Cone-beam computed tomography–synthesized cephalometric study of operated unilateral cleft lip and palate and noncleft children with Class III skeletal relationship

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Introduction: Our objective was to compare the craniofacial hard and soft tissue characteristics between children with operated unilateral cleft lip and palate (UCLP) and children with noncleft lip and palate (non-CLP) with a Class III skeletal relationship. **Methods:** The study sample consisted of 30 subjects (18 boys, 12 girls; mean age, 10.21 years) affected by UCLP and 30 non-CLP subjects (17 boys, 13 girls; mean age, 10.19 years) as the control group. All subjects were in the mixed dentition with a Class III skeletal relationship. Cone-beam computed tomography–synthesized cephalograms were traced and evaluated, and craniofacial hard and soft tissue morphologies were compared between the UCLP and non-CLP groups. **Results:** Maxillary length and gonial angle were 2.66 mm shorter and 3.67° greater, respectively, in the UCLP group than those in the non-CLP group. The SNA and SNB angles describing the sagittal positions of the maxilla and mandible, respectively, relative to the cranial base were significantly smaller in the UCLP group ($P < 0.001$ and $P = 0.003$, respectively). However, the 2 groups had similar sagittal intermaxillary relationships with similar ANB angles ($P = 0.669$). In the vertical dimension, the mandibular plane angle and the growth direction vector were significantly greater in the UCLP group ($P = 0.007$ and $P < 0.001$, respectively). Lastly, the UCLP group had a more concave soft tissue profile, manifested by a reduced facial convexity angle, as well as an acute nasolabial angle and a more protruded lower lip. **Conclusions:** Although the 2 groups had similar sagittal intermaxillary relationships, patients in the UCLP group had more retrusive maxillary and mandibular positions relative to the cranial base and more severe vertical discrepancies. Additionally, the soft tissue profiles of patients affected by UCLP were more concave, and the compensatory adaptation was less satisfactory. (Am J Orthod Dentofacial Orthop 2016;150:802-10)

Cleft lip and palate (CLP) is a congenital facial anomaly characterized by underdevelopment of maxillary growth, caused by surgical repair, palatal muscle strain, scar contracture, or congenital development deficiency.[1-3] Patients affected by CLP often have abnormal lip morphology and increased muscle tension that might exert negative effects on growth and the function of craniofacial structures. According to Shetye and Evans,[4] patients affected by CLP generally have an anterior crossbite and a tendency toward Class III malocclusion. Williams et al[5] reported that among 12-year-old patients affected by CLP, approximately 70% have a of Class III skeletal deformity.

To identify the craniofacial characteristics of patients with CLP, previous studies investigated the differences in hard and soft tissue morphologies between CLP and non-CLP subjects.[1,3,6-12] However, although many patients affected by CLP tend to have a Class III skeletal relationship, few studies have compared the craniofacial morphologies of CLP and non-CLP subjects with a Class III skeletal deformity.[13]

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The leading cause of Class III malocclusion in non-CLP subjects is heredity, and skeletal discrepancies are mainly in the sagittal dimension; however, multiple factors contribute to the development of Class III malocclusion in CLP subjects, including heredity, local cleft defect, surgical disturbance, and abnormal lip tension.

Because of the inherent compensation of the craniofacial structures, growth and development in 3 dimensions would allow interactions across all dimensions, so that transverse asymmetry caused by a cleft defect would also affect the morphology in the sagittal and vertical dimensions. Therefore, it is reasonable to assert that considerable differences exist in both hard and soft tissues between CLP and non-CLP Class III subjects. Notably, the locations of the differences in craniofacial morphology and their impact on the diagnosis and treatment of CLP patients has not yet been studied.

The purpose of this study was to evaluate and compare craniofacial hard and soft tissue morphologies of operated UCLP and non-CLP patients with a Class III skeletal deformity. All patients were in the mixed dentition with a Class III skeletal relationship and an anterior crossbite.

MATERIAL AND METHODS

This retrospective study was approved by the ethics committee of the Peking University School of Stomatology, Beijing, China. All participants and their parents provided written informed consent, and all clinical investigations were conducted according to the principles of the Declaration of Helsinki.

All patients were Chinese residents of Northern Chinese origin. They were selected according to the following criteria. Inclusion criteria for the UCLP group were (1) operated nonsyndromic UCLP, (2) Class III skeletal relationship with an ANB angle less than 1° and an anterior crossbite, (3) mixed dentition and cervical vertebral maturation stage between 1 and 3,[14] and (4) no previous orthodontic treatment.

Included in the UCLP group were 30 children (18 boys, 12 girls) between the ages of 8.3 and 11.9 years (mean, 10.21 years; SD, 1.01 years). Of the UCLP patients, 23 (76.67%) had a cleft on the left side, and 7 (23.33%) had a cleft on the right side. All UCLP subjects underwent cheiloplasty before they were 1 year old, palatoplasty before 3 years old, and alveolar bone grafting surgery at least 3 months before starting this study. All surgeries were performed at the Cleft Lip and Palate Treatment Center, Peking University School of Stomatology, Beijing, China.

The non-CLP subjects had similar inclusion criteria to the UCLP group. They were selected from the Department of Orthodontics, Peking University School and Hospital of Stomatology. Included in the non-CLP group were 30 children (17 boys, 13 girls) between the ages of 8.8 and 11.9 years (mean, 10.19 years; SD, 0.91 years) (Table I).

Table I. Descriptive data of the subjects in the study

	UCLP group (n = 30)	*Non-CLP group (n = 30)*	P *value*
Boys/girls (n)	18/12	17/13	0.793*
Mean age (y)	10.21 ± 1.01	10.19 ± 0.91	0.950†

*Pearson chi-square test; †Independent *t* test.

In assessing the sample size, we used the results from 2 previous studies to calculate the scientifically appropriate number of subjects.[3,9] A 2-sample *t* test power analysis of 3 representative measurements—ANB angle, maxillary length, and mandibular plane angle—was conducted using PASS software (version 11; NCSS, Kaysville, Utah) with alpha, beta, and power values set at 0.05, 0.10, and 0.90, respectively. Results of this analysis confirmed that sample sizes of 30 for the UCLP group and 30 for the non-CLP group were sufficient to achieve 90% power in detecting differences between the groups.

The cone-beam computed tomography (CBCT) images were obtained using the same device (DCT Pro; VATECH-EWOO Group, Seoul, South Korea) before any orthodontic treatment. Each patient was seated in a chair with natural head position oriented by experienced clinicians, in centric occlusion, and with a relaxed tongue and passive lips. All scans were completed using the following protocol: field of view, 200 × 190 mm^2; 90 kV(p); 144 mA; scan time, 24 seconds; and voxel size, 0.4 mm^3.

Cephalograms were built from CBCT images using Dolphin Imaging Software (version 11.7; Dolphin Imaging and Management Solutions, Chatsworth, Calif) in orthogonal projection by parallel rays that allowed no magnification.

Before the cephalograms were generated, the image data were carefully oriented in 3 dimensions using the following protocol: (1) the Frankfort horizontal (FH) plane passed through the bilateral porion and orbitale on the unaffected side of the UCLP patients (for non-CLP subjects, the right side was used) and was parallel to the ground; (2) the sagittal plane passed through sella and nasion and was perpendicular to the FH plane; and (3) the coronal plane passed through basion and was perpendicular to the sagittal and the FH planes.

Cephalometric assessment was performed using the Dolphin Imaging software. Cephalometric landmarks and measurements of hard tissues are shown in