https://doi.org/10.5933/JKAPD.2021.48.2.140
J Korean Acad Pediatr Dent 48(2) 2021
ISSN (print) 1226-8496 ISSN (online) 2288-3819

Distribution of Pediatric Malocclusion Patients in Seoul National University Dental Hospital

Sophia Rhee, Ji-Soo Song, Teo Jeon Shin, Young-Jae Kim, Jung-Wook Kim, Ki-Taeg Jang, Hong-Keun Hyun

Department of Pediatric Dentistry, Dental Research Institute, School of Dentistry, Seoul National University

Abstract

A total of 580 patients, who visited and received an orthodontic diagnosis in the Department of Pediatric Dentistry, Seoul National University Dental Hospital from 2017 to 2019, were investigated in this study. The aim of this study was to evaluate skeletal patterns of pediatric orthodontic patients determined with lateral cephalometric analysis and to analyze the relationship between skeletal pattern and probable associated clinical features. Also, the modality of orthodontic treatment for each skeletal classification was investigated to aid in therapeutic decisions.

Patients aged 7 year accounted for the largest age group; 54.2% of patients showed a skeletal class I pattern, 22.2% showed a skeletal class II pattern, and 23.6% showed a skeletal class III pattern. Bi-maxillary retrusion for skeletal class I, retruded mandible with normal positioning of the maxilla for skeletal class II, and retrusion of the maxilla with protrusion of the mandible for skeletal class III were the largest subgroups by skeletal pattern. Brachyfacial type accounted for 55.0% of patients, followed by 31.9% of mesofacial type and 13.1% of dolichofacial type. The prevalence of anterior crossbite in the study was 43.3%, higher than that in previous studies.

Key words : Pediatric dentistry, Orthodontic patients, Distribution, Skeletal pattern, Anterior crossbite

Ⅰ. Introduction

With increasing public interest in dental and facial aesthetics, there has been increasing recognition that oral disorders can have a significant impact on physical, social, and psychological well-being[1,2]. Orthodontic treatment accounts for a large proportion of the total treatments performed in the department of pediatric dentistry.

Choi *et al*.[3] reported that orthodontic treatment accounted for 21.5% of total treatments performed in a department of pediatric dentistry in 2000, with the rate increasing to 35.9% in 2005. Son *et al*.[4] observed a change in practice patterns in the department of pediatric dentistry from 2001 to 2008, where orthodontic treatments composed 22.8% of total treatments in 2001 but 37.5% in 2008. In a recent study by Seo *et al*.[5], the proportion of patients seeking orthodontic treatment in recent years has declined from 25.0% in 2006 to 21.4% in 2015.

This study conducted an investigation on the distribution of pediatric malocclusion patients who visited the Department of Pediatric Dentistry, Seoul National University Dental Hospital (SNUDH) from 2017 to 2019, and received an orthodontic di-

Corresponding author : Hong-Keun Hyun
Department of Pediatric Dentistry, Dental Research Institute, School of Dentistry, Seoul National University, 101 Daehak-ro, Jongno-gu, Seoul 03080, Republic of Korea
Tel: +82-2-2072-3395 / Fax: +82-2-744-3599 / E-mail: hege1@snu.ac.kr
Received October 29, 2020 / Revised November 26, 2020 / Accepted November 20, 2020
※The authors declare that there is no conflict of interest.

agnosis.

The purpose of the study was to examine pediatric orthodontic patients regarding skeletal pattern as determined with lateral cephalometric analysis and to analyze the correlation between skeletal pattern and probable related clinical characteristics. Also, the study aimed to aid clinicians in establishing orthodontic treatment plans based on investigations of the modality of orthodontic treatment by skeletal classification.

Ⅱ. Materials and Methods

The protocol was approved by the Institutional Review Board of School of Dentistry, Seoul National University (IRB No. S-D20200020).

1. Study subjects

Patients who visited the Department of Pediatric Dentistry, SNUDH between January 1st, 2017 and December 31st, 2019, and underwent lateral cephalogram imaging for establishing an orthodontic diagnosis were reviewed. Patients with severe skeletal deformity or systemic disease were excluded from the study. A total of 819 patients was identified, however 239 patients who received an orthodontic diagnosis due to eruption disturbances (impaction, ectopic eruption, delayed eruption, transposition, and others) were excluded. A total of 580 patients was included in this study.

2. Methods

Orthodontic diagnostic records, dental casts, lateral cephalograms, and electronic medical records (EMRs) were retrieved and studied. Patients with incomplete records were excluded. Statistical tests were conducted with SPSS software version 25 (SPSS Inc., Chicago, IL, USA).

1) Distribution pattern by sex and age

The distribution pattern according to sex and age group was examined. A Chi-square test was performed to observe a statistically significant difference in distribution between sexes according to age.

2) Distribution of chief complaints of patients

Patient EMRs and their orthodontic diagnostic records were used to investigate the patterns of chief complaints by patients needing orthodontic correction.

