

Characteristics of Developmental Anomalies in the Permanent Dentition of Jordanian Orthodontic Patients

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ABSTRACT

Objectives: To evaluate the frequency, distribution and gender differences of developmental permanent teeth anomalies with various malocclusions in a sample of Jordanian orthodontic patients.

Methods: A total of 1,500 non-syndromic orthodontic patients (750 females and 750 males), attended the Dental Departments at King Hussein Medical Center and Prince Rashed Bin Al- Hassan Hospital between July 2008 and September 2011, were included. The study group comprised 180 orthodontic patients (96 females and 84 males), each with at least one developmental dental anomaly. Their ages ranged from 13 to 22 years, with a mean of 16.8 years (± 3.6). Dental history, pretreatment records, intra oral radiographs, and orthopantomograms were used for the diagnosis of various dental anomalies. The following dental anomalies were identified, impacted teeth, transposition, transmigrant canines, ectopic eruption, peg-shaped lateral incisors, fusion, gemination, microdontia, macrodontia, oligodontia, hypodontia, hyperdontia, and amelogenesis imperfecta. The chi-square test was used to investigate the gender differences and the occurrence rate in various malocclusions.

Results: In 180 (12%) of 1500 orthodontic patients, at least one dental anomaly was detected. The most frequent dental anomaly was impacted teeth (3.07%). Peg shaped maxillary lateral incisors were the most frequent anomalous teeth (1.27%). A significant predominance of hypodontia in females and hyperdontia in males was detected. Impaction had a significantly lower frequency in Class II malocclusion. Except for impaction, there were no statistically significant associations between dental anomalies and orthodontic malocclusions.

Conclusion: The characteristics of developmental dental anomalies in this sample of Jordanian orthodontic patients were comparable with the findings of most studies conducted in other countries.

Key words: Dental anomalies, Malocclusion, Orthodontic patients, Orthopantomograms

JRMS March 2014; 21(1): 22-29 / DOI:10.12816/0002574

Introduction

Developmental dental anomalies are formative defects caused by a complex series of interactions between genetic, epigenetic and environmental factors influence human dental development and lead to phenotypic patterning

within the dentition. The process of dental development is controlled by reciprocal interactions between ectodermal epithelium and neural crest-derived mesenchyme and dental anomalies occur sequentially in this process: initiation, morphogenesis, differentiation and

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Manuscript received November 2, 2011. Accepted March 29, 2012

biomineralization.⁽¹⁾ Although dental anomalies are not a serious public health problem, it can severely affect patients' quality of life and impose masticatory and speech dysfunctions and create esthetic problems with orthodontic and prosthetic implications.⁽²⁾ Accurate diagnosis of dental anomalies is the key to orthodontic treatment planning and eventual treatment itself. Furthermore, early recognition of dental anomalies provides a diagnostic indicator of some multiple congenital anomaly syndromes.⁽³⁾ The characteristics of dental anomalies in different populations were the subject of several studies. However, the results were conflicting even within the same population.^(4,5) Although the prevalence and pattern of few dental anomalies have been studied in Jordanians, very little information has so far been published in Jordanian orthodontic patients. Additionally, the occurrence of association between various dental anomalies and malocclusions in Jordanian orthodontic patients has not been documented by earlier studies.

Our study aimed to evaluate the characteristics of developmental permanent teeth anomalies with various malocclusions of Jordanian orthodontic patients and to adjoin a new contribution to the current orthodontic literature in this field. Moreover, further knowledge of dental development will contribute valuable insights for novel therapeutic regimens in the future so that we can move from a mode of diagnosis and treatment to one of prediction and prevention.

