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Research Article

Dento-Skeletal and Facial Profile Changes Following Correction of Anterior Crossbite in Cleft and Non-Cleft Growing Patients

Wisesphon Sutthidechanai, Nopawun Viriyasiri, and Smorntree Viteporn*

Department of Orthodontics, Chulalongkorn University, Thailand

***Corresponding author**

Smorntree Viteporn, Department of Orthodontics, Faculty of Dentistry, Chulalongkorn University, 254 Phayathai Road, Bangkok 10330, Thailand, Tel: 662-218-8730; Email: smontree@hotmail.com

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Keywords

- Skeletal class III malocclusion
- Anterior crossbite
- Unilateral cleft lip and palate
- Orthodontic treatment
- Orthopedic treatment

Abstract

Background: Anterior crossbite and concave facial profile are common problems in unilateral cleft lip and palate (UCLP) and skeletal Class III patients. The objectives of the study were to scrutinize the effect of early orthodontic treatment with different treatment modalities on the cleft and non-cleft patients and to compare the significant differences between the two groups.

Material and methods: The sample was comprised 64 subjects (32 non-syndromic UCLP subjects with mean age 10.91 ± 2.00 years and 32 skeletal Class III non-cleft subjects with mean age 10.52 ± 1.65 years who were treated as a non-extraction case, main treatment mechanics were arch expansion and Class III traction in the cleft patients and protraction headgear in the non-cleft patients. Dento-skeletal and soft tissue profile changes were evaluated from lateral cephalograms before and after treatments. Paired t test and independent t test were utilized to evaluate the significant changes within and between groups, respectively.

Results: The initial characteristics of UCLP patients were skeletal Class III maxillary retrusion and relative mandibular prognathism, retroclination and retrusion of the maxillary incisors. Treatment effects in both groups were mainly dento-alveolar effect. Significant proclination of the upper incisors following anterior crossbite correction attributed to the increase of upper lip protrusion and soft tissue convexity in both groups. Significant lower lip retrusion was found only in the non-cleft group.

Conclusion: Early orthodontic treatment of the anterior crossbite could improve facial profile of the cleft and non-cleft patients, the cleft patients exhibited less favorable response to the treatment especially the lower lip area.

ABBREVIATIONS

UCLP: Unilateral Cleft Lip and Palate

INTRODUCTION

Cleft involving the lip and/or palate is the most common congenital anomalies of the face [1]. Primary surgical closure of unilateral cleft lip and palate (UCLP) usually results in severe malocclusions such as anterior crossbite [2-4], maxillary retrusion [2,5-9] and concave facial profile [9,10]. These characteristics are similar to patients with skeletal Class III maxillary deficiency.

In principle, anterior crossbite and concave profile are corrected by orthopedic treatment in growing patients or orthognathic surgery in adult patients. The effects of facial morphology after orthognathic surgery on cleft patients have been reported by several studies [11-15]. The effects of early treatment were reported in general skeletal Class III children [16-20] and cleft patients [21-23] thus suggested the possibility of the early treatment of anterior crossbite. Anyhow, there were large variations in the effect of protraction headgear on cleft patients [24,25]. One study [24] showed both improvement and deterioration in their patients. Others [22,23] revealed that concave profile of the cleft patients could be improved from 2.8 – 7.0 degrees and the improvement of soft tissue profile following protraction headgear treatment was due to clockwise rotation of the mandible that tends to increase lower face height of the patients [26]. Since the cleft patients are likely to have a long lower face height [2,6,8], the maxillary protraction could deteriorate the soft tissue profile. Additionally, etiologies of anterior crossbite between the cleft and non-cleft patients are different. Genetics and skeletal deformities may be the etiologies in skeletal Class III patients. On the other hand, the cleft patients

have additional causes such as cleft deformity, surgical effects, and pressure from scar tissue of the upper lip.

The objectives of the study were to scrutinize the effects of early orthodontic treatment with different treatment modalities on the cleft and non-cleft patients and to compare the significant differences between the two groups.

