Original Article

Initial growth pattern of children with cleft before alveolar bone graft stage according to cleft type

Unilateral cleft lip and alveolus, unilateral cleft lip and palate, and cleft palate

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ABSTRACT

Objective: To test the null hypothesis that there is no significant difference in the initial growth pattern among three cleft types before alveolar bone graft (ABG) according to cleft type (unilateral cleft lip and alveolus [UCLA], unilateral cleft lip and palate [UCLP], and cleft palate [CP]).

Materials and Methods: Samples consisted of the UCLA group, the UCLP group, and the CP group. Individuals were treated with the identical surgical technique by the same surgeon and had no history of orthodontic/orthopedic treatment. Lateral cephalograms taken 1 month before ABG were analyzed using 29 variables. One-way analysis of variance (ANOVA) testing and bivariate and logistic regression analyses were performed.

Results: An increasing tendency for Class III relationships in the order of UCLA, UCLP, and CP was noted (ANB, AB-to-facial plane angle, AB-to-mandibular plane angle; $P < .001$, respectively). UCLP and CP groups demonstrated more posterior positioning of the maxilla (SNA, A-to-N-perp; $P < .001$, respectively) and a hyperdivergent pattern (gonial angle, SN-GoMe angle, FMA; $P < .001$, respectively) compared with the UCLA group. Because no differences in palatal plane angle and SN-to-occlusal plane angle were noted among the three groups, the hyperdivergent pattern in the UCLP and CP groups might be due to an innate growth pattern and eventual adaptation of the mandible to maxillary growth. UCLP and CP groups showed more Class III relationships (ANB: $P < .05$, $P < .001$, respectively) and a more hyperdivergent pattern (FMA: $P < .05$, $P < .01$, respectively) than the UCLA group.

Conclusion: When the degree of cleft involvement increases from the primary palate to the secondary palate, the predominance of the Class III relationship and the hyperdivergent pattern increases also. (*Angle Orthod* 2011;81:1103–1110.)

KEY WORDS: Cleft type; Growth pattern

INTRODUCTION

The growth pattern of patients with cleft is influenced by cleft type, postsurgical scar tissues, orthodontic/orthopedic treatments, and alveolar bone graft (ABG).[1–6] Because most patients with cleft undergo lip and/or palate surgery within 1 to 2 years after birth, initial growth patterns should be investigated before orthodontic/orthopedic treatment is begun and ABG is performed to obtain a baseline for future growth and to facilitate proper diagnosis and treatment planning. Because of differences in embryologic development between the primary palate (lip and premaxilla) and the secondary palate (hard and soft palate),[7] it is necessary to compare the growth pattern according to cleft type: cleft lip and alveolus (CLA), cleft lip and palate (CLP), and cleft palate only (CP).

Patients with cleft often develop a Class III malocclusion with maxillary hypoplasia caused by inherited

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Table 1. Demographic Data for Cleft Groups[a,b]

	UCLA Group (n = 38)	UCLP Group (n = 38)	CP Group (n = 28)	*P* Value
Gender distribution	28 boys and 10 girls	23 boys and 15 girls	4 boys and 24 girls	-
Mean age, y	9.77 ± 0.98	9.77 ± 0.82	10.14 ± 0.95	0.1925

[a] One-way analysis of variance (ANOVA) was performed.
[b] UCLA indicates unilateral cleft lip and alveolus; UCLP, unilateral cleft lip and palate; and CP, cleft palate only.

growth deficiencies and/or postsurgical scar tissue.[5,6] Baek et al.[5] reported that patients with CP and CLP were 3.9 and 5.5 times more likely to have a Class III malocclusion, respectively, than those with cleft lip (CL) in terms of molar relationship, and that CLA patients did not have a different prevalence of Class III malocclusion compared with CL patients. In addition, patients with cleft are known to have a more vertical growth pattern than noncleft normal patients[3,8–14] and to maintain their initial vertical pattern during growth.[15]

