Facial Growth in Children with Complete Bilateral Cleft Lip and Palate

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Facial growth in children with clefts of the lip and palate is a controversial and confusing subject, mainly because there are very few large, well-controlled studies. Atherton (*1*), in his study on skulls with unilateral cleft lip and palate, found that the maxilla and palatine bones on the cleft side are retroplaced as compared to those on the noncleft side. Coupe and Subtelny (*3*) found that the complete bilateral cases exhibited a deficiency of hard palate tissue and a lateral displacement of bones in the oronasal area as compared to normal infants. Graber (*6*), however, concluded that there was no intrinsic deficiency of tissue in infants with cleft lip and palate, and that without surgery these individuals would show little or no disturbance in growth. Jolleys (*9*) found a reduced growth of the maxilla with all types of operations and concluded that fibrosis was the cause. Pruzansky and Slaughter (*15*) pointed out that in some ways surgery could actually aid and direct natural developmental processes through the re-establishment of more normal forces.

The management of the premaxilla in complete bilateral cleft lip and palate cases has been the source of much controversy. In Lewin's survey of plastic surgeons in the United States and Canada (*11*), 29% of those replying surgically repositioned the premaxilla at least occasionally prior to or in conjunction with lip repair in complete bilateral cases. The premaxilla is resected or repositioned distally to facilitate the repair of the lip, to improve facial aesthetics, to achieve a reasonable arch form, and to prevent collapse of the lateral maxillary segments by placing the premaxilla between them (*4, 8, 12, 13, 18*). Many other authors (*2, 5, 7, 10, 14, 17*) have commented on the inadvisability of these procedures, since they may be unnecessary and may lead to interference with mid-face growth.

This study was undertaken to assess the facial growth of children with complete bilateral cleft lip and palate. Of particular interest was the

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The control sample for this study was obtained from Burlington Research Centre material. The Center was assisted by funds provided by the Evaluation of Interceptive Orthodontics Grant №605-7-299, of the National Health Grants Programme.

This paper was presented at the 1968 annual meeting of the American Cleft Palate Association, Miami Beach.

relationship of the premaxilla to the rest of the face over the entire growth period, and the development of the lateral maxillary segments.

Sample

Forty-seven children with complete bilateral cleft lip and palate from the Maxillo-Facial Clinic of The Hospital For Sick Children were used. The control sample was chosen by random selection from the Burlington Orthodontic Research Centre, Ontario.

The study was divided into two parts. Part I was a base line study of thirty 6-year-old children (Table 1). This age was chosen primarily because the initial maxillary deformity had been affected by surgery and other environmental influences and a certain degree of stability of facial form had been established.

Part II of the study was designed to determine the subsequent growth pattern of the cleft cases. A sufficient number of cases was not available throughout the 6 to 16 years range, so the cleft sample was divided into two groups (Table 1). Group I consisted of 25 children with records at 6 to 12 years. Group II consisted of 19 children with records at 12 to 16 years. The ratio of males to females was matched in the control sample for both groups.

The lip operation was performed at an average age of 4 months (range, 2½ to 8 months). Twenty-six cases were operated by Dr. A. B. Le Mesurier and the remaining cases by other surgeons using similar surgical procedures. In no case was the premaxillary position altered by surgery or orthopedics. Eight cases had 2 lip operations and one case had

TABLE 1. The age and sex distribution of the sample. Since the Burlington radiographs were taken on or near the child's birthday, the range is negligible for the control group.

sample	*bilateral cleft lip and palate*				*control*			
	mean age (years) (range)	*sex*		*total*	*mean age (years)*	*sex*		*total*
		male	*female*			*male*	*female*	
part 1								
base line	6.2 (5.3 to 7.2)	15	15	30	6	15	15	30
part 2								
group 1	6.3 (5.4 to 7.3)	20	5	25	6	20	5	25
	11.4 (10.8 to 12.5)				12			
group 2	11.3 (10.0 to 12.0)	10	9	19	12	10	9	19
	15.7 (15.2 to 17.0)				16			

3 lip operations for revisionary surgery. The average age for palate operation (Dorrance push-back palatoplasty) was 22 months (range 13 to 48 months), but the majority of the cases was operated at 18 to 24 months. Five cases had a second palate operation, and four cases had a pharyngeal flap operation. All the cases had undergone orthodontic treatment, when indicated, for expansion of the maxillary arch and alignment of teeth either in the primary, mixed, or permanent dentition.