3) Distribution of horizontal skeletal patterns

To evaluate the horizontal skeletal pattern, ANB, an angle determined by the A point, nasion, and B point, from the Steiner analysis technique was used[6]. Patients who showed ANB between 0.5 and 4.5 were classified as skeletal class I pattern, patients with ANB value greater than 4.5 were classified as skeletal class II pattern, and patients with ANB value less than 0.5 were classified as skeletal class III pattern. The difference in proportion of horizontal skeletal pattern was investigated according to age, and the Chi-square test was used to identify statistical difference in the distributions.

4) Distribution of anterior crossbite

Diagnostic models were used to examine the distribution of anterior crossbite according to age and horizontal skeletal pattern. To analyze the difference in distribution of anterior crossbite based on the 2 variables, the Chi-square test was performed.

5) Lateral cephalometric analysis of orthodontic patients

Lateral cephalograms were analyzed in Vceph version 5.0 (Osstem Implant, Seoul, South Korea). Patients were subdivided by skeletal pattern based on ANB value and by sex. Mean and standard deviation values were calculated for each cephalometric measurement. The normality of each measurement was assessed using the Kolmogorov-Smirnov test. As all followed a normal distribution, the measurements between male and female patients with the same skeletal pattern were compared by independent t-test. As the assumptions of normality and homogeneity were satisfied by Levene's test, a one-way ANOVA test followed by Tukey HSD post hoc test was used to examine the difference between skeletal patterns.

6) Distribution of vertical skeletal patterns

To evaluate the vertical skeletal pattern, the VERT index from the Ricketts analysis technique was used[7]. If the VERT index was less than -0.5, a dolichofacial type pattern was confirmed, that of -0.5 to 0.5 was a mesofacial type pattern was confirmed, and that greater than 0.5 was a brachyfacial type pattern. The correlation between horizontal and vertical skeletal patterns was investigated, and a Chi-square test was performed to analyze the difference in distribution by skeletal pattern.

7) Horizontal relation of the maxilla and mandible according to skeletal pattern

McA and McPog points from the McNamara analysis were adopted to assess protrusion and retrusion of the maxilla and mandible[8]. When the McA and McPog points were greater than 1 standard deviation above the mean value of the lateral cephalometric analysis, the maxilla and mandible were defined as protrusion; conversely, they were defined as retrusion if the 2 reference points were less than 1 standard deviation below the mean value. To examine the difference in distribution of subgroups by skeletal pattern, Fisher's exact test was performed.

8) Distribution of orthodontic treatment methods

To analyze distribution of treatment methods, patients who started orthodontic treatment at the Department of Pediatric Dentistry, SNUDH were included.

Ⅲ. Results

1. Distribution pattern by sex and age

There were 306 males (52.8%) and 274 females (47.2%) orthodontic patients. According to the Chi-square test, there was no statistically significant difference between the sexes in association with age (p = 0.051). When considering age distribution in this study, participants in the 7-year-old (26.6%, M : F = 1 : 1.2) and 8-year-old (23.6%, M : F = 1.4 : 1) age groups accounted for the largest proportion of the study population.

2. Distribution of chief complaints of patients

Patients reported various reasons for orthodontic treatments. Anterior crossbite was the most common chief complaint, reported in a total of 195 patients (33.6%), while 146 patients (25.2%) complained mainly of crowding, 61 patients (10.5%) had complaints on mandibular protrusion, and 60 patients (10.3%) were dissatisfied with anterior teeth protrusion.

3. Distribution of horizontal skeletal patterns

In the study population, a skeletal class I relationship was found in 314 patients (54.2%), a skeletal class II relationship in 129 patients (22.2%), and a skeletal class III relationship in 137 patients (23.6%). There was a statistically significant difference in age according to skeletal pattern (p < 0.001). Younger diagnosed patients, especially patients younger than 9 years, tended to show a skeletal class III pattern, while more instances of a skeletal class II pattern were found in the older age groups (Table 1).

4. Distribution of anterior crossbite

Of a total of 580 patients, 251 (43.3%) had an anterior crossbite, 222 of whom were younger than 9 years. The distribution of anterior crossbite showed a significant difference by skeletal pattern and age (p < 0.001). The rate of anterior crossbite according to age at the time of the clinic visit was higher in patients younger than 9 years compared with that among all patients. The proportion of patients with anterior crossbite decreased as age increased (Table 2). According to horizontal skeletal pattern, 41.1% of patients with skeletal class I, 7.8% with skeletal class II, and 81.8% with skeletal class III had anterior crossbite.

