Original Article

Effects of sagittal maxillary growth hypoplasia severity on mandibular asymmetry in unilateral cleft lip and palate subjects

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ABSTRACT

Objective: To test the hypothesis that sagittal maxillary growth hypoplasia has no effect on mandibular asymmetry among subjects with complete unilateral cleft lip and palate (UCLP).

Design: A total of 86 subjects (normal noncleft, 42; UCLP, 44) in the age range of 15 to 25 years were chosen. Normal noncleft subjects were included in Group I. Based on the severity of sagittal maxillary growth hypoplasia, subjects with UCLP were divided into two groups. Subjects with UCLP in whom the SNM angle was \geq 71 degrees and the M-point to Nasion perpendicular distance was \leq -10 mm were included in Group II. Group III consisted of subjects with UCLP in whom the SNM angle was <71 degrees and the M-point to Nasion perpendicular distance was angle was <71 degrees and the M-point to Nasion perpendicular distance was >-10 mm. The mandibular asymmetry index (condylar, ramal, and condylar+ramal), gonial angle, and depth of the antigonial notch of three groups of subjects were examined on orthopantomograms (OPGs).

Results: Among Group II subjects in whom sagittal maxillary growth was near normal, ramal and condylar+ramal heights were significantly less on the cleft side than on the normal side (P < .01). Condylar, ramal, and condylar+ramal asymmetry indices were significantly greater among Group II subjects. Mandibular asymmetry indices among Group III subjects were comparable with those in Group I subjects.

Conclusion: The hypothesis was rejected. The mandible was significantly asymmetrical among subjects with UCLP in whom sagittal maxillary growth was near normal, whereas the mandible was nearly symmetrical among subjects with UCLP in whom sagittal maxillary growth hypoplasia was very severe. (*Angle Orthod.* 2011;81:872–877.)

KEY WORDS: Mandibular asymmetry; Unilateral cleft lip and palate

INTRODUCTION

Asymmetrical maxillary growth in subjects with unilateral cleft lip and palate (UCLP) is well documented in the literature.^{1–4} Although mandibular growth in subjects with unilateral cleft lip and palate is not directly affected by the

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cleft, the mandible occludes with the maxilla. It is therefore theorized that mandibular asymmetry exists in subjects with UCLP.^{5–9} Some investigators have reported significant mandibular asymmetry among subjects with UCLP,^{7–10} but others have found no differences.^{5,10–12} Recently, Kurt et al.¹² evaluated the effects of various cleft types on mandibular asymmetry and found that mandibular asymmetry among subjects with unilateral and bilateral cleft lip and palate was comparable with the asymmetry present in normal individuals.

A few studies have mentioned mandibular asymmetry among subjects with UCLP, but to our knowledge, no study in the literature has discussed the effects of sagittal maxillary growth hypoplasia severity on mandibular asymmetry. Thus the present study was designed to evaluate the effects of sagittal maxillary growth hypoplasia severity on mandibular asymmetry among subjects with UCLP.

MATERIALS AND METHODS

The sample for this study was selected from among subjects who were actively undergoing comprehensive

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Fable 1.	Description of Age,	SNM Angle,	and Nperpendicular te	o M-Point Distance	Among Three	Groups of Subjects
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	Group I (n = 42) Mean \pm SD	Group II (n = 17) Mean \pm SD	Group III (n = 27) Mean \pm SD
Age, y	19.55 ± 4.67	16.59 ± 2.06	16.81 ± 2.32
SNM, degrees	74.56 ± 3.51	73.35 ± 1.99	62.81 ± 4.84
Nperpendicular to M Point, mm	-7.49 ± 2.55	-8.16 ± 1.12	-17.03 ± 3.78

orthodontic treatment. Written consent was obtained from all patients, and the study was approved by the Institute Review Board. A total of 86 subjects (age range, 15 to 25 years) were chosen for the study. Among 86 subjects, 42 were normal noncleft subjects and 44 were subjects with UCLP. Subjects with cleft lip and palate had various severities of sagittal maxillary growth hypoplasia. The timing and the technique of cleft palate repair were neglected while subjects with cleft lip and palate were selected for the study. The following inclusion and exclusion criteria were applied in selecting subjects for the study.

