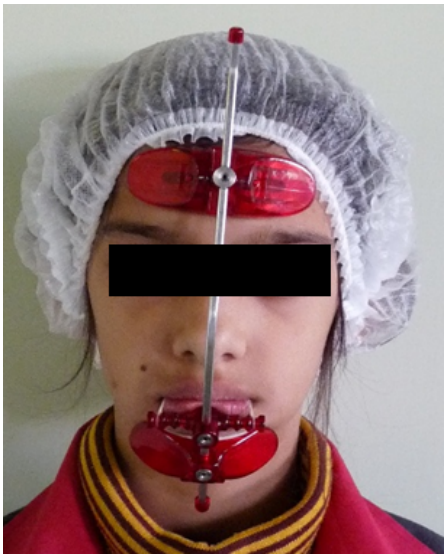

Figure 1: Facemask applied for group A and B (frontal view)

Figure 2: Facemask applied for group A and B (profile view)

Figure 3a: Modified TPA Nance applied with facemask in group A (right view)

Figure 3b: Modified TPA Nance applied with facemask in group A (left view)

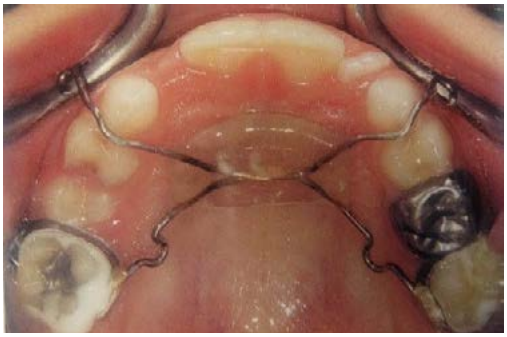

Figure 4: Modified TPA Nance applied with facemask in group A (occlusal view)

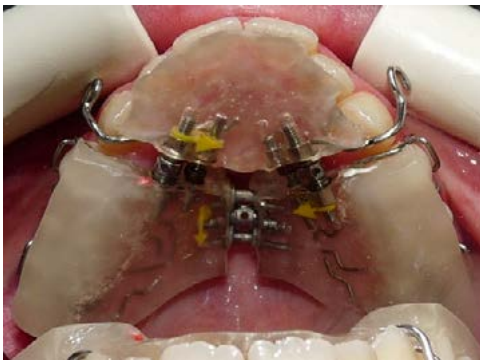

Figure 5: Removable Y-expande plaque applied in group B (As shown in fig, two hooks are embedded in the distal of upper primary canines and three screws (two biaxial screw for anterior posterior expansion and one triaxial for transverse expansion) are embedded in Y expander plaque)

Pretreatment and post treatment cephalometric radiographies of the patients were traced by hand and 13 parameters including (SNA angle, SNB angle, ANB angle, overjet, overbite, maxilla to cranium distance, mandible to cranium distance, witts angle, anterior facial height, posterior facial height, anterior facial height/posterior facial height, Occlusal Plane/SN, Go_Gn distance/SN) were measured and analyzed. For finding out the differences and total effects of two orthodontic treatments, first and second tracings of each patient became superimposed on Ba-Na line which passes from cranial center. Cranial center is the intersection of Ba-Na line and facial axis. Facial axis is the line which connects the gnathion and pterygoid point in each tracing. This is total superimposition (Figure 6).

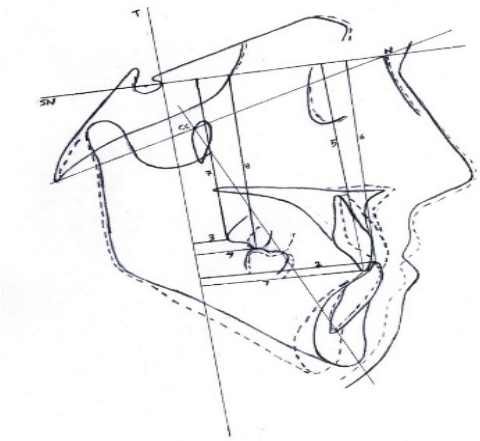

Figure 6: Total superimposition on Ba-Na in CC: (1) Upper central incisor to T, (2) Lower central incisor to T, (3) Upper first molar to T, (4) Lower first molar to T, (5) Upper central incisor to SN, (6) Lower central incisor to SN, (7) Upper first molar to SN, (8) Lower first molar to SN

