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Mandibular asymmetry in cleft lip and palate patients

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SUMMARY The aims of this study were to evaluate condylar, ramal, and condylar plus ramal mandibular vertical asymmetry in a group of cleft lip and palate (CLP) patients and compared with subjects with a 'normal' occlusion. Mandibular asymmetry index (condylar, ramal, and condylar plus ramal) and gonial angle measurements were examined on panoramic radiographs. The study groups comprised 20 unilateral cleft lip and palate (UCLP) patients (10 males and 10 females; mean age 13.03 ± 3.33 years), 20 bilateral cleft lip and palate (BCLP) patients (10 males and 10 females; mean age 13.73 ± 3.53 years), and a control group of 20 subjects (9 males and 11 females; mean age 14.35 ± 2.46 years) with a normal occlusion. Kruskal–Wallis one-way analysis of variance was used to determine statistically significant differences between the groups for condylar, ramal, and condylar plus ramal asymmetry index measurements at the 95 per cent confidence interval.

None of the investigated groups showed statistically significant gender differences for posterior vertical height measurements ($P > 0.05$). Asymmetry indices were similar, with no statistically significant differences found in any of the groups. However, gonial angle showed statistically significant differences ($P < 0.05$) in the UCLP group and condylar height (CH) in the BCLP patients ($P < 0.001$). Except for CH measurement in the BCLP group, CLP patients have symmetrical mandibles when compared with a normal occlusion sample.

Introduction

Asymmetry of the craniofacial complex can be recognized as differences in the size or relationship of the two sides of the face. This may be the result of discrepancies either in the form of individual bones or a malposition of one or more bones in the craniofacial complex. The asymmetry may also be limited to the overlying soft tissues (Sutton, 1968; Bishara *et al.*, 1994).

Cleft lip and palate (CLP) patients generally present anterior and posterior crossbites and mid-face deficiency with a tendency towards a Class III malocclusion (Shetye and Evans, 2006). In the literature, some authors reported significant mandibular asymmetries (Smahel and Brejcha, 1983; Laspos *et al.*, 1997), while others found no differences (Ishiguro *et al.*, 1976; Horswell and Levant, 1988) in CLP patients. Laspos *et al.* (1997) observed that individuals with a unilateral cleft lip and palate (UCLP) show asymmetry of the lower facial skeleton on postero-anterior (PA) radiographs. Smahel and Brejcha (1983) studied lateral and PA radiographs of 58 UCLP (32 complete CLP and 26 incomplete clefts of the palate) individuals and noted a shorter mandibular ramus in complete UCLP patients. Ishiguro *et al.* (1976) compared the morphological craniofacial patterns of 51 UCLP, 27 bilateral cleft lip and palate (BCLP), and 62 isolated cleft palate patients using PA radiographs but found no significant cleft group differences. Horswell and Levant (1988) who compared 16 UCLP subjects with published cephalometric standards did not find any significant differences in mandibular dimensions and morphology between the two groups.

Habets *et al.* (1988) described a method for measuring the vertical condylar and ramal heights for comparing the right and left sides of the mandible for evaluating condylar and ramal asymmetry. This method has been used to determine mandibular asymmetry in patients with temporomandibular disorders (TMD; Habets *et al.*, 1987, 1988; Miller *et al.*, 1996; Miller, 1997; Saglam and Sanli, 2004), Class II (Miller and Smidt, 1996), Class III malocclusions (Miller and Bodner, 1997), bilateral posterior crossbites (Kiki *et al.*, 2007), and different skeletal patterns (Saglam, 2003; Sezgin *et al.*, 2007; Kurt *et al.*, 2008; Uysal *et al.*, 2009).

In a recent study, Kurt *et al.* (2008) evaluated condylar and ramal mandibular asymmetry in a group of patients with Class II subdivision malocclusions using the method described by Habets *et al.* (1988). They showed that, except for condylar, ramal, and condylar plus ramal height measurements, Class II subdivision patients have a symmetrical condyles when compared with subjects with a normal occlusion.

In a review of the orthodontic literature, no published study was found that compared mandibular vertical asymmetry using the method of Habets *et al.* (1988) in a group of UCLP and BCLP patients compared with a normal occlusion sample. Therefore, the aim of this study was to evaluate condylar and ramal mandibular asymmetry in a group of patients with CLP in comparison with subjects with a normal occlusion.

Subjects and methods

Three groups were selected from the archives of the Department of Orthodontics, Faculty of Dentistry, Ondokuz Mayis University. All patients had undergone surgery using the Tennison and Millard techniques for cleft lip reconstruction and the Wardill–Kilner pushback technique for surgical construction of the cleft palate. The sample size and distributions of ages in the different groups are shown in Table 1. The research protocol was approved by the Regional Research Ethics Committee of the University of Erciyes.

