

Orthodontic diagnosis rates based on panoramic radiographs in children aged 6–8 years: A retrospective study

You-Sun Lee^a 
Ji-Yeon Lee^b 

^aDepartment of Orthodontics, Korea University Anam Hospital, Seoul, Korea

^bDepartment of Orthodontics, National Health Insurance Service Ilsan Hospital, Goyang, Korea

Objective: This study aimed to retrospectively analyze the prevalence of orthodontic problems and the proportion of patients who underwent orthodontic diagnosis among children aged 6 ($n = 300$), 7 ($n = 400$), and 8 ($n = 400$) years who had undergone panoramic radiography. **Methods:** Children were divided into five groups according to their chief complaint and consultation: conservative dentistry, oral and maxillofacial surgery, orthodontics, periodontics, and prosthodontics). Chief complaints investigated included first molar eruption, lack of space for incisor eruption, frequency of eruption problems, lack of space, impaction, supernumerary teeth (SNT), missing teeth, and ectropion eruption. The number of patients whose chief complaint was not related to orthodontics but had dental problems requiring orthodontic treatment was counted. The proportion of patients with orthodontic problems who received an orthodontic diagnosis was also examined. **Results:** Dental trauma and SNT were the most frequent chief complaints among the children. The proportion of patients with orthodontic problems increased with age. However, the orthodontic diagnosis rates based on panoramic radiographs among children aged 6, 7, 8 years were only 1.5% (6 years) and 23% (7 and 8 years). **Conclusions:** Accurate information should be provided to patient caregivers to correct misconceptions regarding the appropriateness of delaying orthodontic examination until permanent dentition is established.

Key words: Children, Orthodontic treatment, Diagnosis, Panoramic radiographs

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Corresponding author: Ji-Yeon Lee.

Professor, Department of Orthodontics, National Health Insurance Service Ilsan Hospital, 100 Ilsan-ro, Ilsandong-gu, Goyang 10444, Korea.

Tel +82-31-900-0629 e-mail jylortho@nhimc.or.kr

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INTRODUCTION

Early detection and diagnosis are crucial for the treatment of malocclusion.¹ During the progression of teeth from deciduous to permanent, the shape of the dental arch and the occlusal relationship are altered.² These changes are more pronounced in the presence of malocclusion.³ However, even when patients with malocclusion visit the dentist for common problems, the diagnosis rate is lower than the actual prevalence of malocclusion.

The prevalence of malocclusion has been investigated in many previous studies⁴⁻⁶ using cohorts encompassing school-aged children and adults. Studies have investigated the prevalence of dental abnormalities in a wide range of races and countries.⁷⁻¹² However, none of the previous studies have investigated the extent to which the prevalence of dental anomalies is reflected in the rate of orthodontic diagnosis. In addition, no studies or guidelines have addressed the appropriate timing for the initial diagnosis leading to corrective treatment. From a clinical perspective, the Korean Orthodontic Association recommends regular orthodontic care from the age of seven, when deciduous teeth begin to be replaced by permanent teeth. However, the scientific evidence for this criterion are limited and difficult to find.

Parents and guardians generally believe that orthodontic treatment performed at an early stage will necessitate secondary orthodontic treatment. Early detection of malocclusion is important¹³ because the possibility of tooth extraction can be reduced with early orthodontic or expansion treatment.¹⁴ However, delayed orthodontic diagnosis for the reasons mentioned above may result in missing the appropriate or optimal treatment window. In addition, delayed treatment of impacted teeth may result in progressive root resorption of the permanent teeth,^{15,16} creating a complicated situation or necessitating tooth extraction. To our knowledge, no previous

study has attempted to determine the proportion of patients who visit the dentist for dental caries or other treatments but are not aware that they have a problem that requires orthodontic treatment or did not undergo an orthodontic diagnostic test.

Thus, this study aimed to investigate the importance of linking the prevalence and diagnosis rates of malocclusion by determining the frequency of chief complaints that may cause malocclusion in children between 6 and 8 years of age, the early stage of mixed dentition, and the rate at which this frequency leads to orthodontic diagnosis.