For partial evaluation, maxilla was superimposed on palatal plan in ANS point (Figure 7) and mandible was superimposed on mandibular plan in Gn point (Figure 8) . In each superimposition, SN plan in pretreatment cephalometric radiography was considered as horizontal reference. Perpendicular line to SN plan in T. point (the most superior point in anterior part of sella turcica in

meeting point with tuberculum sellae) in pretreatment cephalometric radiography considered as vertical reference. All of the parameters for superimpositions are based on a Turkish study [21]. Vertical and occlusal orthodontic distances of upper and lower central incisors and first molars from the mentioned references were measured. Sharp pencil and special tracing paper for tracing and precise ruler for measurement s were used. 4-5 copies of pretreatment tracings were provided and the references for total and partial superimpositions were drawn on them. Each pretreatment tracing stayed on post treatment tracing then central incisor and first molar of post treatment tracing were drawn beyond pretreatment tracings. For removing the error resulting from different magnification of radiography equipment and reaching to unification, all measured distances of each patient were divided to each radiography magnification. For recognizing the magnification of radiography, we used the ruler in the right side of image that should be 1 cm otherwise we divided distances to it for unification. Finally, the measured angles and distances were entered into software SPSS22 and the were analyzed by statistical test named Mann Whitney test for comparison of two methods and Wilcoxon to compare before-after effects of treatment on patients (α=0.05).

Pre and post treatment cephalograms of one patient from each group is observable (Figures 9,10).

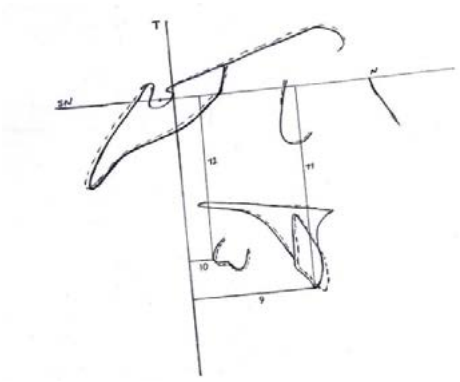

Figure 7: Partial superimposition on palatal plan: (9) Upper central incisor to T, (10) Upper first molar to T, (11) Upper central incisor to SN, (12) Upper first molar to SN

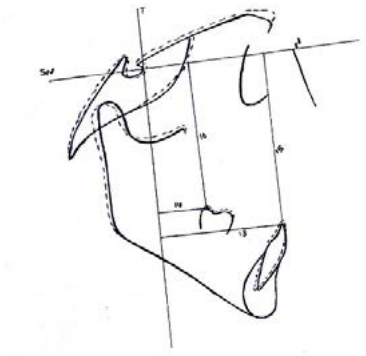

Figure 8: Partial superimposition on mandibular plan: (13) Lower central incisor to T, (14) Lower first molar to T, (15) Lower central incisor to SN, (16) Lower first molar to SN

Figure 9: Pre and post treatment cephalograms of a patient of group A

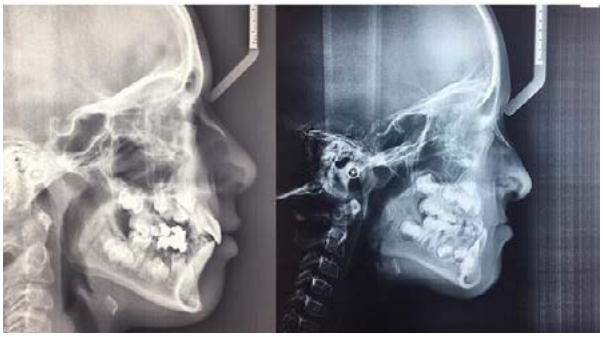

Figure 10: Pre and post treatment cephalograms of a patient of group B

RESULTS

Facemask-TPA Nance group

According to assessment of findings in this group, increasing of SNA, ANB, Co-A, Witts, A-B Difference, U1-SN, U1-PP and decreasing of IMPA was significant (in all parameters (P<0.05)). Increasing of overjet was significant too (P<0.05). Other skeletal and dental parameters didn't change significantly.