To investigate more specifically the initial growth pattern of patients with cleft, the samples need to be limited as follows: (1) unilateral cleft type and cleft hard palate only type, because these types seem to have less complicated and diverse factors related to impairment of maxillary growth than the bilateral cleft type; (2) the identical surgical technique by a single surgeon to reduce surgery-related bias; and (3) similar age to reduce growth-related bias. Although it is possible that differences in growth patterns can be seen among cleft types, few studies have compared the effects of cleft type on initial growth patterns of patients with cleft.[3,8,9] Therefore, the purpose of this study was to investigate the differences in initial sagittal and vertical growth patterns before ABG stage among unilateral cleft lip and alveolus (UCLA), unilateral cleft lip and palate (UCLP), and cleft hard palate only (CP) individuals who had undergone lip and/or palate cleft surgery. The null hypothesis was that significant difference in initial sagittal and vertical growth patterns would not be found among three cleft types before ABG.

MATERIALS AND METHODS

This retrospective study was performed under approval from the Institutional Review Board of Seoul National University Dental Hospital (IRB number: CRI11005). A total of 506 Korean children with cleft who had visited at the Department of Orthodontics, Seoul National University Dental Hospital, Seoul, Korea, from January 1984 to November 2010, were screened for inclusion in the present study. Inclusion criteria were as follows: patients with UCLA, UCLP, or CP; early mixed dentition in which the maxillary and mandibular central incisors and first molars were fully erupted; treatment with the identical surgical technique by the same surgeon (Millard's rotation and advancement flap for cheiloplasty at 3 to 5 months after birth, Furlow's double opposing Z plasty for one-stage palatorrhaphy at 12 to 18 months after birth, and no primary gingivoperiosteoplasty); no history of orthodontic/orthopedic treatment and ABG; no other known syndromes; and no severe asymmetry (less than 4 mm chin point deviation). Bilateral patients with cleft were not included in this study. The study sample was biologically and ethnically homogenous.

Final samples consisted of the UCLA group (N = 38; 28 boys and 10 girls; mean age, 9.8 ± 1.0 y), the UCLP group (N = 38; 23 boys and 15 girls; mean age, 9.8 ± 0.8 y), and the CP group (hard palate only; N = 28; 4 boys and 24 girls; mean age, 10.1 ± 1.0 y). Sample size was determined by power analysis. No significant differences in age were noted among the three groups (Table 1).

Lateral cephalograms recorded 1 month before ABG in UCLA and UCLP groups and before the start of orthodontic treatment with removable or fixed appliances in the CP group were analyzed by the same operator using the V-Ceph program (version 5.5, CyberMed, Seoul, Korea) in units of 0.05 degrees and 0.05 mm. Eighteen landmarks and 29 skeletal and dental variables used are given in Figure 1 and Table 2. All variables from five randomly selected subjects were reassessed by the same operator after 2 weeks. Differences calculated using Dahlberg's formula[16] ranged from 0.37 to 0.61 mm for linear measurements and from 0.48 to 0.76 degrees for angular measurements. Therefore, the first set of measurements was used for this study. One-way analysis of variance testing, bivariate analysis, and logistic regression analysis were performed.

RESULTS

Comparison of Sagittal and Dental Relationships Among Three Cleft Groups (Table 3)

The UCLP and CP groups demonstrated more posterior positioning of the maxilla compared with the UCLA group (SNA, 74.6 degrees and 74.7 degrees vs 79.0 degrees; $P < .001$; A-N perp, −4.9 mm and −5.6 mm vs −0.9 mm; $P < .001$). When compared with normal Korean 10-year-olds[17] (SNA, 80.0 degrees, A to N-perp, 0.0 mm), the UCLA group showed a similar sagittal position of the maxilla. However, the

