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Original Article

Alterations in Facial Soft Tissue Thickness Post-Facemask Treatment in Noncleft Skeletal Class III and Bilateral Cleft Lip Palate Class III Patients

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Main Points

- As a result of rapid maxillary expansion with facemask treatment (RME/FM) treatment, significant changes were observed in hard and soft tissues of Class III patients with bilateral cleft lip and palate (BCLP) and noncleft Class III patients.
- Although the response of BCLP and noncleft Class III groups to RME/FM treatment may differ, an improved soft tissue profile was obtained in both groups.
- Rapid maxillary expansion with facemask treatment-related differences were found in the position and inclination of upper incisors, and in thickness of gnathion, subnasale, and upper lip of BCLP and noncleft Class III groups.

ABSTRACT

Objective: The purpose of this retrospective study was to assess the alteration in the facial soft tissue thickness after rapid maxillary expansion with facemask treatment in bilateral cleft lip and palate (BCLP) Class III patients and noncleft Class III patients.

Methods: Case records including lateral cephalograms of 30 patients (19 females, 11 males) treated using a rapid maxillary expansion with facemask treatment were analyzed. Group I (age: 11.4 ± 1.02 years) (10 females, 5 males) consisted of noncleft skeletal Class III patients, and group II (age: 10.8 ± 0.84 years) (9 females, 6 males) comprised skeletal Class III patients with bilateral cleft lip and palate. Fifteen hard tissue and 10 soft tissue measurements were made at the beginning and at the end of the treatment to evaluate the change with rapid maxillary expansion combined facemask treatment.

Results: The bilateral cleft lip and palate group displayed a statistically significant increase in the thickness of the subnasale, labrale superius, labrale inferius, labiomentale, and pogonion, whereas the thickness of the stomion was found to be significantly decreased. The noncleft group demonstrated a statistically significant decrease in the thickness of the stomion and gnathion. There was a statistically significant difference between the bilateral cleft lip and palate and noncleft groups in the facial soft tissue thickness measurements at labrale superius, gnathion, and subnasale points and in Y axis, U1-SN, U1-NA in the hard tissue measurements.

Conclusion: The results of the study indicated that the rapid maxillary expansion with facemask treatment produced diverse alterations in the facial soft tissue thickness of bilateral cleft lip and palate patients and noncleft Class III patients.

Keywords: Cleft lip and palate, facial soft tissue thickness, skeletal Class III

INTRODUCTION

The main objectives of Class III malocclusion treatment include obtaining optimal functional occlusion as well as delivering facial harmony because the main complaint of these patients is their concave profile, retrusive naso-maxillary area, and protrusive lower face and lips.[1-4] Numerous studies have evaluated facial soft tissue thickness (FSTT) in the literature,[5-12] and FSTT has been shown to be important in determining the facial profile.[5]

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Class III malocclusion can develop due to maxillary deficiency, mandibular prognathism, or their coexistence.[13] Cleft lip and palate (CLP) is a widespread birth defect[14] that takes part in the progression of Class III malocclusion due to maxillary deficiency.[15] Rapid maxillary expansion with facemask treatment (RME/FM) is the most common orthopedic correction approach of Class III malocclusion with maxillary retrusion.[16]

In the current literature, there are studies regarding the soft tissue response to RPE and/or FM therapy in Class III patients,[1-4,17,18] differences in FSTT of varied skeletal malocclusions,[5-8,10] and FSTT in patients with bilateral cleft lip and palate (BCLP).[11,12,19] To the authors' knowledge, no data are available in the literature comparing the alterations in FSTT between the BCLP Class III patients and noncleft Class III patients after RME/FM treatment. The purpose of the present retrospective study is to evaluate the changes in FSTT after RME/FM treatment in patients with BCLP and to compare the findings with those of the noncleft Class III group. The null hypothesis of the study was that RME/FM treatment produced the same changes in the FSTT of BCLP patients and noncleft Class III patients.

METHODS

Lateral cephalometric radiographs of 30 patients (19 females, 11 males) treated with RME/FM were assessed in the current study. The ethical approval for the present retrospective study was obtained from the Local Ethics Committee of Selçuk University, Faculty of Dentistry (2012/12), and the study was conducted in accordance with the Declaration of Helsinki.