MATERIALS AND METHODS

The present study included children aged 6 (n = 300), 7 (n = 400), and 8 (n = 400) years who underwent panoramic radiography at the Department of Dentistry, National Health Insurance Service, Ilsan Hospital. This study was approved by the Institutional Review Board (IRB) of the National Health Insurance Service Ilsan Hospital (IRB No. 2020-11-013). The requirement to obtain informed consent was waived by the IRB due to the study's retrospective nature.

The patients were classified into five groups according to the chief complaint that necessitated their first visit: orthodontics (ORD), conservative dentistry (COD), periodontics (PDD), prosthodontics (PRD), and oral and maxillofacial surgery (OMS) (Table 1). The initial examination to identify the chief complaint was performed by a postgraduate dental trainee or specialist in each department.

Data from panoramic radiographs were collected by three residents and one specialist in the Department of Orthodontics. The frequency of the patient's chief complaints was recorded, and the investigator assessed whether the maxillary and mandibular first molars had

Table 1. Distribution of patients by the age at their first visit to each department

	6 yr (n = 300)		7 yr (n = 400)		8 yr (n = 400)	
	Male	Female	Male	Female	Male	Female
OMS	145	67	120	52	75	51
ORD	22	29	93	79	101	96
COD	18	18	33	21	39	38
PDD	0	0	0	2	0	0
PRD	1	0	0	0	0	0
Total	186	114	246	154	215	185

Values are presented as numbers.

OMS, oral and maxillofacial surgery; ORD, orthodontics; COD, conservative dentistry; PDD, periodontics; PRD, prosthodontics.

erupted normally, the degree of eruption of the maxillary and mandibular central incisors, and any problems with the eruption space. In patients with general dental problems, the frequencies of first permanent molar eruption and insufficient eruption space in the maxillary or mandibular anterior teeth were investigated. The frequencies of eruption problems, such as early loss of primary teeth, lack of space, impaction, supernumerary teeth (SNT), missing teeth, and ectopic eruptions, were also examined. No disagreements were reported in the

results when the data were cross-checked by three residents and one specialist.

The proportion of patients with problems requiring orthodontic treatment, such as crowding, lack of teeth, ectopic eruption, or failure of first molar eruption, was determined. We also recorded whether the patients were diagnosed with orthodontic problems and examined the proportion of patients with orthodontic problems who did not undergo diagnostic orthodontic testing. Among patients with general dental problems, the number of

Table 2. Classification of orthodontic problems with or without an orthodontic diagnosis

	6 yr		7 yr		8 yr	
	ORDx	No-ORDx	ORDx	No-ORDx	ORDx	No-ORDx
Space deficiency*	25 (37.3)	163 (31.8)	169 (88.0)	146 (70.0)	150 (54.9)	103 (41.4)
Incomplete molar eruption [†]	17 (25.4)	124 (24.2)	42 (22.0)	36 (17.0)	14 (5.1)	7 (2.8)
SNT	1 (1.5)	112 (21.9)	25 (13.0)	102 (49.0)	12 (4.4)	49 (19.7)
Ectopic eruption (include locking) [‡]	2 (3.0)	11 (2.1)	20 (10.0)	12 (6.0)	10 (3.7)	5 (2.0)
Impaction [§]	2 (3.0)	46 (9.0)	16 (8.0)	25 (12.0)	16 (5.9)	10 (4.0)
Congenitally missing tooth	6 (9.0)	21 (4.1)	16 (8.0)	23 (11.0)	19 (7.0)	15 (6.0)
WNL	12 (17.8)	19 (3.7)	12 (6.0)	23 (11.0)	38 (13.9)	57 (22.9)
Early loss of deciduous tooth [¶]	1 (1.5)	13 (2.5)	13 (12.0)	10 (5.0)	10 (3.7)	3 (1.2)
Etc. (late eruption**, fusion)	1 (1.5)	3 (0.7)	1 (1.0)	2 (1.0)	4 (1.4)	0 (0)
Total ^{††}	46	254	191	209	210	190

Values are presented as number (%).