Methods

Tracings were made from lateral cephalometric radiographs with the teeth in occlusion using the landmarks shown in Figure 1. The individual tracings were used for direct measurements and for the construction of composite facial diagrams. In the construction of these diagrams, all the tracings for a group are used to find the mean position of each landmark. The composite facial diagram for the group is obtained by joining these mean points.

The following linear and angular measurements were obtained for all cases (see Figure 1): cranial base length, nasion to basion (point 1 to point 16); maxillary length, anterior nasal spine to posterior maxilla (2 to 4); lateral maxillary segment length, piriform fossa point to posterior maxilla (3 to 4); mandibular length, greatest length of mandible (17 to approximately 11); anterior facial height, nasion to menton projected on the facial plane (1 to 12 projected on 1 to 11 plane); nasal height, nasion to anterior nasal spine projected on the facial plane (1 to 2 projected on 1 to 11 plane); oral height, nasion to menton projected on the facial plane (2 to 12 projected on 1 to 11 plane); posterior facial height, sella to gonion projected on the facial plane (18 to 4 projected on 1 to 11 plane); craniofacial angle, the angle between the cranial base plane and the facial plane (16 to 1 to 11); maxillary inclination, the angle of the maxillary plane to the cranial base (angle between 16 to 1 and 2 to 4); mandibular inclination, the angle of the mandibular plane to the cranial base (angle between 16 to 1 and 13); gonial angle, the angle of the mandible (12 to 14 to 17); and profile jaw relations, the angle representing the relative prognathism of the maxilla ("A" point) and the mandible ("B" point) to nasion (5 to 1 to 10).

Cranial base was used as a stable base for determining differences in growth trends since it is unaffected by the presence of a cleft (*16*). The slightly different lengths of the growth periods of the cleft and control samples (Table 1) were mathematically equalized, and absolute linear increments were expressed as percentage increase of the original measurements.

Findings

The measurements and statistics for Part I of the study are shown in Table 2. The composite diagrams made from the tracings were super-