Table 1. Distribution of the horizontal skeletal patterns by age

	Class I	Class II	Class III	p value
Under 7	34 (66.7%)	2 (3.9%)	15 (29.4%)	
7	81 (52.6%)	23 (14.9%)	50 (32.5%)	
8	66 (48.2%)	26 (19.0%)	45 (32.8%)	
9	46 (59.7%)	22 (28.6%)	9 (11.7%)	< 0.001
10	27 (40.3%)	30 (44.8%)	10 (14.9%)	
11	28 (58.4%)	16 (33.3%)	4 (8.3%)	
Over 11	32 (69.6%)	10 (21.7%)	4 (8.4%)	
Total	314 (54.2%)	129 (22.2%)	137 (23.6%)	

p value from Chi-square test

Table 2. Distribution of patients with anterior crossbite according to patient age

Age	Anterior crossbite	No anterior crossbite	*p* value
Under 7	41 (80.4%)	10 (19.6%)	
7	106 (68.8%)	48 (31.2%)	
8	75 (54.7%)	62 (45.3%)	
9	16 (20.8%)	61 (79.2%)	< 0.001
10	11 (16.4%)	56 (83.6%)	
11	2 (4.2%)	46 (95.8%)	
Over 11	0 (0.0%)	46 (100.0%)	
Total	251 (43.3%)	329 (56.7%)	

p value from Chi-square test

5. Cephalometric analysis of orthodontic patients

Table 3 shows the mean and standard deviation of cephalometric measurements of patients analyzed for orthodontic diagnosis. Significant difference between sexes in skeletal class I pattern was shown in cranial length, corpus length and UL to E. plane. Significant difference between sexes in skeletal class II pattern was found in cranial length and corpus length. Only the ANB value showed a significant difference between male and female patients in skeletal class III pattern. The measurements that that did not show a significant difference between skeletal patterns were cranial deflection, mandibular arc, and U1 to FH. Convexity, maxillary depth, facial depth, SNA, SNB, ANB, facial axis, corpus length, U1 to APo (mm), U1 to APo (degree), L1 to mandibular plane, interincisal angle, UL to E. plane, ODI (Overbite Depth Indicator), APDI (Anteroposterior Dysplasia Indicator), McA, and McPog showed a significant difference among the 3 skeletal patterns.

6. Distribution of vertical skeletal patterns

Overall, 319 patients (55.0%) showed the brachyfacial type pattern, 185 (31.9%) showed the mesofacial type pattern, and 76 (13.1%) showed the dolichofacial type pattern. The distribution of vertical skeletal patterning in skeletal class I was similar to the overall distribution. In skeletal class II, the dolichofacial type and mesofacial type were more frequently seen and the brachyfacial type was less frequently seen than in the overall group. In skeletal class III, the brachyfacial type was more common and the dolichofacial and mesofacial types were less common than in the overall group (Fig. 1). There was a statistically significant difference in distribution of vertical skeletal patterns according to horizontal skeletal pattern ($p < 0.001$).

7. Horizontal relation of maxilla and mandible according to skeletal pattern

Table 4 displays the distribution of horizontal positions of both jaws by skeletal pattern. Subgroups of skeletal patterns showed a significant difference in distribution ($p < 0.001$). In the skeletal class I relationship, patients with retrusion of both the maxilla and mandible accounted for the largest proportion (34.4%). In skeletal class II, patients with normally positioned maxilla and retruded mandible were the largest proportion (39.5%). In the skeletal class III pattern, patients with retrusion of the maxilla but protrusion of the mandible (35.0%) accounted for the largest proportion.

8. Distribution of orthodontic treatment methods

Depending on distribution of skeletal classes I, II, and III, the rates of execution of orthodontic treatment at the Department of Pediatric Dentistry, SNUDH were 84.4%, 85.3%, and 89.1%, respectively. Among the treatment methods performed on orthodontic patients, the most used appliances were rapid palatal expansion with face mask, removable orthodontic appliance, fixed orthodontic appliance, and 2 × 4 appliance in that order (Table 5).