Individuals to be included in the study were selected through the records of all patients who received RME/FM treatment in the Selçuk University, Faculty of Dentistry, Department of Orthodontics, between 2013 and 2018. Written informed consent was obtained from each participant and/or their legal representative permitting scientific investigations including the patients' records prior to dental or orthodontic treatment. The research groups were formed after the evaluation of the records containing information on chronological age, daily wear time of removable appliances, cooperation, the treatment method, and lateral cephalometric radiographs of all patients. It was determined that there were 156 patients who received RME/FM treatment. Of these patients, 24 patients were found to have BCLP.

The sample size was calculated according to a formula,[20] with a significance level of .05 and a power of 85% to observe a difference of 3.4 mm (±3.4 mm) in subnasale thickness (distance from point A to subnasale) between the groups, in accordance with a study conducted by Celikoglu et al.[11] The sample must consist of 14 patients in each group according to the power analysis.

The inclusion and exclusion criteria of the study are presented in Table 1. Fifteen patients with BCLP were detected who met the criteria in Table 1. The study was carried out with the records of 15 individuals in both groups in order to have an equal number of individuals in the groups. Group I consisted of 15 subjects (10 females, 5 males; mean age, 11.4 ± 1.02 years) who had skeletal Class III malocclusion. Group II included 15 subjects (9 females, 6 males; mean age, 10.8 ± 0.84 years) who had BCLP with Class III malocclusion. All subjects were operated, and the identical primary surgical correction was performed at the same hospital. The lip, hard and soft palate were surgically closed before one year of age. In the present study, there was no control group due to ethical reasons, and the groups were compared with each other.

Table 1. Inclusion and exclusion criteria of the study

Inclusion Criteria
Retrognatic upper jaw detected in the cephalometric analysis of the individual (SNA ≤ 79°)
Presence of skeletal class III malocclusion (ANB ≤ 0°)
Mild skeletal malocclusion (ANB >−2°)[29]
Skeletal class III malocclusion due to maxillary retrusion or a combination of maxillary retrusion and mandible protrusion
Presence of class III molar relationship with anterior crossbite
Normal or horizontal growth pattern
Skeletal maturation at the prepubertal stage according to the cervical vertebra maturation method (CS1 or CS2)[30]
No previous orthodontic treatment
Cooperative patient according to the information obtained from the patient files
The net facemask wear-time reported as 6 months in the patient files
Positive overjet reported in the patient files after 6 months of face mask treatment
For group I, absence of any metabolic or systemic disorders and craniofacial deformities
For group II, presence of BCLP without any other syndromes or congenital anomalies, metabolic or systemic disorders
Exclusion Criteria
Pseudo class III malocclusion (functional shift)
Severe skeletal malocclusion (ANB < −2°)[29]
Vertical growing pattern
The net facemask wear-time reported as more than 6 months in the patient files
Completed growth and development
Normal position of the maxilla and skeletal class III malocclusion due to mandibular protrusion only
Incomplete or unclear patient records
Patient has received previous orthodontic treatment
For group I, presence of any metabolic or systemic disorders and craniofacial deformities
For group II, presence of any syndrome, metabolic, or systemic disorder accompanying BCLP

BCLP, bilateral cleft lip and palate group.

A full-coverage Hyrax (Forestadent, St. Louis, Mo, USA) acrylic cap splint-type rapid maxillary expansion appliance with vestibular hooks (Figures 1 and 2) was cemented to the maxilla and activated 2 times a day for 7 days. The midpalatal suture was monitored with occlusal radiographs to detect a suture opening. After the sutural separation, the midline expansion screw

Figure 1. Intraoral frontal view of the rapid maxillary expansion appliance

was activated once a day, until the lingual cusps of the upper first molar teeth were aligned with the buccal cusps of the lower first molar teeth. At the time that the face masks (Petit-type) were assigned, a force of 300 g per side was applied. It has been determined from the clinical records that in the first month the protraction force between the facemask and the intraoral anchor system was 300 g from the front hook only, whereas in the second month, a force of 300 g from the front hook and 200 g from the rear hook (a total of 500 g for each side) was applied. This force was applied in forward and downward motions at an angle of 30-45° with the occlusal plane, and the patients were instructed to use the facemask appliance 24 hours a day (excluding meals).[21]