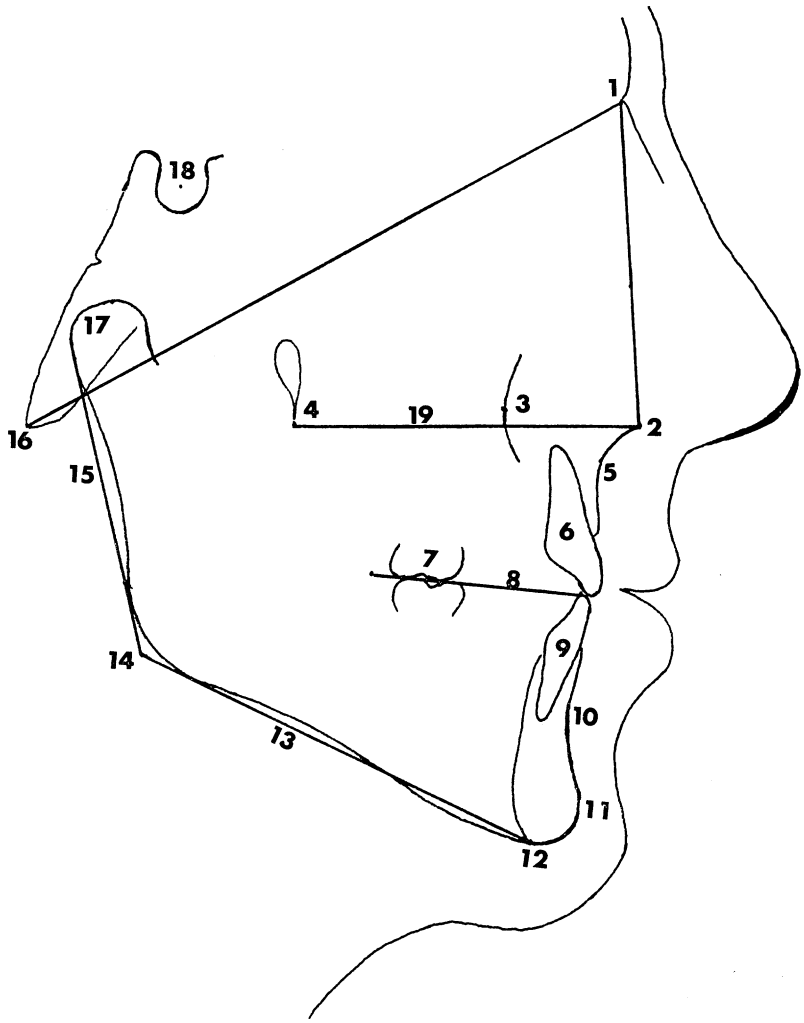

FIGURE 1. Landmarks used for tracings. 1, nasion; 2, anterior nasal spine; 3, piriform fossa point (the most posterior point on the bony profile of the anterior aperture of the nasal cavity); 4, posterior maxilla (intersection of the palatal plane and the perpendicular from the palatal plane to the pterygomaxillary fissure); 5, "A" point; 6, upper incisor; 7, first permanent molars; 8, occlusal plane; 9, lower incisor; 10, "B" point; 11, pogonion; 12, menton; 13, mandibular plane; 14, gonial angle; 15, mandibular ramus plane; 16, basion; 17, mandibular condyle; 18, sella turcica; 19, maxillary plane; 1–11 facial plane.

imposed on the cranial base (Figure 2) and on the facial plane (Figure 3).

The findings for Part II of the study are presented in Tables 3 and 4. In Table 3 the absolute increments of growth are expressed as a percentage of the measurement at the beginning of each age span. It should be noted, therefore, that one millimeter of growth from 6 to 12 years will

TABLE 2. Findings for Part I of the study on the 6 year base line sample in millimeters or degrees with statistical calculations.

measurement	*bilateral cleft lip and palate*		*control*		*t*
	mean	*SD*	*mean*	*SD*	
linear (mm)					
cranial base length	97.2	3.80	96.6	3.03	0.674
maxillary length	56.3	3.16	50.5	2.10	8.373**
lateral maxillary segment	38.7	3.38	37.7	2.33	1.334
mandibular length	97.2	3.34	98.2	3.54	1.125
anterior facial height	102.0	5.22	100.9	4.87	0.843
nasal height	41.2	2.78	42.2	2.02	1.592
oral height	60.8	5.12	58.7	3.50	1.853
posterior facial height	63.7	3.19	64.7	3.80	1.102
angular (degrees)					
cranio-facial angle	57.6	2.57	59.2	2.24	2.568*
maxillary inclination	28.1	3.01	25.2	2.03	4.365**
mandibular inclination	53.5	5.60	51.0	4.18	1.957
gonial angle	135.5	6.37	133.7	3.68	1.338
profile jaw relations	12.4	3.05	4.7	2.05	11.457**

* $P < .05$.
** $P < .01$.

produce a higher percentage increment than would a millimeter from 12 to 16 years. Figure 4 summarizes through diagrammatic representation the growth changes of key structures.

Discussion

The overall anteroposterior length of the maxilla at 6 years of age was 5.8 millimeters more in cleft cases (Table 2). The significant difference in anteroposterior length was due to two factors: first, a forward positioning of the premaxilla, as reflected by the 12.4° profile jaw relations in the cleft group compared to 4.7° in the control group (Table 2). The second factor was a retropositioning of the lateral maxillary segments as seen in Figures 2 and 3.

During the growth period from 6 to 16 years the profile jaw relations reduced in a striking manner in the cleft group. The 12.4° profile jaw relation at age 6 was reduced to 4.7° for the cleft group at 16 years while the control reduced from 4.7° at 6 years to 3.0° at 16 years. (Table 1 and 4). The linear and angular increments when compared with Figure 4 confirm the above findings. Thus the severely protrusive premaxilla at 6 years of age became near normal at 16 years. Further improvement past the age of 16 years is possible with further growth of the mandible (especially in males) and little if any growth of the maxilla.