Normal occlusion sample

Dental pantomograms (DPTs) were taken of 20 subjects (9 males and 11 females) for surgical indications with normal occlusion meeting the following criteria (Uysal, 2003):

1. Class I canine and molar relationship with minor or no crowding, normal growth and development, and well-aligned upper and lower dental arches;
2. All teeth present except third molars;
3. Good facial symmetry determined clinically;
4. No significant medical history; and
5. No history of trauma or any previous orthodontic or prosthodontic treatment, maxillofacial, or plastic surgery.

UCLP group

The following selection criteria were used in the UCLP group (10 males and 10 females):

1. Complete unilateral cleft lip, alveolus, and palate (5 right and 15 left side);
2. No systemic disease, no developmental or acquired craniofacial, or neuromuscular deformities;
3. No significant facial asymmetry;
4. No history of orthodontic treatment; and
5. No signs or symptoms of TMD.

Table 1 Mean and standard deviations (SD) of chronological ages for each group.

Groups	Gender	*n*	Age (years)	
			Mean	SD
Normal occlusion	Male	9	13.44	2.65
	Female	11	15.09	2.12
	Total	20	14.35	2.46
Unilateral cleft lip and palate group	Male	10	13.35	3.57
	Female	10	12.70	3.23
	Total	20	13.03	3.33
Bilateral cleft lip and palate group	Male	10	14.95	3.34
	Female	10	12.50	3.45
	Total	20	13.73	3.53

BCLP group

The last four selection criteria (2–5) for UCLP patients were also valid for this group. Twenty subjects (10 males and 10 females) with complete bilateral cleft lip, alveolus, and palate were taken as the BCLP group.

The DPTs were exposed with Planmeca Proline CC, Helsinki, Finland, and processed (Dent-X 810, Elmsford, New York, USA) which had been previously standardized. All radiographs were taken in a standard manner by the same operator. The subjects were positioned with the lips at rest and the head orientated at the Frankfort horizontal plane (Azevedo *et al.*, 2006). The outlines of the condyle, the ascending ramus, and corpus of both sides were traced on acetate paper. On the tracing paper, a line (A-line) was drawn between the most lateral points of the condylar (O_1) and of the 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 the O_1 and O_2 ramus height. A C-line was constructed as a tangent on the mandibular corpus of each side and the angle between the A- and C-line was measured as the gonial angle (Figure 1). To measure condylar, ramal, and condylar plus ramal asymmetry, the following formula was used:

$$\text{Asymmetry index: } \left|\frac{CH_{right} - CH_{left}}{CH_{right} + CH_{left}}\right| \times 100.$$

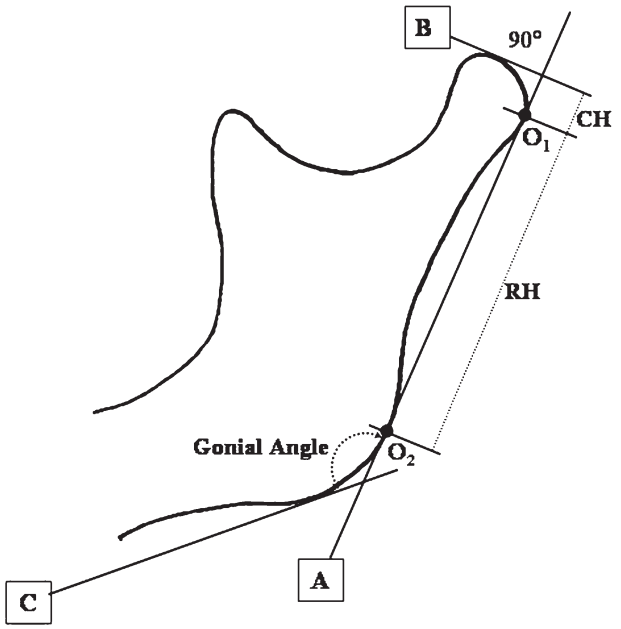

Figure 1 Measuring method according to Habets *et al.* (1988). O_1 and O_2, most lateral points of the image; A, ramus tangent; B, perpendicular line from A to the most superior part of the condylar image; C, corpus tangent; CH, condylar height; and RH, ramus height.

Statistical analysis

All statistical analyses were performed using the Statistical Package for Social Sciences for Windows, version 10.1 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were computed. The Kruskal–Wallis one-way analysis of variance was used to determine statistically significant differences between the groups for condylar, ramal, and condylar plus ramal asymmetry index measurements at a significance level of $P < 0.05$. A Mann–Whitney *U*-test was used to determine statistically significant differences between genders and sides for condylar, ramal, and condylar plus ramal height measurements.