Normal Subjects

Inclusion criteria:

- · Orthognathic and pleasing profile
- · Apparently symmetrical face
- Bilateral Class I molar relationship with mild to moderate crowding or spacing (<6 mm) and/or with unilateral or bilateral impacted maxillary canines
- Presence of full complement of teeth except third molars

Exclusion criteria:

- · History of past orthodontic treatment
- Presence of unilateral and/or bilateral posterior cross-bite
- Any known systemic disease affecting general growth and development

Subjects with Unilateral Cleft Lip and Palate

Inclusion criteria:

Complete UCLP

Exclusion criteria:

- History of past orthodontic treatment
- · Subjects with syndromic cleft lip and palate
- Any known systemic disease affecting general growth and development

Initially, lateral cephalograms of normal noncleft subjects (n = 42; M = 21, F = 21) and of subjects with UCLP (n = 44; M = 23, F = 21) were traced manually for evaluation of the sagittal position of the maxilla in relation to the anterior cranial base. The sagittal position of the maxilla was evaluated from the SNM

angle (the angle between point Sella, Nasion, and Mpoint [M-point represented the center of the premaxilla¹³]) and the linear distance from M-point to Nasion perpendicular. All normal noncleft subjects were included in Group I. Based on the severity of maxillary hypoplasia, subjects with UCLP were divided into Groups II and III. In normal subjects (n = 42), the SNM angle and the linear distance from M-point to Nasion perpendicular were calculated first as 74.56 \pm 3.51 degrees and -7.49 ± 2.55 mm, respectively. Subjects with cleft lip and palate in whom the SNM angle was less than one standard deviation (SD) of 74.56 degrees (ie, SNM angle approximately <71 degrees) and the linear distance from M-point to Nasion perpendicular was more than one SD of -7.49 mm (ie, approximately >-10 mm) were included in the severe sagittal maxillary growth hypoplasia group (Group III). Subjects with cleft lip and palate in whom



Figure 1. Measurement on the orthopantomogram (OPG), according to Habets et al. O_1 and O_2 , most lateral points of the ramus; A, ramus tangent; B, perpendicular line from A to the most superior part of the condylar image; C, corpus tangent; CH, condylar height; and RH, ramus height.

	Group I (n = 42)			Group II ($n = 17$)		
Variables	Right Side, Mean \pm SD	Left Side, Mean \pm SD	Comparison (<i>P</i> Value)†	Cleft Side, Mean \pm SD	Normal Side, Mean \pm SD	Comparison (<i>P</i> Value)†
Condylar (Co) height, mm Ramus (Ra) height, mm	7.16 ± 1.65 46.63 ± 4.72	7.44 ± 1.49 46.16 ± 4.38	.066 ^{NS} .052 ^{NS}	6.03 ± 1.26 41.09 ± 5.05	6.42 ± 1.02 43.09 ± 6.21	.252 ^{NS} .003**
Co+Ra height, mm Gonial angle, degrees Antigonial notch, mm	$\begin{array}{c} 53.79 \pm 5.02 \\ 124.87 \pm 7.42 \\ 1.83 \pm 1.37 \end{array}$	$\begin{array}{r} 53.60 \pm 4.66 \\ 125.09 \pm 7.22 \\ 1.71 \pm 1.37 \end{array}$.400 ^{NS} .487 ^{NS} .281 ^{NS}	$\begin{array}{r} 47.12\ \pm\ 5.61\\ 129.38\ \pm\ 4.98\\ 2.09\ \pm\ 1.09\end{array}$	$\begin{array}{r} 49.51\ \pm\ 6.57\\ 127.26\ \pm\ 4.61\\ 1.74\ \pm\ 1.11\end{array}$.004** .026* .194 ^{№S}

Table 2. Measurement of Various Orthopantomogram (OPG) Variables Among Three Groups of Subjects

† NS, nonsignificant; * $P \leq .05$; ** $P \leq .01$.

the SNM angle was \geq 71 degrees and the linear distance from M-point to Nasion perpendicular was \leq -10 mm were included in the less severe sagittal maxillary growth hypoplasia group (Group II). Chronological age and other descriptors of each group are presented in Table 1.