Each patient underwent a lateral cephalogram before (T1) and after (T2) the treatment. All radiographs of the 30 cases included in the investigation were taken using a standard digital imaging device (Planmeca Promax, Dimax 3 Ceph, Helsinki, Finland) and by the same researcher. For the standardization, a cephalostat

Figure 2. Intraoral occlusal view of the rapid maxillary expansion appliance

was used to ensure that the patient's head was fixed in proportion to the film. Ear rods were placed into the ear canals. The cephalometric radiographs were taken under standard conditions. X-ray images were obtained with the lips in a relaxed position, the teeth in centric occlusion, and the Frankfort plane parallel to the horizontal plane.

Dentoskeletal measurements (SNA, SNB, ANB, Y axis, FMA, SN-GoGn, SN-PP, U1-SN, U1-PP, U1-NA (mm), U1-NA, IMPA, L1-NB (mm), L1 – NB, interincisal angle) and FSTT measurements (glabella (G), rhinion (Rhi), subnasale (Sn), labrale superior (Ls), stomion (Sto), labrale inferior (Li), labiomentale (Labm), nasion (N), pogonion (Pog), gnathion (Gn)) (Table 2 and Figure 3) on the lateral cephalometric radiographs were analyzed by the same researcher (SK) using a computer program (Quick Ceph Image, Quick Ceph Systems Inc., Calif, USA). The details concerning the process of FSTT analysis have been explained in previous studies[6,9,12]. For each measurement, the mean and standard deviation values of all groups were determined.

Statistical Analysis

Twenty radiographs were selected randomly to detect any errors associated with the measurements. All measurements were repeated with an interval of 3 weeks by the same researcher (SK). A paired sample *t*-test was performed to assess the random error. There were no statistically significant differences between the 2 sets of measurements. The intra-class correlation coefficients were above 0.938, thus confirming reliability. Statistical analysis was conducted using Statistical Package for the Social Sciences 22.0 (IBM SPSS Corp., Armonk, NY, USA). A paired sample *t*-test was performed for the intra-group comparisons, while an independent sample *t*-test was used for the inter-group comparisons. The association between craniofacial measurements and the FSTT was evaluated through regression analysis.

RESULTS

Table 3 presents the demographics and characteristics of the groups. There were no statistically significant differences between the groups in any of the variables at T1.

In Table 4, the pre-treatment (T_1) and post-treatment (T_2) values of dentoskeletal and soft tissues of the 30 cases (15 patients with BCLP and skeletal Class III; 15 patients with skeletal Class III without any cleft) treated via RME/FM are presented. In both groups, the maxilla was significantly protracted, while the mandible was retracted although this motion was not statistically significant. The angle of ANB increased substantially with the treatment. The BCLP group demonstrated a significant increase in FSTT at the Sn, Ls, Li, Labm, and Pog points, whereas a substantial decrease was observed in the thickness at the Sto. Additionally, in the noncleft group, the Sto and Gn values decreased significantly.

As can be seen in Table 5, the investigated parameters differ (T2-T1) among the groups. The post-treatment changes between the groups show a significant difference at Y axis, U1-SN, and

Table 2. Dentoskeletal and soft tissue variables

Variables	Definition
Hard tissue variables and their definition	
SNA	Angle between Sella-Nasion (SN) plane and Nasion-A (NA) plane
SNB	Angle between Sella-Nasion (SN) plane and Nasion-B (NB) plane
ANB	Angle between Nasion-A (NA) plane and Nasion-B (NB) plane
Y axis	Angle between Frankfort horizontal plane and sella-gnathion line
FMA	Angle between Frankfurt horizontal plane and mandibular plane
SN-GoGn	Angle between SN plane and gonion-gnathion (GoGn) plane
SN-PP	Angle between SN plane and palatal plane
U1-SN	Angle between SN plane and the long axis of the maxillary incisor
U1-PP	Angle between palatal plane (PP) and the long axis of the maxillary incisor
U1-NA (mm)	Distance between the anterior point of the maxillary incisor and NA line
U1-NA	Angle between NA plane and the long axis of the maxillary incisor
IMPA	Angle between the mandibular plane and the long axis of the mandibular incisor
L1-NB (mm)	Distance between the anterior point of the mandibular incisor and NB line
L1 – NB	Angle between the NB plane and the long axis of the lower mandibular incisor
Interincisal angle	Angle between the long axis of the maxillary incisor and the mandibular incisor
Soft tissue variables and their measurements	
Glabella (G)	Perpendicular to Frankfort horizontal plane or to the bony surface
Rhinion (Rhi)	Perpendicular to Frankfort horizontal plane or to the bony surface
Subnasale (Sn)	The distance between point A and subnasale
Labrale superior (Ls)	The distance between prosthion and labrale superius
Stomion (Sto)	The shortest distance between the upper incisor and the attachment points of the upper and lower lip
Labrale inferior (Li)	The distance between infradentale and the vermillon border of the lower lip
Labiomentale (Labm)	The distance between point B and the deepest point of the labiomental crease
Nasion (N)	Perpendicular to Frankfort horizontal plane or to the bony surface
Pogonion (Pog)	Perpendicular to Frankfort horizontal plane or to the bony surface
Gnathion (Gn)	Perpendicular to Frankfort horizontal plane or to the bony surface