ORDx, patients with an orthodontic diagnosis; No-ORDx, patients without an orthodontic diagnosis; SNT, supernumerary tooth; WNL, within normal limit (no special findings in panoramic radiographs).

*Overlapping of the maxillary 4 incisors is seen or expected in the panoramic view.

[†]Equally or apically positioned first molar in comparison to the cemento-enamel junction of the adjacent teeth (at least one).

[‡]An abnormal eruption pattern, such as locking and transposition, was observed or expected.

[§]Impaction of tooth germ is suspected due to mechanical obstruction or developmental problems.

^{||}Missing tooth germ.

[¶]Loss of deciduous molar (D or E).

**Delayed eruption of the maxillary central incisor in comparison with the opposite teeth without any developmental problems.

^{††}The total at the bottom is the number of patients surveyed. Because the list of patients' orthodontic problems is multiple and overlapping, it is larger than the total number of patients.

Table 3. Distribution of orthodontic diagnosis by the first visit department

		OMS	ORD	COD	PDD	PRD
		6 yr	ORDx	3 (1.4)	43 (88.0)	0 (0)
	No-ORDx	209 (98.6)	8 (12.0)	36 (100.0)	0 (0)	1 (100.0)
7 yr	ORDx	24 (14.0)	162 (94.0)	5 (9.0)	0 (0)	0 (0)
	No-ORDx	148 (86.0)	10 (6.0)	49 (91.0)	2 (100.0)	0 (0)
8 yr	ORDx	16 (12.7)	186 (94.4)	8 (10.4)	0 (0)	0 (0)
	No-ORDx	110 (87.3)	11 (5.6)	69 (89.6)	0 (0)	0 (0)

Values are presented as number (%).

ORDx, patients with an orthodontic diagnosis; No-ORDx, patients without an orthodontic diagnosis; OMS, oral and maxillofacial surgery; ORD, orthodontics; COD, conservative dentistry; PDD, periodontics; PRD, prosthodontics.

Table 4. Classification of orthodontic problems in patients with an orthodontic diagnosis

	6 yr				7 yr				8 yr				
	OMS	ORD	PDD	COD	OMS	ORD	PDD	COD	OMS	ORD	PDD	COD	PRD
Space deficiency*	1 (16.6)	24 (39.4)	0 (0)	0 (0)	22 (92.0)	142 (88.0)	5 (100.0)	0 (0)	10 (30.3)	136 (59.1)	4 (36.5)	0 (0)	0 (0)
Incomplete molar eruption†	1 (16.6)	16 (26.2)	0 (0)	0 (0)	5 (2.0)	37 (23.0)	0 (0)	0 (0)	3 (9.1)	10 (4.3)	1 (9.0)	0 (0)	0 (0)
Ectopic eruption (include locking)‡	1 (16.6)	1 (1.6)	0 (0)	0 (0)	4 (16.0)	16 (10.0)	0 (0)	0 (0)	1 (3.0)	8 (3.5)	1 (9.0)	0 (0)	0 (0)
WNL	0 (0)	12 (19.8)	0 (0)	0 (0)	0 (0)	12 (7.0)	0 (0)	0 (0)	3 (9.1)	31 (13.5)	4 (36.5)	0 (0)	0 (0)
Congenitally missing tooth§	1 (16.6)	5 (8.2)	0 (0)	0 (0)	2 (8.0)	13 (8.0)	1 (20.0)	0 (0)	3 (9.1)	16 (7.0)	0 (0)	0 (0)	0 (0)
Early loss of deciduous tooth	0 (0)	1 (1.6)	0 (0)	0 (0)	2 (8.0)	11 (7.0)	0 (0)	0 (0)	1 (3.0)	9 (3.9)	0 (0)	0 (0)	0 (0)
SNT	1 (16.6)	0 (0)	0 (0)	0 (0)	16 (67.0)	9 (6.0)	0 (0)	0 (0)	4 (12.2)	8 (3.5)	0 (0)	0 (0)	0 (0)
Impaction¶	1 (16.6)	1 (1.6)	0 (0)	0 (0)	8 (33.0)	7 (4.0)	1 (20.0)	0 (0)	7 (21.2)	9 (3.9)	1 (9.0)	0 (0)	0 (0)
Etc. (late eruption**, 0 (0)	1 (1.6)	1 (1.6)	0 (0)	0 (0)	0 (0)	1 (1.0)	0 (0)	0 (0)	1 (3.0)	3 (1.3)	0 (0)	0 (0)	0 (0)
Total††	6	61	0	0	24	162	5	0	33	230	11	0	0

