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Cleft type and Angle's classification of malocclusion in Korean cleft patients

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SUMMARY This study was performed to investigate the contributing factors, such as cleft type, side of cleft, patient's age, and gender, associated with Angle's classification of malocclusion in Korean cleft patients. The records of 250 cleft patients (175 males, 75 females) who attended the Department of Orthodontics, Seoul National University Dental Hospital between 1988 and 1999 were examined.

The percentages of subjects with cleft lip (CL), cleft lip and alveolus (CLA), cleft palate (CP), and cleft lip and palate (CLP) were 7.6, 19.2, 9.6, and 63.6, respectively. The overall distributions of unilateral and bilateral clefts were 76 and 24 per cent, respectively. The overall percentages of Class I, II, and III malocclusions were 18.5, 8.8, and 72.7. The frequency of Class III malocclusions was most prevalent in all age groups. Bivariate analysis showed that whilst gender was not significant, the type of cleft significantly influenced the development of a Class III malocclusion ($P < 0.01$). Using logistic regression analysis, subjects in the CP ($P < 0.05$) and CLP groups ($P < 0.01$) were 3.9 and 5.5 times more likely to have a Class III malocclusion than those in the CL group. There was, however, no statistical difference in the prevalence of a Class III malocclusion between the CL and the CLA groups ($P > 0.05$). When the degree of cleft involvement in the palate increased, so did the predominance of a Class III malocclusion.

Introduction

Cleft lip and/or palate (CLP) is one of the most common congenital craniofacial anomalies. Its incidence has been increasing due to the decrease in post-natal mortality and post-surgical morbidity, and the increase of genetic and environmental epidemiological factors (Fogh-Andersen, 1961; McCarthy, 1976; Rintala and Stegars, 1982).

CLP in Orientals has been reported to occur with an incidence of 1:500 to 1:600 (Ching and Chung, 1974; Chapman, 1983; Vanderas, 1987), and in Koreans from 1:1598 to 1:444 (Nam, 1975; Shin *et al*., 1979; Kim and Loo, 1982; Yang *et al*., 1983; Kim and Yoon, 1987; Kim, 1987; Min *et al*., 1996). However, the wide variations in Koreans were due to problems in sample selection.

Because the development of the primary palate (lip and premaxilla), which takes place during the fourth to the seventh week of gestation, is embryologically different from that of the secondary palate (hard and soft palate), which develops during the seventh to the 12th week (Conway and Wagner, 1966), epidemiological studies on CLP should be carried out by classification of cleft types.

Scar tissue, which develops after CLP surgery, can play a crucial role in the disturbance of normal maxillary growth (Bardach *et al*., 1979). Due to hypoplasia of the maxilla and relative prognathism of the mandible, orthodontic treatment and orthognathic surgery might not achieve satisfactory results. The incidence of a Class III malocclusion is predominant in Korean cleft patients (Yang, 1995), but the relationship of the degree of Class III malocclusion to CLP is as yet unclear.

This study was, therefore, performed to investigate contributing factors, such as type and

side of cleft, patient's age, and gender, associated with Angle's classification of malocclusion in Korean cleft patients.

Subjects and methods

The subjects consisted of 250 patients (175 males, 75 females) with non-syndromic CLP who were enrolled for treatment at the Department of Orthodontics, Seoul National University Dental Hospital between 1988 and 1999. All subjects were examined by observing clinical and cleft charts, diagnostic dental casts, dental pantomograms, and lateral and postero-anterior cephalograms.

