



The Prevalence of Dental Anomalies in Orthodontic Patients at the State University of New York at Buffalo

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ABSTRACT

Objective: To determine the prevalence of permanent tooth anomalies in patients attending the graduate orthodontic clinic at the State University of New York at Buffalo.

Materials and methods: Charts of 496 subjects (310 females and 186 males) met the inclusion criteria for this study. The mean ages were 16 years and 3 months for the combined gender sample that received orthodontic treatment in the graduate orthodontic clinic between 2007 and 2010. Full pretreatment records (intraoral photographs, digital study models, lateral cephalograms and panoramic radiographs) were used for the assessment. Charts were examined for these anomalies: agenesis, supernumerary, impaction and delayed tooth eruption. Subjects were categorized by gender and ethnicity. The percentages of the anomalies were assessed according to type of malocclusion, gender, race, location, tooth class and region in the dental arches.

Results: Sixty-four subjects (12.9%) had at least one occurrence of delayed eruption and impaction (DEI), followed by 47 subjects (9.5%) who had at least one occurrence of agenesis, and seven (1.4%) had a supernumerary condition. Approximately 80% of the subjects had no dental anomalies. The presence of more than one anomaly was observed in 61 subjects. Twelve subjects (2.4%) had both agenesis and DEI. Aggenesis tended to be more common in class II malocclusions ($p = 0.012$).

Conclusion: The prevalence of permanent tooth anomalies was (20.4%). The percentage occurrence of DEI was the highest (12.9%) followed by dental agenesis (9.5%) and supernumerary teeth (1.4%) in the orthodontic patients at the State University of New York at Buffalo.

Keywords: Prevalence, Orthodontics, Tooth abnormalities, Epidemiology.

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INTRODUCTION

Various studies have investigated the prevalence of dental anomalies but few such studies have included the relation

of the malocclusion to the recorded dental anomalies. Uslu¹ reported that 40.3% of patients ($n = 363$) had at least one dental anomaly. The most prevalent dental anomaly was agenesis (21.6%) followed by dens evaginatus (6.2%), invaginatus (5.0%), pulp stone (4.2%) and impaction (2.9%).²

Dental anomalies may cause discrepancies in the dental arches; therefore, they may affect the dental occlusion. The dental anomalies pertaining to the alteration in number are supernumerary and dental agenesis. A supernumerary tooth is defined as an extra tooth or tooth like structure in addition to the 32 permanent teeth; usually presents in the permanent dentition or the 20 deciduous teeth usually formed in the temporary dentition.^{3,4} Supernumerary teeth may exist unilaterally or bilaterally, be single, double or multiple,⁵ however, they mostly occur bilaterally.⁶ They can be erupted, impacted or exhibit ectopic eruption,³ and can be similar to the normal teeth or be amorphous.^{5,7} The most common supernumerary tooth is the mesiodens which develops between the maxillary central incisors.^{6,7} The prevalence rates of supernumerary teeth in Caucasian populations in the permanent and primary dentition are 0.1 to 3.6% and 0.3 to 0.8% respectively.^{4,6,8,9} The etiology leading to supernumerary teeth is not well understood, but there are many possible causes that include atavism, excessive growth of the dental lamina, and dichotomy of the tooth germ, heredity and genetics.⁴ Supernumerary teeth are classified according to their location. Mesiodens is located between the upper central incisors, it has a conical or triangular crown and is located palatally or labially.¹⁰ Paramolars are placed in the molar region, either buccally or lingually/palatally¹¹ or in the interproximal space buccal to a second molar and to the adjacent wisdom tooth.¹⁰ Distomolars are situated distal to third molar and usually have rudimentary shapes.¹⁰ Parapremolar type is similar to a premolar tooth and it occurs in the premolar region.¹⁰

Dental agenesis is defined as the congenital absence of a tooth/tooth germ in the permanent dentition.¹¹ It is one of the most commonly seen dental developmental anomalies.¹² The dental agenesis term is most frequently used because it implies a developmental defect.¹³ The prevalence of the dental agenesis, excluding the third molars, is said to vary according to the population as from 7.7% in an African-American population, with the most commonly affected tooth being the mandibular second premolars to 9.9% in a Japanese population where the most common tooth to be affected is the mandibular lateral incisor.¹³ The etiology of dental agenesis is not well understood.¹⁰ If there is a mutation in one of the human genes such as transcription growth factors TGFA,¹⁰ MSX1 and PAX9,¹⁴ AXIN,⁶ and FGFR1,¹⁵ dental agenesis may occur.¹⁰ Dental agenesis is frequently associated with various types of dental anomalies such as microdontia, delayed dental development and isolated tooth ectopias.^{16,17}

The objectives of this retrospective study were to determine the prevalence of permanent tooth anomalies present in patients attending the orthodontic clinic at the State University of New York at Buffalo and the types of malocclusions associated with them.

