Craniofacial morphology characteristics of operated unilateral complete cleft lip and palate patients in mixed dentition

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**Objective.** The objective of this study was to analyze craniofacial morphologic characteristics at the stage of mixed dentition in Chinese children who had received surgery for unilateral complete cleft lip and palate (UCCLP) compared with the healthy population.

**Material and methods.** Lateral cephalometric radiographs were taken for 2 groups of individuals: (1) 48 UCCLP patients who had been operated on before 2 years of age, and (2) 60 noncleft peers as controls.

**Results.** The operated UCCLP groups differed from the control group as follows: reduced cranial base length, less maxillary length, more retrognathic maxilla, retusion of the entire maxilla, more incongruous intermaxillary relation, more concave skeletal profile, and more lingually inclined maxillary and mandibular incisors.

**Conclusions.** The operated UCCLP children at the mixed dentition stage showed serious craniofacial deformities and the craniofacial growth was influenced (especially in maxilla). (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:e16-e25)

Nonsyndromic cleft lip and palate is one of the most common congenital craniofacial anomalies. The clefts result in dentomaxillofacial deformities that lead to functional, esthetic, and psychosocial disturbances.1 The optimal management of cleft lip and palate patients from birth to completion of treatment presents a formidable challenge to the plastic surgeon and associated health care system. Infants born with cleft lip and palate are ideally treated by a multidisciplinary team approach, including primary surgery in infancy to repair the defects and treat associated functional problems.2,3

The operated patients with unilateral complete cleft lip and palate (UCCLP) are, however, generally characterized by craniofacial deformities especially in the midface area, such as the retroposition of the maxilla.4 The prevention and treatment of craniofacial deformities in operated UCCLP patients is a critical task. The causes of the growth deviations have been the object of a large number of studies, but no true consensus has been reached at this time.5-10 Thus, it is very important to understand the craniofacial growth and morphologic characteristics of operated children with cleft lip and palate so as to provide information about the outcome of primary repair surgery, which has important clinical significance in their orthodontic treatment and further surgery. The aim of our study was to investigate the craniofacial growth and morphologic characteristics of operated UCCLP in mixed dentition.

**MATERIAL AND METHODS**

**Sample**

The study sample comprised a total of 108 Chinese children aged between 7 and 11 years divided into an operated and control group. The operated group was composed of 48 children (25 male, 23 female) with UCCLP and no other congenital anomaly or syndrome whose repair operations had been performed by the same surgeon using the same techniques at the West China Hospital of Stomatology, Sichuan University, Chengdu, China, between 2000 and 2004. Lip repair had been performed at 9 months of age using the rotation-advancement technique, and palatoplasty was done at 38 months using the mucoperiosteal pushback technique. None had received any presurgical orthopedic treatment, orthodontics, or dental reconstruction.

The control group was composed of 60 healthy children (30 male, 30 female) without cleft lip and/or palate.
or any other congenital anomalies of the same age range as the operated group randomly chosen from a local public primary school in Chengdu, China. These children all had normal skeletal relationships, symmetric faces, and normal occlusion and no history of orthodontic treatment or craniofacial surgery. The average age of the operated group was 10 years and 2 months (males) and 10 years and 4 months (females), and the average age of the control group was 10 years and 1 month (males) and 10 years and 2 months (females).

Cephalometric analysis

Lateral cephalometric radiographs were taken for each subject under standardized conditions with the head oriented along Frankfort horizontal plane parallel to the floor. Subjects were asked to relax their lips for them to be in resting position, and place their teeth in centric occlusion. An EASYMTIC 3298-125 Cephalometry X-ray machine (Chemetron Co., Chicago, IL, USA) was used for all subjects. The digital cephalometric radiographs were sent directly from the machine to a computer for analysis. All digital radiographs were analyzed on the same computer. Each subject was assessed by one trained observer (R.L.) without knowing age or gender. Fig. 1 shows the landmarks that were used in the cephalometric analysis. The 37 parameter measurements are shown in Figs. 2 to 6.