Values are presented as number (%).

OMS, oral and maxillofacial surgery; ORD, orthodontics; COD, conservative dentistry; PDD, periodontics; PRD, prosthodontics; WNL, within normal limit (no special findings in the panoramic radiographs); SNT, supernumerary tooth.

*Overlapping of the four maxillary incisors can be seen or expected in the panoramic view.

†Equally or apically positioned first molar in comparison to the cementoamel junction of the adjacent teeth (at least one).

‡An abnormal eruption pattern, such as locking and transposition, was observed or expected.

§Missing tooth germ.

|| Loss of deciduous molar (D or E).

¶ Impaction of tooth germ is suspected due to mechanical obstruction, developmental problem.

**Delayed eruption of the maxillary central incisor compared to the opposite teeth without any developmental problems.

††The total at the bottom is the number of patients surveyed. Because the list of patients' orthodontic problems is multiple and overlapping, it is larger than the total number of patients.

Table 5. Classification of orthodontic problems in patients without an orthodontic diagnosis

	6 yr					7 yr					8 yr				
	OMS	ORD	COD	PDD	PRD	OMS	ORD	COD	PDD	PRD	OMS	ORD	COD	PDD	PRD
Space deficiency*	134 (30.7)	6 (30.0)	23 (42.6)	0 (0)	0 (0)	107 (72.0)	7 (70.0)	31 (63.0)	1 (50.0)	0 (0)	66 (40.7)	6 (46.2)	31 (41.9)	0 (0)	0 (0)
Incomplete molar eruption†	109 (24.9)	3 (15.0)	0 (0)	0 (0)	0 (0)	96 (65.0)	3 (30.0)	3 (6.0)	0 (0)	0 (0)	49 (30.2)	0 (0)	0 (0)	0 (0)	0 (0)
Ectopic eruption (including locking)*	102 (23.3)	5 (25.0)	17 (31.5)	0 (0)	0 (0)	30 (20.0)	2 (20.0)	7 (14.0)	1 (50.0)	0 (0)	5 (3.1)	2 (15.4)	0 (0)	0 (0)	0 (0)
WNL	45 (10.3)	1 (5.0)	0 (0)	0 (0)	0 (0)	23 (16.0)	0 (0)	2 (4.0)	0 (0)	0 (0)	8 (5.0)	0 (0)	2 (2.7)	0 (0)	0 (0)
Congenitally missing tooth§	13 (3.0)	3 (15.0)	5 (9.3)	0 (0)	0 (0)	16 (11.0)	2 (20.0)	5 (10.0)	0 (0)	0 (0)	6 (3.7)	2 (15.4)	7 (9.5)	0 (0)	0 (0)
Early loss of deciduous tooth	14 (3.2)	0 (0)	4 (7.4)	0 (0)	1 (100.0)	12 (8.0)	0 (0)	10 (20.0)	1 (50.0)	0 (0)	24 (14.8)	3 (23.0)	30 (40.5)	0 (0)	0 (0)
SNT	10 (2.3)	1 (5.0)	0	0 (0)	0 (0)	8 (5.0)	1 (10.0)	3 (6.0)	0 (0)	0 (0)	4 (2.5)	0 (0)	1 (1.4)	0 (0)	0 (0)
Impaction¶	8 (1.8)	1 (5.0)	4 (7.4)	0 (0)	0 (0)	8 (5.0)	0 (0)	2 (4.0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (4.0)	0 (0)	0 (0)
Etc. (late eruption**, fusion)	2 (0.5)	0 (0)	1 (1.8)	0 (0)	0 (0)	2 (1.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total††	437	20	54	0	1	148	10	49	2	0	162	13	74	0	0

Values are presented as number (%).