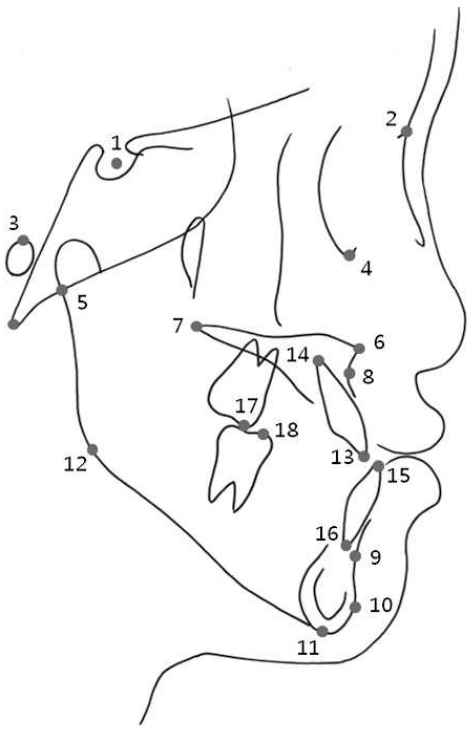

Figure 1. Cephalometric landmarks used in this study. 1: sella; 2: nasion; 3: porion; 4: orbitale; 5: articulare; 6: anterior nasal spine; 7: posterior nasal spine; 8: point A; 9: point B; 10: pogonion; 11: menton; 12: gonion; 13: incisal tip of the maxillary central incisor; 14: root apex of the maxillary central incisor; 15: incisal tip of the mandibular central incisor; 16: root apex of the mandibular central incisor; 17: tip of the mesiobuccal cusps of fully erupted maxillary first molars; and 18: tip of the mesiobuccal cusps of fully erupted mandibular first molars.

UCLP and CP groups demonstrated a more retrusive maxilla.

The UCLP group exhibited more backward positioning of the mandible than the CP group (SNB, 72.7 degrees vs 75.1 degrees; $P < .05$; Pog to N-perp, −12.9 mm vs −9.1 mm; $P < .05$). Although there was no significant difference in the mandibular body length among the three groups, all groups demonstrated a retrusive mandible when compared with normal Korean 10-year-olds[17] (SNB, 76.9 degrees, Pog to N-perp, -5.1 mm).

Regarding the sagittal relationship between the maxilla and the mandible, an increasing Class III tendency was found in the following order: UCLA, UCLP, and CP (ANB, 4.3 degrees, 1.9 degrees, −0.4 degrees; $P < .001$; AB to facial plane angle, −6.6 degrees, −2.7 degrees, 0.1 degrees; $P < .001$; AB to mandibular plane angle, 74.7 degrees, 67.6 degrees, 62.3 degrees; $P < .001$; and APDI, 78.4 degrees, 82.0 degrees, 87.4 degrees; $P < .001$, respectively). IMPA decreased in the following order: UCLA, UCLP, and CP (92.2 degrees, 88.2 degrees, 80.2 degrees, respectively; $P < .001$), implying that the mandibular incisors were increasingly retroclined in the same order.

Comparison of the Vertical Relationship Among Three Cleft Groups (Table 3)

The UCLP and CP groups demonstrated a more hyperdivergent pattern than the UCLA group (gonial angle, 126.8 degrees and 128.8 degrees vs 122.0 degrees; $P < .001$; lower gonial angle, 78.0 degrees and 79.6 degrees vs 74.1 degrees; $P < .001$; SN-GoMe, 42.2 degrees and 42.1 degrees vs 36.9 degrees; $P < .001$; FMA, 31.6 degrees and 32.5 degrees vs 26.7 degrees; $P < .001$; and Bjork sum, 402.2 degrees and 402.1 degrees vs 396.9 degrees; $P < .001$, respectively). The overbite depth indicator (ODI) decreased in the following order: UCLA, UCLP, and CP (74.7 degrees, 68.9 degrees, 64.5 degrees, respectively; $P < .001$), which means that the open bite tendency increased in the same order.

Comparison of the Vertical Proportion Among Three Cleft Groups (Table 3)

The UCLP and CP groups had significantly shorter ramus height (39.8 mm and 39.2 mm vs 42.6 mm, respectively; $P < .01$) and posterior facial height (71.5 mm and 69.2 mm vs 75.8 mm, respectively; $P < .001$) and smaller lower facial height ratio (59.7% and 59.6% vs 63.7%, respectively; $P < .001$) compared with the UCLA group. These findings imply that the UCLP and CP groups had a more hyperdivergent pattern than the UCLA group. However, no significant differences in the palatal plane angle and the SN to occlusal plane angle were observed among the three groups.