MATERIALS AND METHODS

This study was undertaken after the approval of Human Research Ethic Committee, of the Faculty of Dentistry, Chulalongkorn University (Approval number HREC-DCU 2017-007). The 64 subjects aged 8-12 years old were divided into 2 groups (Table 1). The cleft group comprised 32 UCLP patients from the Craniofacial Anomaly Clinic, Dental Hospital, Faculty of Dentistry, Chulalongkorn University and 32 non-cleft patients from one private clinic. All subjects were treated from December 2006 to November 2016.

Inclusion criteria

1. All subjects presented with anterior crossbite, moderate to severe crowding in the upper arch. The dental relationship of the cleft subjects was scored "3" according to GOSLON yardstick index [27]. The skeletal relation was Class III normal to deep bite due to maxillary deficiency and facial profile was concave.
2. The cleft subjects were non-syndromic patients who received lip closure at 3-6 months old, palatal closure at 12-24 months old, secondary bone graft before eruption of the upper permanent canine, followed by orthodontic treatment

Exclusion criteria

1. Subjects presented with severe mandibular prognathism and dental compensation comprising upper incisor proclination.
2. Subjects with vertical growth pattern of the face and lower lip protrusion was their major concern.

Treatment protocol

1. The cleft subjects were treated by the second author as a non-extraction case except the maxillary lateral incisor adjacent to cleft site to assist the bone grafting procedures, and space closure was done after completed orthodontic treatment in 21 of 32 cases. The treatment mechanics comprised maxillary arch expansion and Class III traction to obtain maximum interception with acceptable overbite and overjet (Figure 1).
2. The non-cleft subjects were treated by the third author as a non-extraction case with similar treatment mechanics, protraction headgears with 500 gram force per side were prescribed to 22 cases (Figure 2).

Hard and soft tissue structures were scrutinized from lateral cephalographs before and after treatments. Lateral cephalometric radiographs were taken under standardized conditions (standing upright, head was oriented horizontally to the Frankfort horizontal plane and fixed with the cephalostat and ear rods, teeth in centric occlusion with relaxed lip). The distance from the focus to the median plane was 180 cm and distance from the median plane to the film was 10 cm. The enlargement for the median plane is 5.5 percent.

The cephalometric landmarks (Figure 3) were traced and soft tissue profile measurements (Figure 4) were undertaken by the first author. Linear and angular measurements were made to the nearest of 0.5 mm. and 0.5 degrees, respectively

Method error study

Pretreatment and post treatment radiographs of 10 patients were randomly selected. The films were retraced and all variables were measured two times with at least 2 week interval to avoid recognition of the previous measurement. The method error was determined by Dahlberg's formula [28].

$$ME = \sqrt{\frac{\Sigma(d)^2}{2n}}$$

Where d is the difference between the first and second measurements (millimeters or degrees) and n is the number of duplicated measurement.

Statistical analysis

Dento-skeletal and facial profile changes were evaluated by paired t-test at 0.05 significant level. For comparisons of cephalometric measurements between cleft and non-cleft patients, independent t-tests was used at 0.05 significant level.

RESULTS

The method errors for linear and angular measurements ranged from 0.23 - 0.87 mm and from 0.17 - 1.84 degrees, respectively. Shapiro-Wilk test indicated that all variables of each group were normally distributed, parametric statistics were used for comparisons within and between groups.

Before treatment (Table 2) there were significant differences of dento-skeletal and soft tissue profile of the cleft and non-cleft subjects. The cleft subjects exhibited greater cranial base angle (N-S-Ba angle). Comparing with clinical norm, both groups presented skeletal Class III malocclusion (ANB angle) with significant differences of jaw positions between groups. The cleft patients showed more retrusion of the maxilla (SNA angle) but less protrusion of the mandible (SNB, SNPog angles) than the non-cleft patients. More severe jaw discrepancy was observed in the non-cleft patients. Skeletal Class III in the cleft group was characterized maxillary retrusion and relative mandibular prognathism. Meanwhile, true mandibular prognathism was observed in the non-cleft patients. The facial height ratio was higher in the non-cleft patients. The upper incisors of the cleft group were more retroclined and retruded (U1-NA mm and angle, U1-SN angle) which resulted in less protrusion of the upper lip (Ls to Sn-Pg' mm).Meanwhile, the lower lip showed more protrusion with more acute inferior labial sulcus angle (Li-ILs-Pg' angle). After treatment (Tables 3,4), the cranial base dimensions increased significantly in both groups. The treatment effect in the cleft patients was mainly dento-alveolar effect. Significant changes of the overbite and over jet were based on significant proclination of the upper incisors. There were significant