Table 3. The mean and standard deviation of lateral cephalometric measurements

	Skeletal Class I				Skeletal Class II				Skeletal Class III				
Measurement	Total (n = 314) Mean (SD)	Male (n = 171) Mean (SD)	Female (n = 143) Mean (SD)	*p* value*	Total (n = 129) Mean (SD)	Male (n = 63) Mean (SD)	Female (n = 66) Mean (SD)	*p* value*	Total (n = 137) Mean (SD)	Male (n = 72) Mean (SD)	Female (n = 65) Mean (SD)	*p* value*	*p* value**
Convexity	2.6 (1.4)[b]	2.6 (1.3)	2.5 (1.4)	0.691	6.2 (1.6)[a]	6.1 (1.6)	6.4 (1.7)	0.343	-1.3 (1.3)[c]	-1.1 (1.1)	-1.4 (1.4)	0.170	<0.001
Maxillary depth	88.7 (2.4)[b]	88.7 (2.6)	88.6 (2.3)	0.580	90.3 (2.4)[a]	90.3 (2.4)	90.3 (2.3)	0.969	87.2 (2.6)[c]	87.4 (2.4)	87.0 (2.9)	0.422	<0.001
Facial depth	86.2 (2.4)[b]	86.3 (2.3)	86.1 (2.5)	0.480	84.5 (2.3)[c]	84.6 (2.3)	84.3 (2.3)	0.510	88.4 (2.6)[a]	88.3 (2.4)	88.4 (2.8)	0.794	<0.001
SNA	79.6 (2.9)[b]	79.6 (3.1)	79.5 (2.7)	0.809	80.9 (3.0)[a]	81.0 (3.0)	80.7 (3.0)	0.578	78.4 (3.4)[c]	78.6 (3.4)	78.1 (3.3)	0.340	<0.001
SNB	77.0 (2.8)[b]	76.9 (2.9)	77.0 (2.7)	0.832	74.8 (3.0)[c]	75.0 (3.0)	74.5 (3.0)	0.373	79.5 (3.5)[a]	79.5 (3.6)	79.4 (3.3)	0.785	<0.001
ANB	2.6 (1.2)[b]	2.6 (1.1)	2.5 (1.2)	0.265	6.1 (1.2)[a]	6.0 (1.4)	6.2 (1.1)	0.418	-1.1 (1.1)[c]	-0.9 (0.9)	-1.3 (1.2)	0.030	<0.001
Cranial deflection	28.0 (1.9)[a]	28.2 (1.9)	27.9 (1.8)	0.210	28.1 (1.8)[a]	28.2 (2.0)	28.1 (1.6)	0.878	27.8 (2.0)[a]	27.9 (1.9)	27.6 (2.1)	0.367	0.217
Cranial length	56.2 (3.4)[a]	57.2 (3.1)	55.0 (3.3)	<0.001	56.4 (3.1)[a]	57.0 (2.9)	55.8 (3.3)	0.044	55.3 (2.8)[b]	55.5 (3.1)	55.0 (2.4)	0.259	0.006
Lower facial height	47.1 (3.6)[a]	47.1 (3.4)	47.1 (3.9)	0.937	47.4 (4.1)[a]	46.9 (3.6)	47.8 (4.6)	0.258	44.4 (3.6)[b]	44.6 (3.5)	44.1 (3.8)	0.412	<0.001
Facial axis	85.9 (3.4)[b]	85.8 (3.1)	86.0 (3.6)	0.634	83.9 (3.5)[c]	84.1 (3.4)	83.7 (3.6)	0.477	89.2 (3.2)[a]	88.8 (3.1)	89.6 (3.4)	0.126	<0.001
Mandibular plane angle	29.4 (4.8)[a]	29.1 (4.5)	29.7 (5.1)	0.288	29.1 (5.1)[a]	28.5 (5.0)	29.6 (5.1)	0.218	26.5 (4.7)[b]	26.6 (4.8)	26.4 (4.5)	0.802	<0.001
Mandibular arc	34.8 (5.9)[a]	34.6 (4.8)	35.1 (7.0)	0.475	34.7 (5.2)[a]	34.2 (4.9)	35.3 (5.4)	0.245	36.1 (3.5)[a]	36.0 (4.4)	36.2 (4.6)	0.773	0.060
Corpus length	63.8 (4.2)[b]	64.9 (4.0)	62.6 (4.0)	<0.001	62.1 (3.7)[c]	62.9 (3.3)	61.3 (3.9)	0.140	65.3 (3.5)[a]	65.7 (3.7)	64.8 (3.4)	0.120	<0.001