Methods

A total of 1,500 non-syndromic orthodontic patients (750 females and 750 males), who attended the orthodontic clinics at King Hussein Medical Center and Prince Rashed Hospital between July 2008 and September 2011, were non-randomly selected and enrolled in this study. The study protocol was reviewed and approved by the Human Research Ethics Committee at the Royal Medical Services. Diagnosis of various dental anomalies (tooth form, number, position, and structural anomalies) was based on detailed medical history, intraoral examination, pretreatment records, panoramic and intraoral radiographs. All the patients were examined

clinically and radiographically in the orthodontic clinics by two examiners for the presence of any dental anomalies and all radiographs were fit the diagnostic clarity. Subjects were not considered eligible for the study if they had received orthodontic treatment, previous loss of teeth (excluding third molars), craniofacial syndromes, damaged either maxillary or mandibular first molars. The following dental anomalies were identified, impacted teeth, transposition, transmigrant canines, ectopic eruption, peg-shaped lateral incisors, fusion, gemination, microdontia, macrodontia, oligodontia, hypodontia, hyperdontia, and amelogenesis imperfecta. The study group comprised 180 healthy orthodontic patients (96 females and 84 males) each with at least one developmental permanent tooth anomaly. Their ages ranged from 13 to 22 years, with a mean of 16.8 years (\pm 3.6). Concomitant dental anomalies were not found. Descriptive characteristics of these dental anomalies including frequency in relation to gender, orthodontic malocclusions, jaws, and sides of the jaw were recorded. The chi-square test was used to investigate the gender differences and the occurrence rate in various malocclusions. The data were analyzed using SPSS software version 17 for statistical analysis (Statistical Package for Social Sciences, SPSS Inc., Chicago, Illinois, USA), the level of significance tested was ($P < 0.05$).

Results

In the present study, developmental permanent teeth anomalies were found in 180 patients (96 females and 84 males), each demonstrated at least one developmental tooth anomaly. It represented (12%) of 1,500 examined subjects and comprised 96 (53.33%) females and 84 (46.66%) males. The frequency of dental anomalies was 12% (6.4% for females and 5.6% for males) for this sample of Jordanian orthodontic patients, with no statistically significant gender differences ($P=0.40$). The distribution of patients by gender was shown in Table I. Table II demonstrates a total of 180 patients with various dental anomalies. Impaction was observed in 46 patients (3.07%), of which 26 (3.47%) in females and 20 (2.66%) in males. Hypodontia was identified in 37 patients

Table I: Distribution of the patients with dental anomalies by gender

Gender	Patients with dental anomalies		Patients without dental anomalies		Total	
	N	%	N	%	N	%
Male	84	5.60	666	44.40	750	50
Female	96	6.40	654	43.60	750	50
Total	180	12.00	1320	88.00	1500	100)

(P = 0.40), no statistically significant gender differences.

Table II: Frequency and distribution of dental anomalies by genders and results of chi-square tests

Dental anomaly	Female (%) n =750		Male (%) n =750		P	Total (%) n=1500	
	N	%	N	%		N	%
	Impacted teeth	26	3.47	20		2.67	0.38
Transposition	3	0.40	2	0.27	0.65	5	0.33
Transmigrant teeth	2	0.27	1	0.13	0.56	3	0.20
Ectopic eruption	12	1.60	5	0.67	0.09	17	1.13
Peg-shaped lateral incisors	12	1.60	7	0.93	0.25	19	1.27
Fusion	-	-	1	0.13	-	1	0.07
Gemination	-	-	2	0.27	-	2	0.13
Microdontia	1	0.13	2	0.27	0.56	3	0.20
Macrodontia	3	0.40	9	1.20	0.08	12	0.80
Oligodontia	3	0.40	2	0.27	0.65	5	0.33
Hypodontia	25	3.33	12	1.60	0.035*	37	2.47
Hyperdontia	6	0.80	19	2.53	0.01*	25	1.67
Amelogenesis imperfecta	3	0.40	2	0.27	0.65	5	0.33
Total	96	12.80	84	11.20		180	12.00

*(P < 0.05), P values equal to or less than 0.05 were considered significant.