Figure 1 Principle biomechanics of orthodontic treatment in cleft patients
a. Maxillary arch expansion with Quad helix
b. Class III intermaxillary traction

Figure 2 Principle biomechanics of orthodontic treatment in non-cleft skeletal Class III patients.
a. Fixed appliance edgewise technique
b. Protraction headgear

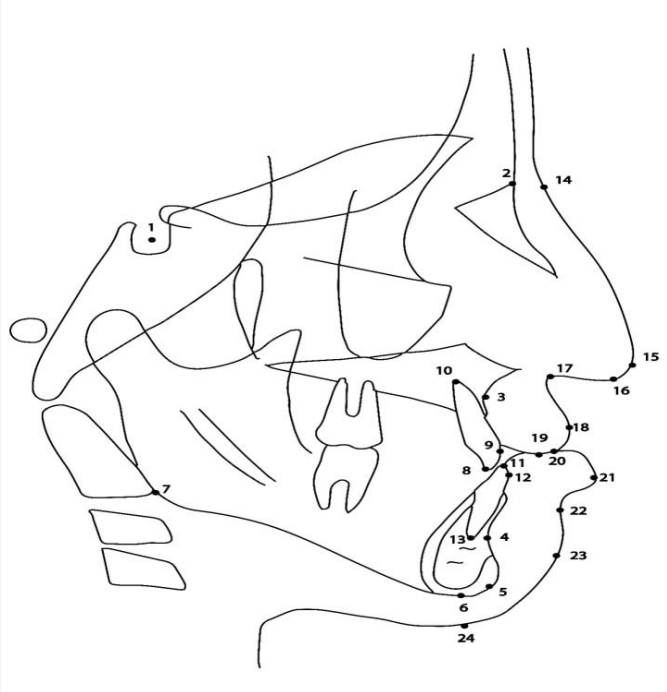

Figure 3 Cephalometric landmarks.
1 S (sella turcica); 2 N (nasion); 3 A (subspinale); 4 B (supramentale); 5 Gn (gnathion); 6 Me (menton); 7 Go (gonion); 8 Isi (maxillary central incisor edge); 9 U1 (the most anterior labial point of maxillary central incisor); 10 Isa (maxillary central incisor apex); 11 Iii (mandibular central incisor edge); 12 L1 (the most labial point of mandibular incisor); 13 Iia (mandibular central incisor apex); 14 N' (soft tissue nasion); 15 Prn (pronasale); 16 Cm (columella); 17 Sn (subnasale); 18 Ls (labial superius); 19 Sts (stomionsuperius); 20Sti (stomioninferius) ; 21 Li (labial inferius); 22 Ils (inferior labial sulcus); 23 Pg' (soft tissue pogonion); 24 Me' (soft tissue menton)