Difference in Distribution of Class III Relationship and Hyperdivergent Pattern According to Cleft Groups (Tables 4 and 5)

Cleft type significantly influenced the distribution of a Class III relationship (ANB, $P < .001$) and of a hyperdivergent pattern (FMA, $P < .01$).

Associations Between Class III Relationship, Hyperdivergent Pattern, and Cleft Type (Table 6)

Subjects in the UCLP and CP groups were more likely to have a Class III relationship (ANB, UCLP, 13.2 times, $P < .05$; and CP, 42.7 times, $P < .001$) and a hyperdivergent pattern (FMA, UCLP, 3.9 times, $P < .05$; and CP, 7.4 times, $P < .01$) compared with those in the UCLA group.

DISCUSSION

Sagittal and Dental Relationships

Most of the sagittal variables demonstrated that the Class III relationship was significantly increased in the

Table 2. Definitions of the Variables

Variables		Definition
Sagittal relationship	SNA, degrees	Angle between the anterior cranial base (SN) and the NA line
	SNB, degrees	Angle between the anterior cranial base (SN) and the NB line
	ANB, degrees	Angle between the NA and NB lines
	AB to facial plane angle, degrees	Angle between the AB plane and the facial planes (N-Pog)
	AB to mandibular plane angle, degrees	Angle between the AB plane and the mandibular plane (Go-Me)
	AB to occlusal plane angle, degrees	Angle between the AB plane and the occlusal planes
	A-N perp, mm	Perpendicular distance from A to the N perpendicular line to the FH plane
	Pog-N perp, mm	Perpendicular distance from Pog to the N perpendicular line to the FH plane
	APDI, degrees	Sum of the facial plane to FH plane angle, the AB to facial plane angle, and the palatal plane (ANS-PNS) to FH plane angle
	Mandibular body length, mm	Length from Go to Me
Vertical relationship	Saddle angle, degrees	Angle constructed by the SN plane and the S-Ar line
	Articular angle, degrees	Angle constructed by the S-Ar and Ar-Go lines
	Gonial angle, degrees	Angle constructed by the Me-Go and Go-Ar lines
	Upper gonial angle, degrees	Angle constructed by the N-Go and Go-Ar lines
	Lower gonial angle, degrees	Angle constructed by the N-Go and Go-Me lines
	Bjork sum, degrees	Sum of the saddle, articular, and gonial angles
	Palatal plane angle, degrees	Angle between the FH plane and the palatal plane (ANS-PNS)
	SN-GoMe, degrees	Angle between the SN plane and the mandibular plane
	FMA, degrees	Angle between the FH plane and the mandibular plane
	Occlusal plane to SN, degrees	Angle between the SN plane and the occlusal plane
	Occlusal plane to mandibular plane angle, degrees	Angle between the occlusal plane and the mandibular plane
	ODI, degrees	Sum of the AB to mandibular plane angle and the palatal plane to FH plane angle
Vertical proportion	Ramus height, mm	Length from Go to Ar
	Posterior facial height, mm	Length from S to Go
	Anterior facial height, mm	Length from N to Me
	Facial height ratio, %	(posterior facial height/anterior facial height) × 100
Dental relationship	U1 to SN, degrees	Angle between the maxillary central incisor axis line and the S-N plane
	IMPA, degrees	Angle between the mandibular central incisor axis line and the mandibular plane
	Interincisal angle, degrees	Angle between the maxillary incisor axis line and the mandibular incisor axis line

following order: UCLA, UCLP, and CP (ANB, $P < .001$; AB to facial plane angle, $P < .001$; AB to mandibular plane angle, $P < .001$; and APDI, $P < .001$; Table 3). The finding that patients in the UCLP and CP groups were more likely to have a Class III relationship than those in the UCLA group (ANB, UCLP, 13.2 times, $P < .05$; and CP, 42.7 times, $P < .001$; Table 6) is in accordance with the findings of Baek et al.,[5] who reported that the CP and CLP groups demonstrated a greater tendency toward Class III malocclusion than the CL and CLA groups in terms of molar relationship.