The lateral maxillary segments, although retropositioned at 6 years of age, were of normal length (Table 2). During the growth period from 6

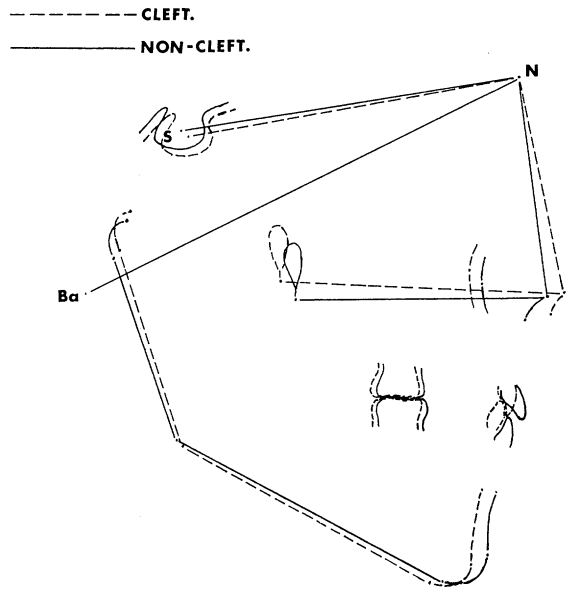

FIGURE 2. Composite facial diagrams of the 6-year base line samples superimposed on the cranial base (N-Ba), registered at nasion (N).

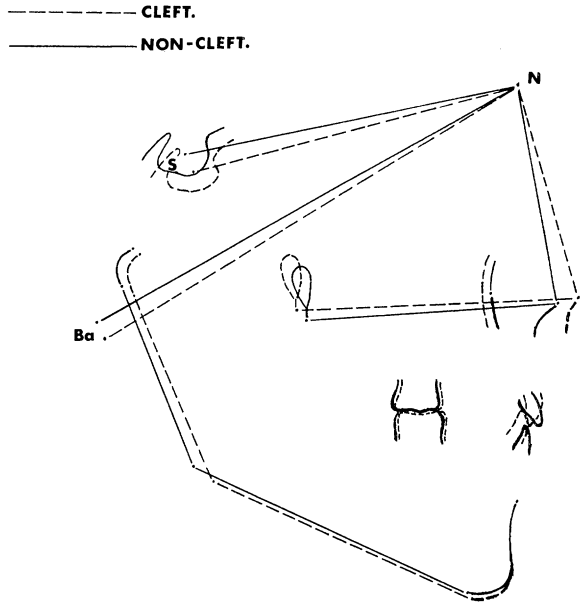

FIGURE 3. Composite facial diagrams of the 6-year base line samples superimposed on the facial plane, registered at nasion (N).

to 16 years they continued to grow in length at the same rate in both groups (Table 3).

The lateral maxillary segments were positioned superiorly as well as posteriorly in cleft cases (Figure 2) which indicates an overall deficiency

TABLE 3. Percentage increase of linear measurements from 6–16 years of age.

measurement	*age*	*cleft*		*control*		*mean values*		*total 6–16 yrs.*	
		male	*female*	*male*	*female*	*cleft*	*control*	*cleft*	*control*
cranial base length	6–12	8.1	10.4	8.5	8.1	8.6	8.4	13.8	12.9
	12–16	6.6	3.8	6.9	2.0	5.2	4.5		
maxillary length	6–12	7.2	10.1	10.4	13.7	7.8	11.2	12.2	16.7
	12–16	5.2	3.5	7.1	3.9	4.4	5.5		
maxillary segment length	6–12	6.5	10.5	5.3	9.6	7.3	6.1	9.7	10.4
	12–16	3.0	1.7	5.0	3.5	2.4	4.3		
mandibular length	6–12	14.9	19.8	15.7	15.2	15.9	15.6	24.3	24.4
	12–16	10.9	5.8	11.6	5.9	8.4	8.8		
anterior facial height	6–12	13.5	16.5	12.7	12.0	14.1	12.6	23.1	19.1
	12–16	10.5	7.6	9.2	3.9	9.0	6.5		
nasal height	6–12	18.9	24.1	18.9	16.5	19.9	18.4	29.5	26.4
	12–16	12.9	6.4	11.4	4.5	9.6	8.0		
oral height	6–12	9.4	12.0	8.2	7.3	9.9	8.1	18.5	13.7
	12–16	8.8	8.4	7.7	3.5	8.6	5.6		
posterior facial height	6–12	13.1	18.5	15.0	14.7	14.2	14.9	23.4	24.5
	12–16	12.4	6.0	13.1	6.1	9.2	9.6		

TABLE 4. Angular changes in degrees from 6–16 years of age, bilateral complete cleft lip and palate.