From an analysis of the departmental records, cleft lip repair was completed in 215 out of 250 patients. Surgery was performed as follows: 0–3 months (60.3 per cent), 4–6 months (17.9 per cent), 7–9 months (6.2 per cent), 10–12 months (7.2 per cent), more than 1 year (8.4 per cent). The methods of unilateral cleft lip surgery were rotational-advancement (74 per cent), triangular flap (17 per cent), rectangular flap (9 per cent), straight line (9 per cent), and others (9 per cent). The methods for bilateral cleft lip repair were Millard (62 per cent), straight line (10 per cent), Manchester (10 per cent), Skoog (5 per cent), and others (20 per cent). Cleft palate repair was completed in 199 out of 250 patients. The prevailing surgical times were 1–2 years (31.7 per cent), 0–1 year (25.6 per cent), 2–3 years (18.1 per cent), more than 5 years (11.6 per cent), 4–5 years (7.5 per cent), and 3–4 years (5.5 per cent). The methods of cleft palate repair were Wardill V–Y flap (39 per cent), Von Langenbeck (26 per cent), Dorrance flap (22 per cent), Vomer flap (4 per cent), and others (9 per cent).

The subjects were separated by gender and then divided into isolated cleft lip (CL), cleft lip and alveolus (CLA), isolated cleft palate (CP), and CLP. CL, CLA, and CLP were subdivided into unilateral and bilateral and then further subdivided according to the side. CP was subdivided into hard and soft palate cleft [CP(H+S)], soft palate cleft [CP(S)], and submucous cleft palate (SMCP).

The age groups were categorized into deciduous and early mixed dentition, before eruption of the permanent canine and premolar (DEM), late mixed dentition during eruption of the permanent canine and premolar (LM), early permanent dentition after eruption of the permanent canine and premolar and before eruption of the permanent second molar (EP), and full permanent dentition after eruption of the permanent second molar (FP).

The malocclusion groups were divided into Class I, II, and III according to Angle's classification and subdivided according to cleft type. Twelve neonates were excluded because they could not be classified by Angle's classification.

The findings were analysed using standard descriptive statistical parameters. Significance was tested using the Chi-square test and logistic analysis (SPSS version 10.0; SPSS Inc., Chicago, IL, USA).

Results

The percentages of CL, CLA, CP, and CLP were 7.6, 19.2, 9.6, and 63.6, respectively (Table 1). The overall percentages of unilateral and bilateral clefts were 76.1 and 23.9 (a ratio of approximately 3:1) (Figure 1). For the cleft side, the overall ratio was 3:2 so that the left side was affected substantially more than the right (Figure 2).

For the relationship between cleft type and gender, the prevalence was higher in males than in females in CL, CLA, and CLP in ascending order. However, in the CP group, especially CP(H+S), the prevalence was greater in females (Table 1).

For the relationship between cleft type and malocclusion, the overall percentages of Class I, II, and III were 18.5, 8.8, and 72.7, respectively. There was no significant difference between Class I and III malocclusions in the CL group, but Class III malocclusion occurred significantly more often in the CLA, CP, and CLP groups in ascending order (Table 2).

The distribution of age groups was LM, EP, DEM, FP in descending order (Table 3). In all age groups, the frequency of a Class III malocclusion was most prevalent (Table 3).

The results of bivariate analysis for gender and type of cleft to Class III malocclusion are shown in Tables 4 and 5. Whilst gender was

Table 1 Distribution of clefts by gender and type.

Cleft type	Male	Female	Total
Cleft lip			
UCL	8	7	15
BCL	3	1	4
Total	11 (57.9%)	8 (42.1%)	19 (7.6%)
Cleft lip and alveolus			
UCLA	25	12	37
BCLA	8	3	11
Total	33 (68.8%)	15 (31.2%)	48 (19.2%)
Cleft palate			
CP(H+S)	3	9	12
CP(S)	6	5	11
SMCP	1	0	1
Total	10 (41.7%)	14 (58.3%)	24 (9.6%)
Cleft lip and palate			
UCLP	88	32	120
BCLP	33	6	39
Total	121 (76.1%)	38 (23.9%)	159 (63.6%)
Sum	175 (70%)	75 (30%)	250

UCL, unilateral cleft lip; BCL, bilateral cleft lip; UCLA, unilateral cleft lip and alveolus; BCLA, bilateral cleft lip and alveolus; CP(H+S), hard and soft palate cleft; CP(S), soft palate cleft; SMCP, submucous cleft palate; UCLP, unilateral cleft lip and palate; BCLP, bilateral unilateral cleft lip.