Error of method

To determine the error in measurements, 10 radiographs were randomly selected and reassessed after a 4-week interval by the same examiner (R.L.). Method errors were calculated using the formula proposed by Dahlberg,\textsuperscript{11} ME = \sqrt{\frac{\sum d^2}{n}}, where \sum d^2 is the sum of the squared differences between the 2 mean values, and n is the number of double measurements. The method errors for angular and linear measurement were not statistically significant with less than 0.8 degrees and 1 mm, respectively.

Statistical analysis

Statistical analysis was done using the Statistical Package for Social Sciences SPSS Version 10.0 for windows. The mean and standard deviation were calculated for every parameter measured in both groups. The Student t test was used to compare the means of the 2 groups for all parameters at 5% and 1% significance levels.

RESULTS

The mean values, standard deviations, and Student t tests of all the variables used in this study are shown in Tables I through X. The level of significance adopted for statistical test was \( P < .05 \).

Cranial base

Descriptive statistical data of the cranial base morphology measurements between operated UCCLP children and healthy children are shown in Tables I and II.

The main difference in the cranial base morphology between the operated and control groups was that posterior cranial base length (S-Ba) and total cranial base length (N-Ba) were significantly more reduced in the operated than control group (\( P < .01 \)). The anterior cranial base length (N-S) was smaller and the cranial base angle (N-S-Ba) was larger in the male UCCLP group (\( P < .01 \)) but not in the female group. There was no obvious difference in SN-FH angle between the operated and control groups.

Maxillary skeleton

Descriptive statistical data of the maxillary skeleton morphology measurements between operated UCCLP children and healthy children are shown in Tables III and IV.

Relative to the healthy controls, the operated UCCLP patients had reduced maxilla length (Ptm-A), retruded point A (N-A, Ptm-A), reduced SNA angle, and S-Ptm (\( P < .01 \)). These suggested that the maxilla must be obviously retrognathic in relation to the cranium and the growth of maxillary to be severely restrained. Palate plane (PP) had an obvious rotation and the PP-SN angle was increased (\( P < .01 \)). Other face height measurements, such as N-ANS/N-Me and S-Ar/S-Go, had similar dimensions in the operated and control groups.

Mandibular skeleton

Descriptive statistical data of the mandibular skeleton morphology measurements between operated UCCLP children and healthy children are shown in Tables V and VI.

Relative to the healthy controls, the operated UCCLP patients had reduced mandible length (Go-Pg) (male, \( P < .01 \); female, \( P < .05 \)) and increased mandibular angle (Ar-Go-Me) (\( P < .01 \)). Ramus mandibular height (Ar-Go) was smaller in the male UCCLP group (\( P < .01 \)) but not in the female group. Most of the other measurements, such as FH-MP, FH-SGn, ANS-Me/N-Me, Ar-Go/S-Go, N-B (/ FH) and N-Pg (/ FH), were not significantly different between the operated and control groups.

The relationship of maxilla and mandible

Descriptive statistical data of the relationship of maxilla and mandible between operated UCCLP children and healthy children are shown in Tables VII and VIII.

Relative to the healthy controls, the operated UCCLP patients had smaller ANB angle and reduced Ptm-A/
Ar-Pg ($P < .01$). These indicated the maxilla length and mandible length of operated UCCLP children to be inconsonant. In the operated group, the change of the N-A-Pg angle (male, $-6.79$ degree; female, $-4.71$ degree) indicated the maxilla to be in a more retruded position in relation to the mandible. Although the palate plane had a clockwise rotation, no significant difference in PP-MP was found between the 2 groups.

**Dental relationships**

Descriptive statistical data of the dental relationships between operated UCCLP children and healthy children are shown in Tables IX and X.