MATERIALS AND METHODS

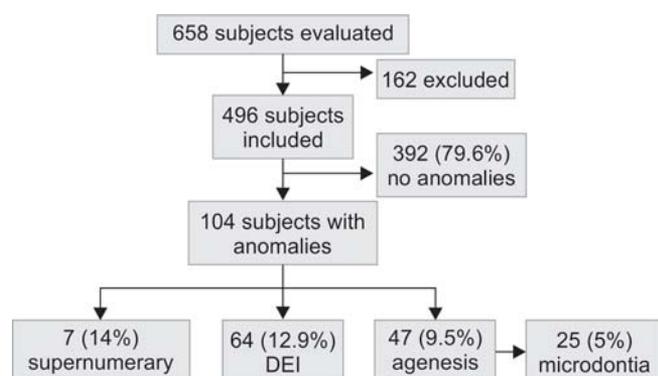
The study was approved by the Health Sciences Institutional Review Board of the University at Buffalo. The pretreatment orthodontic records of 658 healthy female and male patients admitted to the graduate orthodontic clinic at the University at Buffalo between 2007 and 2010 were retrieved and screened. One hundred and sixty-two subjects were excluded due to incomplete records and/or not meeting the inclusion criteria. Four hundred and ninety-six subjects (186 males and 310 females) were included in the study (Flow Chart 1). The mean ages were 16 years and 3 months for the combined gender sample. The records were accessed through Dolphin software version 11 (Chatsworth, California) and OrthoCAD™ software from their computer

storage in the Department of Orthodontics at the University at Buffalo in New York. Full pretreatment records were defined as initial intraoral photographs, digital study models, and lateral cephalograms, and panoramic radiographs. Subjects were excluded if they had craniofacial developmental anomalies such as cleft lip or palate or Down's syndrome or if presented with traumatized or extracted teeth. Third molar anomalies were not taken into account in the statistical analysis.

Subjects were categorized according to their gender, ethnicity, and type of anomaly (agenesis, supernumerary, impaction or delayed tooth eruption, microdontia). The anomalies were defined as follows: Dental supernumerary: a tooth that appears in addition to the regular number of the teeth. Dental agenesis: the congenital absence of a permanent tooth germ evaluated on panoramic X-rays, to be differentiated from dental pseudoagenesis: a tooth that is absent clinically because of delayed eruption and impaction (DEI). Delayed eruption: a tooth that erupts after its accepted time of eruption into the oral cavity.¹⁸ Delayed eruption may also be recorded when a tooth has more than 3/4th of its root length completed, as evaluated radiographically, yet the tooth has not erupted.¹⁸ Impaction is defined as the failure of a tooth to erupt into the oral cavity because of crowding, a physical barrier in the path of its eruption, ankylosis where the unerupted tooth is fused to the bone or due to premature loss of a primary tooth.^{18,19} Microdontia: the reduction of the mesiodistal and/or gingivoincisor crown dimension of maxillary lateral incisor (peg-shaped lateral). If its size is less than 2/3rd of the size of the maxillary central it is considered to be a peg-shaped lateral incisor. The expected size of lateral incisors was calculated by using mesiodistal width measurement of the mandibular and maxillary incisors (previously obtained from OrthoCAD™ study models) according to mathematical formulas. The size of the maxillary and the mandibular incisors used to determine if there was a correlation between dental agenesis of the mandibular premolars and microdontia of the maxillary lateral incisors.

Subjects were categorized according to the number of teeth affected by the anomalies, by the location of the anomalies according to which dental quadrant was affected, according to their sagittal skeletal malocclusion obtained from cephalometric X-ray, and Angle's molar classification obtained from digital study models. For comparisons of continuous data (age, Wits appraisal) the two-sample Student's t-test was performed. When comparing the distributions of discrete data (gender, ANB°, and dental malocclusion), the Chi-square contingency table analysis was performed. All tests were done with a 5% level of significance ($\alpha \leq 0.05$).