measurement	*age*	*cleft*	*control*	*change 6–16 years*	
				cleft	*control*
cranio facial angle	6–12	1.3	1.6	1.8	3.2
	12–16	0.5	1.6		
maxillary inclination	6–12	0.7	1.2	1.3	1.3
	12–16	0.6	0.1		
mandibular inclination	6–12	0.4	−0.6	1.1	−2.2
	12–16	0.7	−1.6		
gonial angle	6–12	−2.0	−3.8	−3.1	−6.5
	12–16	−1.1	−2.7		
profile jaw relations	6–12	−5.5	−1.4	−7.8	−1.7
	12–16	−2.3	−0.3		

in downward and forward growth. Despite this, the occlusal level of the first molars was approximately the same in cleft and noncleft groups (Figures 2 and 3), indicating an overeruption of maxillary buccal teeth. At 16 years of age, the posterior maxilla in cleft cases remained deficient in vertical growth.

The differences in anterior and posterior facial heights were not significant at 6 years of age. However, the oral height was close to being

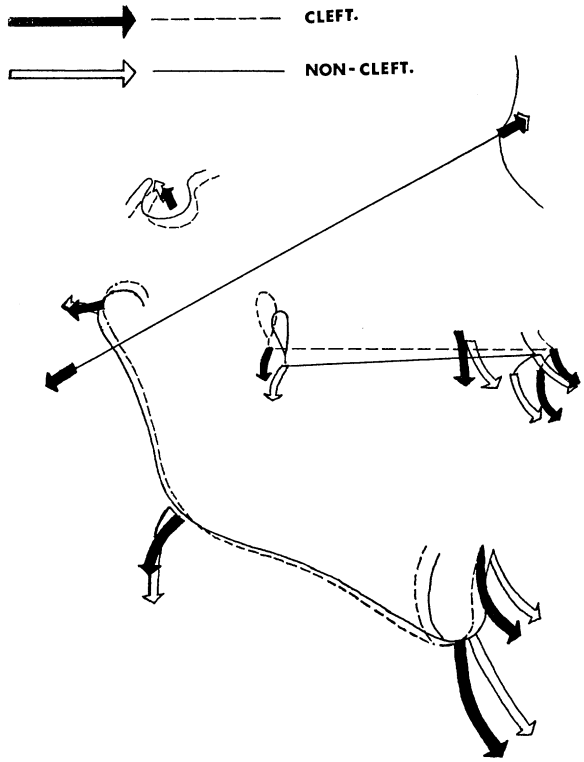

FIGURE 4. Summarizes and diagrammatically represents the direction and extent of the major growth changes in the face from 6 to 16 years.

significantly greater in the cleft group even though the nasal height was close to being significantly less (Table 2). These differences in the facial proportions become more obvious with growth as the nasal heights become equal while oral height increases even more in the cleft group (Table 3).

The mandibular length at 6 years of age was not significantly smaller in cleft cases (Table 2) and the percentage increase in their lengths with growth was the same (Table 3). Hence it can be stated that the mandibular length is normal in children with complete bilateral cleft lip and palate. However, the difference in mandibular form at 6 years of age became even greater by 16 years. The slight differences in mandibular inclination and gonial angle at 6 years had further increased by 16 years (Table 4). Since the overall length of the mandible was the same, these alterations in shape were the result of changes at the gonial angle of the mandible in cleft cases, and were probably related to differences in mandibular posture.

The cranio-facial angle at 6 years of age was less in the cleft group (Table 2 and Figure 2). During the growth period from 6 to 16 years it was further reduced (Table 4).

It should be recognized that every child has his own inherent growth potential which may vary from the average pattern. However, this study does indicate general growth trends and permits the stating of several generalizations about facial growth in complete bilateral cleft lip and palate cases.

Summary

A study of facial growth in normal children and children with complete bilateral cleft lip and palate from 6 to 16 years was carried out using lateral cephalometric radiographs. The conclusions drawn from the study are as follows.

1. The premaxilla was very prominent at 6 years of age in children with clefts, but by the age of 16 years the protrusion was reduced almost to normal, and further improvement may occur.

2. The lateral maxillary segments were retropositioned and superiorly positioned in cleft cases at 6 years, but were not deficient in length. This relationship was maintained throughout the growth period.

3. The mandible was normal in length at 6 years and grew normally until 16 years.

4. The oral component of facial height was only slightly greater at 6 years of age in cleft cases but this difference became more marked with further growth.

5. Alterations occurred at the angle of the mandible in cleft cases so that the angle formed between the body and the ramus of the mandible becomes more obtuse.

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