U1-NA in the hard tissue measurements and at the Ls, Gn, and Sn in the FSTT measurements.

The results of multiple linear regression analysis are reported in Table 6. This analysis was performed to describe the statistically significant differences of Sn, Ls, and Gn as dependent variables and the skeletal measurements as predictors. Regression models revealed statistically insignificant relationships between Sn (R^2 = 27.2, P = .089), Ls (R^2 = 17.3, P = .218), and Gn (R^2 = 12.6, P = .313).

DISCUSSION

The present study compared the changes in the FSTT due to the RME/FM treatment in BCLP patients and noncleft Class III patients using lateral cephalometric radiographs. In many studies, the effect of maxillary traction on facial soft tissues has been evaluated through cephalometric films.[1,2,4] Multiple imaging methods (two-dimensional (2D) or three-dimensional (3D)) are used to evaluate craniofacial measurements and the surrounding facial soft tissue. The most frequently preferred 3D systems are computed tomography (CT), cone-beam computed tomography (CBCT), stereophotogrammetry, magnetic resonance imaging, and laser surface; CBCT in particular is broadly used.[22,23] However, 3D systems are costlier in comparison to conventional 2D systems. The radiation dose that CBCT offers is lower than CT, nevertheless higher in comparison to cephalometric radiography. Furthermore, poor soft tissue contrast and artifacts can be observed in CBCT imaging. Overall, the main imaging method for orthodontic treatment remains as cephalometric radiography.[24]

In the literature, the findings concerning the difference in FSTT between the sexes are inconsistent. While some studies have reported a sex-related difference in FSTT,[5,8] others have reported no differences.[6,11] It was reported that there was no statistically significant difference in FSTT between the sexes in Class III individuals by Perović and Blažej[7] and in individuals with BCLP by Celikoglu et al.[11] In the present study, the groups were not divided by sex. In view of the fact that ethical principles do not allow the treatment of diagnosed Class III patients to be postponed for scientific purposes, a control group was not formed in the study, and the groups were compared with each other.