Table III: Distribution and location of impacted teeth

Impacted teeth	L	R	L+R	Total (%)
Maxillary canines	13	6	2	21 (1.40)
Maxillary central incisors	3	2	-	5 (0.33)
Mandibular second premolars	2	3	1	6 (0.40)
Mandibular canines	2	1	1	4 (0.27)
Maxillary second premolars	2	1	-	3 (0.20)
Mandibular first premolars	1	1	-	2 (0.13)
Maxillary lateral incisors	2	-	1	3 (0.20)
Mandibular second molars	1	-	1	2 (0.13)
Total (%)	26 (1.73)	14 (0.93)	6 (0.40)	46 (3.06)

(2.47%), of which 25 (3.33%) in females and 12 (1.60%) in males with a statistically significant gender difference (P = 0.035). Hyperdontia was observed in 25 patients (1.67%), of which six (0.80%) in females and 19 (2.53%) in males with a statistically significant gender difference (P = 0.01). Peg-shaped lateral incisors was diagnosed in 19 patients (1.27 %), ectopic eruption in 17 patients (1.13%), macrodontia in 12 patients (0.80%), transposition in five patients (0.33%), oligodontia in five patients (0.33%), amelogenesis imperfecta in five patients (0.33%), transmigrant teeth in three patients (0.20%), microdontia in three patients (0.20%), gemination in two male patients (0.13%) and 1

male patient with dental fusion anomaly (0.07%). Table III demonstrates the distribution and location of impacted teeth. In total, 46 patients (3.07%) with impacted teeth were detected, 26 impacted teeth (1.73 %) on the left side, 14 (0.93 %) on the right side and bilateral impaction in six (0.40%) patients. Canines impaction was observed in 25 patients (1.67%), 21 impacted canines (1.40%) were in the maxilla and four (0.27%) in the mandible. Impaction of mandibular second premolars was observed in six patients (0.40%). Most impacted teeth (70 %) were in the maxilla and unilateral left side impaction was predominant. Table IV demonstrates the distribution and location of

Table IV: Distribution and location of hypodontia

Hypodontic teeth	L	R	L+R	Total (%)
Maxillary lateral incisors	5	7	4	16 (1.07)
Mandibular second premolars	4	3	2	9 (0.60)
Maxillary second premolars	3	2	1	6 (0.40)
Mandibular central incisors	1	2	1	4 (0.27)
Maxillary canines	–	–	1	1 (0.07)
Maxillary first premolars	–	–	1	1 (0.07)
Total (%)	13 (0.87)	14 (0.93)	10 (0.67)	37 (2.47)

Table V. Distribution and location of ectopic teeth

Ectopic teeth	L	R	L+R	Total (%)
Maxillary canines	4	2	1	7(0.47)
Mandibular canines	1	1	–	2(0.13)
Mandibular second molars	2	1	–	3 (0.20)
Maxillary second molars	3	1	1	5(0.33)
Total (%)	10 (0.67)	5(0.33)	2(0.13)	17 (1.13)

Table VI: Distribution of subjects with dental anomalies in each malocclusion type according to Angle's classification

Dental anomaly	CI I n=600		CI II div 1 n =540		CI II div 2 n=80		CI III n=280	
	N	%	N	%	N	%	N	%
Impacted teeth	26	4.33	7	1.3	-	-	13	4.6
Transposition	2	0.33	1	0.18	1	1.25	1	0.36
Transmigrant teeth	2	0.33	-	-	-	-	1	0.36
Ectopic eruption	7	1.17	8	1.48	-	-	2	0.71
Peg-shaped lateral incisors	6	1.00	5	0.93	4	5.00	4	1.43
Fusion	-	-	-	-	1	1.25	-	-
Gemination	1	0.17	1	0.18	-	-	-	-
Microdontia	-	-	1	0.18	1	1.25	1	0.36
Macrodontia	5	0.83	4	0.74	-	-	3	1.07
Oligodontia	-	-	1	0.18	3	3.75	1	0.36
Hypodontia	20	3.33	9	1.67	6	7.50	2	0.71
Hyperdontia	14	2.33	11	2.04	-	-	-	-
Amelogenesis imperfecta	3	0.50	1	0.18	-	-	1	0.36
Total	86	14.33	49	9.07	16	20.00	29	10.36