Flow Chart 1: Included sample



RESULTS

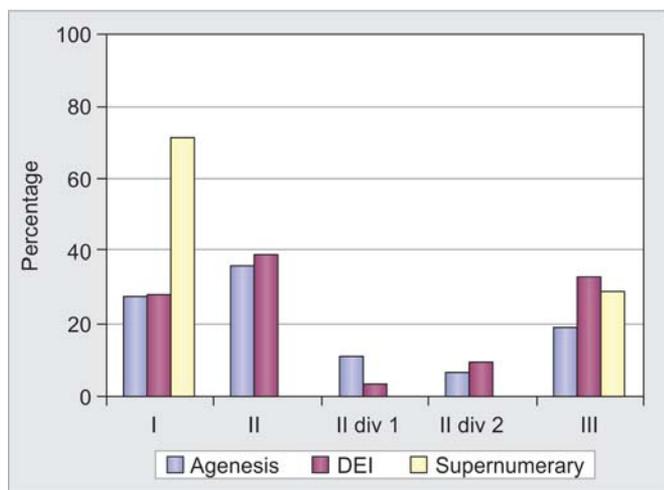
Approximately 80% of the subjects had no dental anomalies (Table 1). The percentage incidence of these entities was similar in both females and males. The presence of more than one anomaly was observed in 61 subjects (12.3% in females and 11.6% in males) without statistically significant gender differences ($p = 0.657$).

Agensis was significantly prevalent in subjects with class II malocclusions (53.19%, $p = 0.012$) followed by those with class I malocclusions (27.66%) while; it occurred the least in class III malocclusion (19.15%) (Graph 1). Supernumerary teeth mostly occurred in class I malocclusions (71.43%) followed by class III (28.57%) malocclusions and no supernumerary was found in Class II malocclusions. There was no statistically significant difference in the occurrence of the supernumerary teeth ($p = 0.167$). DEI was closer to being evenly distributed among the classes of occlusion with class II malocclusion

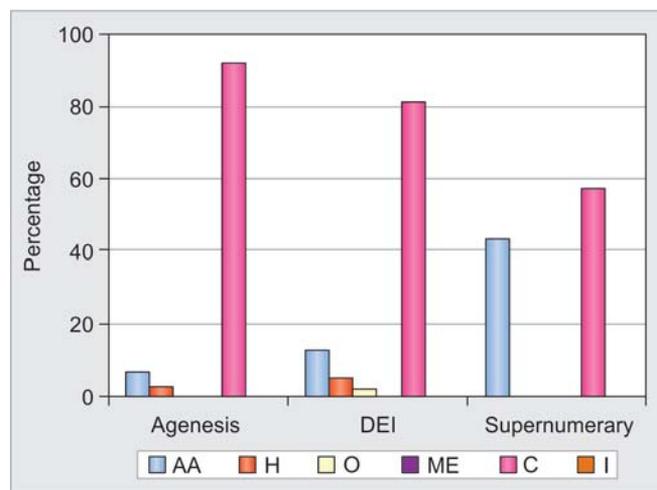
being the likeliest (39.06%) followed by class III (32.81%) and class I being the least likeliest (28.13%) of the three malocclusion types. There was not a statistically significant difference in the incidence of DEI teeth in the three occlusal types. There were too few occurrences of supernumerary teeth for a meaningful statistical analysis to be performed.

Graph 2 shows the prevalence of anomalies by race. Agensis and DEI occurred primarily among Caucasians. When compared to the proportion of Caucasians included in the sample (80.4%), the number of those with agensis was significantly greater ($p = 0.047$); while for impaction this relationship was not statistically significant ($p = 0.878$). For supernumerary teeth, there was a similar distribution for Caucasians and African-Americans. However, the total number of occurrences, seven, were too few for valid statistical analysis.

As shown in Table 2, the prevalence of subjects with supernumerary teeth was 1.4%. In the seven cases that had



Graph 1: Distribution of anomalies according to type of malocclusion



Graph 2: Distribution of anomalies by race (AA: African-American; H: Hispanic; O: Oriental; ME: Middle Eastern; C: Caucasian; I: Indian)

	Female (n) %	Male (n) %	Total (n) %
None	249 (79.0)	143 (80.3)	392 (76.9)
1 anomaly	25 (8.1)	18 (8.1)	43 (9.7)
More than 1 anomaly	36 (12.3)	25 (11.6)	61 (13.4)
Total	310 (62.5)	186 (37.5)	496 (100)