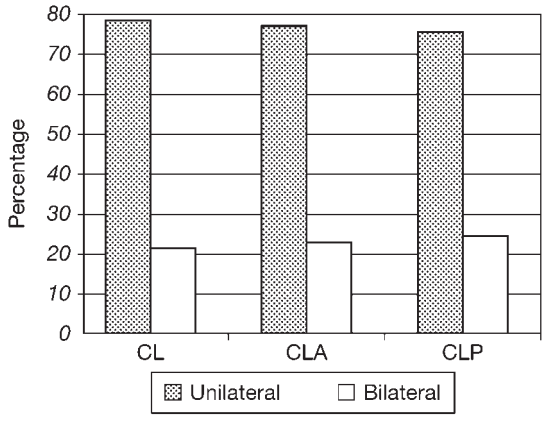

Figure 1 Incidence of unilateral and bilateral cleft. The relative ratio of bilateral cleft:unilateral cleft increased from CL and CLA to CLP in ascending order. CL, cleft lip; CLA, cleft lip and alveolus; CLP, cleft lip and palate.

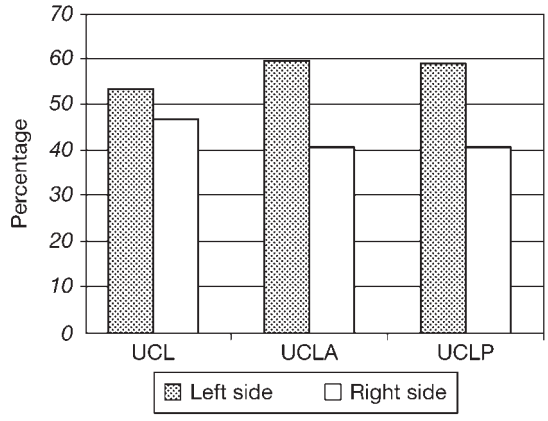

Figure 2 Incidence of cleft side. UCL, unilateral cleft lip; UCLA, unilateral cleft lip and alveolus; UCLP, unilateral cleft lip and palate.

not significant (Table 4), the type of cleft significantly influenced the prevalence of a Class III malocclusion ($P < 0.01$) (Table 5). Logistic regression analysis also confirmed that the type of cleft significantly influenced the prevalence of a Class III malocclusion. The CP and CLP groups were 3.9 and 5.5 times more likely to have a Class III malocclusion than the CL group ($P < 0.05$ and $P < 0.01$, respectively). However, there was no statistical difference in the

Table 2 Distribution of Angle's classification of malocclusion according to type of cleft.

Cleft type	Class I	Class II	Class III	Total
Cleft lip				
UCL	9	1	5	15
BCL	0	1	3	4
Total	9 (47.4%)	2 (10.5%)	8 (42.1%)	19
Cleft lip and alveolus				
UCLA	10	5	21	36
BCLA	2	1	8	11
Total	12 (25.5%)	6 (12.8%)	29 (61.7%)	47
Cleft palate				
CP(H+S)	3	2	7	12
CP(S)	1	0	9	10
SMCP	0	0	1	1
Total	4 (17.4%)	2 (8.7%)	17 (73.9%)	23
Cleft lip and palate				
UCLP	12	7	95	114
BCLP	7	4	24	35
Total	19 (12.7%)	11 (7.4%)	119 (79.9%)	149
Sum	44 (18.5%)	21 (8.8%)	173 (72.7%)	238

UCL, unilateral cleft lip; BCL, bilateral cleft lip; UCLA, unilateral cleft lip and alveolus; BCLA, bilateral cleft lip and alveolus; CP(H+S), hard and soft palate cleft; CP(S), soft palate cleft; SMCP, submucous cleft palate; UCLP, unilateral cleft lip and palate; BCLP, bilateral unilateral cleft lip.

