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Comparison of occlusal function in children with and without cleft lip and/or palate

Koko Chida*[1], Yuriko Yoshida*[1], Yuko Momma*[1], Shoko Kochi*[2], Hideaki Mayanagi*[1] and Satoshi Fukumoto*[1]

*[1] Division of Pediatric Dentistry, Department of Oral Health Science, Tohoku University Graduate School of Dentistry,
*[2] Clinical for Maxillo-Oral Disorders, Tohoku University Hospital Dental Center
4-1 Seiryo-machi, Aoba-ku, Sendai 980-8575, JAPAN

Abstract The bite force prior to orthodontic treatment was determined to examine whether occlusal and masticatory functions in children with cleft lip and/or palate (CL/P), but with most teeth participating in occlusion, are inferior to those in children with normal occlusion without CL/P. The subjects were 31 children (20 boys and 11 girls) with CL/P and 26 children (10 boys and 16 girls) with normal occlusion without CL/P. All the children were 4 years old. To examine occlusal function, we measured the occlusal contact area, bite pressure, and bite force using bite pressure detection film "dental prescale" (R-type) and the "Occluser" system (Fuji Photo Film Co.). The average and maximum bite pressures in children with CL/P were significantly higher than those for children with normal occlusion without CL/P. The bite pressure and bite force in children with CL/P were similar to or greater than those for children with normal occlusion without CL/P, provided that the children with CL/P had only a slightly asymmetric dental arch and that most teeth participated in occlusion. These results suggest that occlusion functions in children with CL/P are not inferior to those of children with normal occlusion without CL/P.

Key words
Bite force,
Cleft lip and/or palate,
Deciduous dental arch,
Dental prescale,
Occlusal contact area

Introduction

Children with cleft lip and/or palate (CL/P) have a congenital oral organ morphology and functional disorders[1)], and these conditions markedly impair growth and development of the occlusal system[1)]. Acquisition of normal mastication, swallowing and speech are important for healthy development of the stomatognathic system, and management of systemic health, occlusion and masticatory guidance in pediatric dentistry are very important for children in the developmental period.

In patients with CL/P, primary lip repair is performed in babyhood and palatoplasty is performed in early infancy. These stages are important for development of ingestional function as infants learn intake of liquids such as milk and of solid food[2,3)]. In children with CL/P, inadequate learning of mastication may occur because of surgery on organs that plays roles in masticatory function. Scar formation after surgery on the upper lip and palate may cause children with CL/P to fail to achieve sufficient masticatory function, and several studies have shown that masticatory function in children with CL/P is lower than that in children with a normal dental arch[4,5)].

Tanaka found a significant difference in the occlusal contact area between children with and without CL/P, but no difference in the average bite pressure or bite force[6)], whereas other reports have shown a correlation between masticatory force and occlusal contact area in healthy children[7,8)]. From these studies, it is unclear if the low level of occlusal