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**Fig. 1. Reference points on the profile cephalometric radiographs.**

- $S$ = sella, the center of sella turcica
- $N$ = nasion, the most anterior part of the frontonasal suture
- $Or$ = orbitale, the lowest point in the inferior margin of the orbit
- $ANS$ = anterior nasal spine, the tip of the bony anterior nasal spine
- $A$ = subspinale, the point at the deepest midline concavity on themaxilla below the anterior nasal spine
- $B$ = supramentale, the point at the deepest midline concavity of mandibular symphysis; mandibular
- $Pg$ = pogonion, the most anterior point of the mandibular symphysis
- $Gn$ = gnathion, the most anteroinferior point on the symphysis
- $Me$ = menton, the lowermost midline point on the mandibular symphysis
- $Go$ = gonion, the constructed point of intersection of the ramus plane and the mandibular plane
- $Po$ = porion, superior border of external auditory meatus
- $Ba$ = basion, anterior border of foramen magnum
- $Ar$ = articulare, the point at the intersection between the condylar process of the mandible and the occipital bone
- $Ptm$ = pterygomaxillary fissure, the most superior point on the outline of the pterygomaxillary fissure
- $PNS$ = posterior nasal spine, intersection between the nasal floor and the posterior contour of the maxilla
- $UIA$ = the apex of the root of the upper central incisor
- $UP$ = the most prominent point of the upper central incisor
- $UIE$ = the incisal edge of the upper central incisor
- $IO$ = the midpoint of overbite of incisors
- $LIE$ = the incisal edge of the lower central incisor

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**Fig. 2. Measurements of cranial base**

1. $N-S$ (mm): length of anterior cranial base;
2. $N-Ba$ (mm): length of total cranial base;
3. $S-Ba$ (mm): length of posterior cranial base;
4. $N-S-Ba$ (degrees): angle of cranial base;
5. $SN-FH$ (degrees): the angle of intersection between SN line and Frankfort horizontal plane.

Frankfort horizontal plane (FH): line through porion and orbit
Anterior basion plane (SN): line through nasion and sella.

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**Figures**

- Fig. 1: Reference points on the profile cephalometric radiographs.
- Fig. 2: Measurements of cranial base
Relative to the healthy controls, the operated UCCLP patients had more lingually inclined incisors (U1-SN, L1-mandibular plane [MP]), increased interincisal angle (U1-L1), reduced U1-SN angle and L1-MP angle, reduced OP-FH angle, larger OP-MP angle, decreased U6-Ptm, and decreased U1-PP (P < .01). Other dental alveolus height measurements, such as L1-MP, U6-PP, and L6-MP found no significant differences between the operated and control groups.

DISCUSSION

Although there are many reports on morphology in patients with clefts, these studies lacked elucidation about the effect of primary surgery on craniofacial morphology in UCCLP patients. Our study was the first to investigate the craniofacial morphology of operated children with UCCLP in mixed dentition before the adolescent growth spurt. We attempt to provide some basic data for dentofacial orthopedics.

The change of cranial base

The results of previous studies about cranial base dimensions of operated UCCLP patients have been controversial. Scholars found no statistically significant difference in cranial base length between operated and control groups.12-14 However, Ross15 found that the length of cranial base in UCCLP patients seemed to be smaller than in the control group.

Our data showed at the stage of mixed dentition the overall cranial base length of children with operated UCCLP was significantly smaller than the control group. Additionally, increased cranial base angle and
reduced anterior cranial base length were found in the male UCCLP group, whereas no difference was found in female groups. These findings suggest that the growth of cranial base of operated children with UCCLP has been influenced at the stage of mixed dentition.

The change of maxilla and mandible

According to the results of our study, the maxillofacial growth of operated children with UCCLP at the mixed dentition was severely inhibited. The length of maxilla was significantly reduced, length of maxilla and mandible were remarkable incongruous, and the entire maxilla was obviously retrusive in relation to the cranial base. This is in agreement with the results of Johnson,\textsuperscript{16} Gaukroger et al.,\textsuperscript{17} and Treutlein et al.\textsuperscript{18}

Our data also showed that the SNA and N-A-Pg angle, which represents the relationship of maxilla and mandible, was negative, which indicates serious maxillary retrognathism in relation to mandible. Nakamura et al.\textsuperscript{19} claimed that the mandible of operated patients with UCCLP was retrognathic in relation to cranial bones and the deficiency in forward growth would be more and more aggravated with increasing age. However, we found mandibular changes were not remarkable at the mixed dentition. The change of mandible presented only less mandible length and increased gonial and mandibular angle. These suggest that the
The change of dental relationships

