

## Age, extraction rate and jaw surgery rate in Korean orthodontic clinics and small dental hospitals

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**Objective:** This study aimed to investigate the current data regarding age, sex, and Angle Classification of Korean orthodontic patients and influence of these factors on the tendency to undergo extraction and orthognathic surgery. **Methods:** The recent trends of Korean orthodontic patients were assessed using questionnaire survey. The questionnaires were e-mailed to orthodontists who met the study criteria; 58% of the orthodontists opened the e-mails, and 27.7% replied to the e-mails. In all, the medical records of 11,340 patients who underwent orthodontic treatment at private clinics and small dental hospitals in Korea were analyzed. **Results:** The percentage of female patients in the study sample was 69.6%, and the average age of the patients was 19.87 years. The percentage of patients who were older than 19 years was 50.2%. Class II and Class III malocclusions were noted in 33.6% and 23.6% of patients, respectively. Extraction and orthognathic surgery were performed in 60.4% and 6.9% of patients, respectively. **Conclusions:** The results showed that there were a high percentage of adult, Class II malocclusion and extraction patients in private practices and small dental hospitals during the study period. Further, a relatively high proportion of adult patients opted to undergo orthognathic surgery.

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## INTRODUCTION

In Korea, although the adolescent population has decreased during the past 15 years<sup>1</sup> owing to the low birth rate, the demand for orthodontic treatment has increased because of a higher income, greater interest in facial esthetics, and public awareness regarding the availability of adult orthodontic treatment.<sup>2,3</sup>

Epidemiological studies conducted worldwide have revealed geographical and cultural differences in the development of malocclusion and need for orthodontic treatment.<sup>4,5</sup> However, there can be differences in the perception of malocclusion in the general public and in orthodontic patients who receive orthodontic treatment. Knowledge about the demand for orthodontic treatment and the treatment plans chosen by patients can provide valuable information regarding the needs of patients.

The need for the extraction of permanent teeth during orthodontic treatment has been debated for many years. The decision for performing extraction or non-extraction orthodontic treatment can be justified on the basis of post hoc analyses since both treatment options yield good outcomes. The previous studies showed wide range of extraction treatment frequency. However, these studies could not acquire sufficient data since some studies used the estimated percentage of dental extractions performed by each clinician<sup>6,7</sup> and others used the data obtained from a single clinic.<sup>3,8</sup>

Although the esthetic standards for facial attractiveness is largely dependent on the cultural background,<sup>9</sup> the relationship between racial or cultural background and orthodontic extraction decisions remains to be completely analyzed.

Generally, local orthodontic clinics or small dental hospitals do not gather and assess patient's data for investigative purposes because they usually lack the means or motivation (high performance rating, incentive bonus, or promotion) to perform such investigations of their own accord. Therefore, no published data on orthodontic patients' characteristics such as Angle classification, average age, extraction rate, and sex ratio are available from these institutions.

This investigation aimed to identify the characteristics of orthodontic patients and to estimate the frequencies of dental extractions and surgical orthodontic treatments performed at private clinics and small dental hospitals in Korea.

## MATERIAL AND METHODS

This study was a questionnaire survey. The data from 11,340 (3,444 [30.4%] men and 7,896 [69.6%] women) patients who were undergoing orthodontic treatment at Korean orthodontic clinics were analyzed. Patient data

regarding orthodontic therapy, sex, age at orthodontic treatment initiation, extraction sites, whether or not orthognathic surgery was planned, and Angle classification were collected and analyzed. In 2008, Korea had 188 private orthodontic clinics and 134 dental hospitals, most of which include an orthodontic department.<sup>10</sup> Approximately 40% of orthodontic clinics and hospitals are located in Seoul.<sup>6</sup>

This study included data from full-time orthodontists; orthodontists who had been practicing for fewer than 3 years or had treated fewer than 100 new patients in 2007 were excluded. Orthodontists working at university hospitals or large hospitals (training institutions) as residents, fellows, or professors were also excluded. If 2 or more orthodontists practiced at the same clinic, the data from only one of the orthodontists were collected. In the case of uncertainty regarding the fulfillment of the inclusion criteria for orthodontists because of insufficient information, those data were excluded.