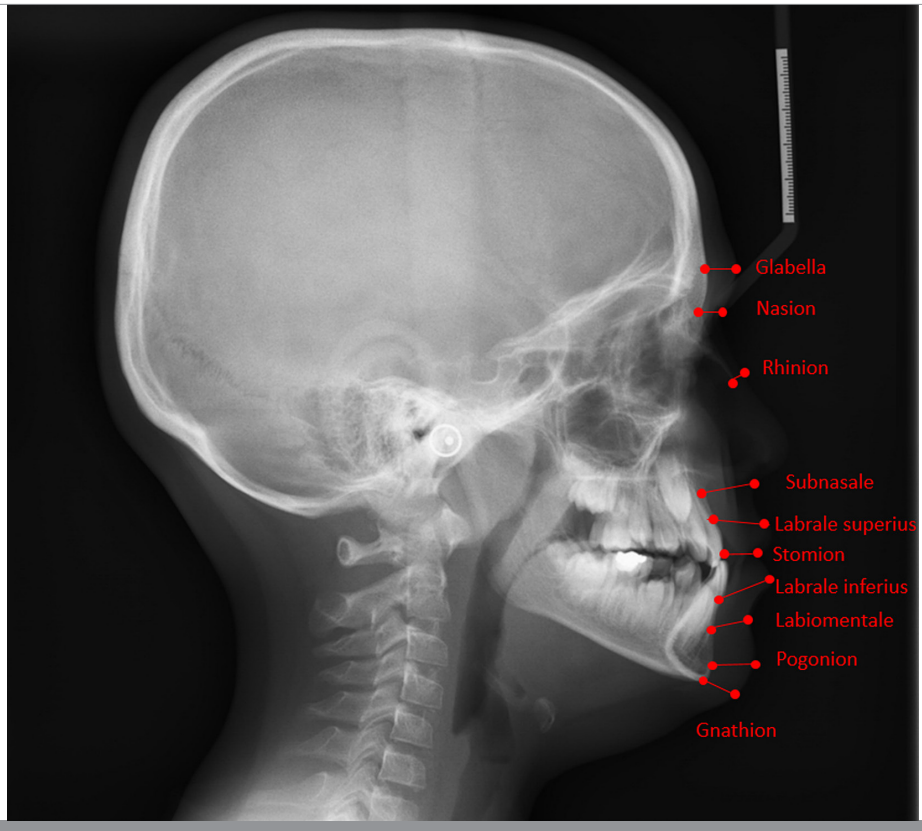

Figure 3. The selected measurement points of the facial soft tissue thickness

Table 3. Demographics and characteristic features of the groups

	BCLP group		Noncleft group		
	Mean	SD	Mean	SD	*P*
Mean age	10.08	0.84	11.4	1.02	.054
Hard tissue measurements					
SNA	76.91	4.59	78.75	4.62	.062
SNB	76.43	3.58	79.39	4.53	.057
ANB	0.87	2.95	−0.64	2.35	.052
Y axis	60.21	3.33	55.51	2.84	.081
SN-GoGn	38.12	6.64	35.46	7.10	.060
SN-PP	10.50	3.59	9.91	4.99	.208
IMPA	85.51	6.99	85.68	3.13	.418
Soft tissue measurements					
Glabella (G)	6.06	1.27	6.60	1.27	.608
Rhinion (Rhi)	2.75	0.64	2.81	0.61	.598
Subnasale (Sn)	10.54	2.60	12.52	2.46	.072
Labrale superior (Ls)	12.41	2.17	13.06	2.47	.128
Stomion (Sto)	8.74	2.63	7.65	2.31	.117
Labrale inferior (Li)	14.74	1.43	15.73	1.80	.136
Labiomentale (Labm)	9.96	1.36	11.64	2.33	.052
Nasion (N)	6.09	2.13	6.90	1.56	.304
Pogonion (Pog)	11.06	2.10	12.09	1.80	.090
Gnathion (Gn)	8.41	1.63	8.51	1.87	.469

BCLP, bilateral cleft lip and palate; SD, standard deviation.

The same appliance and force system were used on all patients participating in the study at the same period, and no additional orthodontic therapy was used. Thus, the factors that could affect the interpretation of the data were eliminated. In some recently conducted studies, it has been reported that rapid maxillary expansion does not have a significant effect on maxillary protraction.[25-28] Yavuz et al.[27] reported in 2012 that similar dentoskeletal and facial soft tissue changes were observed in groups that underwent facemask treatment regardless of rapid maxillary expansion and that the mean duration of treatment was similar. Zhang et al.[28] reported in their meta-analysis that the effect of facemask was similar in groups with and without rapid maxillary expansion. The alterations in the present study are thought to be due to facemask treatment since in recent studies, no statistical difference was found between the effects of facemask treatment applied in the presence and absence of rapid maxillary expansion.

In studies evaluating the effect of RME/FM treatment on soft tissues in the literature, a statistically significant anterior movement in the upper lip and midface region has been reported as a result of anterior movement of the maxilla with maxillary protraction treatment. It has been shown that this condition tends to alter the soft tissue profile from concave to a more orthognathic or convex profile.[1,2,4,17,18,25] To the authors' knowledge, no data are available in the literature comparing the alterations in FSTT between the BCLP Class III patients and noncleft Class III patients succeeding RME/FM treatment.