L1 to Apo (mm)	4.1 (2.2)[a]	4.1 (2.4)	4.2 (2.1)	0.717	2.7 (2.8)[b]	2.5 (2.7)	2.9 (2.9)	0.322	4.6 (2.0)[a]	4.7 (2.2)	4.6 (1.7)	0.760	<0.001
L1 to Apo (degree)	22.5 (4.9)[a]	22.9 (5.1)	22.1 (4.7)	0.145	21.2 (5.4)[b]	20.8 (5.2)	21.6 (5.7)	0.434	22.6 (5.4)[a]	22.7 (5.8)	22.6 (5.0)	0.937	0.029
U1 to Apo (mm)	5.8 (3.0)[b]	5.9 (3.2)	5.5 (2.8)	0.225	9.1 (3.4)[a]	8.8 (3.1)	9.3 (3.6)	0.417	3.0 (2.6)[c]	3.0 (2.4)	3.0 (2.7)	0.911	<0.001
U1 to Apo (degree)	27.7 (7.4)[b]	27.7 (7.7)	27.5 (7.0)	0.634	35.4 (8.9)[a]	34.5 (7.6)	36.3 (10.0)	0.258	21.7 (7.1)[c]	21.5 (6.4)	21.9 (7.9)	0.750	<0.001
L1 to Mand.pl	89.9 (6.5)[b]	90.5 (6.7)	89.3 (6.3)	0.120	94.7 (6.3)[a]	94.5 (6.9)	94.9 (5.8)	0.743	86.1 (6.6)[c]	86.2 (6.9)	86.0 (6.4)	0.835	<0.001
Interincisal angle	129.8 (10.1)[b]	129.2 (10.6)	130.4 (9.6)	0.295	123.4 (11.0)[c]	124.7 (9.9)	122.2 (12.0)	0.195	135.8 (10.7)[a]	135.8 (10.2)	135.8 (11.3)	0.984	<0.001
Upper molar position	10.4 (3.2)[a]	10.8 (3.2)	10.1 (3.1)	0.050	10.8 (3.1)a	10.7 (2.9)	10.9 (3.3)	0.702	9.8 (3.1)[b]	10.2 (3.0)	9.4 (3.3)	0.130	0.032
Nasolabial angle	88.3 (10.8)[b]	87.9 (10.4)	88.8 (11.4)	0.480	89.8 (12.6)[b]	87.9 (12.6)	91.6 (12.4)	0.089	92.5 (12.2)[a]	91.7 (13.2)	93.4 (10.9)	0.421	0.002
UL inclination	114.4 (7.2)[b]	115.0 (7.3)	113.7 (7.2)	0.111	113.3 (7.8)[b]	113.7 (7.9)	113.0 (7.7)	0.613	117.4 (8.6)[a]	116.7 (8.6)	118.2 (8.7)	0.297	<0.001
UL to E. plane	1.7 (1.9)[b]	2.0 (1.9)	1.3 (1.8)	0.001	3.7 (1.8)[a]	3.8 (1.9)	3.5 (1.7)	0.285	-0.2 (2.0)[c]	-0.1 (2.0)	-0.4 (2.1)	0.309	<0.001
LL to E. plane	3.0 (2.4)[a]	3.0 (2.4)	2.9 (2.5)	0.680	3.5 (2.5)[a]	3.2 (2.9)	3.7 (2.0)	0.346	2.4 (2.4)[b]	2.4 (2.5)	2.4 (2.3)	0.912	0.003
ODI	68.5 (5.2)[b]	68.9 (5.2)	67.9 (5.2)	0.087	76.1 (6.8)[a]	76.2 (6.8)	76.1 (6.9)	0.934	63.5 (4.9)[c]	63.9 (5.1)	63.0 (4.6)	0.292	<0.001
APDI	82.4 (3.6)[b]	82.4 (3.5)	82.5 (3.8)	0.776	75.2 (3.6)[c]	75.3 (3.7)	75.2 (3.5)	0.794	89.8 (3.6)[a]	89.6 (3.4)	90.0 (3.8)	0.439	<0.001
McA	-1.3 (2.5)[b]	-1.3 (2.7)	-1.4 (2.4)	0.677	0.4 (2.5)[a]	0.4 (2.5)	0.4 (2.5)	0.959	-2.8 (2.6)[c]	-2.6 (2.5)	-2.9 (2.8)	0.534	<0.001
McPog	-7.3 (4.6)[b]	-7.2 (4.5)	-7.3 (4.8)	0.825	-10.6 (4.6)[c]	-10.6 (4.6)	-10.9 (4.6)	0.583	-2.8 (4.8)[a]	-2.8 (4.4)	-2.8 (5.2)	0.990	<0.001
U1 to FH	110.9 (7.5)[a]	111.2 (7.7)	110.6 (7.1)	0.453	112.8 (8.7)[a]	112.3 (7.5)	113.3 (9.7)	0.490	111.7 (7.9)[a]	111.3 (7.4)	112.0 (8.4)	0.603	0.075