Class III occlusions were found in operated children with UCCLP at the mixed dentition. The maxillary and mandibular incisors were obviously lingually inclined. This is in accordance with the results of Dogan et al.20 Shibasaki and Ross21 claimed that maxillary incisors, especially the incisal margin, were sensitive to the changes of pressure. After the lip operation, lip pressure obviously increased because of the scar tissue, which resulted in retrusive and lingually inclined maxillary incisors. To obtain concordant dental relationship, mandibular incisor presented compensatory lingual inclination. However, the dental compensatory change cannot correspond to the skeletal deficiency because of serious shortage of maxilla growth, so anterior cross-bite presents.
Table IV. Descriptive statistics of maxillary skeleton morphology measurements between female children operated on for UCCLP and healthy children

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S, sella; N, nasion; A, subspinale; Ptm, pterygomaxillary fissure; Me, menton; Ar, articulare; Go, gonion; FH, Frankfort horizontal line; UCCLP, unilateral complete cleft lip and palate.

*P < .05.
†P < .01.

Table V. Descriptive statistics of mandibular skeleton morphology measurements between male children operated on for UCCLP and healthy children

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<td>Ar-go/S-Go</td>
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S, sella; N, nasion; B, supramentale; Gn, gnathion; Ar, articulare; Go, gonion; Me, menton; Pg, pogonion; MP: line from Me tangent to lower border of the mandible; FH, Frankfort horizontal line; UCCLP, unilateral complete cleft lip and palate.

*P < .01.

Table VI. Descriptive statistics of mandibular skeleton morphology measurements between female children operated on for UCCLP and healthy children

<table>
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S, sella; N, nasion; B, supramentale; Gn, gnathion; Ar, articulare; Go, gonion; Me, menton; Pg, pogonion; MP: line from Me tangent to lower border of the mandible; FH, Frankfort horizontal line; UCCLP, unilateral complete cleft lip and palate.

*P < .05.
†P < .01.
The present study had some limitations. First, there is no comparison between the operated children and the control group before the operation(s). Previous studies showed that a normal growth potential exists in patients with UCLP, and the cranial base and skeletal face are not significantly different between individuals with unoperated UCLP and matched healthy individuals.22-24 Thus, we believe the craniofacial morphology of patients during infancy before receiving surgical treatment was similar to those of healthy individuals. Second, in this study, the experimental group was composed of individuals with UCCLP who had received both cheiloplasty and palatoplasty. These 2 types of surgery should have some differences in the influences of maxillofacial soft tissue morphology. In subsequent study, we will select patients with only cleft
lip who have been operated with lip repair, as well as patients with cleft palate only who accepted palatoplasty to further research the effects of surgical factors on craniofacial soft tissue morphology.

**CONCLUSIONS**

According to the results of the survey, we found that the craniofacial skeletal growth of the operated children with UCCLP at the mixed dentition had been affected and presented serious craniofacial deformities. These are as follows: decrease in length of cranial base, decrease in length of maxilla, retrusion of the entire maxilla, incongruous intermaxillary relation, more concave skeletal profile, and more lingually inclined maxillary and mandibular incisors. These suggest that it is very important to correct the malposition of the maxillary segments before operation on UCCLP patients and we should adopt useful prevention and treatment measures to stimulate the craniofacial growth in operated children with UCCLP during the late deciduous and early mixed dentition.

**REFERENCES**


**Table X.** Descriptive statistics of the dental relationship measurements between female children operated on for UCCLP and healthy children

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U1, the line through points UIE and UIA; LI, the line though points LIE and LIA; OP, the line though points IO and Mo; U6, the mesiobuccal cusp of the maxillary first molar; L6, the mesiobuccal cusp of the mandibular first molar; Ptm, pterygomaxillary fissure; FH, line through porion and orbit; MP, line from Me tangent to lower border of the mandible; SN, the line through points S and A; UCCLP, unilateral complete cleft lip and palate.

*P < .05.
†P < .01.

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