Table 4. Changes in dentoskeletal and soft tissue measurements after treatment, and the significance of these changes in each group

	BCLP Group (n = 15)					Noncleft Group (n = 15)				
	T1		T2			T1		T2		
Hard tissue measurements	**Mean**	**SD**	**Mean**	**SD**	***P***	**Mean**	**SD**	**Mean**	**SD**	***P***
SNA	76.91	4.59	79.10	4.26	.001***	78.75	4.62	80.72	3.72	.044**
SNB	76.43	3.58	75.91	3.33	.208	79.39	4.53	79.08	3.25	.799
ANB	0.87	2.95	3.20	3.05	.001***	−0.64	2.35	1.65	2.35	.001***
Y axis	60.21	3.33	60.57	4.68	.566	55.51	2.84	56.10	2.04	.357
FMA	27.06	5.66	27.34	6.81	.661	22.59	4.11	23.77	2.55	.114
SN-GoGn	38.12	6.64	38.94	7.15	.151	35.46	7.10	37.15	4.23	.255
SN-PP	10.50	3.59	8.06	4.44	.001***	9.91	4.99	8.28	3.36	.233
U1-SN	85.47	11.13	93.49	9.74	.001***	102.61	6.58	105.72	5.90	.128
U1-PP	−84.02	11.33	−78.24	11.20	.014*	−67.48	7.76	−65.99	6.75	.284
U1-NA (mm)	−0.94	4.31	1.49	4.04	.007**	4.25	2.00	5.03	1.86	.058
U1-NA	7.69	12.74	14.84	11.72	.004**	23.85	7.10	25.01	5.85	.411
IMPA	85.51	6.99	84.46	7.75	.404	85.68	3.13	87.21	5.32	.276
L1-NB (mm)	3.26	2.06	3.71	2.49	.185	3.28	1.12	3.66	1.41	.191
L1 – NB	19.35	6.59	19.79	7.27	.710	20.51	4.82	23.43	5.04	.060
Interincisal angle	150.88	11.72	143.09	13.81	.005**	136.26	8.07	129.93	7.49	.003**
Soft tissue measurements										
Glabella (G)	6.06	1.27	6.60	1.27	.610	6.07	1.28	6.20	1.26	.611
Rhinion (Rhi)	2.75	0.64	2.81	0.61	.590	2.31	0.64	2.33	0.76	.902
Subnasale (Sn)	10.54	2.60	12.52	2.46	.001***	15.59	1.71	15.45	1.17	.725
Labrale superior (LS)	12.41	2.17	13.06	2.47	.048*	14.65	1.66	14.18	1.43	.203
Stomion (Sto)	8.74	2.63	7.65	2.31	.017*	7.01	1.29	5.26	1.16	.001***
Labrale inferior (Li)	14.74	1.43	15.73	1.80	.036*	13.81	1.21	14.35	1.37	.145
Labiomentale (Labm)	9.96	1.36	11.64	2.33	.005**	10.68	1.50	11.20	1.94	.320
Nasion (N)	6.09	2.13	6.90	1.56	.154	5.88	1.52	5.52	1.91	.404
Pogonion (Pog)	11.06	2.10	12.09	1.80	.014*	11.13	2.15	11.29	2.04	.502
Gnathion (Gn)	8.41	1.63	8.51	1.87	.769	9.97	2.39	9.03	2.43	.017*

Paired Sample *t*-Test, BCLP, bilateral cleft lip and palate group; SD, standard deviation.
*$P \leq .05$; **$P \leq .01$; ***$P \leq .001$.

Utsuno et al.[10] in their study evaluating FSTT in different skeletal malocclusions reported statistically significant differences between the Sn and Ls points, regarding the comparison of Class I and Class III patients in the upper lip region and the influence of maxillary growth on FSTT at the Sn and Ls points. They also found that the mental area of the mandible was more anteriorly positioned in Class III patients due to the reduced maxillary growth or overgrowth of the mandible. As a result of this, increased FSTT was expected in these 2 points in Class III patients. They reported that the FSTT was the thinnest in Class III at the Labm and Pog points. They found no significant differences at the Sto or Li point. In the present study, in the noncleft group, there was a significant decrease in the thickness of Sn, Ls, and Sto, following RME/FM treatment, while the thickness of Labm and Pog points increased although this difference was not statistically significant. The inconsistency in the study conducted by Utsuno et al.[10] regarding the Sto point may be due to the fact that the results reported a comparison of treatment-related alterations rather than directly pointing out the difference between classes. Moreover, the angulation of the teeth could affect the thickness of the Sto.[6]

Kamak and Celikoglu[6] stated that the thickest FSTT at the Ls and Sto points and the thinnest Li belonged to Class III patients. In the present study, Sto thickness decreased and Li thickness increased with RME/FM treatment in both groups, although the increase in the thickness of Li was not statistically significant in the noncleft group. While there was a decrease in the thickness of Ls in the noncleft group, it was increased in the group with BCLP.