Table 3 Relationship between Angle's classification of malocclusion and age.

	Class I		Class II		Class III		Total	
	Number of subjects	%	Number of subjects	%	Number of subjects	%	Number of subjects	%
DEM	5	12.8	1	2.6	33	84.6	39	16.4
LM	31	23.8	13	10	86	66.2	130	54.6
EP	3	7	1	2.3	39	90.7	43	18.1
FP	5	19.2	6	23.1	15	57.7	26	0.9
Sum	44	18.5	21	8.8	173	72.7	238	

DEM, deciduous and early mixed dentition before eruption of the permanent canine and premolar; LM, late mixed dentition during eruption of the permanent canine and premolar; EP, early permanent dentition after eruption of the permanent canine and premolar but before eruption of the permanent second molar; FP, full permanent dentition after eruption of the permanent second molar.

Table 4 Bivariate analysis of gender by Angle's classification of malocclusion.

Gender	Class I and II	Class III	% of Class III	Pearson's Chi-square	*P*-value
Female	22	50	69.4		
Male	43	123	74.1	0.338	0.561

Table 5 Bivariate analysis of cleft type by Angle's classification of malocclusion.

Cleft type	Class I and II	Class III	% of Class III	Pearson's Chi-square	*P*-value
Cleft lip	11	8	42.1		
Cleft lip and alveolus	18	29	61.7		
Cleft palate	6	17	73.9		
Cleft lip and palate	30	119	79.9	15.693	0.001**

**$P < 0.01$.

Table 6 Association between cleft type and Class III malocclusion by logistic analysis.

Variable	Beta coefficient	S.E.	Odds ratio	95% CI	*P*-value
Intercept	0.644	0.189			0.001
Type of cleft					
Cleft lip			1		0.002
Cleft lip and alveolus	0.795	0.553	2.215	0.749, 6.550	0.150
Cleft palate	1.360	0.664	3.896	1.059, 14.326	0.041*
Cleft lip and palate	1.696	0.508	5.454	2.017, 14.749	0.001**

*$P < 0.05$; **$P < 0.01$.

prevalence of a Class III malocclusion between the CL and CLA groups ($P > 0.05$) (Table 6).

Discussion

The ratio of CL, CP, and CLP has been reported to be 1:1:2 (Fogh-Andersen, 1942) and 34:39:27 (Jensen *et al*., 1988). A wide variation has also been reported in Koreans (Nam, 1975; Shin *et al*., 1979; Kim and Loo, 1982; Yang *et al*., 1983; Huh *et al*., 1986; Kim, 1987; Kim and Yoon, 1987; Lee and Min, 1987; Yang *et al*., 1990; Chang *et al*., 1996). The subjects in the present study were divided by cleft type, i.e. CL, CLA, CP, and CLP, and the percentages were found to be 7.6:19.2:9.6:63.6, respectively, a ratio of approximately 1:3:1:8 (Table 1).

Unilateral clefts occurred significantly more often than bilateral clefts (approximately 3:1). This result is in agreement with previous studies (Wilson, 1972; Lee and Min, 1987; Lee *et al*., 1996). The ratio of unilateral and bilateral clefts decreased from CL and CLA to CLP in descending order (Figure 1).

Fraser (1970) reported the prevalence of a left sided cleft to be 66.6 per cent in CL and CLA, and Wilson (1972) and Drillien *et al*. (1996) found it to be 60 per cent. In studies of Koreans (Kim and Loo, 1982; Lee and Min, 1987), the prevalence of a left side cleft was found to be 65–70 per cent. The results of the present study show the prevalence of a left side cleft (Table 3) to be similar to that found by Wilson (1972) and Drillen *et al*. (1996). The incidence of a left sided cleft increased from CL and CLA to CLP in ascending order (Figure 2). Jurkewicz and Bryant (1968) suggested that the reason for the left side predominance of cleft in the early stages of development was due to the right side of the embryo's head receiving a somewhat greater supply of blood due to higher blood pressure from the right internal carotid artery, which has a more direct line of blood flow than the left.