OMS, oral and maxillofacial surgery; ORD, orthodontics; COD, conservative dentistry; PDD, periodontics; PRD, prosthodontics; WNL, within normal limit (nothing special in panoramic radiographs); SNT, supernumerary tooth.

*Overlapping of the maxillary 4 incisors is seen or expected in the panoramic view.

†Equally or apically positioned first molar compared to the cemento-enamel junction of the adjacent teeth (at least one).

‡An abnormal eruption pattern, such as locking and transposition, was observed or expected.

§Missing tooth germ.

|| Loss of deciduous molar (D or E).

¶ Impaction of tooth germ is suspected due to mechanical obstruction or developmental problem.

**Delayed eruption of the maxillary central incisor compared to the opposite teeth without any developmental problems.

††The total at the bottom is the number of patients surveyed. Because the list of patients' orthodontic problems is multiple and overlapping, it is larger than the total number of patients.

those with eruption problems, such as insufficient space, impaction, SNT, missing teeth, and ectopic eruption, was examined in the four groups of patients whose chief complaint was not related to orthodontic treatment (Table 2).

The frequencies of patients showing the problems mentioned above among the patients who underwent orthodontic diagnostic testing, those who did not, and those who did not receive further ORD diagnosis were determined. By combining these results, the frequency of patients who had orthodontic problems but did not undergo orthodontic diagnostic tests was investigated (Tables 3–5). The mesiodistal inclinations of the left and right crowns of the maxillary canines were also investigated (Table 6). Linear regression analysis was used to determine the proportion of patients with orthodontic problems according to age and determine they showed any significant age-related differences (Table 7).

RESULTS

Among the children who visited the hospital, most patients aged 6–7 years underwent OMS consultations, while most patients aged 8 years underwent ORD consultations (Table 1). The most common chief complaint was dental trauma in 6- and 8-year-olds and SNT in 7-year-olds (Figure 1).

The most common orthodontic problem identified by panoramic radiography was lack of space (Table 2). Among the patients who underwent OMS consultations and were recommended to undergo an orthodontic diagnostic test because the consultation indicated an orthodontic problem, the proportion of patients who actually underwent a subsequent orthodontic diagnostic test was < 14%, while the corresponding proportions of patients who underwent PDD or PRD consultations was 0% and that for patients who underwent COD consultations was < 10.4%. The proportion of patients and their guardians who underwent an ORD consultation that indicated the need for a diagnostic test and underwent the test immediately varied depending on age, ranging from 88% to 94% (Table 3).

Table 6. Crown inclination of maxillary canines

	6 yr		7 yr		8 yr	
	#13	#23	#13	#23	#13	#23
Mesial	215 (71.7)	204 (68.0)	336 (84.0)	322 (80.0)	359 (89.8)	348 (87.0)
Distal	83 (27.7)	95 (31.7)	61 (15.0)	75 (19.0)	40 (10.0)	51 (12.8)
Missing	2 (0.6)	1 (0.3)	3 (1.0)	3 (1.0)	1 (0.3)	1 (0.3)
Mean ± standard deviation (°)*	2.3 ± 6.4	1.8 ± 6.1	5.4 ± 7.2	4.4 ± 7.6	7.9 ± 7.9	7.9 ± 8.3

Values are presented as number (%).

*Inclination of maxillary canines.