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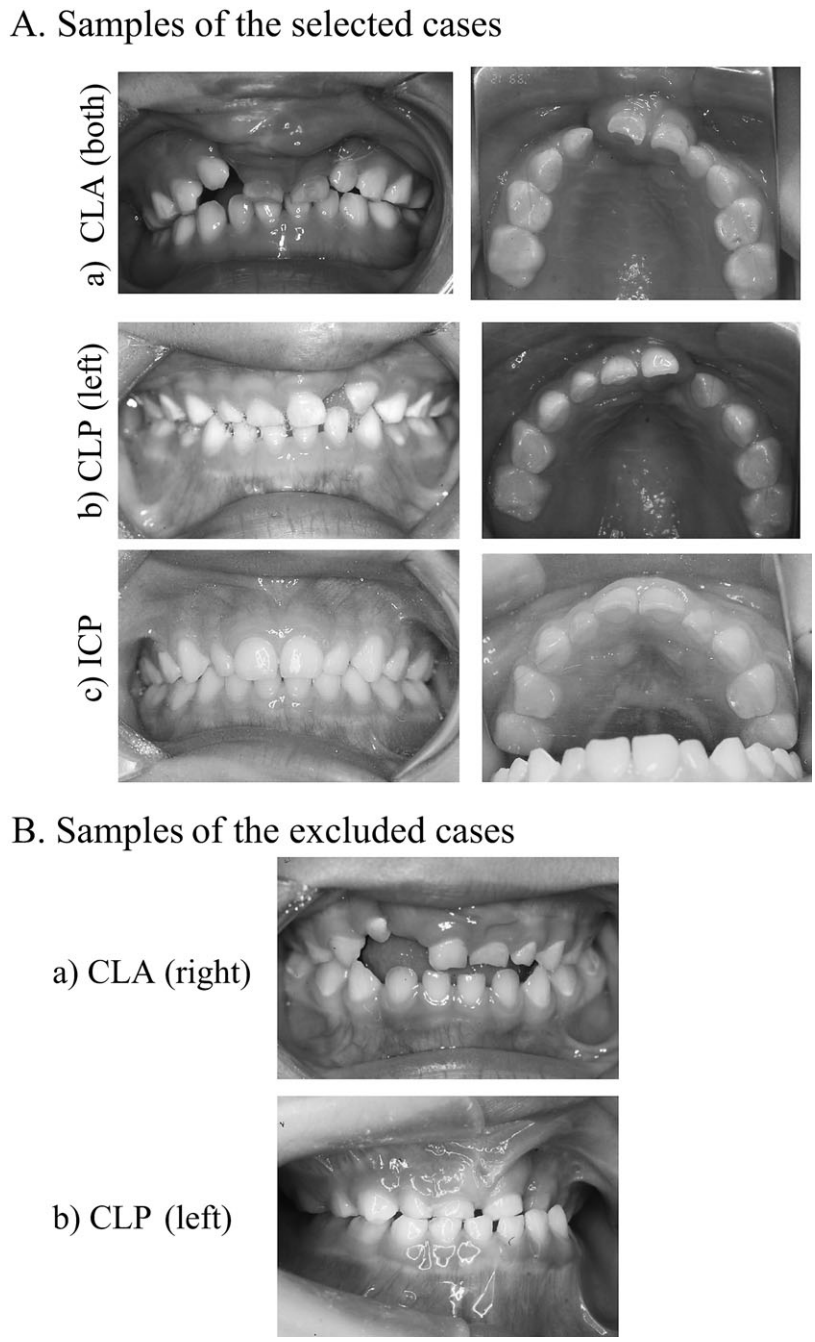

Fig. 1 Oral photographs of the samples of the selected cases and the excluded cases for the CL/P group
CLA: cleft lip and alveolus, CLP: cleft lip and palate, ICP: isolated cleft palate
a) Dental arch forms of the selected case were almost symmetry, the deciduous molar teeth were almost normal intercuspal position, and the anterior teeth contacts were maintained.
b) The case which had the anterior open-bite or cross-bite in deciduous molar part were excluded.

function in children with CL/P is affected by the degree of distortion of the dental arch. We hypothesized that bite force should be the same for a given occlusal contact area, and that the occlusal contact area and bite force of deciduous dentition in children with CL/P may be similar to those of children with normal occlusion without CL/P, provided that the maxillary dental arch in children with CL/P is almost symmetric and has an approximately normal denture pattern. To examine this hypothesis, we

Table 1 Number of the subjects

	Male	Female	Total
Children with cleft lip and/or palate (CL/P)	20	11	31
CLA	8	2	
CLP	9	5	
ICP	3	4	
Children with normal occlusion (N)	10	16	26

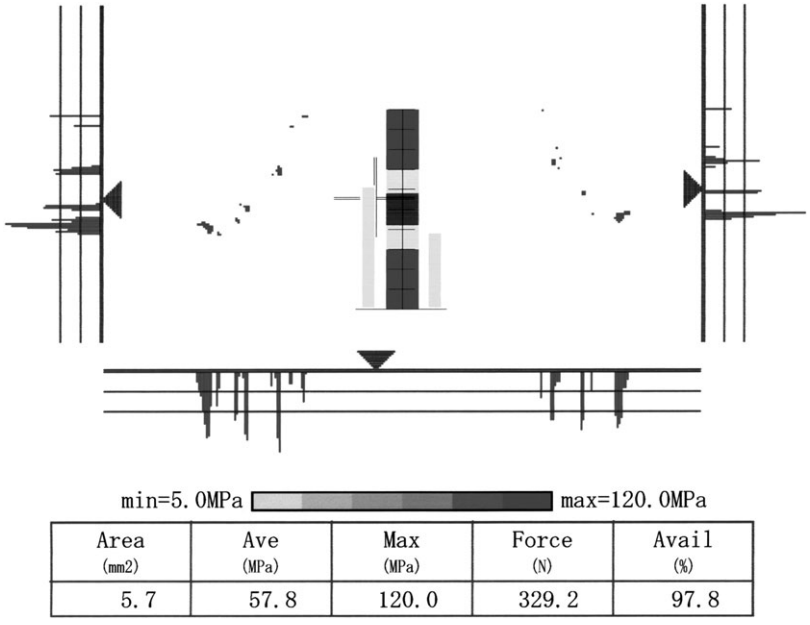

Fig. 2 An example of dental prescale analysis data of the child shown by Fig. 1-A-a)

measured the bite force, occlusal contact area and bite pressure in children with or without CL/P.