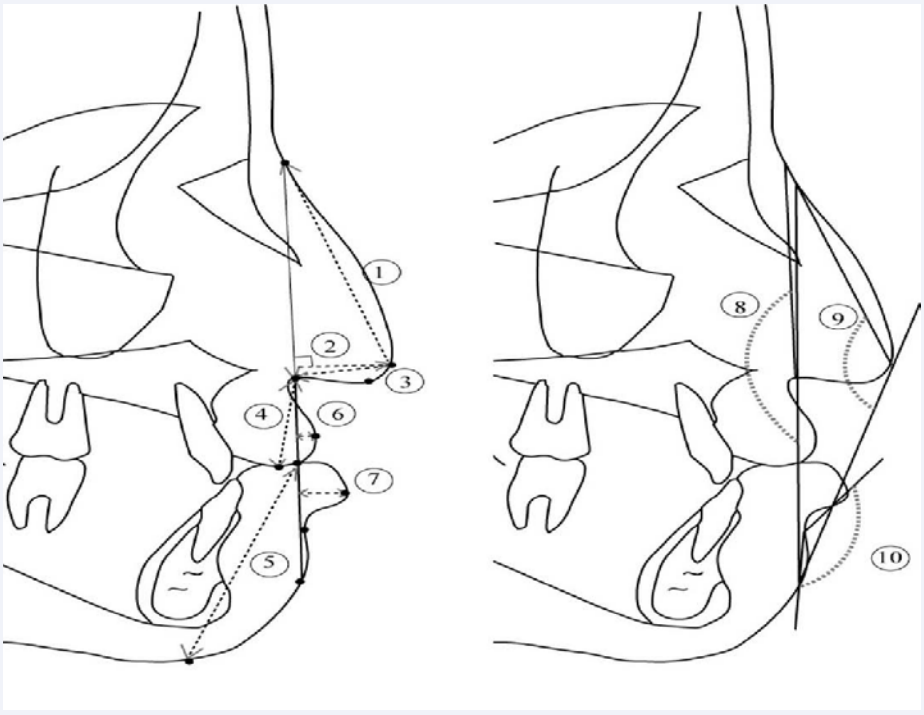

Figure 4 Cephalometric measurements utilized for evaluation of soft tissue profile changes. 1 Nose length (N'- Prn); 2 Nose depth (Prn to N'- Sn); 3 Columellar length (Sn - Prn); 4 Upper lip length (Sn - Sts); 5 Lower lip length (Sti - Me'); 6 Upper lip protrusion (Ls to Sn - Pg'); 7 Lower lip protrusion (Li to Sn - Pg'); 8 Soft tissue convexity without nose (N'- Sn - Pg'); 9 Soft tissue convexity with nose (N'- Prn -Pg'); 10 Inferior labial sulcus angle (Li -Ils - Pg').

Table 1: Age and sex details of the samples.

Time	Cleft group		Non-cleft group	
	Boy(n=15)	Girl(n=17)	Boy (n=14)	Girl (n=18)
T1 (year)	11.69 ± 1.99	10.23 ± 1.80	10.18 ± 1.98	10.78 ± 1.35
T2 (year)	17.19 ± 2.19	15.31 ± 2.43	14.11 ± 2.20	14.06 ± 1.70

Table 2: Comparison of pretreatment cephalometric measurements of cleft and non-cleft groups.

	Thai Norm		Pretreatment Cleft		Pretreatment Non-cleft		t-value
	Mean	SD	Mean	SD	Mean	SD	
Cranial base							
1. S - N (mm)	n/a		66.86	3.57	65.95	2.60	1.16
2. S - Ba (mm)	n/a		45.66	3.39	45.66	3.91	0.00
3. Ba - N (mm)	n/a		101.25	5.43	100.89	6.61	0.24
4. N - S - Ba (°)	n/a		127.98	4.16	125.44	5.28	2.06*
Skeleton							
1. SNA (°)	83	4	78.11	3.66	81.73	3.80	-3.89**
2. SNB (°)	79	3	78.47	2.82	83.14	3.76	-5.63**
3. SNPog (°)	n/a		78.95	2.85	83.16	3.86	-4.95**
4. ANB (°)	4	2	-0.28	2.36	-1.63	2.12	2.39*
5. SN - GoGn (°)	34	6	33.05	5.50	31.69	4.59	1.07
6. Ar - Go - Me (°)	n/a		124.38	5.99	125.75	4.38	-1.05
7. N - A - Pog (°)	n/a		182.28	5.20	183.09	4.52	0.67
8. N - ANS / N - Me	n/a		0.45	0.02	0.46	0.02	-2.17*
Dental							
1. U1- NA (°)	28	4	18.28	6.01	23.86	7.26	-3.35**
2. U1- NA (mm)	6	2	3.17	2.13	4.45	2.13	-2.41*
3. U1- SN (°)	n/a		96.42	6.05	104.05	9.16	-3.93**
4. L1- NB (°)	32	6	24.45	5.89	24.31	6.45	0.91
5. L1- NB(mm)	6	2	5.64	2.19	6.03	2.05	-0.74
6. L1- MP(GoGn) (°)	99	4	92.20	6.87	90.33	6.61	1.11
7. Overjet (mm)	2	1	-3.06	1.02	-3.47	1.33	1.37
8. Overbite (mm)	2	1	4.03	1.90	4.42	1.88	-0.83
Soft tissue profile							
1. N'- Sn - Pg' (°)	n/a		176.22	6.58	173.89	4.71	1.63
2. N'- Prn - Pg' (°)	n/a		149.69	6.65	148.64	3.53	0.79
3. Ls - Sn - Cm (°)	90	9	94.69	11.27	96.64	11.50	-0.69
4. N'- Prn (mm)	n/a		47.03	4.28	46.39	3.88	0.63
5. Prn to N'- Sn (mm)	n/a		11.94	2.02	12.00	1.50	-0.14
6. Sn - Prn (mm)	n/a		16.83	1.78	16.50	2.27	0.65
7. Sn - Me'/ N'- Me'	n/a		0.55	0.03	0.55	0.02	-0.42
8. Sn -Sts (mm)	n/a		19.86	3.17	20.13	1.60	-0.42
9. Sti - Me'(mm)	n/a		48.72	5.53	47.34	3.38	1.20
10. Ls to Sn -Pg' (mm)	n/a		4.02	1.25	5.36	1.79	-3.48**
11. Li to S' -Pg' (mm)	n/a		8.08	1.73	7.25	1.87	1.84
12. Li – Ils -Pg' (°)	n/a		133.39	11.46	149.09	10.53	-5.71**