hypodontia. In total, 37 patients (2.47%) with missing teeth were detected. Agenesis of maxillary lateral incisors was observed in 16 patients (1.07 %), five on the left side (0.33%), seven on the right side (0.47%), and four bilaterally (0.27%). The distribution between left and right side was nearly equally represented, 13 (0.87%) on left side and 14 (0.93%) on right side. Agenesis of mandibular second premolars was observed in nine patients (0.6 %). In addition, four mandibular central incisors and one case of bilateral maxillary canines were identified as missing. Most missing teeth (65 %) were in the maxilla. Table V demonstrates the distribution and location of ectopic teeth. Table VI demonstrates the distribution of patients with dental anomalies by malocclusion type according

to Angle's classification. Class II division two malocclusion had the highest frequency of dental anomalies (20.00%), followed by Class I (14.33%), Class III (10.36%), and Class II division one malocclusion (9.07%). Hypodontia (7.50%), Peg-shaped lateral incisors (5.00%), oligodontia (3.75%), fusion (1.25%), transposition (1.25%), and microdontia (1.25%), had the highest frequency in Class II division two malocclusion. Hyperdontia had the highest frequency in Class I malocclusion (2.33%). Impaction (4.6%), macrodontia (1.07%), transmigrant teeth (0.36%), and amelogenesis imperfect (0.36%), had the highest frequency in Class III malocclusion. Ectopic eruption (1.48%), and gemination (0.18%), had the highest frequency in Class II division one malocclusion.

There were no statistically significant differences in the occurrence rate of dental anomalies between Class I and Class II malocclusions ($P = 0.0715$), Class I and Class III malocclusions ($P = 0.1502$), and Class II and Class III malocclusions ($P = 0.9587$). Only impaction showed a statistically significant difference between Class I and Class II malocclusions ($P = 0.0008$), and between Class II and Class III malocclusions ($P = 0.0013$), but it was not found in Class II Division two malocclusion.

Discussion

A frequency of 12% for dental anomalies in this sample of Jordanian orthodontic patients is higher than the 5.46% reported by Altug-Atac *et al.*⁽⁴⁾ for developmental dental anomalies of permanent dentition in the Turkish orthodontic patients, but impaction was not included in their study. On the other hand, a frequency of 12% is by far lower than the 40.3% reported by Uslu *et al.*⁽⁵⁾ in various malocclusions of a Turkish orthodontic patient population. This variation in results of these epidemiological studies conducted on orthodontic patients was attributed to varying sampling techniques (inclusion of tooth impaction and exclusion of permanent third molars in the present study), racial differences and different diagnostic criteria. Teeth impaction, transmigrated teeth, transposition, and ectopic eruption are categorized under tooth position abnormalities. Failure of the eruption of permanent teeth is a common dental anomaly and detection of impacted teeth is imperative for orthodontic diagnosis and treatment. A tooth is impacted when it fails to emerge in a timely fashion and its eruption is arrested. According to the literature, the maxillary canine is the second to the mandibular third molar in its frequency of impaction. Impacted maxillary canines occur in 1% to 3% of the population and internal or external root resorption of adjacent teeth is the most common sequela. Two major theories have been delineated to explain the occurrence of canines' impaction, the "Genetic theory" and the "Guidance theory".^(5,6)