Case #	Number of teeth	Bilateral or unilateral	Right	Left	Maxillary	Mandibular	Anterior	Posterior	Type
237	1	Unilateral	X			X		X	Distomolar
153	1	Unilateral	X		X			X	Distomolar
78	1	Unilateral		X	X		X		Mesiodens
85	1	Unilateral	X		X			X	Distomolar
420	1	Unilateral	X		X			X	Distomolar
236	2	Bilateral	X	X	X			X	Distomolar
39	2	Bilateral	X	X		X		X	Parapremolars
Total	9 5 unilateral	2 bilateral	6	3	5	2	1	6	



supernumerary teeth there were a total of nine extra teeth. In five cases the supernumerary teeth occurred unilaterally. More supernumerary teeth were found in the maxillary arch ($n = 5$). In six of the subjects the supernumerary teeth occurred in the posterior region and in only one subject did the supernumerary teeth occur in the anterior region of the arch. In five cases the supernumerary teeth were distomolar, while in the other two cases they were parapremolar and mesiodens.

The location of dental agenesis is summarized in Table 3. The locations were widely distributed in the maxillary arch but concentrated among the premolars in the mandibular arch. Among the 104 missing teeth, 41 were found in the maxillary (39.4%) and 63 in the mandibular arches (60.57%). This distribution was statistically significant ($p = 0.039$). Among the missing 104 teeth, 28 were found in the anterior region of the mouth (26.9%) and 76 in the posterior (73.1%) ($p = 0.029$). When the teeth were grouped by side of the mouth there were 51 occurrences on the left side (49%) and 53 on the right side (51%) ($p = 0.992$). There were 15 subjects with agenesis of the upper lateral incisors; six unilateral on the left side, six unilateral on the right side and three bilateral for a total of 18 missing lateral incisors. There were 29 subjects with agenesis of the lower second premolar; six unilateral on the left side, three unilateral on the right side and 20 bilateral for a total of 48 missing premolars.

This study investigated the correlation between microdontia of maxillary lateral incisors and agenesis of lower second premolars. Out of 47 agenesis subjects there were 25 cases with microdontia of the maxillary lateral incisors. Twenty-four subjects had agenesis of lower second premolars and of these, only 13 subjects had microdontia of the maxillary lateral incisors. Of the 18 subjects that had agenesis of a maxillary lateral incisor, only 12 subjects had microdontia of the contralateral maxillary lateral incisor. Only one subject had both conditions.

DISCUSSION

In the present study, the prevalence of permanent tooth anomalies was 20.4%. The percentage occurrence of DEI

was the highest (12.9%) followed by dental agenesis (9.5%) and supernumerary teeth (1.4%). The recorded incidence of dental anomalies may be somewhat higher than in the general population because the subjects involved in this study were orthodontic patients who may be expected to have a greater tendency for dental anomalies such as impaction, delayed eruption, agenesis and peg-shaped lateral incisors. Also, some of the orthodontic patients seen in the Department of Orthodontics at Buffalo may have required preprosthetic orthodontic treatment. Differences in the prevalence identified in the present study and that reported in the literature could be attributed to differences in populations studied, methodology, diagnostic criteria, racial/ethnic groups, sex, age and local environmental influences, as well as variations in the definitions of the anomalies studied.

In the general population, the incidence of supernumerary teeth appears to be in the range of 1-3% to 3.95% in the anterior region of the maxilla.⁶ In our study, the prevalence of supernumerary teeth (1.4%) agreed with the range, for such teeth, as reported by others. Supernumerary teeth were more commonly found in Caucasians than in African-Americans. They occurred more in class I malocclusions (71.43%) followed by class III (28.57%) malocclusions and no supernumerary was found in class II malocclusions. In our study, the presence of supernumerary teeth did not show a statistically significant correlation with other dental anomalies.