* = $p \leq 0.05$, ** = $p \leq 0.01$

Table 3: Alterations of dento-skeletal and soft tissue profile in the cleft group.

Measurement	Pretreatment		Posttreatment		t-value
	Mean	SD	Mean	SD	
Cranial base					
1. S - N (mm)	66.86	3.57	69.77	3.96	-7.19**
2. S - Ba (mm)	45.66	3.39	47.42	3.35	-7.21**
3. Ba - N (mm)	101.25	5.43	101.25	5.43	-7.05**
4. N - S - Ba (°)	127.98	4.16	127.73	4.82	0.58
Skeleton					

1. SNA (°)	78.11	3.66	77.81	4.24	0.69
2. SNB (°)	78.47	2.82	78.16	3.55	0.90
3. SNPog (°)	78.95	2.85	79.23	3.56	-0.83
4. ANB (°)	-0.28	2.36	-0.25	2.34	-0.11
5. SN -GoGn (°)	33.05	5.50	33.67	7.65	-0.89
6. Ar - Go -Me (°)	124.38	5.99	122.08	6.91	3.97**
7. N - A -Pog (°)	182.28	5.20	183.30	5.88	-1.43
8. N -ANS / N - Me	0.45	0.02	0.44	0.02	1.80
Dental					
1. U1- NA (°)	18.28	6.01	33.55	7.10	-15.13**
2. U1- NA (mm)	3.17	2.13	8.39	2.66	-12.43**
3. U1- SN (°)	96.42	6.05	109.81	7.39	-9.38**
4. L1- NB (°)	24.45	5.89	24.38	5.33	0.08
5. L1- NB(mm)	5.64	2.19	5.98	2.04	-1.22
6. L1- MP(GoGn) (°)	92.20	6.87	92.28	6.82	-0.08
7. Overjet (mm)	-3.06	1.02	1.78	0.94	-21.11**
8. Overbite (mm)	4.03	1.90	1.30	0.63	7.85**
Soft tissue profile					
1. N'- Sn - Pg' (°)	176.22	6.58	174.59	5.42	2.36*
2. N'- Prn - Pg' (°)	149.69	6.65	146.44	5.13	3.94**
3. Ls - Sn - Cm (°)	94.69	11.27	92.00	9.25	1.43
4. N'- Prn (mm)	47.03	4.28	51.95	3.99	-7.78**
5. Prn to N'- Sn (mm)	11.94	2.02	14.48	2.23	-9.61**
6. Sn - Prn (mm)	16.83	1.78	19.13	2.27	-7.45**
7. Sn - Me'/ N'- Me'	0.55	0.03	0.57	0.02	-2.73**
8. Sn -Sts (mm)	19.86	3.17	21.97	2.49	-7.58**
9. Sti - Me'(mm)	48.72	5.53	53.11	4.87	-7.72**
10. Ls to Sn -Pg' (mm)	4.02	1.25	5.38	1.39	-6.52**
11. Li to S' -Pg' (mm)	8.08	1.73	7.73	1.93	1.05
12. Li -Ils -Pg' (°)	133.39	11.46	132.34	12.05	0.53
* = p ≤ 0.05, ** = p ≤ 0.01					