Previous studies implied that the cause of maxillary hypoplasia seemed to be the scar tissue on the lip and palate.[6,13,14] In the present study, although subjects with UCLP and CP had a more retrusive maxilla than normal Korean 10-year-olds[17] (SNA, 74.6 degrees and 74.7 degrees vs 80.0 degrees; A-N perp, −4.9 mm and −5.6 mm vs 0.0 mm, respectively; Table 3), those with UCLA demonstrated a similar maxillary position to normal Korean 10-year-olds[17] (SNA, 79.0 degrees vs 80.0 degrees; A-N perp, −0.9 mm vs 0.0 mm, respectively; Table 3). Therefore, it is reasonable to suggest that palatal scarring influences impairment of maxillary growth more than lip scarring does.

In the sagittal relationship of the mandible, although the UCLP group had a more posteriorly positioned mandible than the CP group (SNB, 72.7 degrees vs 75.1 degrees, $P < .05$; Pog-N perp, −12.9 mm vs −9.1 mm, $P < .05$), all three groups demonstrated a more retrusive mandible than normal Korean 10-year-olds[17] (Pog-N perp, −9.4 mm, −12.9 mm, and −9.1 mm vs −5.1 mm, respectively; Table 3), which is in accordance with the results of previous studies.[10,12,14,18] The retrusive mandible might occur as the result of large gonial angle and clockwise rotation of the mandible (gonial angle, lower gonial angle, SN-GoMe, FMA; Table 3), as noted in previous cleft studies.[10,12,18–21]

The finding that IMPA was decreased from UCLA to UCLP to CP ($P < .001$; Table 3) means that differences in the amount of dental compensation could be the result of differences in the sagittal relationship according to cleft type.

Table 3. Comparison of Skeletal and Dental Variables Among the Three Groups[a,b]