Mandibular asymmetry in normal noncleft subjects and subjects with cleft lip and palate was evaluated from orthopantomograms (OPGs). All OPGs were recorded in the Kodak x-ray machine (Kodak 8000C digital panoramic and cephalometric system, Eastman Kodak Company, Horsham, Pa) using similar standard procedures. The head of the subject was positioned securely in the OPG machine with the head well centered in the head holder and with the Frankfort horizontal (FH) plane of the subject kept parallel to the floor. The outline of the whole mandible was traced on acetate paper. Condylar height, ramal height, condylar+ramal height, gonial angle, and depth of the antigonial notch were measured on OPG tracings by the same method as suggested by Habets et al.14 in 1988. On the OPG tracing, a line (A-line, the ramus tangent) was drawn between the most lateral points of the condylar (O_1) and ascending ramus (O_2) image (Figure 1). To the A-line (the ramus tangent) from the most superior point of the condylar image, a perpendicular B-line was drawn. The vertical distance from this line on the ramus tangent to O_1 projected on the ramus tangent was measured. This distance was termed condylar height (CH), and that between O₁ and O₂ was referred to as ramus height (RH). A C-line was constructed as a tangent on the mandibular corpus of each side, and the angle between the Aand C-lines was measured as the gonial angle. The maximal depth from the C-line to the lower border of the mandible was considered as the depth of the antigonial notch (Figure 1). For estimation of condylar, ramal, and condylar+ramal asymmetry, the following indices were used:

Condylar asymmetry index =
$$\left[\frac{CH_{right} - CH_{left}}{CH_{right} + CH_{left}}\right] \times 100$$

Ramal asymmetry index =
$$\begin{bmatrix} RH_{right} - RH_{left} \\ RH_{right} + RH_{left} \end{bmatrix} \times 100$$

Condylar + Ramal asymmetry index =

$$\left[\frac{(\text{CO} + \text{RH})_{\text{right}} - (\text{CO} + \text{RH})_{\text{left}}}{(\text{CO} + \text{RH})_{\text{right}} + (\text{CO} + \text{RH})_{\text{left}}}\right] \times 100$$

The same investigator completed all measurements on the OPGs thrice, and the mean value was subjected to statistical analysis.

Statistical Analysis

A master file was created and the data were statistically analyzed on a computer with Statistical Package for the Social Sciences (SPSS) software, version 13 (SPSS Inc, Chicago, III). A data file was created under dBase and was converted into a microstat file. Data were subjected to descriptive analysis to determine mean, SD, and range. Any significant differences in condylar height, ramal height, condylar+ramal height, gonial angle, and depth of the antigonial notch between the right and left sides in Group I subjects, and between the cleft side and the normal side in Group II and Group III subjects, were analyzed with a *t*-test. The Kruskal-Wallis test was applied to determine statistically significant differences

Table 3. Measurement of Various Asymmetrical Indices Among Three Groups of Subjects†

	Group	l (n = 42)		Group	II (n = 17)	Group) III (n = 2	7)
Variables	$\text{Mean} \pm \text{SD}$	Min	Max	$\text{Mean}\pm\text{SD}$	Min	Max	$\text{Mean} \pm \text{SD}$	Min	Max
Condylar (Co) index, %	4.62 ± 4.95	0.12	19.45	8.80 ± 6.52	2.04	28.00	6.83 ± 6.31	0.09	28.57
Ramal (Ra) index, %	1.17 ± 1.00	0.01	4.02	4.07 ± 6.23	0.12	27.12	$1.34~\pm~1.20$	0.02	3.66
Co+Ra index, %	0.84 ± 0.91	0.01	4.59	3.05 ± 2.15	0.30	7.72	1.27 ± 0.91	0.09	3.84

† Max, maximum; Min, minimum; NS, nonsignificant; * $P \le .05$; ** $P \le .01$; *** $P \le .001$.