Table 4: Alterations of dento-skeletal and soft tissue profile in the non-cleft group.

Measurement	Pretreatment		Posttreatment		t-value
	Mean	SD	Mean	SD	
Cranial base					
1. S - N (mm)	65.95	2.60	68.05	2.96	-5.80**
2. S - Ba (mm)	45.66	3.91	48.07	3.24	-5.73**
3. Ba - N (mm)	100.89	6.61	104.21	5.06	-5.46**
4. N – S - Ba (°)	125.44	5.28	125.44	5.28	0.33
Skeleton					
1. SNA (°)	81.73	3.80	82.70	3.99	-2.17*
2. SNB (°)	83.14	3.76	82.41	3.87	1.88
3. SNPog (°)	83.16	3.86	83.05	3.89	0.27
4. ANB (°)	-1.63	2.12	0.27	2.28	-5.77**
5. SN – GoGn (°)	31.69	4.59	32.47	4.93	-1.70
6. Ar – Go – Me (°)	125.75	4.38	123.95	5.16	3.15**
7. N – A – Pog (°)	183.01	4.52	180.22	4.81	4.70**
8. N – ANS / N – Me	0.46	0.02	0.45	0.02	3.86**
Dental					
1. U1- NA (°)	23.86	7.26	32.56	8.01	-6.22**
2. U1- NA (mm)	4.45	2.13	8.36	3.02	-8.52**
3. U1- SN (°)	104.05	9.16	114.88	7.85	-5.93**
4. L1- NB (°)	24.31	6.45	24.47	6.09	-0.14
5. L1- NB(mm)	6.03	2.05	6.15	2.71	-0.27
6. L1- MP(GoGn) (°)	90.33	6.61	88.58	8.12	1.28

7. Overjet (mm)	-3.47	1.33	2.13	1.12	-17.64**
8. Overbite (mm)	4.42	1.88	1.59	0.94	7.35**
Soft tissue profile					
1. N'- Sn - Pg' (°)	173.89	4.71	169.83	5.95	4.42**
2. N'- Prn - Pg' (°)	148.64	3.53	144.45	4.99	7.52**
3. Ls - Sn - Cm (°)	96.64	11.50	94.84	10.54	0.85
4. N'- Prn (mm)	46.39	3.88	50.77	3.26	-8.05**
5. Prn to N'- Sn (mm)	12.00	1.50	13.84	1.55	-11.13**
6. Sn - Prn (mm)	16.50	2.27	17.92	1.99	-4.21**
7. Sn - Me'/ N'- Me'	0.55	0.02	0.57	0.02	-4.35**
8. Sn -Sts (mm)	20.13	1.60	22.94	2.32	-9.05**
9. Sti -Me'(mm)	47.34	3.38	52.28	2.72	-13.97**
10. Ls to Sn -Pg' (mm)	5.36	1.79	7.16	1.65	-7.57**
11. Li to S' -Pg' (mm)	7.25	1.87	6.50	2.02	2.74**
12. Li -Ils -Pg' (°)	149.09	10.53	142.89	9.24	3.53**
* = p ≤ 0.05, ** = p ≤ 0.01					

Table 5: Comparison of posttreatment cephalometric measurements of the cleft and non-cleft groups.