In the general population, third molar agenesis represents the most common form of dental agenesis. Dental agenesis, excluding the third molars has been reported to occur in the range of 1 to 9.6%.^{6,13} The present study did not include third molars but the prevalence of dental agenesis did fall at the highest levels previously reported (9.5%). In this study dental agenesis was more prevalent in Caucasians and it tended to be more common in class II malocclusions, followed by class I and III malocclusions. It was noted that dental agenesis occurred more frequently in the mandibular, than in the maxillary arches. This study also reflected a high incidence of agenesis in orthodontic patients. The teeth that

Table 3: Distribution of dental agenesis by tooth type and location

Type of tooth	Count (n)				Percentage (%)			
	Maxillary		Mandibular		Maxillary		Mandibular	
	Left	Right	Left	Right	Left	Right	Left	Right
Central	0	0	2	3	0.00	0.00	1.92	2.88
Lateral	9	9	0	0	8.65	8.65	0.00	0.00
Canine	2	3	0	0	1.92	2.88	0.00	0.00
1st premolar	1	1	3	4	0.96	0.96	2.88	3.85
2nd premolar	6	8	26	23	5.77	7.69	25.00	22.12
1st molar	0	0	0	0	0.00	0.00	0.00	0.00
2nd molar	1	1	1	1	0.96	0.96	0.96	0.96

were most commonly missing were the mandibular second premolars followed by the maxillary lateral incisors and then by the maxillary second premolars. This finding is in disagreement with the findings of other studies that report that the maxillary lateral incisor is most commonly absent followed by mandibular second premolars.⁷ Differences in the types of the teeth most frequently affected by dental agenesis may be explained by population differences that exist in the United States.⁷

Many explanations have been put forward as to why agenesis occurs and why certain types of the teeth are affected. Three theories have been reported to explain agenesis: the first of these is Svnhufvud's¹³ field theory according to which dental agenesis of the mandibular second premolar occurs in a fragile region which is represented by the distal end of the dental lamina. According to a second theory, dental agenesis occurs most frequently in the maxillary lateral incisor teeth where an embryonic fusion occurs between the lateral surface of the maxilla and the medial nasal process.¹³ The third theory mentioned that frequently dental agenesis occurs in the two mandibular central incisors region.¹³ This is also a 'fragile' area where the two embryonic mandibular processes fuse.¹³ It has been said that genetic alteration in certain types of genes may contribute to dental agenesis,¹⁴ of these genes MSX1 induces the gene that plays a role in the agenesis of premolar teeth, the gene PAX9 is associated with the dental agenesis of molar teeth and the gene TGFA is associated with the agenesis of incisor teeth.¹⁴ Intrauterine disturbances, trauma, infection and radiation have also been associated with dental agenesis.¹⁵

In this study the prevalence of DEI was 12.9% and it was more prevalent in Caucasians (10.5%) as compared to other ethnic groups. It also showed that dental impaction was more commonly seen in class II followed by class III and then class I malocclusions. However, no statistically significant differences between classes of occlusion or males and females in the incidence of DEI teeth were noted. The findings of this study revealed that the teeth that were most frequently impacted or involved with delayed eruption were the maxillary canines followed by the maxillary second premolars. Both impaction and delayed tooth eruption were observed more frequently in the maxillary arch and especially in the anterior, more than posterior, region of this arch. There were no differences in the rate of occurrence of dental impaction between the right or left side of the arch and they occurred more bilaterally than they did unilaterally.

According to the literature, there are some correlations in some of the dental anomalies. For example, Bacceti¹⁹ reported a correlation between dental agenesis of the second

premolars and microdontia of the maxillary lateral incisor. In this study there was a trend of an association between dental agenesis of the mandibular second premolar and microdontia of the maxillary lateral incisors. There was also an association between dental agenesis and DEI, this was based on the observed percentages of dental agenesis (9.5%) and DEI (12.9%), 1.2% of the subjects had both of these anomalies. A possible explanation for this finding lies in the fact that dental agenesis and DEI may have the same genetic background.¹⁷

The findings of this study cannot be generalized to all ethnic and age groups nor can it be generalized to nonorthodontic patients. Future studies are warranted to identify the prevalence of dental anomalies in larger samples of orthodontic population presenting from different race, age group, and severity of malocclusion and explore the causes of occurrences.

CONCLUSION

1. The prevalence of dental anomalies was 20.4%.
2. The most prevalent dental anomalies were DEI (12.9%) followed by dental agenesis (9.5%) and then supernumerary teeth (1.4%).
3. There was a trend for an association between dental agenesis of mandibular second premolars and microdontia of maxillary lateral incisors.
4. Agenesis and impaction tended to be more common in class II malocclusions than other types of malocclusion.
5. There was a correlation between DEI and dental agenesis.

CLINICAL SIGNIFICANCE

This study provided important information about the prevalence of dental developmental anomalies in an orthodontic sample of patients and provided frequencies of occurrences by type of malocclusion. The findings of this study warrant future studies on larger samples of orthodontic patients to confirm the occurrences and explore the causes and clinical management in such patients.

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