* : *p* value from independent t-test among male and female patients in the same skeletal pattern
** : *p* value from one-way ANOVA followed by Tukey's HSD post-hoc test among the skeletal pattern
Different letters indicate significant difference among the skeletal pattern groups when comparing within rows.

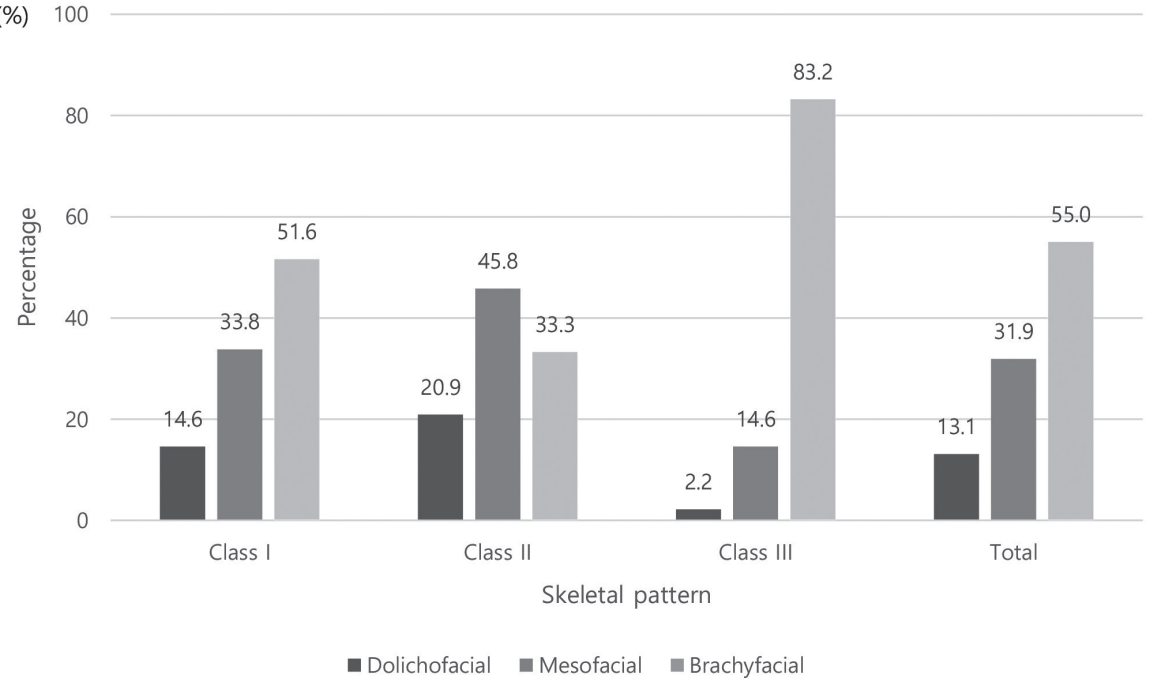

Fig. 1. Distribution of patients by vertical skeletal pattern. A significant difference in distribution was shown by the Chi-square test, according to the horizontal skeletal pattern (p < 0.001).

Table 4. The horizontal relation of maxilla and mandible in each skeletal pattern

Class I					
	Mandible retrusion	Within normal limit	Mandible protrusion	Total	p value
Maxilla retrusion	108 (34.4%)	56 (17.8%)	6 (1.9%)	170 (54.1%)	
Within normal limit	14 (4.5%)	68 (21.7%)	50 (15.9%)	132 (42.1%)	<0.001
Mandible protrusion	0 (0.0%)	1 (0.3%)	11 (3.5%)	12 (3.8%)	
Total	122 (38.9%)	125 (39.8%)	67 (21.3%)	314	
Class II					
	Mandible retrusion	Within normal limit	Mandible protrusion	Total	p value
Maxilla retrusion	38 (29.5%)	0 (0.0%)	0 (0.0%)	38 (29.5%)	
Within normal limit	51 (39.5%)	20 (15.5%)	2 (1.6%)	73 (56.6%)	<0.001
Mandible protrusion	4 (3.1%)	11 (8.5%)	3 (2.3%)	18 (13.9%)	
Total	93 (72.1%)	31 (24.0%)	5 (3.9%)	129	
Class III					
	Mandible retrusion	Within normal limit	Mandible protrusion	Total	p value
Maxilla retrusion	12 (8.8%)	39 (28.5%)	48 (35.0%)	99 (72.3%)	
Within normal limit	0 (0.0%)	1 (0.7%)	37 (27.0%)	38 (27.7%)	<0.001
Mandible protrusion	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Total	12 (8.8%)	40 (29.2%)	85 (52.0%)	137	

p value from Fisher's exact test

Table 5. Distribution of orthodontic treatment methods

Treated methods	Class I	Class II	Class III	Total
Rapid palatal expansion	2	3	0	5
Rapid palatal expansion with face mask	107	1	96	204
Removable orthodontic appliance	52	27	9	88
2 × 4 appliance	26	10	3	39
Fixed orthodontic therapy	56	32	4	92
Bionator	0	3	0	3
Twinblock	1	15	0	16
Myobrace	3	1	1	5
Hotz and headgear	0	6	0	6
Functional regulator III	6	0	1	7
Growth observation and re-evaluation	7	8	8	23
Others	5	4	0	9
Total	265 (84.4%)	110 (85.3%)	122 (89.1%)	497
No treatment	49 (15.6%)	19 (14.7%)	15 (10.9%)	83

IV. Discussion

This study conducted an investigation on 580 pediatric orthodontic patients who visited the Department of Pediatric Dentistry, SNUDH from 2017 to 2019, based on associations with chief complaints, age, sex, skeletal pattern, treatment methods, and anterior crossbite prevalence.

Patients 7 or 8 years old were most common, making up about half of the total subjects, followed by those 9 or 10 years of age. The average eruption age of the maxillary central incisors is 6.81 years in male patients and 6.73 years in female patients in Korea, while the average age of eruption of the maxillary lateral incisors is 7.78 years in male patients and 7.65 years in female patients[9]. The most common age groups coincide with eruption of maxillary anterior permanent teeth. This indicates that caregivers largely recognize the need for orthodontic treatment after emergence of the maxillary anterior teeth, which is aesthetically important. When children' s teeth do not achieve the norm for esthetic appearance, caregiver response to sociocultural expectations motivates desire for orthodontic treatment[10]. Yang and Choi[11] reported the 8- and 9-year-olds as the largest age group that visited the Department of Pediatric Dentistry for orthodontic treatment in 2000. Both studies of Koo *et al*.[12] and Cho *et al*.[13] reported an 8-year-old age largest group in 2009 and 2015. The 7-year-old group was largest in the present study. Compared with previous studies, the age of patients at visit for orthodontic treatment is decreasing, indicating increasing parental recognition on malocclusion and need for early orthodontic treatment.