Variables	Norm of Korean 10-Year-Olds	UCLA Group		UCLP Group		CP Group		*P* Value	Multiple Comparison
	Mean	Mean	SD	Mean	SD	Mean	SD		
Sagittal relationship									
SNA, degrees	79.95	79.02	3.42	74.63	4.79	74.70	4.31	.0000***	(2,3) < 1
SNB, degrees	76.88	74.71	2.97	72.72	4.50	75.14	5.12	.0406*	(2,1) < (1,3)
ANB, degrees	3.03	4.31	2.38	1.91	3.50	−0.44	3.63	.0000***	3 < 2 < 1
AB to facial plane angle, degrees	4.40	−6.61	3.76	−2.72	4.72	0.14	5.25	.0000***	1 < 2 < 3
AB to mandibular plane angle, degrees	69.98	74.69	5.73	67.61	5.87	62.26	6.76	.0000***	3 < 2 < 1
AB to occlusal plane angle, degrees	91.95	89.09	5.34	92.18	5.39	97.87	6.37	.0000***	1 < 2 < 3
A-N perp, mm	0.00	−0.85	3.36	−4.87	4.46	−5.61	3.84	.0000***	(3,2) < 1
Pog-N perp, mm	−5.10	−9.42	5.27	−12.90	7.01	−9.09	8.73	.0417*	2 < (1,3)
APDI, degrees	82.60	78.37	4.57	81.97	7.86	87.40	8.53	.0000***	1 < 2 < 3
Mandibular body length, mm	66.63	70.25	4.18	67.98	3.39	67.41	7.60	.0533	
Vertical relationship									
Saddle angle, degrees	123.90	127.87	4.84	128.83	6.27	125.69	5.93	.0863	
Articular angle, degrees	147.35	146.96	8.72	146.61	9.04	147.56	7.75	.9066	
Gonial angle, degrees	126.65	122.02	7.48	126.77	6.78	128.82	7.21	.0006***	1 < (2,3)
Upper gonial angle, degrees	49.93	47.97	5.63	48.73	5.83	49.23	5.37	.6574	
Lower gonial angle, degrees	76.70	74.05	4.07	78.04	4.32	79.59	4.65	.0000***	1 < (2,3)
Bjork sum, degrees	397.90	396.85	4.63	402.21	6.13	402.06	7.39	.0002***	1 < (3,2)
Palatal plane angle, degrees	0.33	−0.12	2.69	1.26	4.12	2.18	4.64	.0516	
SN-GoMe, degrees	37.90	36.85	4.63	42.21	6.13	42.06	7.39	.0002***	1 < (3,2)
FMA, degrees	27.80	26.73	4.59	31.61	5.10	32.45	5.60	.0000***	1 < (2,3)
Occlusal plane to SN angle, degrees	19.88	20.63	4.74	22.01	4.90	22.19	6.70	.4151	
Occlusal plane to mandibular plane angle, degrees	18.00	11.43	3.55	15.16	4.14	16.66	5.20	.0000***	1 < (2,3)
ODI, degrees	70.40	74.65	6.27	68.94	7.14	64.50	9.07	.0000***	3 < 2 < 1
Vertical proportion									
Ramus height, mm	41.08	42.59	3.71	39.84	3.67	39.16	5.76	.0031**	(3,2) < 1
Posterior facial height, mm	71.48	75.82	4.50	71.45	5.67	69.22	9.12	.0002***	(3,2) < 1
Anterior facial height, mm	114.40	119.22	5.38	119.89	6.54	116.19	9.43	.0963	
Facial height ratio, %	60.00	63.65	3.63	59.66	4.59	59.58	5.65	.0002***	(3,2) < 1
Dental relationship									
U1 to SN, degrees	106.05	96.45	7.71	96.37	7.50	100.07	8.21	.1084	
IMPA, degrees	86.53	92.19	6.4	88.22	6.65	80.20	7.54	.0000***	3 < 2 < 1
Interincisal angle, degrees	122.75	134.6	10.65	133.26	11.69	137.74	12.03	.2858	

[a] One-way analysis of variance (ANOVA) and Duncan's multiple comparison tests were performed.

[b] SD means standard deviation. In the column of multiple comparison, 1, 2, and 3 mean UCLA group, UCLP group, and CP group, respectively. Normal values of Korean 10-year-olds were cited by Sung et al. (2001).

* $P < .05$; ** $P < .01$; *** $P < .001$.

Table 4. Distribution of Class III Relationship and Hyperdivergent Pattern Among Three Groups

		UCLA Group		UCLP Group		CP Group	
		Number of Subjects	%	Number of Subjects	%	Number of Subjects	%
Sagittal relationship[a]	Class III	1	2.63	10	26.32	15	53.57
	Class I and II	37	97.37	28	73.68	13	46.43
Vertical pattern[b]	Hyperdivergent pattern	4	10.53	12	31.58	13	46.43
	Normodivergent and hypodivergent patterns	34	89.47	26	68.42	15	53.57

[a] Class III pattern means the value of ANB was less than 0.00 degrees; Class I and Class II pattern, the value of ANB was greater than 0.00 degrees.

[b] Hyperdivergent type means the value of FMA was greater than 33.00 degrees; normodivergent and hypodivergent types, the value of FMA was less than 33.00 degrees.

Table 5. Comparison of Distribution of Class III Relationship and Hyperdivergent Pattern Among the Three Groups[a]

	Class III Relationship					Hyperdivergent Pattern				
Cleft Type	Class III	Class I and II	% of Class III	Pearson's Chi-Square	*P* Value	Hyperdivergent	Normodivergent and Hypodivergent	% of Hyperdivergent	Pearson's Chi-Square	*P* Value
UCLA group	1	37	2.63	22.366	.0000***	4	34	10.53	10.740	.0047**
UCLP group	10	28	26.32			12	26	31.58		
CP group	15	13	53.57			13	15	46.43		

[a] Bivariate analysis was performed;
*$P < .05$; **$P < .01$; *** $P < .001$.