In all, 201 orthodontists were included in the study. The e-mail addresses of 174 of these 201 orthodontists were obtained via an online search or from the membership lists of the Korean Association of Orthodontists and Korean Society of Orthodontists. Of the 174 orthodontists, 89 practiced at clinics located in Seoul and 85 in other cities. The survey questionnaire was e-mailed to these orthodontists. Considering the fact that completing a questionnaire is a time-consuming process, those orthodontists who did not send the completed questionnaire after 6 - 8 weeks were sent a reminder e-mail. Further, orthodontists who did not respond 6 - 8 weeks after receiving the second e-mail were sent a third e-mail.

In all, 101 orthodontists (58%) opened the e-mail, but only 28 completed questionnaires were returned. Of the 28 (27.7%) orthodontists who completed the survey, 14 worked at clinics (2 of which were dental hospitals) located in Seoul, and 14 worked at clinics (2 of which were dental hospitals) located in other areas of Korea. Data obtained in 2005 shows that the population of Korea was 47.28 million<sup>1</sup> with 10 million living in Seoul. The 28 orthodontists had graduated from 6 different dental schools in Korea and had undergone residency training at the Orthodontic Departments of 13 different graduate schools in Korea, Japan, and the United States. Information regarding years of experience after completing orthodontic training was also collected (Table 1).

The data for 405 recent consecutive patients were collected from each clinic. For those clinics that had less than 405 recent patients, the records of previously treated consecutive patients were included. All patients were classified into 1 of 6 age groups:  $\leq 6$ , 7 - 12, 13 - 18, 19 - 24, 25 - 39, and  $\geq 40$  years. Further, the patients were categorized into 1 of 6 extraction groups: upper and lower

first premolars, upper first premolars and lower second premolars, upper and lower second premolars, upper first premolars, other types of extractions, and non-extraction. The patients who underwent orthognathic surgery were not classified according to the type of surgery. Patients who received treatment which included orthognathic surgery were classified into the surgery group.

The influence of clinic location on the characteristics of malocclusion and the decisions that were made regarding treatment plans were evaluated by comparing these variables between clinics located in Seoul and those located in other cities of Korea. Standard descriptive statistics were calculated, and chi-square tests were performed. The effect of work experience on extraction and surgery rates was evaluated using the Kruskal-Wallis test. Logistic regression analysis was used to calculate the odds ratio for dental extractions performed in the 13 - 18 and > 19 year age groups. All statistical analyses were performed using SPSS version 16.0 for Windows (SPSS Inc., Chicago, IL, USA).

## RESULTS

### Sex and age

The study sample comprised 11,340 patients: 3,444 (30.4%) were male and 7,896 (69.6%) were female.

The age distribution of the patients is shown in Table 2. The average age of the study population was 19.87 years, and 2.3% of the patients were over 40 years of age. There was a significant difference in age ( $p < 0.01$ ) between patients from Seoul and those from other cities in Korea.

### Angle classification

Class I, Class II division 1, Class II division 2, and Class III malocclusions were noted in 42.8%, 30.2%, 3.4%, and 23.6% of the patients, respectively (Table 1). The frequency of Class II malocclusions was significantly higher in Seoul (36.2%) than in other cities.

### Extraction rate and site

The percentage of patients who underwent extraction was 60.4% (Table 2). Extraction was performed in 66.0% of the patients older than 13 years of age. There was a

wide range of extraction rate in each clinic (32.3 - 76.8%) and there were no significant differences in the extraction rate between patients from Seoul and those from the other cities of Korea.

In patients more than 13 years of age, the extraction rate was higher in female patients (69.2%) than in male patients (57.2%). The extraction of the upper and lower first bicuspid was the most common type of extraction (42.4%). Extraction of the first upper bicuspid and second lower bicuspid was performed in 12.2%, and extraction of only the upper first bicuspid occurred in 14.0% .