Among the patients who underwent orthodontic diagnostic tests, the most frequent problem was lack of space, followed by ectopic eruption of the first permanent molars (Table 4). In the OMS, ORD, COD, and PDD groups, the most common problem among patients who did not undergo orthodontic diagnostic tests was also lack of space (Table 5). The crown inclinations of the left and right maxillary canines were measured (Figure 2), and the mesial inclination ratio was found to be high in patients of all ages (Table 6).

The proportions of patients of each age who showed orthodontic problems and belonged to the group that underwent orthodontic diagnostic examination and the group that did not were analyzed using linear regression analysis, and no significant difference was found between the groups. This finding implied that orthodontic problems do not naturally resolve with age and are unrelated to the presence or absence of a diagnostic examination (Table 7).

DISCUSSION

This study identified problems requiring orthodontic

Table 7. Distribution of patients with orthodontic problems by age

	Age (yr)	Number of patients with orthodontic problem	P value*
ORDx	6	34	0.69
	7	179	
	8	172	
No-ORDx	6	235	
	7	186	
	8	123	

Values are presented as numbers.

ORDx, patients with an orthodontic diagnosis; No-ORDx, patients without an orthodontic diagnosis.

*P value was calculated using a generalized linear regression model.

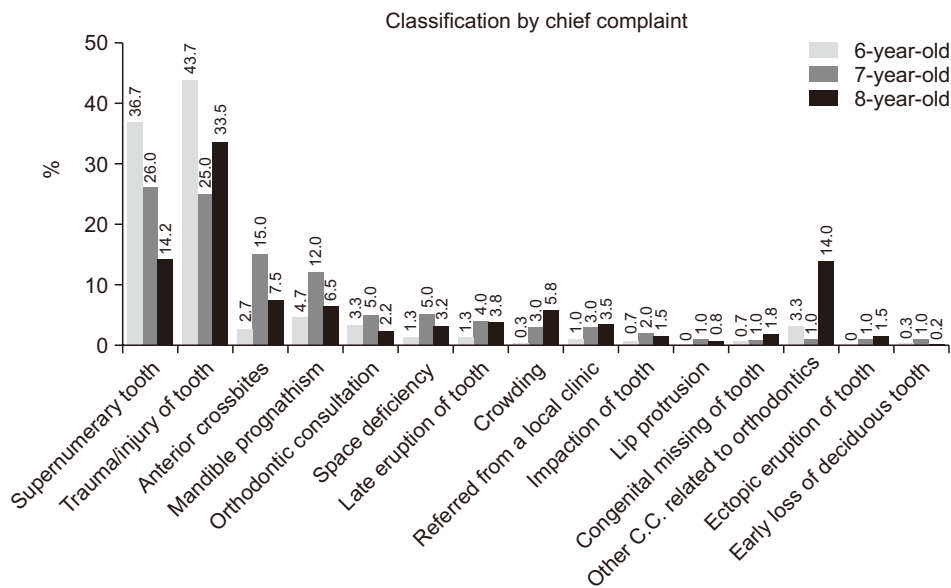


Figure 1. Classification by chief complaint. Values are presented as percentage.

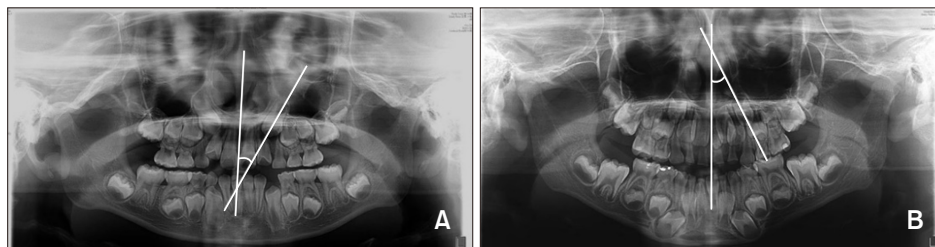


Figure 2. Crown inclination of maxillary canines. The maxillary canine long axis was divided into “mesial” or “distal” groups according to the direction of the long axis of the maxillary canine. **A**, Mesial; **B**, distal.

treatment that could be observed on panoramic radiographs in 1,100 children aged 6, 7, and 8 years. Even among the patients who were informed that orthodontic diagnostic examinations were necessary, > 10% did not undergo diagnostic examinations.