In summary, the UCLP and CP groups developed a Class III relationship as a result of maxillary growth impairment in spite of having a retrusive and clockwise rotated mandible. Because the sagittal relationship of the mandible is related to the vertical relationship, these relationships must be considered together.

Vertical Relationship

Numerous studies have reported that patients with cleft had a more vertical growth pattern and reduced posterior facial height compared with the noncleft normal group.[3,8–14] In addition, Hermann et al.[22] reported that UCLP patients had a more vertical pattern than CP patients in a sample of 2-year-olds. In this study, although the UCLP and CP groups demonstrated a more hyperdivergent pattern than the UCLA group, no significant differences were noted between the UCLP and CP groups (Tables 3 and 6).

Although anterior facial height was not significantly different among the three groups, ramus height and posterior facial height were shorter in the UCLP and CP groups than in the UCLA group ($P < .01$ and $P < .001$, respectively; Table 3). Values for SN-GoMe, FMA, Bjork sum, gonial angle, and lower gonial angle were greater in the UCLP and CP groups than in the UCLA group ($P < .001$, $P < .001$, $P < .001$, $P < .001$, and $P < .001$, respectively; Table 3). These findings imply that clockwise rotation and divergence of the mandible were attributable to the hyperdivergent pattern.

In addition, although the inclination of the maxilla, such as palatal plane angle and occlusal plane to SN angle, was not significantly different among the three groups, the UCLP and CP groups did have a tendency toward clockwise rotation of the maxilla compared with the UCLA group and normal Korean 10-year-olds[17] (palatal plane angle, 1.3 degrees and 2.2 degrees vs −0.1 degrees and 0.3 degrees, respectively; Table 3). These findings are similar to those of previous studies,[8,12,23] which reported that the maxilla was rotated in a more clockwise direction in patients with cleft than in normal subjects. Therefore, cleft involvement and postsurgical scar tissue in the palatal area might influence the vertical growth pattern of the maxilla.

Mandibular Morphology

In the present study, differences in mandibular morphology were found according to cleft types. Although mandibular body length was not different among the three groups and normal Korean 10-year-olds,[17] the UCLP and CP groups exhibited significantly shorter ramus heights ($P < .01$; Table 3) and significantly larger gonial angles ($P < .001$; Table 3) compared with the UCLA group and normal Korean 10-year-olds.[17] These findings are in accordance with previous studies, which observed shorter and a more clockwise rotated mandible in patients with cleft.[10,12,18–21] In addition, Fudalej et al.[24] reported that the mandibular morphology of UCLA patients was similar to that of the noncleft normal group. These findings imply that size, shape, and position of the mandible might be influenced by cleft type. Therefore, the mandibular morphology of patients with cleft might reflect com-

Table 6. Association Between Class III Relationship, Hyperdivergent Pattern, and Cleft Type[a,b]

	Class III Relationship					Hyperdivergent Pattern				
Cleft Types	Beta Coefficient	SE	Odds Ratio	95% CI	*P* Value	Beta Coefficient	SE	Odds Ratio	95% CI	*P* Value
UCLA group			1					1		
UCLP group	2.581	1.078	13.214	1.597, 109.370	.0167*	1.367	0.633	3.923	1.134, 13.576	.0309*
CP group	3.754	1.082	42.692	5.121, 355.883	.0005***	1.997	0.650	7.367	2.059, 26.356	.0021**

[a] Logistic regression analysis was performed.
[b] CI indicates confidence interval; SE, standard error.
* means, $P < .05$; ** $P < .01$; *** $P < .001$.