The protocol for treatment of children with CL/P in Tohoku University Hospital is as follows. Primary lip repair is initiated at 3–4 months after birth and palatoplasty using a push-back method (raw surface covered with fibrin paste) is performed at 15–18 months. No presurgical orthopedic appliance or nursing plate is used. Infants with CL/P are breast-fed and proceed to solid food in a similar manner to a healthy child. Use of a feeding bottle is stopped 1 month before palatoplasty in cases with cleft palate. After palatoplasty, oral ingestion of water is started on day 1 and eating habits return at 1 month after the operation. A speech therapist starts consultation on language development and pronunciation from about 6 months after birth. From 1 year old, a program for prevention of dental caries is started by pediatric dentists. Dental recall examinations are continued until 4 years old to gain masticatory function and normal articulation, and to prevent dental caries. During the second half of infancy and the elementary school period, occlusal management including expansion of the maxillary dental arch, anterior guidance of maxillary growth, and prevention of dental caries is performed. Transplantation of a bone graft at the site of the alveolar cleft in later childhood and secondary correction of the lips or nose after adolescence are performed if needed.

Subjects and Methods

The subjects were 4-year-old patients with CL/P who were born in 1994 or 1995 and received the standard medical care described above. Thirty-one

Table 2 Comparison of occlusal function

	CL/P group	N group
Occlusal contact area (mm^2)	6.6 ± 2.8	6.3 ± 3.2
Average occlusal pressure (MPa)	48.4 ± 4.9	43.9 ± 5.5 **
Maximum bite pressure (MPa)	113.4 ± 6.9 *	108.0 ± 8.7
Bite force (N)	307.4 ± 116.8	268.5 ± 118.2

*: $P<0.05$, **: $P<0.01$

Table 3 Comparison of occlusal function in different types of cleft lip and/or palate

	CL/P group			N group
	CLA	CLP	ICP	
Occlusal contact area (mm^2)	7.3 ± 2.1	6.7 ± 3.2	5.1 ± 2.7	6.3 ± 3.2
Average occlusal pressure (MPa)	47.2 ± 3.7 *	47.6 ± 5.6	51.7 ± 3.9 **	43.9 ± 5.5
Maximum bite pressure (MPa)	113.4 ± 6.9	118.1 ± 8.1	116.6 ± 4.4 *	108.0 ± 8.7
Bite force (N)	307.4 ± 116.8	307.3 ± 117.7	263.6 ± 149.6	268.5 ± 118.2

*: $P<0.05$, **: $P<0.01$

children in whom deciduous molar occlusion showed an almost normal pattern and over jets were normal or edge-to-edge bite were selected for the study (CL/P group, Fig. 1A). Patients with marked deformation of the maxillary dental arch, anterior open bite or unilateral cross-bite were excluded (Fig. 1B). Ten patients had cleft lip and alveolus (CLA) (unilateral, n = 7; bilateral, n = 3); 14 had cleft lip and palate (CLP) (unilateral, n = 9; bilateral, n = 5); and seven had isolated cleft palate (ICP). Occlusion function was analyzed in these three groups to examine the effects of different cleft types. For comparison, 26 healthy 4-year-old children with normal occlusion who attended five nursery schools in Sendai were enrolled in the study (Table 1). These children had no artificial crowns, defective fillings or defective caries in deciduous teeth, and no orthodontic appliances.

To evaluate the occlusal function, we used a high R type 50H dental prescale (pressure domain: 5–120 MPa) with occlusal pressure measurement film (Fuji Photo Film, Inc.). This type of dental prescale has been shown to give appropriate reproducibility in evaluation of occlusal conditions in children[8–11]. Occlusion was assessed in the intercuspal position and the subjects were instructed to bite the film as hard as possible for 2 seconds[8]. This was repeated three times for each subject, and the films were analyzed using the "Occluser FPD-703" system (Fuji Photo film Co.). Figure 2 shows data from the dental prescale of a child with CLA on both sides (Fig. 1A-a). The occlusal contact area, maximum bite pressure, average bite pressure and bite force were measured. The average of three measurements was calculated for each parameter and statistical analysis was performed by ANOVA and Mann-Whitney U test.