Utsuno et al.[8] reported that in skeletal Class III patients, there is a concave facial profile showing excessive growth in the mandible or decreased growth in the maxilla, and FSTT from the Sn to the Labm was greater in the less growth site. According to the data obtained from studies evaluating FSTT in different skeletal patterns in the literature,[6,8,10] a decrease in FSTT in the upper lip region is expected with RME/FM treatment.

Table 5. Comparison of the treatment-related changes between the groups

	BCLP Group		Noncleft Group		
	T2-T1		T2-T1		
	Mean	SD	Mean	SD	*P*
Hard tissue measurements					
SNA	2.19	1.38	1.97	5.07	.872
SNB	−0.52	1.53	−0.31	4.69	.872
ANB	2.33	1.71	2.29	1.55	.947
Y axis	0.37	2.40	3.11	1.68	.001***
FMA	0.27	2.35	0.59	2.41	.716
SN-GoGn	0.81	2.08	1.18	2.71	.681
SN-PP	−2.43	2.12	1.69	5.53	.012
U1-SN	8.02	7.60	2.10	2.05	.005**
U1-PP	5.78	7.93	3.11	7.45	.351
U1-NA (mm)	2.43	2.96	1.49	5.19	.550
U1-NA	7.15	8.03	0.77	1.45	.005**
IMPA	−1.04	4.70	1.15	5.28	.239
L1-NB (mm)	0.45	1.25	1.53	5.21	.445
L1 – NB	0.44	4.52	0.38	1.07	.960
Interincisal angle	−7.79	9.02	−6.33	6.94	.623
Soft tissue measurements					
Glabella (G)	0.54	0.80	0.13	0.94	.206
Rhinion (Rhi)	0.06	0.40	0.02	0.62	.835
Subnasale (Sn)	1.99	1.41	−0.13	1.44	.001***
Labrale superior (Ls)	0.65	1.16	−0.47	1.35	.022*
Stomion (Sto)	−1.09	1.56	−1.75	1.21	.206
Labrale inferior (Li)	0.99	1.66	0.54	1.35	.419
Labiomentale (Labm)	1.67	1.93	0.52	1.95	.115
Nasion (N)	0.81	2.08	−0.36	1.62	.097
Pogonion (Pog)	1.03	1.42	0.15	0.86	.052
Gnathion (Gn)	0.09	1.20	−0.93	1.05	.019*

Independent Sample *t*-Test, BCLP, bilateral cleft lip and palate group; SD, standard deviation.
*$P \leq .05$; **$P \leq .01$; ***$P \leq .001$.

Ngan et al.[2] and Vaughn et al.[25] reported that there was an anterior and inferior movement in the upper lip, an increase in the length and a decrease in the thickness of the upper lip, a posterior and inferior shift in the lower lip, and an increase in the lower lip length and thickness as a result of maxillary protraction. Arman et al.[4] reported that the upper lip thickness decreased and the lower lip thickness increased after maxillary protraction. In the present study, the decrease in the FSTT in the upper lip region seen in the noncleft group, the increase in the Li thickness although not statistically significant, and the increase in the Li thickness in the BCLP group are consistent with these studies.

When the 2 groups were compared pertaining to facemask treatment and the maxillary expansion treatment, SNA and ANB angles increased while the interincisal angle decreased in both groups. There was a statistically significant increase in the measurements showing the angle and position of the maxillary incisors in the BCLP group. A significant treatment-related difference was found between the 2 groups in the angles of the upper incisors. In general, the upper incisors are inclined labially, while lower incisors are inclined lingually in Class III subjects.[6] However, the upper and lower incisors of Class III patients with CLP are generally in a retrusive position. The upper lip scar may be responsible for this condition.[11] A statistically significant decrease was found at the Sn and Ls points in the noncleft Class III, while in the BCLP group, a significant increase was observed at these points. A significant decrease was found in the noncleft group at the Gn point in comparison with the BCLP group. The difference between the Sn and Ls points is considered to be due to the contrast in the inclination of incisors.