The significant decrease in the prevalence of dental caries among infants and school-aged children during national health checkups has been attributed to recent policies that have strengthened coverage. However, because oral examinations only involve clinical examinations without radiography, they cannot easily evaluate a child’s growth and tooth development and determine the appropriate timing of orthodontic treatment. In addition, our findings indicated that problems requiring orthodontic treatment, such as tooth eruption disorders and lack of space, were observed when patients visited a dentist for general dental problems. However, such patients often did not undergo orthodontic diagnostic testing and missed the appropriate treatment window.

Most dental treatments involve hard tissues, and radiography is crucial for diagnosis. Many problems cannot be detected without panoramic radiography during oral

examination, including ectopic canine eruption, undermining resorption, SNT, or congenital missing teeth.¹⁷⁻²⁰ In intraoral examinations performed to assess the number and size of permanent or deciduous teeth and the space between extracted primary teeth, panoramic radiography is essential for accurate assessment. Digital panoramic radiographs are advantageous because they enable examination of the jaws and teeth using low-dose radiation at a low cost.

Trauma to the teeth was the most common complaint among children aged 6 and 8 years, and the second most common complaint among children aged 7 years (Figure 1). Because the present study was conducted at a dental hospital, the patients’ chief complaints were mainly traumatic dental injuries.²¹ While children aged 6, 7, and 8 years with non-orthodontic chief complaints were referred for orthodontic diagnostic examination because they were considered to require orthodontic treatment, orthodontic diagnostic examinations were performed in only 14% and 9% of the patients in the OMS and COD groups, respectively. Orthodontic assessment was not performed in the remaining patients,

although they were identified as requiring orthodontic treatment at an appropriate time.

This study, which involved 1,100 children aged 6–8 years, found that only 10–14% of those who visited a non-orthodontic department and were recommended to undergo an orthodontic diagnostic examination because an orthodontic problem was detected on their panoramic photographs subsequently underwent the diagnostic examination. Lack of space was the most common orthodontic problem, and mesial angulation of the upper canine was dominant in this age group.

Even among orthodontists, designing an accurate orthodontic treatment strategy based solely on panoramic radiographs and intraoral clinical examinations is difficult. However, regular examinations may allow early detection of problems that may arise in the future and yield better clinical outcomes. In cases showing such problems, an accurate diagnosis must be obtained at each developmental stage, and a continuous treatment plan is essential. General dentists may also be uninformed about the appropriate timing of orthodontic treatment,²² and may advise patients to wait until the permanent teeth erupt, even if the problem is detected in early childhood, resulting in lower prevalence and diagnosis rates and missed timing of orthodontic treatment. Thus, patients must be properly informed about the timing of their treatment so that they can be educated on avoiding problems and mitigating risks.²³

Among the chief complaints of patients who underwent ORD consultations, the most frequent complaints were related to skeletal Class III malocclusion, including anterior crossbite or excessive mandibular growth,^{24,25} followed by those who were recommended that ORD was necessary or pursued it themselves, while the third most frequent complaint was lack of space. The highest percentage of expected orthodontic problems on the panoramic radiographs of the patients who presented was lack of space (Table 2). Lack of space was also the most common problem in patients who underwent orthodontic diagnostic examinations (Table 4) and in the group of patients who did not undergo subsequent orthodontic diagnostic examinations (Table 5).