An investigation on chief complaints was conducted to examine the motivation and purpose of pediatric patients to visit the department of pediatric dentistry for orthodontic treatment. When assessing the distribution of chief complaints, the reasons that patients wanted orthodontic treatment were various. The largest proportion of patients who visited for orthodontic treatment due to anterior crossbite was consistent with previous studies[14-16]. The percentage of patients with anterior crossbite increased from 28.0% in 2009 to 43.3% in present study period[12]. Anterior crossbite as the most common complaint is likely because it can be easily noticed by patients and caregivers. This suggests that parental awareness of anterior crossbite malocclusion has increased and leads them to pursue early orthodontic treatment.

Regarding horizontal skeletal pattern, 54.2% of patients showed a skeletal class I pattern, 22.2% of patients showed a skeletal class II pattern, and 23.6% of patients showed a skeletal class III pattern. In comparison with previous studies that classified orthodontic patients using the same criteria of ANB value, changes in distribution of skeletal pattern of malocclusion patients who visited the department of pediatric dentistry

were observed. In the study of Koo *et al*.[12], the percentages of skeletal Class I, II, and III were 52.0%, 29.0%, and 19.0%. The percentages in the study of Cho *et al*.[13] were 48.1%, 28.7%, and 23.2%, respectively. The overall distributions of skeletal patterns were similar. Over time, the proportion of skeletal class III pattern increased, whereas the proportion of skeletal class II pattern decreased. In the survey of 7- to 18-year-old Korean adolescents[17], 52.6% of class III, 52.2% of class II, and 44.4% of class I malocclusion patients recognized the need for orthodontic treatment. Comparing the degree of awareness of need for orthodontic treatment, the increase in skeletal class III patients is because this relationship has a larger non-favorable effect on the aesthetics of facial features relative to other skeletal patterns[18]. Relatively long period and high level of difficulty of skeletal class III treatment may have led more patients to visit the dental hospital rather than private clinics. Although the perception of need for orthodontic treatment for class II patients was similar to that of class III patients, the actual patient visit rate was low regarding awareness of need for treatment.

The mean and standard deviation values of lateral cephalometric measurements were calculated according to skeletal class pattern. According to McNamara[8], the norm for McA is 0 mm in mixed dentition and 1 mm in adult female and adult male patients. The norm for McPog is -8 to -6 mm in mixed dentition and -2 to 4 mm in adults. Due to growth of the mandible, McPog moves forward about 0.5 mm per year. The average McPog of skeletal class II patients was -10.6 mm, below the normal range proposed by McNamara[8], indicating retrognathic mandible. Smaller corpus length in skeletal class II patients indicates hypogrowth of the mandible. McNamara[19] reported that mandibular skeletal retrusion was the most common characteristic of class II subjects in his study. This is consistent with the horizontal relationship of the jaws of skeletal class II pattern shown in the present study. More skeletal class II patients presented a retruded maxilla (29.5%) than a protruded maxilla (13.9%) and retruded mandible (72.1%) than a protruded mandible (3.9%). These tendencies suggest that the main cause of skeletal class II malocclusion lies in the mandible rather than the maxilla. The mean values of McA and McPog of skeletal class III pattern were -2.8 mm and -2.8 mm, respectively, suggesting retrusion of the maxilla and protrusion of the mandible. Larger corpus length was noted in skeletal class III, meaning hypergrowth of the mandible. This coincides with the study of Guyer *et al*.[20], which reported that juvenile and adolescent class III patients generally showed retrusive maxilla with protrusive mandible. This is related to the horizontal positions of the maxilla and mandible shown in the skeletal class III pattern of the present study. More patients showed a retruded maxilla (72.3%) than a protruded maxilla (0.0%) and a protruded mandible (52.0%) than a retruded mandible (8.8%). This result implies that both jaws are factors in the occurrence of a skeletal class III relationship, and retrusion of the maxilla is somewhat more likely to play a role.

In this study, 55.0% of patients presented the brachyfacial type, 31.9% of patients presented the mesofacial type, and 13.1% of patients presented the dolichofacial type. Koo *et al*.[12] reported the mesofacial type in 41.0% of patients, followed by brachyfacial type (35.0%) and dolichofacial type (24.0%). Cho *et al*.[13] reported that 65.0% of the patients showed mesofacial type, 19.3% for dolichofacial type, and 15.8% for brachyfacial type. The proportion of brachyfacial type increased over time for vertical skeletal pattern, whereas the frequency of mesofacial and dolichofacial types decreased. In the brachyfacial type, the proportion decreased in the order of skeletal classes III, I, and II; in the dolichofacial type, the proportion increased in the same order. These findings seem to be influenced by positioning of the mandible. Mandibular clockwise rotation tended to be stronger in dolichofacial subjects than in brachyfacial subjects. In the dolichofacial type, the mandible may rotate clockwise and tend to retreat horizontally, producing a large proportion of skeletal class II pattern cases.