In our study, impacted teeth were the most frequent dental anomaly (3.07%) and canines were the most frequently impacted teeth (1.67%) followed by mandibular second premolars (0.40%). These findings confirm the previous

results of studies conducted by Uslu *et al.*⁽⁵⁾ in a Turkish orthodontic patient population, and Faradi *et al.*⁽⁷⁾ in a North Greek population. Impaction had a significantly lower frequency in Class II malocclusion, and this finding was consistent with a previous result reported by Uslu *et al.*⁽⁵⁾ Of 13 maxillary left impacted canines, nine were palatally displaced, defining the ratio buccal: palatal at 1 : 2.25. Our study revealed the frequency of impaction was higher in females (3.47%) than in males (2.67%) defining the ratio male: female at 1 : 1.30 and left maxillary impactions were dominant. These findings are in agreement with a recent study reported by Chung *et al.*⁽⁸⁾ Conversely, impaction frequency of (3.07%) is significantly lower than the 8.8% reported by Faradi *et al.*⁽⁷⁾ Agenesis of permanent teeth is a common phenotypic feature in humans, with an overall incidence of (2.6% to 11.3%), excluding third molars.⁽⁹⁾ Oligodontia is defined as the congenital absence of 6 or more teeth, excluding the third molars. Oligodontia was found in three females and two males, with a frequency of 0.33%. Hypodontia and oligodontia had the highest frequency in Class II division two malocclusion.

In the present study, the second most frequent anomaly was hypodontia. The frequency of hypodontia was 2.47% (3.33% for females and 1.60% for males). The distribution of hypodontia by tooth number indicates a significantly higher incidence of missing maxillary lateral incisors. The upper lateral incisors were the most frequently missing teeth (1.07%), followed by lower second premolars (0.60%) and upper second premolars (0.40%). Agenesis of upper lateral incisors was unilateral in 12 (5 left and 7 right) and bilateral in 4 patients. These findings were in accordance with Altug-Atac *et al.*⁽⁴⁾ who reported hypodontia as the most frequent tooth number anomaly in Turkish orthodontic patients, but impaction was not included in their study. In our study, a hypodontia frequency of 2.47% is lower than the 6.3%, 6.5%, 7.54%, 8.5%, 9.11% reported for orthodontic patients in Brazil, Spain, Turkey, Japan, and Iran respectively.⁽¹⁰⁻¹⁴⁾

Several authors report a little but not significant predominance of hypodontia in females.⁽⁹⁻¹³⁾ However, our study revealed the frequency of hypodontia was higher in females (3.33 %) than in males (1.60 %) defining the ratio male: female

at 1 : 2.08 with a statistically significant gender difference ($P = 0.035$). These findings of the present study confirm earlier studies.^(4,10,12) In contrast to our findings, Endo *et al.*⁽¹³⁾ and Rahardjo⁽¹⁵⁾ reported that mandibular second premolars were the most commonly missing teeth in Japanese and Chinese orthodontic patients (excluding third molars). Hyperdontia (supernumerary teeth) are teeth in excess of the normal dental formula.

In our study, supernumerary teeth occurred more frequently in males 19 (2.53%) than in females six (0.80%), with a total frequency of (1.67%) was recorded. It is pertinent to note a statistically significant gender difference was found for this anomaly ($P = 0.01$). In contrast to our study, Esenlik *et al.*⁽¹⁶⁾ reported no significant gender differences. Our findings were in agreement with previous reports.^(17,18,19) Supernumerary teeth had a higher frequency in CI I and CI II div 1 malocclusions. Peg-shaped lateral incisors are defined as teeth with a reduced mesiodistal diameter with proximal surfaces converging markedly toward the incisal direction. In our study, the most frequent dental shape anomaly was peg-shaped lateral incisors with a frequency of 1.27%. Further, missing or anomalous maxillary lateral incisors are frequently associated with other dental anomalies.^(20,21) However, in the present study, agenesis or shape anomalies of maxillary lateral incisors were not concomitant with other dental anomalies. Peg-shaped lateral incisors had the highest frequency in Class II division two malocclusion. Ectopic eruption is referred to any aberrant and abnormal eruption path taken by a tooth. In our study, a frequency of 1.13% for ectopic eruption mostly in females was detected. Canines and second molars were mostly affected (9:8). The existence of unilateral ectopic teeth was dominant. These findings were consistent with a previous study.⁽²²⁾ Because it is obvious to a casual observer, ectopic canines are a frequent complaint that motivates patients to seek treatment. Ectopic eruption had the highest frequency in Class II division one malocclusion. Macrodonia is a rare tooth form abnormality. In our study, macrodonia was observed mostly in males. However, a frequency of (0.80%) for macrodonia was higher than that in Turkish orthodontic patients and that in Indian adult