A power analysis indicated that, a sample size of 60 subjects was required [20 normal occlusion, 9 male and 11 female (power: 68%); 20 unilateral, 10 male and 10 female (power: 72%); and 20 bilateral, 10 male and 10 female (power: 0.70%); CLP group].

Four weeks after the first measurements, 20 randomly selected DPTs were re-measured by the same author. A paired samples *t*-test was applied to the measurements. The difference between the first and second measurements of the 20 radiographs was insignificant. Correlation analysis yielded the highest *r* value, 0.991, for left gonial angle measurement and the lowest *r* value, 0.884, for left CH measurements. The method error was calculated using Dahlberg's formula. The values changed from 0.492 to 0.984 and were within acceptable limits.

Results

The descriptive mandibular asymmetry index for both male and female subjects were calculated separately in the normal occlusion and CLP patient groups to investigate the relationship between genders. Statistical testing revealed no significant differences between the mean values of the male and female subjects. Therefore, data for both genders were pooled for further analyses.

Statistical comparison of condylar, ramal, condylar plus ramal height, and gonial angle for the right and left sides in the normal occlusion and BCLP groups and for the cleft side and normal side in UCLP group are shown in Table 2.

There was no statistically significant difference in the normal occlusion group. Gonial angle exhibited a statistically significant difference ($P < 0.05$) in the UCLP group and CH ($P < 0.001$) in the BCLP group. Other measurements did not show any significant differences ($P > 0.05$; Table 2).

Descriptive statistics (mean, standard deviation, minimum, and maximum) and comparisons of the asymmetry indices between the normal occlusion, UCLP, and BCLP groups are shown in Table 3. Condylar asymmetry, ramal asymmetry, and condylar plus ramal asymmetry indices measurements did not exhibit any statistically significant difference. Thus, the use of further tests was not necessary for comparison of asymmetry indices among the investigated groups.

Discussion

DPTs have been used for the assessment of side-to-side height differences and measurement of condylar, ramal, and total heights to define side-to-side asymmetries (Habets *et al.*, 1987, 1988; Miller and Smidt, 1996; Miller *et al.* 1996; Miller, 1997; Miller and Bodner, 1997; Saglam, 2003; Saglam and Sanli, 2004; Kiki *et al.*, 2007; Sezgin *et al.*, 2007; Kurt *et al.*, 2008; Uysal *et al.*, 2009). A bilateral view of the mandible can be obtained with a DPT, and vertical measurements can be achieved (Wabeke *et al.*, 1995). A number of studies have been used DPTs to evaluate side-to-side differences (Habets *et al.*, 1987, 1988; Bezuur *et al.*, 1989). Kambylafkas *et al.* (2006) showed that DPTs can be used to asses vertical posterior mandibular asymmetries. Kyrkanides and Richter (2002) concluded that the degree of antegonial notching noted on DPTs can be used as an early indicator of developing mandibular and lower facial asymmetry in individuals with UCLP. These reports suggest that acceptable results can be achieved with DPTs and that they have a favourable cost–benefit relationship, and expose subjects to relatively low doses of radiation (Kambylafkas *et al.*, 2006).

The reproducibility of vertical and angular measurements on DPTs is acceptable if the patient's head is correctly positioned in the cephalostat (Yale, 1969; Larheim *et al.*, 1984; Kiki *et al.*, 2007). Habets *et al.* (1987) concluded that the head holder must be securely fixed to the DPT with the head well centred in the head holder of the DPT when a clinical film is to be evaluated. In this study, all films were taken under ideal conditions and inadequate and/or poor quality films were excluded.

Condylar, ramal, and condylar plus ramal height values were higher for the normal than the cleft side in the UCLP group, but the differences were statistically insignificant. Horswell and Levant (1988) who compared 16 UCLP subjects with published cephalometric standards did not find any significant differences in mandibular dimensions or morphology between the two groups. Gonial angle was higher on cleft side than on the normal side, and the difference was statistically significant ($P < 0.05$). This higher gonial angle value can be attributed to a compensation mechanism of the mandible on the cleft side for maintaining bilateral symmetry.

Comparison of right and left sides for condylar, ramal, condylar plus ramal height values, and gonial angle measurements in the BCLP group showed only a statistically significant difference for CH, indicating a symmetrical posterior vertical height of the mandible. The method described by Habets *et al.* (1988) has been used for evaluating condylar and ramal asymmetries in TMD patients (Habets *et al.*, 1987, 1988; Miller *et al.*, 1996; Miller, 1997; Saglam and Sanli, 2004) and in different malocclusions (Miller and Smidt, 1996; Miller and Bodner, 1997; Saglam, 2003; Kiki *et al.*, 2007; Sezgin *et al.*, 2007; Kurt *et al.*, 2008; Uysal

Table 2 Statistical comparison of height measurements and gonial angle for right and left sides in normal and bilateral cleft lip and palate (BCLP) groups and for cleft and normal sides in unilateral cleft lip and palate (UCLP) group.