Measurement	Post-tx cleft		Post-tx noncleft		t-value
	Mean	SD	Mean	SD	
Cranial base					
1. S - N (mm)	69.77	3.96	68.05	2.96	1.97*
2. S - Ba (mm)	47.42	3.35	48.07	3.24	-0.78
3. Ba - N (mm)	101.25	5.43	104.21	5.06	0.42
4. N - S - Ba (°)	127.73	4.82	125.44	5.28	1.82*
Skeleton					
1. SNA (°)	77.81	4.24	82.70	3.99	-4.75**
2. SNB (°)	78.16	3.55	82.41	3.87	-4.58**
3. SNPog (°)	79.23	3.56	83.05	3.89	-4.10**
4. ANB (°)	-0.25	2.34	0.27	2.28	-0.89
5. SN - GoGn (°)	33.67	7.65	32.47	4.93	0.75
6. Ar - Go - Me (°)	122.08	6.91	123.95	5.16	-1.23
7. N - A - Pog (°)	183.30	5.88	180.22	4.81	2.29*
8. N - ANS / N - Me	0.44	0.02	0.45	0.02	-1.42
Dental					
1. U1- NA (°)	33.55	7.10	32.56	8.01	0.52
2. U1- NA (mm)	8.39	2.66	8.36	3.02	0.04
3. U1- SN (°)	109.81	7.39	114.88	7.85	-2.66*
4. L1- NB (°)	24.38	5.33	24.47	6.09	-0.07
5. L1- NB(mm)	5.98	2.04	6.15	2.71	-0.28
6. L1- MP(GoGn) (°)	92.28	6.82	88.58	8.12	1.98*
7. Overjet (mm)	1.78	0.94	2.13	1.12	-1.33
8. Overbite (mm)	1.30	0.63	1.59	0.94	-1.49
Soft tissue profile					
1. N'- Sn - Pg' (°)	174.59	5.42	169.83	5.95	3.35**
2. N'- Prn - Pg' (°)	146.44	5.13	144.45	4.99	1.57
3. Ls - Sn - Cm (°)	92.00	9.25	94.84	10.54	-1.15
4. N'- Prn (mm)	51.95	3.99	50.77	3.26	1.30
5. Prn to N'- Sn (mm)	14.48	2.23	13.84	1.55	1.34
6. Sn - Prn (mm)	19.13	2.27	17.92	1.99	2.25*
7. Sn - Me'/ N'- Me'	0.57	0.02	0.57	0.02	-0.91
8. Sn -Sts (mm)	21.97	2.49	22.94	2.32	-1.61
9. Sti - Me'(mm)	53.11	4.87	52.28	2.72	0.84
10. Ls to Sn -Pg' (mm)	5.38	1.39	7.16	1.65	-4.67**
11. Li to S' -Pg' (mm)	7.73	1.93	6.50	2.02	2.50*
12. Li -Ils -Pg' (°)	132.34	12.05	142.89	9.24	-3.93**
* = p ≤ 0.05, ** = p ≤ 0.01					

changes of the soft tissue profile at the nasal and upper lip areas, face height ratio. The treatment effect in the non-cleft patients was orthopedics. Significant forward movement of the maxilla could improve jaw relation from skeletal Class III to skeletal Class I relation. Improvement of the soft tissue profile was found at all studied areas. Anyhow, there were significant differences of the maxillary position, mandibular position and soft tissue profile after treatment between the two groups (Table 5).

DISCUSSION

Correcting severe malocclusions as well as facial deformities is one of the most challenging responsibilities of orthodontists. To date, this was the first study that tried to investigate patient responses to various treatment modalities in cleft and non-cleft subjects who presented similar dental malocclusion and facial profile upon the hypothesis that the early orthodontic treatment with different treatment modalities could produce similar acceptable occlusion and facial profile in both cleft and non-cleft subjects

The study prevailed characteristics of the UCLP subjects (Table 2) comprising larger cranial base angle that corresponded with previous studies [6,8]. However, in contrast to another study [29], smaller cranial base angle when compared with Class I patients was reported. There was only one study [29], comparing cranial base angle of the cleft patients with that of Class III patients, that showed no difference in cranial base measurements of the cleft and the Class III patients. Theoretically, acute cranial base angle decreases the anteroposterior dimension of middle cranial morphology and can be the cause of retrognathic maxilla and prognathic mandible [30]. This could imply that successfully treated cleft patients tend to have larger cranial base angle, and may indicate a favorable growth pattern for anterior crossbite correction. Skeletal Class III malocclusion due to maxillary retrusion and relative mandibular prognathism was observed in the UCLP subjects at both time points (Table 2,3). This trait was also mentioned in the previous studies [6,9,31,32] and reported progressive reduction of facial convexity with increased age. Retroclination and retrusion of the upper incisors in the UCLP subjects coincided with the previous studies [3,5]. Therefore, early orthodontic treatment in growing patients with maxillary arch constriction and anterior crossbite should be necessary to create favorable environment for facial development