In the current study, although the skeletal pattern in the BCLP group differed from Class III to Class I, the increase in FSTT at the Sn and Ls points was attributed to the fact that the upper incisors were in the retrusive position in the BCLP group, unlike in the noncleft Class III group. Celikoglu et al.[11] reported significant correlations between U1-SN among the Sn and Ls thicknesses. Moreover, they reported that patients with BCLP had thinner Sn and Ls. Hasanzadeh et al.[19] and Erdur et al.[12] reported in their studies that BCLP patients had a thinner Sn compared with noncleft healthy individuals.

Table 6. The association between craniofacial measurements and subnasale, labrale superior and gnathion thicknesses according to the multiple linear regression analyses

	Subnasale			Labrale superior			Gnathion		
	R^2=27.2, P=0.089			R^2=17.3, P=0.218			R^2=12.6, P=0.313		
	R	P	R^2	r	P	R^2	r	P	R^2
SNA	-0.186	0.118	3.2	-0.236	0.206	4.1	-0.243	0.185	0.8
SNB	-0.026	0.614	0.001	-0.042	0.302	0.002	-0.018	0.428	0.001
ANB	-0.212	0.084	5.2	-0.198	0.408	0.4	-0.312	0.106	3.1
FMA	-0.098	0.242	0.8	-0.162	0.094	1.2	-0.201	0.088	2.1
SN-GoGn	-0.144	0.318	1.6	-0.112	0.146	2.1	-0.111	0.161	2.3
U1-SN	0.268	0.046	5.2	0.176	0.108	4.1	0.208	0.143	6.4
IMPA	0.169	0.074	7.2	0.097	0.136	0.9	0.097	0.254	1.9

R^2, coefficient of determination; P, 1-tailed significance level of correlation of each variable; r, Pearson correlation coefficient.

The results of the multiple linear regression analysis for the present study, which was performed to determine the relation of the craniofacial measurements, indicated that there was no association among Sn, Ls, and Gn.

The limitations of the study are that there is no sex assortment, the duration of appliance use was determined only through the information obtained from the patients, and 2D imaging method was used for the evaluation and the absence of a control group. An extensive investigation is required to achieve a more accurate comparison. Although the sample size is small, it is noted that in both groups, the soft tissue thickness is prone to change with treatment. In addition to hard tissue measurements, soft tissue measurements are necessary to determine the best treatment option and to provide an ideal facial appearance. The presented study contains information that may be helpful when planning the treatment of patients with BCLP and noncleft individuals.

CONCLUSION

1. As a result of RME/FM treatment, there were significant changes in hard and soft tissues and incisor inclinations in both groups. The maxilla was significantly protruded, while the mandible was retracted although this alteration was not statistically significant. The ANB angle increased following the increase in the SNA angle and the decrease in the SNB angle.
2. In the BCLP group, there was a statistically significant decrease in interincisal angle values and a statistically significant *increase in the values associated with upper incisor proclination and protrusion*. In the noncleft group, the interincisal angle was statistically significantly decreased.
3. In both groups, the facial profile changed from a concave profile to a more orthognathic profile with treatment.
4. The BCLP group exhibited a statistically significant increase in subnasale, upper lip, lower lip, and labiomentale thickness and a statistically significant decrease was observed at the stomion point ensuing RME/FM treatment.
5. The noncleft Class III group presented a statistically significant decrease at the stomion and gnathion points.
6. When the treatment-related changes between the groups were evaluated, a statistically significant difference was found in the Y axis, *upper incisor proclination and protrusion* values in the hard tissue, and upper lip, gnathion, subnasale thickness in the soft tissue.
7. Based on the differences between the BCLP and noncleft groups, the null hypothesis of the study can be rejected.

Ethics Committee Approval: Ethical Committee approval was received from the Ethics Committee of Selçuk University, Faculty of Dentistry (Approval No: 2012/12).

Informed Consent: Written informed consent was obtained from each participant and/or their legal representative.

Peer-review: Externally peer-reviewed.

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