Results

The occlusal contact area, occlusal pressure and bite force in patients with CL/P and healthy control subjects are shown in Table 2. The mean occlusal contact areas in the two groups were 6.6 ± 2.8 and 6.3 ± 3.2 mm^2, respectively, showing no significant difference ($P>0.05$). The average and maximum bite pressures in patients with CL/P were significantly higher than those in healthy subjects (48.4 ± 4.9 vs. 43.9 ± 5.5 MPa, $P<0.01$; 113.4 ± 6.9 vs. 108.0 ± 8.7 MPa, $P<0.05$, respectively). The bite force in patients with CL/P (307.4 ± 116.8 N) was greater than that in the healthy controls (268.5 ± 118.2 N),

but without a significant difference.

The occlusal function parameters for different cleft types are shown in Table 3. Unilateral and bilateral cases were combined because these data showed no significant difference and the numbers of patients with CLA and CLP were small. There was no relationship between occlusal contact area and cleft type, and each value in the three cleft groups did not differ significantly from the respective values in healthy controls. The average bite pressure in patients with ICP was significantly higher than that in patients with CLA (51.7 ± 3.9 vs. 47.2 ± 3.7 MPa, $P<0.05$), but there were no significant differences in maximum bite pressure and bite force among the three cleft types. The average and maximum bite pressures in patients with ICP were significantly higher than those in healthy subjects (51.7 ± 3.9 vs. 43.9 ± 5.5 MPa, $P<0.01$; 116.6 ± 4.4 vs. 108.0 ± 8.7 MPa, $P<0.05$, respectively). There were no sex differences for any parameters.

Discussion

The bite pressure and bite force in children with CL/P were equal to or greater than those for children with normal occlusion without CL/P in cases which fulfilled the following three conditions: 1) the dental arch in children with CL/P was almost half round; 2) the deciduous molar teeth adopted an almost normal intercuspal position; and 3) anterior teeth contacts were maintained. Patients with CL/P were excluded from the study if the dental arch showed marked asymmetry or a unilateral posterior cross bite was observed. After this pre-selection of cases, there was no significant difference in the occlusal contact area between patients with CL/P and age-matched healthy controls. The occlusal contact area in the excluded children with CL/P was smaller than that in the children with CL/P included in the study (data not shown). Tanaka also described similar results[6]. These data indicate that the form of the dental arch and width of the maxilla is associated with the occlusal contact area. The average and maximum bite pressures in patients with CL/P were significantly greater than those in healthy controls, indicating that the occlusal function of children with CL/P is not necessarily inferior to that of children with normal occlusion without CL/P.

Some reports have suggested that the bite force in children with CL/P is generally low because of the asymmetric maxillary dental arch, and in children with unilateral CL/P the bite force on the affected side is smaller than that on the healthy side because the asymmetric dental arch diminishes the area of occlusal contact[6]. Our current results suggest that normal dental arch morphology is an indicator for acquisition of normal occlusal function, and together with Tanaka's data[6] this indicates that an improved dental arch morphology is very important for occlusal function during the deciduous dentition period in children with CL/P.

Masticatory function in children with CL/P has also been found to be lower than in healthy children in several studies. Jo[12] reported a close relationship between masticatory movement and dental arch morphology in healthy individuals, and Hozumi *et al.*[8] documented differences in bite force and masticatory efficiency among various occlusion types and found a correlation between masticatory function and occlusal contact area[8]. Yamamoto[5] compared the masticatory efficiency of children with CL/P using peanuts, and found lower efficiencies of 53.4%, 28.4% and 15.1% relative to controls in those with ICP, unilateral CLP and bilateral CLP, respectively. However, in cases of unilateral CLP there were no significant differences in masticatory efficiencies between the cross-bite side and non-cross side in the molar part of the dental arch, or between the cleft side and the unaffected side. Miyawaki[4] suggested a decrease in the dynamic occlusal contact relationship in the molar region during mastication as one of the reasons for the reduction of masticatory function in children with CL/P. Furthermore, Yamamoto[5] showed that tongue movement in a patient with CL/P who had undergone orthopedic surgery was somewhat restricted because the patient had a shallow palate and a small oral cavity volume.

In our data for three cleft types, the average bite pressure in patients with ICP was greater than that for the other types. If masticatory function in children with ICP has obstacles, as shown by Yamamoto[5], this function in children with CLA and CLP in our study might have been expected to be greater than for those with ICP. We did not investigate masticatory function, but we showed that the bite force was not reduced in children with CL/P with occlusal contact for most of the upper and lower teeth. We suggest that further studies of the relationship of masticatory function with occlusion in children with CL/P are required to improve the management of CL/P patients.

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