The rate of orthodontic treatment carried out after diagnosis was 85.7% and was highest for skeletal class III patients. Early or phase I orthodontic treatment refers to treatment that precedes the conventional treatment protocol of fixed orthodontic appliances. Due to the nature of pediatric dentistry, most patients who started the orthodontic treatment at SNUDH received early orthodontic treatment. Excluding the fixed orthodontic appliance, early orthodontic treatment was received by about 80% of the total patients. The most common technique was removable orthodontic appliances and rapid palatal expansion with facemasks. The timing and necessity of initial orthodontic treatment depend on patient situation. For skeletal class III patients, several studies have suggested early intervention before the age of 10 years[21,22]. Therefore, it can be inferred that the majority of skeletal class III patients was treated with rapid palatal expansion with a facemask. Two-stage orthodontic treatment for skeletal class II patients was not as effective compared to 1-stage orthodontic treatment

and there was no advantage in final treatment result[23,24]. Thus, the proportion of fixed orthodontic appliance of class II patients was higher compared to other skeletal patterns. Future research on treatment methods performed in pediatric dentistry should examine the changes in orthodontic treatment modality.

This study aimed to examine the pediatric orthodontic patients as the proportion of orthodontic treatment has increased in pediatric dental clinics. However, this study analyzed only orthodontic patients who visited the Department of Pediatric Dentistry at SNUDH, which may differ from the distribution of patients at local dental clinics or dental hospitals in other regions. Future studies involving more patients will be needed to better assess the overall distribution of pediatric patients who undergo orthodontic treatment and to compare with the epidemiologic prevalence of pediatric malocclusion.

V. Conclusion

Within the limitation of this study, pediatric orthodontic patients were analyzed by skeletal pattern using lateral cephalometric analysis to determine the association between skeletal patterns and possible related clinical traits. The orthodontic treatment modality for each skeletal pattern was investigated for reference in therapeutic planning. A total of 580 patients who visited and received orthodontic diagnosis in the Department of Pediatric Dentistry, SNUDH from 2017 to 2019 was included in this investigation. The 7-year-old group was the largest in the overall age distribution. Skeletal class I pattern accounted for 54.2% of patients, followed by skeletal class III pattern (23.6%), and skeletal class II pattern (22.2%). Retrusion of both jaws in skeletal class I, normal positioned maxilla with retrusive mandible in skeletal class II, and retrusive maxilla and protrusive mandible in skeletal class III were the largest subgroups by skeletal pattern. The age of patients at which they visit for orthodontic treatment has decreased. The proportion of skeletal class III patients and the prevalence of anterior crossbite have increased over the years, whereas the proportion of skeletal class II patients has decreased.

Authors' Information

Sophia Rhee *https://orcid.org/0000-0003-0292-0268*
Ji-Soo Song *http://orcid.org/0000-0002-4469-5903*
Teo Jeon Shin *http://orcid.org/0000-0003-4499-8813*
Young-Jae Kim *http://orcid.org/0000-0003-4916-6223*
Jung-Wook Kim *http://orcid.org/0000-0002-9399-2197*
Ki-Taeg Jang *http://orcid.org/0000-0002-4060-9713*
Hong-Keun Hyun *http://orcid.org/0000-0003-3478-3210*

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국문초록

서울대학교치과병원 소아치과 부정교합 환자의 분포양상

이소피아 · 송지수 · 신터전 · 김영재 · 김정욱 · 장기택 · 현홍근

서울대학교 치의학대학원 소아치과학교실, 치학연구소

이번 연구는 2017 - 2019년에 서울대학교치과병원 소아치과에 내원하여 교정 진단을 받은 580명의 환자를 대상으로 조사를 시행하였다. 이 연구는 소아치과에 내원하는 교정환자의 골격 형태를 측모두부방사선 분석으로 파악하고 골격 형태와 관련된 임상적 특징과의 상관관계를 분석하고자 하였다. 또한, 골격 형태에 따라 행해진 치료방법에 대해 조사하여 임상의가 교정치료 계획 수립시 도움이 되고자 시행되었다.

연령분포는 7세 연령군이 교정진단을 받은 환자 중 가장 많은 분포를 차지하였다. 골격분포는 골격성 1급 부정교합이 54.2%로 가장 많았고 2급은 22.2%, 3급은 23.6%를 차지하였다. 골격성 1급의 경우 상하악 모두 후퇴인 환자가 34.4%, 골격성 2급의 경우 상악은 정상범주이나 하악이 후퇴인 경우가 39.5%, 골격성 3급의 경우 상악 후퇴 및 하악 전돌이 35.0%로 가장 높은 비율을 보였다. 수직적 골격형태는 brachyfacial type이 55%으로 가장 많았고 mesofacial type은 31.9%, dolichofacial type은 13.1%로 나타났다. 전체 환자 중 43.3%가 전치부 반대교합을 보였다.