population.^(4,19) Further, macrodonia had the highest frequency in Class III malocclusion.

Transposition is a tooth position anomaly and considered the most difficult to manage clinically. It is manifested by a positional interchange of two adjacent teeth within the same quadrant of the dental arch. A transposition frequency of 0.33% mostly left maxillary canine-first premolar form of transposition was coincident with previous studies.^(23,24) In contrast, Celikoglu *et al.* reported maxillary canine-lateral incisor was the most commonly observed transposition (60%).⁽²⁵⁾ Further, transposition had the highest frequency in Class II division two malocclusion.

The frequency of amelogenesis imperfecta was studied in only a few populations and was reported to range from 1 in 700 to 1 in 15,000.⁽²⁶⁾ Diagnosis of amelogenesis imperfecta was based on radiographic examination and the primary clinical problems caused by alterations in the structure of enamel, which are tooth sensitivity, loss of occlusal vertical dimension, dysfunction, and esthetics. In our study, the frequency of this structural anomaly was 0.33%, mostly in Class III malocclusion. Microdonia is a tooth formation anomaly. Altug-Atac *et al.*⁽⁴⁾ and Guttal *et al.*⁽¹⁹⁾ reported a microdonia frequency of (1.58% and 9.14%). However, in the present study, the frequency of microdonia was (0.20%). Microdonia had the highest frequency in Class II division two malocclusion. Fusion and gemination are two different morphological dental anomalies, characterized by the formation of a clinically wide tooth. Fusion results from the conjoining of two teeth buds, while gemination originates when one tooth bud attempts to split into two. Fusion was the most infrequent anomaly in the study group with a frequency of (0.07%). Gemination was the second most infrequent anomalies with a frequency of (0.13%). These findings were in accordance with Altug-Atac *et al.*⁽⁴⁾ in Turkish orthodontic patients. In contrast to our study, Guttal *et al.*⁽¹⁹⁾ reported a frequency of (4.85%) for fusion and (0.28%) for gemination of all dental anomalies in Indian adult population. Fusion had the highest frequency in Class II division two malocclusion, whereas gemination had the highest frequency in Class II division one malocclusion. Except for impaction, which had a significantly higher

frequency in Class I and Class III malocclusions, there were no statistically significant associations between the frequency dental anomalies and various orthodontic malocclusions. Our findings confirm the previous results of studies conducted by Uslu *et al.*⁽⁵⁾ and Basdra *et al.*⁽²⁷⁾ Though, the study of Basdra *et al.* was confined on Class II Division one and Class III malocclusions.

Conclusion

From our findings, the following conclusions were drawn. It was found that 12% of the Jordanian orthodontic patients showed at least one permanent tooth anomaly. Impacted teeth were the most frequent dental anomaly, followed by hypodontia, and hyperdontia. Peg shaped maxillary lateral incisors were the most frequent anomalous teeth. A significant predominance of hypodontia in females and hyperdontia in males was detected. Impaction had a significant higher frequency in Class I and Class III malocclusions. In the present study, the characteristics of developmental dental anomalies together with the frequency in relation to gender and malocclusions were comparable with the findings of most studies conducted in other countries.

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