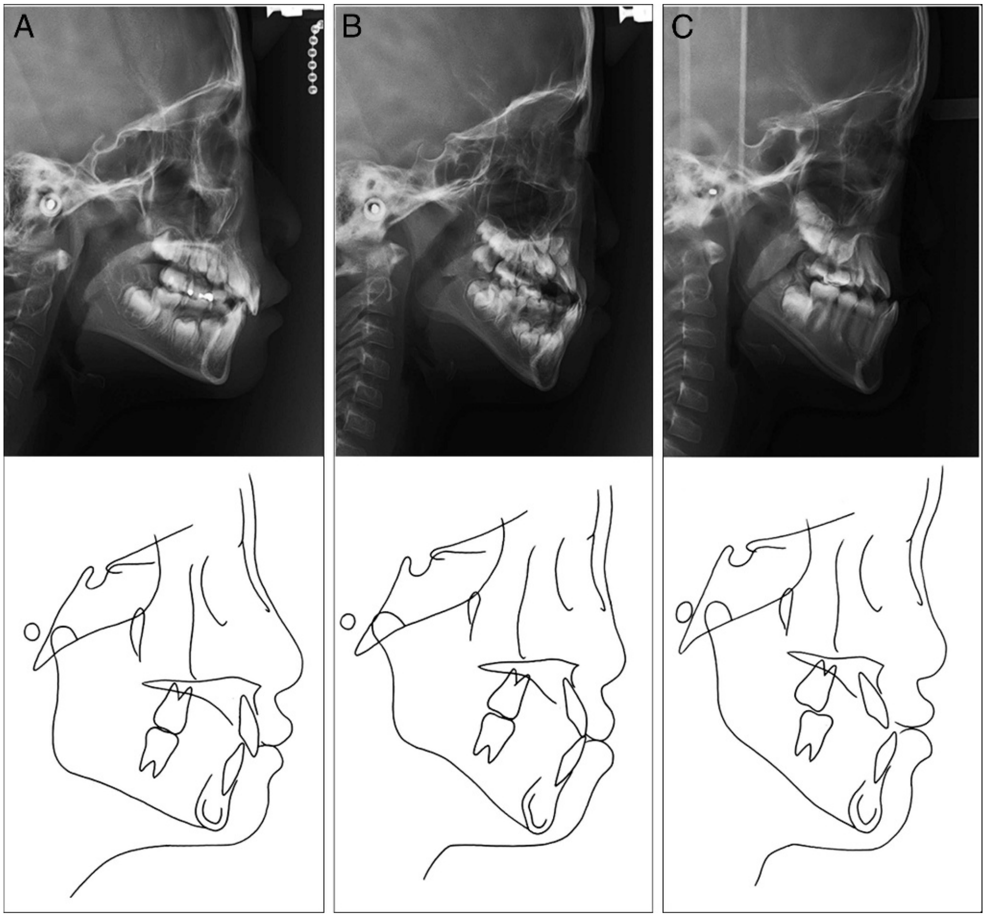

Figure 2. Examples demonstrating a typical growth pattern for each cleft type. (A) Unilateral cleft lip and alveolus. (B) Unilateral cleft lip and palate. (C) Cleft palate only.

bined results from the innate growth pattern of the mandible and eventual adaptation of the mandible to maxillary growth impairment.

In summary, significant differences in initial growth patterns among the UCLA, UCLP, and CP groups were observed in terms of Class III relationship and hyperdivergent pattern (Figure 2). These findings might have resulted from the degree of maxillary growth impairment, changes in mandibular morphology, and adaptation of mandibular growth to maxillary growth. However, because the present study was carried out in children with cleft prior to ABG, orthodontic/orthopedic treatment, and the pubertal growth spurt, additional long-term studies are needed to address the effects of ABG and orthodontic/orthopedic therapy on the growth patterns of patients with cleft.

CONCLUSION

- The null hypothesis was rejected.
- The findings of this study suggest that when the degree of cleft involvement increased from the primary palate (UCLA) to the secondary palate (CP or UCLP), so did the predominance of the Class III relationship and the hyperdivergent growth pattern.
- These are important initial growth patterns to be considered in diagnosis and treatment planning according to cleft type.

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Erratum

Please see the following article: Initial growth pattern of children with cleft before alveolar bone graft stage according to cleft type Unilateral cleft lip and alveolus, unilateral cleft lip and palate, and cleft palate (Yu-Jin Seo; Ji-Wan Park; Young Ho Kim; Seung-Hak Baek. 2011;81(6):1103–1110.

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