The logistic regression analysis (Table 3) performed to evaluate the influence of orthognathic surgery, sex, age, and orthodontic clinic location on extraction rate revealed that the non-extraction method was more commonly used in orthognathic surgery patients and in male patients. There was no significant difference in

**Table 2.** Characteristics of patients

	Total	Seoul	Other cities
Age (year)	19.87 ± 8.27	20.90 ± 8.74	18.84 ± 7.62 <sup>†</sup>
0 - 6	103 (0.9)	67 (1.2)	36 (0.6)**
7 - 12	2,621 (23.1)	1,185 (20.9)	1,436 (25.3) <sup>†</sup>
13 - 18	2,912 (25.7)	1,177 (20.8)	1,735 (30.6) <sup>†</sup>
19 - 24	2,892 (25.5)	1,476 (26.0)	1,416 (25.0)
25 - 39	2,546 (22.5)	1,609 (28.3)	940 (16.6) <sup>†</sup>
40-	266 (2.3)	159 (2.8)	107 (1.9)**
Sex			
Male	3,444 (30.4)	1,604 (28.3)	1,840 (32.5) <sup>†</sup>
Female	7,896 (69.6)	4,066 (71.7)	3,830 (67.5)**
Angle classification			
Class I	4,857 (42.8)	2,347 (41.4)	2,510 (44.4)*
Class II div. 1	3,430 (30.2)	1,881 (33.2)	1,549 (27.3) <sup>†</sup>
Class II div. 2	381 (3.4)	170 (3.0)	211 (3.7)*
Class III	2,672 (23.6)	1,272 (22.4)	1,400 (24.7)*
Rate of extraction			
Extraction	6,845 (60.4)	3,634 (60.3)	3,411 (60.2)
Extraction (age = 13 years)	5,689 (66.0)	2,940 (66.5)	2,749 (65.5)*
Rate of orthognathic surgery			
With surgery	780 (6.9)	477 (8.4)	303 (5.5) <sup>†</sup>
With surgery (age = 19 years)	625 (11.0)	386 (11.7)	239 (10.0) <sup>†</sup>

Values are presented as average ± standard deviation or n (%). div., Division.

\*Significantly different between Seoul and other cities at  $p = 0.05$ ; \*\*significantly different between Seoul and other cities at  $p = 0.01$ ; <sup>†</sup>significantly different between Seoul and other cities at  $p = 0.001$ .

**Table 1.** Years of experience after orthodontic training of the orthodontists and the location of their clinics

Years of experience	Seoul	Other cities
5 - 9	5	3
10 - 14	2	4
15 - 19	3	5
20 - 24	4	2
Total	14	14

**Table 3.** Odds ratio and relative risk of extraction treatment (age  $\geq$  13 years)

	OR (95% CI)	p-value
Age (13-18 years vs. $\geq$ 19 years)	0.95 (0.86 - 1.05)	0.293
Orthognathic surgery (with vs. without)	0.62 (0.54 - 0.73)	< 0.001
Location (Seoul vs. others)	1.03 (0.94 - 1.13)	0.469
Sex (male vs. female)	0.61 (0.55 - 0.67)	< 0.001

OR, Odds ratio; CI, confidence interval.

the extraction and surgery rates between different work experience groups.

### Orthognathic surgery

Fixed appliance therapy and orthognathic surgery were performed in 6.9% of the patients. The rate of orthognathic surgery was significantly higher in Seoul than in other Korean cities (Table 2). In patients older than 19 years, 11.0% underwent treatment which included orthognathic surgery, and the rate of surgery was higher for male patients (11.8%) than for female patients (7.8%). Among the patients who underwent orthognathic surgery, 70.7% had Class III malocclusions.