In total superimposition Upper Incisor-T, Upper Molar-T, Lower molar-SN, Upper molar-SN and Upper incisor-SN increased significantly (in all parameters (P<0.05)). Decreasing of Lower Incisor-T was significant too (P<0.05). In partial superimposition on maxilla increasing of Upper Molar-T and Upper Incisor-T was significant (in all parameters (P<0.05)). In partial superimposition on mandible increasing of Lower incisor-SN was significant (P<0.05).

Facemask-removable plaque group

Increasing of SNA, Co-A and ANS-Men were significant in this group (in all parameters (P<0.05)). Increasing of Overjet, Maxilla to cranium, ANB, Witts, A-B Difference, Anterior facial height and decreasing of IMPA was significant too (in all parameters (P<0.05)).

In total superimposition in this group, increasing of Upper molar-SN and Lower molar-SN and decreasing of Lower Incisor-T was significant (in all parameters (P<0.05)). In partial superimposition on maxilla the

Table 1: Comparison the cephalometric parameters, pre and post treatment

Group	Group A (facemask-TPA Nance)					Group B (facemask-removable plaque)					P Value (Mann-Whitney U-test)
	Pre treatment		Post treatment		P-Value (Wilcoxon Test)	Pre treatment		Post treatment		P-Value (Wilcoxon Test)	
Cephalometric parameters	Average	Standard Deviation	Average	Standard Deviation		Average	Standard Deviation	Average	Standard Deviation		
SNA	77.21	3.76	80.33	5.71	0.002*	78.35	3.91	80.77	3.94	0.02*	0.79
SNB	78.13	4.14	78	6.46	0.14	81.08	8.51	80.19	4.83	0.23	0.84
Overjet (mm)	-2.36	1.47	2.8	1.04	0.02*	-1.94	2.5	2.8	1.37	0.006*	0.85
Maxilla to Cranium (mm)	-3.23	2.63	-1.1	2.82	0.16	-4.33	2.35	-2.5	2.4	0.003*	0.78
Mandible to cranium(mm)	-6.12	3.9	-6	4.66	0.79	-4.32	5.55	-6.08	5.87	0.16	0.15
Co-A (mm)	70.45	5.54	73.22	5.3	0.03*	71.37	6.36	73.81	6.3	0.04*	0.98
Co-Gn (mm)	94.75	7	96.38	8.05	0.57	98.27	8.73	98.53	7.09	0.39	0.78
Occlusal plane/SN	20.29	6.25	20.42	5.66	0.78	16.81	4.81	17.62	5.93	0.54	0.48
ANB	6	24.3	8.83	22.8	0.004**	3.57	23.06	7.15	22.29	0.001**	0.6
SN/Go-Gn	36.04	5.82	37.38	4.74	0.12	29.46	10.26	29.96	10.79	0.44	0.46
Overbite	1.12	3.27	1.67	1.27	0.93	1.11	2.8	1.68	1.38	0.3	0.98
Wits (mm)	-5.1	2.37	1.4	2.24	0.002**	-6.22	2.21	-1.57	3.74	0.001**	0.32
A-B Difference (mm)	-2.17	1.47	4.02	2.62	0.002**	-2.06	3.19	3.57	3.51	0.001**	0.53
Anterior facial height(mm)	99.73	8.7	101.9	7.26	0.21	93.21	11.8	99.73	8.41	0.001**	0.51
Posterior facial height(mm)	60.73	7.1	62.75	8.36	0.29	59.75	6.68	60.14	5.37	0.49	0.54
Posterior/ anteriorFacial height	61.9	6.83	61.5	5.78	0.65	62.07	4.34	60.43	3.84	0.12	0.2
IMPA	93	8.99	86.13	6.71	0.002**	90.08	6.81	84.6	7.12	0.002**	0.8
U1-SN	99.75	9.56	105.8	9.02	0.003**	106.7	6.23	108.7	4.94	0.06	0.02
U1-PP	108.5	9.28	115.4	5.43	0.005**	114.7	4.64	116.4	5.72	0.11	0.03
Interincisal Angle	131.5	9.45	130.4	9.41	0.35	128.7	9.84	129.8	10.71	0.52	0.34
ANS–Me (mm)	53.67	4.04	55.17	3.8	0.06	52.8	4.51	55.18	4.97	0.01*	0.37

*: P value<0.05, **: P value<0.01

parameters including Upper Incisors-T, Upper Molar-T, Upper incisor-SN and Upper molar-SN increased significantly (in all parameters (P<0.05)). In partial superimposition on mandible decreasing of Lower Incisor-T was significant (P<0.05).