	Normal group				Test	UCLP group				Test	BCLP group				Test
	Right side		Left side			Cleft side		Normal side			Right side		Left side		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Condylar height	5.18	1.54	5.03	1.44	NS	6.25	1.54	6.95	1.97	NS	7.10	2.08	5.78	1.51	***
Ramus height	34.38	3.67	33.70	3.66	NS	45.63	5.72	45.83	6.37	NS	44.25	5.53	45.03	5.01	NS
Condylar plus ramal height	39.55	4.01	38.73	3.69	NS	51.88	5.94	52.78	6.66	NS	51.35	6.17	50.80	5.13	NS
Gonial angle	125.53	8.11	125.23	7.35	NS	128.48	5.23	127.4	5.72	*	133.78	8.65	133.25	8.28	NS

NS, not significant. *$P < 0.05$, ***$P < 0.001$.

Table 3 Statistical comparison of asymmetry index measurements among normal occlusion, unilateral cleft lip and palate (UCLP), and bilateral cleft lip and palate (BCLP) groups.

Variable	Normal group				UCLP group				BCLP group				Test
	Mean Difference	SD	Minimum	Maximum	Mean Difference	SD	Min	Max	Mean Difference	SD	Min	Max	
Condylar index	9.95	10.42	0.00	38.46	10.27	10.13	0.00	42.11	10.78	10.02	0.00	30.77	NS
Ramal index	2.91	2.29	0.00	7.44	3.02	3.11	0.00	12.56	2.82	3.08	0.00	14.29	NS
Condylar plus ramal index	2.26	1.26	0.65	5.03	2.62	2.84	0.00	9.73	2.85	2.07	0.50	9.27	NS

NS, not significant.

et al., 2009). According to Habets *et al.* (1987), a 3 per cent index ratio may result from a 1 cm change in head position while the DPT is being taken, and thus asymmetry index values (condylar, ramal, and condylar plus ramal asymmetry indices) greater than 3 per cent should be considered as mandibular posterior vertical asymmetry. In this study, for all three groups, condylar asymmetry index values were above 3 per cent, 9.95 ± 10.42, 10.27 ± 10.13, and 10.78 ± 10.02, for the normal, UCLP, and BCLP groups, respectively, indicating asymmetry, but the difference was not significant. Other studies evaluating condylar asymmetry with this method in different malocclusions and in TMD patients also found asymmetry values greater than 3 per cent both in study and control groups (Miller *et al.* 1996; Miller and Smidt, 1996; Miller and Bodner, 1997; Saglam and Sanli, 2004; Kurt *et al.*, 2008). These high values indicating asymmetry both in the treatment and control groups can be attributed to shape, angular, and positional differences between the right and left condyles without any pathology or without any related malocclusion (Yale, 1969). Cohlmia *et al.* (1996) found that the left condyle was positioned more anteriorly than the right condyle and Yale (1969) showed shape and angular differences of the condyles.

Ramal and condylar plus ramal index measurements used for evaluating posterior vertical dimensions of the mandible were similar among the three groups; the differences were statistically insignificant. No study exists that has evaluated mandibular asymmetry in CLP patients using the method of Habets *et al.* (1988). Laspos *et al.* (1997) found that the degree of mandibular asymmetry in UCLP appears not to be the major contributing factor to lower facial asymmetry in these individuals. Those authors attributed such asymmetry to possible cranial-base/temporal region anomalies.

Patients with no significant facial asymmetry were included in this study to evaluate possible, isolated asymmetry of the mandible in CLP individuals. No posterior vertical asymmetry (ramal and condylar plus ramal indices) was found in the mandibles of either the UCLP or BCLP individuals. Early detection of skeletal asymmetry in these patients gives an opportunity for interceptive therapy that can improve long-term treatment outcome. Diagnosis, treatment planning, and design of mechanics for the asymmetric patient requires the differentiation between problems of dental and skeletal origin (Kyrkanides and Richter, 2002).

Conclusion

1. No statistically significant gender differences in mandibular asymmetry were found among the normal occlusion sample or the UCLP and BCLP patient groups, as condylar asymmetry index values were significantly higher compared with the 3 per cent threshold value of Habets *et al.* (1987) in each of the three individual groups. Comparisons between groups were not statistically significant.
2. A statistically significant increase was found for gonial angle on the cleft side in the UCLP group.

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