## DISCUSSION

In the United States, most orthodontic patients are children,<sup>11</sup> and early orthodontic treatment comprises a majority of orthodontic procedures. The demand for adult orthodontic treatment has been increasing in the United States during the last 30 years;<sup>12</sup> this increase in demand has also been noted in Korea.<sup>2,3</sup> The results of this study suggest that the average age of orthodontic patients in Korea is relatively high, where 50.2% were at least 19 years of age, and 2.3% were older than 40. The percentage of adult orthodontic patients was considerably higher in Korea than in the United States (20%).<sup>12</sup> The average age of patients (20.9 years) and the percentage of adults ( $\geq$  19 years, 57.1%) requiring orthodontic treatment were even higher in Seoul.

Recent studies have suggested that early orthodontic treatment in patients with Class II malocclusions cannot yield better outcome than treatment in later age;<sup>13</sup> hence, many orthodontists now avoid using early orthodontic treatment in their patients. Because the results from because the results from this study were based on data from patients who had already started orthodontic treatment, the average age of patients visiting orthodontic clinics for consultation might be lower.

The number of children has increased from 49.15 million in 1995 to 53.32 million in 2006 in the United

States,<sup>14</sup> whereas the number in Korea has decreased from 10.03 million in 1995 to 9.08 million in 2005.<sup>1</sup> In Korea, patients with mild malocclusions are generally treated by general dentists and not referred to orthodontists. Taken together, these findings might explain the high average patient age and extraction rates observed in this study.

In Western populations, the frequency of Class II malocclusion is considerably higher than that of Class III malocclusion.<sup>15,16</sup> Many previous studies have shown that the frequency of Class III malocclusion is much higher in Asian populations than in Western populations.<sup>4,17</sup> Although the prevalence of Class II malocclusion was shown to be similar or slightly higher than that of Class III malocclusion in the Korean population,<sup>18,19</sup> many previous studies performed using data from large university hospitals have shown that the frequency of Class III malocclusion was much higher than that of Class II malocclusion among patients seeking orthodontic treatment.<sup>2,3</sup>

The results of this study suggest a recent trend of higher Class II malocclusion than Class III malocclusion in Korean patients. The proportion of Class II malocclusion patients was higher in Seoul than in other Korean cities. The increasing demand for orthodontic treatment in Class II malocclusion patients may be related to the westernization of Korean standard of beauty, mainly in the large cities.

In this study, 60.4% of the patients underwent extraction; this percentage was considerably higher than that in the United States (18 - 39%)<sup>6-8</sup> and similar to or higher than that reported in previous studies conducted in Korea (24.6 - 60.9%).<sup>2,20,21</sup> When the analysis was performed using the data from patients older than 13 years of age in whom buccal segment eruption had occurred and who were old enough to make the final extraction decision, the percentage of extraction cases was even higher (66.1%). We found that extraction rates were not dependent on the location of the clinic (Table 2), but some clinics had significantly different extraction rates than others. The extraction decisions seemed to be influenced by both patient's and orthodontist's preferences.

Interestingly, the clinic that recorded the lowest extraction rate (32.3%) also had the lowest percentage of adult cases (30.9%) and the lowest mean age (17.2 years). Had there been mixed dentition patients in the sample and if the extraction rate was calculated including them, it would have been difficult to obtain precise and correct information about extraction rate.

The orthodontists who performed the lowest number of extractions (32.3%) and those who performed the highest number of extractions (76.8%) graduated from the same dental school and had residency training in the same graduate school. Hence, the influence of dental school or graduate school on extraction rate seemed minimal, at

least in the case of orthodontists who had more than 5 years of the orthodontic practice.

And although there was a tendency of higher extraction rate in older orthodontic patients (age  $\geq 19$  years), the odds ratio was not significantly different from younger orthodontic patients (13 - 19 years; Table 3). There was no statistical difference in extraction rate between private clinics and dental hospitals.

Previous studies have shown that Korean and other Asian individuals tend to have more protrusive lip profiles<sup>22-24</sup> than Western individuals.<sup>25,26</sup> These studies also showed that Koreans and Asians prefer a more retrusive lip profile and Westerners prefer a more protrusive lip profile.<sup>27</sup> Such differences in lip profile and profile preferences might have contributed to the high extraction rates observed in this study.