Table 2. Extended

	Group III (n = 27)	
Cleft Side Mean \pm SD	Normal Side, Mean \pm SD	Comparison (<i>P</i> Value)†
$\begin{array}{c} 6.46 \pm 1.49 \\ 45.21 \pm 5.08 \\ 51.67 \pm 5.22 \\ 131.70 \pm 6.66 \\ 2.20 \pm 1.21 \end{array}$	$\begin{array}{c} 6.73 \pm 1.69 \\ 45.41 \pm 5.39 \\ 52.14 \pm 6.14 \\ 131.52 \pm 5.98 \\ 1.87 \pm 1.31 \end{array}$.466 ^{NS} .482 ^{NS} .174 ^{NS} .690 ^{NS} .058 ^{NS}

within groups, and the Mann-Whitney *U*-test was used for intergroup comparisons of condylar, ramal, and condylar+ramal asymmetry indices. The probability (*P* value) of .05 was considered statistically significant. The power of the study was calculated as 73%.

RESULTS

OPG measurements among the three groups of subjects are described in Table 2. In Group I subjects, all measurements on OPGs were comparable between right and left sides. In Group II subjects, condylar height and depth of the antigonial notch were comparable between cleft and normal sides; however, ramal and condyle+ramal heights were significantly less on the cleft side than on the normal side (P < .01). The gonial angle on the cleft side in Group II subjects also was significantly greater than on the normal side (P < .05). In Group III subjects, all OPG measurements between cleft and normal sides were comparable, and no significant difference between them was noted.

Descriptive statistics and comparison of asymmetry indices between the three groups are described in Table 3. All asymmetry indices were significantly different among the three groups of subjects. The condylar index was significantly greater in Group II subjects than in Group I subjects (P < .01); however, it was comparable among Group II and Group III subjects (P = .278). The ramal index among subjects in Groups I and III was comparable, but a significant difference was noted between Groups I and II (P < .001) and between Groups II and III (P < .001) and between Groups II and III (P < .05). The condylar+ramal index was significantly greater in Group II subjects (P < .001) and Group III subjects (P < .01). The

Table 3. Extended

Comparison	Intergroup Comparison					
(P Value)	I vs II	II vs III				
.025*	.008**	.126 ^{№S}	.278 ^{№S}			
.006**	.001***	.749 ^{NS}	.016*			
.001***	<.001***	.013*	.002**			

condylar+ramal index was also significantly greater in Group III subjects as compared with Group I subjects (P < .05).

DISCUSSION

The use of OPGS for the evaluation of side-to-side mandibular asymmetry is well established in the literature.^{1,12,15–21} It is also well established that vertical and angular measurements on the OPG are reproducible if the OPGs are recorded properly.²⁰ Thus in the present study, OPGs were used for evaluation of mandibular asymmetry. In the present study, the age of all subjects was greater than 15 years to ensure that mandibular growth had reached near adult levels.

Lower face asymmetry among subjects with UCLP manifests at an early age, and asymmetry increases with growth and peaks at postpubertal growth spurt stages.⁹ Asymmetry is greater among subjects with UCLP than among noncleft control subjects at all stages of growth and follows the affected maxilla closely, indicating a parallel growth pattern of the jaw.²²

Possible causative factors contributing to the development of mandibular asymmetry among subjects with UCLP include true skeletal asymmetry, positional adaptation of the lower jaw to an asymmetrical mandibular fossa (cranial base), and functional adaptation to dentoalveolar and occlusal disharmonies.²² Smahel and Brejcha⁷ suggested that mandibular asymmetry most probably was related to the more marked dentoalveolar malocclusion of the frontal segment of the denture in complete clefts, and mandibular malfunction was independent of cleft types, suggesting underlying primary impairment of growth of the lower jaw. Kyrkanides et al.²³ reported that the degree of lower facial asymmetry correlated with the severity of the maxillary dentoalveolar vertical discrepancy.