The non-cleft subjects presented greater jaw discrepancies before treatment (Table 2). Therefore, protraction headgear was prescribed to improve jaw relationship.

After treatment (Table 5) the ANB angle of the two groups was comparable. In detail, the SNA angle was reduced in the cleft group but increased in the non-cleft group. The reduction of the SNA angle should be the effect of scar tissue in the upper lip preventing forward growth of the maxilla in the UCLP patients [33] and proclination of the upper incisors caused resorptive remodeling of point A [34-36]. However, proclination of the upper incisors had to be performed to enhance the upper lip protrusion and to achieve the proper interincisal angle for stability of deep bite correction [37,38].

The hard tissue convexity was reduced in the cleft group but was increased in the non-cleft group while soft tissue convexity was improved in both groups. Thus the advantage of proclination of the upper incisors on the upper lip protrusion was indicated. The different treatment mechanics produced similar incisor position in the two groups (Table 5) except theU1-SN angle of the cleft group was more acute than that of the non-cleft group. This could be explained by a relatively more obtuse cranial base angle in the cleft group. Orthopedic appliance was not prescribed to the cleft group because the mandible was only relatively prognathism. Future studies should be undertaken to assess the relationships between dental position, bone remodeling and soft tissue changes.

Comparing the lower incisor position of both groups with the clinical norm (L1-NB =32 ± 6°, 6 ± 2 mm) [39], the result exhibited retroclination of the lower incisors before treatment. Therefore, increase of the upper arch length and proclination of the upper incisors were our main treatment objectives for correction of the anterior crossbite instead of retracting the lower incisors. After treatment, the lower incisor position of the two groups which seemed to be unchanged indicating that acceptable overbite and overjet were achieved without dental compensation. Improvement of the lower lip protrusion without retraction of the lower incisors was found only in the non-cleft group. This could be functional distortion of the lower lip in the cleft group to compensate foran impaired function of the upper lip [5,10,40]. Smaller inferior labial sulcus angle (Li-Ils-Pg'angle) of the cleft group at post-treatment time point (Table 5) represented the protrusion and everted lower lip which might be a sign of alteration in the lower lip function. Further studies on lip morphology and function of the cleft and non-cleft groups should be done as they could be a key for case selection between camouflage treatment or orthognathic surgery in cleft patients

Skeletal Class III retrusive maxilla and relative mandibular prognathism was observed in the UCLP patients at the both time points corresponding with previous studies [6,9,31,32]. A retrusive facial pattern may be specific characteristics of UCLP as syndromic appearance regardless of ethnic. These characteristics could not be altered by orthodontic intervention alone since the effect of treatment was restricted by scar tissue in the upper lip. Orthognathic surgery should be optional treatment if the goal of treatment includes the correction of retrusive facial pattern and lower lip protrusion.

Previous studies [9,32] on growing UCLP patients reported a progressive reduction in facial convexity. Our study indicated that early orthodontic treatment in growing UCLP patients could improve soft-tissue profile. However, this had to be incorporated with growth of the nose. In contrast to soft tissue improvement, the hard tissue convexity was reduced after treatment. This finding supports the notion that the soft tissue profile should be considered in planning and diagnosis combined with skeletal measurements since the soft tissue profile in cleft patients did not correspond well with skeletal morphology [41].

CONCLUSION

The early treatment of anterior crossbite and concave facial profile in the UCLP and general skeletal Class III patients could produce dento-alveolar or orthopedic effects depending upon treatment modalities. There were significant alterations of upper

incisal position and soft tissue profile at the nasal and upper lip areas in both groups. The cleft patients did not show significant improvement of the lower lip position after treatment.

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