Although previous studies have shown that female adults concerned themselves about facial profile but female adolescents did not,<sup>28,29</sup> there were no significant differences in the extraction rates between female adults and adolescents. Because the treatment plan for adolescent patients is usually decided by not only the patients but also parents and orthodontists, further research is needed to evaluate the correlation between the extraction decision and profile preferences in adolescents.

Most of the previous studies on extraction rates used self-reported and estimated data. Weintraub et al.<sup>7</sup> showed significant differences (10.4 - 19.6%) between the estimated and actual extraction rates in their study sample. Hence, a review of a patient's complete record can provide more precise data, even though such a review is a time-consuming process.

Surgery combined with orthodontic treatment was performed in 6.9% of the patients and orthognathic surgery was performed in 11.0% of the patients aged 19 years or older. Surgery was performed in 11.6% of the adult patients who were treated at clinics located in Seoul. This rate was extremely high, considering that previous studies have reported the proportion of proposed optimal treatment plans that included orthognathic surgery to obtain ideal treatment results in adult orthodontic patients was approximately 15.4%.<sup>30</sup> This finding may be related to the increasing demand for orthognathic surgery in Korea.<sup>3</sup> Moreover, since patients with mild malocclusions are frequently treated by general dentists, the severity of malocclusions might have been higher in this sample.

Extraction rates were significantly lower in patients who underwent orthognathic surgery, and logistic regression analysis revealed a significantly lower odds ratio for the surgery group (Table 3). This result reflects the fact that in some borderline patients, extraction is necessary in order to perform camouflage treatment.

Patients who opt to undergo jaw surgery after growth

completion are able to start early orthodontic treatment for reasons such as maxillary expansion and molar distalization in the case of premature loss of the deciduous second molar. This might become a confounding factor in data interpretation. Interestingly, 33 male and 27 female Class III patients who planned to undergo jaw surgery started their orthodontic treatment between the ages of 16 and 18 years. Because many patients are eager to correct their jaw deformities before university admission, adhering to the rules for deciding the time of surgery might be difficult. Jaw growth completion occurs as late as 22 - 24 years in Class III patients;<sup>31</sup> hence, surgery should be planned accordingly in these patients.

Because of the lack of relevant data, the demand for orthodontic treatment in Korea could not be compared with that in countries other than the United States. In recent years, international exchanges among malocclusion patients and orthodontists of different geographical origins and cultural backgrounds have increased remarkably. The increasing globalization of orthodontic approaches indicates the need for cross-cultural investigations that measure the demand for and trends regarding orthodontic treatments for patients from different parts of the world.

This study has some limitations. Because questionnaires were sent only via e-mails, there is a possibility that some potential orthodontists who might have fulfilled the inclusion criteria were excluded since they might not be familiar with using e-mails. In addition, orthodontists without a website or those who did not provide their current e-mail addresses to the professional organizations from which the e-mail addresses were obtained might have also been excluded.

The low response rate (28 forms returned/101 e-mails opened) is another limitation. Because the survey questionnaire required a considerable time to complete, achieving a higher response rate was difficult. The seasonal variation effect on patients' characteristics could be avoided only if a sufficient number of patients were included from each clinic; this was the main reason for the low response rate. A larger nationwide study needs to be conducted to address these issues.

## CONCLUSION

Data obtained from the records of 11,340 consecutive orthodontic patients treated at private clinics and small dental hospitals in Korea were analyzed.

1. The percentage of female patients was 69.6%, and the average age of the study participants was 19.87 years. The percentages of adult patients and extraction cases were considerably higher in this study than in studies conducted in the United States.

2. The proportion of Class II patients was higher than that of Class III patients.
3. Orthognathic surgery was chosen by 11.0% of the adult orthodontic patients and 6.9% of the total patients included in this study.

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