Excessive antigonial notching is associated with deficient mandibular growth, that is, a growth adaptation compensatory for aberrant muscle activity and condylar pathology.23 According to Subtenly,24 antigonial notching and reduced ramal height correlated with the side of reduced mandibular development, which suggested a causative correlation between the degenerative mandibular condyle and lower facial asymmetry. Ricketts²⁵ also found that excessive antigonial notching was associated with poor condylar growth and lack of vertical posterior facial growth. According to Singer et al.,²⁶ the depth of the antigonial notch was correlated with impaired mandibular growth. In the present study, similar observations were noted. The depth of the antigonial notch was greater on the cleft side than on the noncleft side, and the height of the condyle was less on the cleft side as compared with the noncleft side among subjects with cleft lip and palate. This clearly suggested that vertical growth of the mandibular condyle was deficient on the cleft side as compared with the noncleft side.

In the present study, side-to-side measurements on the OPG among normal subjects were comparable. However, all side-to-side measurements were not exactly equal in any of the normal subjects. This showed that some mandibular asymmetry is present among subjects with a pleasing and apparently symmetrical face. Kurt et al.¹² reported similar observations. Among Group II subjects in whom sagittal maxillary growth hypoplasia was much less, ramal and condylar+ramal heights on the cleft side were significantly less as compared with dimensions on the noncleft side. The gonial angle and the depth of the antigonial notch on the cleft side were also greater as compared with the normal side. However, among Group III subjects in whom sagittal maxillary growth hypoplasia was very severe, all side-to-side measurements were comparable, possibly because when sagittal maxillary growth hypoplasia was very severe, no or minimal influence of maxillary growth on the mandible was noted, and the mandible grew according to its innate growth potential. However, when sagittal maxillary growth hypoplasia was much less, in those subjects the influence of maxillary growth on the mandible was greater, and adaptation of mandibular growth occurred as compensation for asymmetrical maxillary growth.

All asymmetrical indices in Group II subjects were significantly greater as compared with normal subjects. Although all asymmetrical indices were greater among Group III subjects as compared with normal subjects, they were comparable. Also all asymmetries were significantly greater in Group II subjects as compared with Group III subjects. According to Habets et al.,15 asymmetrical index values greater than 3% should be considered as true mandibular posterior vertical asymmetry. In our study, in Group II subjects all asymmetry indices were greater than 3%, whereas in Group III subjects, all asymmetry indices except condylar index were less than 3%. This suggested that mandibular posterior vertical growth was more symmetrical among subjects with cleft lip and palate in whom sagittal maxillary growth hypoplasia was very severe than among subjects with cleft lip and palate in whom sagittal maxillary growth was near normal.

Thus the present study showed that posterior vertical growth of the mandible was always deficient on the cleft side, irrespective of sagittal maxillary growth hypoplasia severity. However, this deficiency was very minimal when sagittal maxillary growth hypoplasia was very severe. Although mandibular asymmetry was much greater among subjects with minimal sagittal maxillary growth hypoplasia, this may not have much significant clinical importance.

CONCLUSIONS

- Mandibular growth was deficient on the cleft side among subjects with unilateral cleft lip and palate, irrespective of the severity of sagittal maxillary growth hypoplasia.
- Mandibular asymmetry was significantly greater among subjects with unilateral cleft lip and palate in whom sagittal maxillary growth was near to normal.
- The mandible was nearly symmetrical among subjects with unilateral cleft lip and palate in whom sagittal maxillary growth hypoplasia was very severe.

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