Comparison the results of two groups

In comparison of the results of two groups, none of the 13 cephalometric parameters changed significantly (P>0.05).

In comparison of the results of total superimpositions, the differences of Upper incisors-SN (3.75 mm increasing in group A and 4.32 mm increasing in group B), Upper molar-SN (1.75 mm increasing in group A and 2.16 mm increasing in group B), Lower molar-SN (2.33 mm increasing in group A and 1 mm increasing in group B) and Lower Molar-T (1.42 mm decreasing in group A and 1.99 mm increasing in group B) were significant (in all parameters (P<0.05)) (Tables 1 and 2). According to the results of this study, null hypothesis is accepted.

DISCUSSION

Two study groups included patients with CLIII disorder that had been treated according to the treatment plan was suggested by their orthodontists.

Appliance facemask with modified TPA-Nance plaque as anchorage in group A and facemask with Y-plate removable plaque as anchorage in group B was considered.

The main aim of this study was to evaluate the cephalometric changes during treatment and comparison of these changes in two groups. The results of this evaluation in group A, showed that the parameters included SNA, ANB, Co-A, A-B Difference were increased. The parameter included SNA, ANB, Co-A, A-B Difference, Witts and Maxilla to cranium in group B increased too. These results indicate that both treatments are effective for improving the maxilla and mandible skeletal relationship (due forward movement of maxilla and improvement ANB angle). The point that should be noticed is that the SNB parameter didn't decrease in both groups significantly. SN/GoGn angle didn't change significantly too. Therefore, the observed change in improvement of ANB angle is because of the effective treatment by appliances on maxilla basically and these two appliances do not rotate the mandibular plan significantly. This process can be because of successful application of U-loop in group A and posterior bite plan in group B in controlling the vertical dimension of the face. Another reason can be the right selection of patients in appropriate age. Their ability to growth results to increasing of ramus height therefore mandibular plan

Table 2: Comparison of the superimpositions of two groups

Group	Group A (facemask-TPA Nance)					Group B (facemask-removable plaque)					P Value (Mann-Whitney U-test)
	Pre treatment		Post treatment		P-Value (Wilcoxon Test)	Pre treatment		Post treatment		P-Value (Wilcoxon Test)	
Cephalometric parameters	Average	Standard Deviation	Average	Standard Deviation		Average	Standard Deviation	Average	Standard Deviation		
Total superimposition											
Upper Incisor-SN	69.16	6.45	72.19	5.63	0.005**	65.5	6.8	69.82	6.59	0.12	0.05*
Upper Incisor-T	46	7.68	48.41	9.6	0.04*	47.57	5.57	51.69	6.97	0.004	0.37
Upper molar-SN	55.91	5.58	59.91	4.9	0.003**	54.26	5.26	56.42	6.08	0.01	0.15
Upper molar-T	12.91	5.07	14.66	6.48	0.04*	14.3	4.99	19	5.65	0.002	0.03*
Lower Incisor-SN	69.13	6.9	70.25	5.5	0.4	64.88	5.79	65.07	5.8	0.67	0.68
Lower Incisor-T	48.75	7.21	46.08	8.8	0.02*	50.5	6.13	49.26	7.9	0.21	0.61
Lower molar-SN	57.83	5.42	60.16	4.81	0.006**	56	5.33	57	5.73	0.16	0.01*
Lower molar-T	16.3	4.81	14.91	6.18	0.1	17.5	3.77	18.96	5.76	0.19	0.04*
Local Superimposition Of maxilla											
Upper Incisor-SN	69	7.24	70.83	5.42	0.26	65.69	6.54	66.88	6.38	0.02	0.4
Upper Incisor-T	45.75	7.22	47.83	7.77	0.01*	47.23	5.8	48.19	6.04	0.04	0.37
Upper molar-SN	58.83	5.6	57.5	6.52	0.01*	54.11	5.28	56.53	7.01	0.01	0.9
Upper molar-T	13.08	4.67	13.75	5.4	0.37	13.65	5.18	15.46	4.71	0.01	0.32
Local Superimposition of mandible											
Lower Incisor-SN	66.33	5.63	66.41	5.31	0.01*	64.88	5.5	63.88	5.5	0.06	0.27
Lower Incisor-T	48.33	6.62	47.5	6.44	0.07	49.15	6.03	47.69	6.42	0.02	0.47
Lower molar-SN	58.83	5.44	58.91	4.48	0.91	55.84	5.28	56.07	5.29	0.95	0.85
Lower molar-T	15.75	4.3	16	4.26	0.35	16.65	4.3	17	5.25	0.6	0.47