The appropriate time for orthodontic treatment varies according to the type of malocclusion. The timing of treatment also differs according to Angle's classification of malocclusion.²⁶ Each stage of development requires an accurate diagnosis and an ongoing treatment plan.²⁷ The type of problem varies depending on the chief complaint.²⁸ The aim of the present study was to highlight the detection of these factors. In Class I malocclusion, space supervision of the exchange of teeth in the mixed dentition, careful management of available arch discrepancy, and the sequence of primary exchanges should be evaluated.²⁹ In Class II malocclusion, the skeletal

problem should preferably be resolved before the peak growth period. In Class III malocclusion, if an anterior crossbite is detected, treatment should be initiated as soon as possible, and planned and continuous monitoring of the condition should not be neglected. Early detection of Class III malocclusions is particularly important.

The appropriate timing for orthodontic treatment varies depending on the severity of malocclusion.³⁰ We recommend orthodontic diagnosis at 7 years of age, when the anterior deciduous teeth of the upper and lower jaws are replaced by permanent teeth. During this period, orthodontic diagnostic examinations, including oral examinations and radiography, should be performed in advance to determine any orthodontic problems that may not have been discovered by the patient or guardian. There is no specific age limit for patients who can undergo orthodontic treatment. The guidelines of the American Academy of Orthodontics recommend examination by an orthodontic specialist as soon as the child shows signs of an orthodontic problem and that children should visit an orthodontic specialist at least at approximately 7 years of age.

Canine impaction is a common occurrence,³¹ and clinicians must be prepared to manage it. Because the position of the canines contributes to the guidance of the intercuspal position and the type of malocclusion, the canine should be evaluated during development and eruption.³² Measurements of maxillary left and right canine inclinations (Figure 2) revealed a high ratio of mesial inclinations at all age levels (Table 6). Once identified, mesial angulation should be carefully followed up to prevent further malocclusion, because it is closely related to canine impaction or transposition.³³

With the designation of oral examinations as a part of a national initiative, many improvements have been made in the early detection and prevention of dental caries. However, without panoramic radiography, problems such as SNT, missing teeth, and impacted teeth affecting adjacent teeth or cases requiring orthodontic treatment are difficult to identify solely through clinical examinations. The age of primary school entry in South Korea has changed to seven years. At this age, primary school children undergo an oral examination at a national check-up, which can identify orthodontic problems that may be present in the anterior incisors, such as anterior crossbites. Obtaining panoramic radiographs at the national check-up would allow for early diagnosis of the need for orthodontic treatment for various problems.

In this study, we determined the number of patients with dental problems who had problems requiring orthodontic treatment but did not undergo orthodontic diagnostic tests. This findings also provide an appropriate basis for considering 7 years of age as the appropri-

ate timing of an orthodontic diagnostic test, since this is typically when the first molars have erupted and the front permanent teeth begin to erupt.^{34,35}

Because pediatric dentistry was excluded as a target group in this study, the fact that most patients were in the OMS and ORD groups can be considered a limitation. If additional multicenter studies involving patients of the same age are conducted in the future, more accurate comparisons of orthodontic diagnostic test performance rates will become possible. The establishment of an artificial intelligence-based assessment and problem-detection system based on panoramic radiographs in the healthcare system may improve the rate at which patients with orthodontic problems are quickly screened and referred to an orthodontist, and thereby receive an orthodontic diagnosis.

CONCLUSIONS

The first orthodontic examination should be usually performed at approximately 6–8 years of age, when the permanent incisors emerge. If panoramic imaging is performed as a part of the Korean national oral examination even for 7-year-old children in the first grade of elementary school and an appropriate orthodontic diagnostic examination is performed for diverse problems, accurate treatment strategies can be established and problems can be solved, ensuring that the window for optimal treatment is not missed. In addition, accurate information must be provided to correct the patient's or guardian's misunderstanding that orthodontic diagnostic examinations should be postponed until the permanent dentition is complete.

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AUTHOR CONTRIBUTIONS

Conceptualization: JYL. Data curation: JYL. Formal analysis: YSL. Funding acquisition: JYL. Investigation: JYL. Project administration: YSL. Supervision: JYL. Validation: YSL. Visualization: YSL. Writing–original draft: YSL. Writing–review & editing: JYL.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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