The overall ratio of male and female clefts reported by Jensen *et al*. (1988) was 61:39. In studies on the overall gender distribution of Korean clefts (Shin *et al*., 1979; Huh *et al*., 1986;

Kim, 1987; Lee and Min, 1987; Lee *et al*., 1996), the ratio of males and females was stated to be 60:40. In the present study, the overall ratio was males 70, females 30. Compared with the above studies, the percentage of males was slightly higher (Table 1).

CL and CLP are known to be more common in males, and CP in females. Cooper *et al*. (1979) reported the ratio of males to females as 1.6:1 for CL and CLP and 1:1.3 in CP. In Korean cleft sample studies (Yang *et al*., 1983; Kim, 1987; Yang *et al*., 1990; Chang *et al*., 1996), the ratios of males to females were around 1.6:1 for CL, 2.5:1 for CLP, and 1:1.5 for CP. However, these studies did not subdivide cleft type according to developmental embryology and aetiology. In the present study there was a higher prevalence of males in all groups except CP(H+S) (Table 1).

With regard to the difference in the distribution by gender, Fogh-Andersen (1942) speculated that CL and CLP had no relevance genetically to CP. Meskin *et al.* (1968) hypothesized that CP was more common in females because the secondary palate of female fused later than males, so females were more often affected. Burdi and Silvey (1969) confirmed this hypothesis experimentally with histologically sectioned human embryos.

Fifty per cent of patients in the present study commenced orthodontic treatment during the mixed dentition (Table 3). In all age groups, Class III malocclusions were more prevalent and an anterior crossbite was the most common complaint of cleft patients (Table 3).

According to a Korean non-cleft normal population study (Kang and Ryu, 1992), 16.7 per cent of all malocclusions are Class III. Massler and Frankel (1951) found the incidence of a Class III malocclusion to be 11.9 per cent in 14- to 18-year-old high school students in Illinois, USA. Yang (1995) reported that the distribution of the Korean orthodontic patients according to Angle's classification between 1985 and 1994 was Class III, 48.28 per cent; Class I, 35.98 per cent; Class II division 1, 14.00 per cent; and Class II division 2, 1.74 per cent. Therefore a Class III malocclusion is more common and a Class II malocclusion less prevalent in Korean non-cleft patients compared with Caucasians.

Although the CL group did not show a difference between the occurrence of Class I and III malocclusions, in the CLA, CP, and CLP groups Class III malocclusions occurred significantly more often than Class I or II (Table 2). There was a significant difference in the frequency of developing Class III malocclusions among cleft types when examined by bivariate analysis ($P < 0.01$) (Table 5). The Odds Ratios of CP and CLP in association with Class III malocclusions using logistic regression analysis showed Class III malocclusions in CP and CLP subjects to be more common than in those with CL and CLA (Table 6). The degree of palatal involvement in the cleft, tissue deficiency, surgical trauma, and formation of scar tissue were the main causative factors for the development of Class III malocclusions with maxillary deficiency.

Conclusion

Bivariate analysis showed that in Koreans the type of cleft significantly influenced the prevalence of a Class III malocclusion ($P < 0.01$). Logistic regression analysis confirmed that subjects with CP ($P < 0.05$) and CLP ($P < 0.01$) were 3.9 and 5.5 times more likely to have a Class III malocclusion than those with CL. There was no statistical difference in the prevalence of a Class III malocclusion between the CL and CLA groups ($P > 0.05$). When the degree of cleft involvement in the palate increased, so did the incidence of a Class III malocclusion.

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