*: P value<0.05, **: P value<0.01

rotation is not observed. Overjet was another parameter that increased in both groups. According to forward movement of maxilla and increasing the upper central incisors angle, increasing the overjet is justified. In evaluation of vertical cephalometric parameters in this study, SN-GoGn, post-anterior ratio and overbite changes were not significant in both groups. Despite our study Ngan et al. [22], have reported 2.6 mm decreasing in overbite during treatment of them by facemask in their study. This difference is because of different biomechanics applied for vertical control in two studies and mandibular molar extrusion in Ngan et al., study. Chong et al. [23] have reported no change in overbite during treatment by facemask.

Mermigos et al. [24] have reported similar results in their study and there are statistically significant but slight and clinically insignificant skeletal changes. These results indicate that applied biomechanics for vertical control in both groups were successful. Mermigos explains that this linear increasing in anterior and posterior facial height are most likely a reflection of growth rather than the direction result of therapy. The age range in this study was 4-14. According to the appropriate age in our study, the growth is important parameter to linear increases in anterior and posterior facial height.

In evaluation of the angular parameters, U1-SN and U1-PP angles increased and IMPA angle decreased in both groups. Increasing the U1-SN and U1-PP angles can be because of anchorage loss during entering the force through facemask to the teeth in group A. Increasing of these angles in group B is because of facemask 's force and raising the arc environment by Y-expander plate to provide enough space for eruption of teeth. Noticeable point is that increasing of this parameters in group A is more than the increasing in group B and despite the increasing in dental arc environment in group B, increasing of U1-SN and U1-PP angles were less than their increasing in group A. It can show that removable appliances used in group B, is more successful in maintaining the anchorage than modified TPA-Nance used in group A.

Decreasing of IMPA angle is because of the pressure of chin part of the facemask to lower incisors in both groups.

In total superimposition, the distances between upper central incisors and vertical reference and these teeth and horizontal references increased noticeably in both groups that it's because of upper incisors movement during treatment. In fact, these teeth had occlusal drift.

In total superimposition the distance between upper molars and vertical references and upper molars and horizontal references increased that shows occlusal drift of upper molars.

In partial superimpositions in both groups, distance between upper incisors and vertical reference increased (partial superimposition on palatal plan). Distance between lower incisors and vertical reference decreased (partial superimposition on mandibular plan). The reason of lower incisors retrusion is the force that enters from chin part of facemask to lower teeth. Also the distance between lower incisors and SN line decreased in partial superimposition that it's because of lower incisors extrusion and retrusion.

In partial superimposition on palatal plan, distances between upper molars and SN line increased that shows molars extrusion.

As mentioned, in total superimpositions, upper molars and incisors moved to forward and downward. These movements have been reported in other studies. Kapust et al. [25] and Sung et al. [26] have reported 2.5–3.5 mm extrusion of upper molars in their study. Ishii et al. [27] have reported upper molars extrusion too. In several studies [25,27-29] downward and backward rotation of mandible during treatment by facemask has been because of upper molars extrusion. The study of Yüksel et al. [21] has showed similar results to our study (molar extrusion without rotation in mandibular plan).

LIMITATIONS

The limitations of this study are no straight access to patients and no possibility to exhaustive evaluation of treatment plan and cooperation of patients. The only documents for evaluation were patient's pre and post treatment radiographies and the parameters like cooperation were not considered. Our suggestion is to do a clinical trial study with more sample size to evaluation the effects of these two treatment methods on the Class III children. Also the effect of gender in the process of treatment should be considered.

CONCLUSION

Both appliances are successful in improvement of the class III malocclusion by protraction of maxilla in the affected children and there is no significant difference in treatment results between these two applied modalities regarding the measured parameters.

ETHICS COMMITTEE

The ethical clearance from the university's ethical committee was given (No: 394443).

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