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Congenital tooth anomalies and malocclusions: a genetic link?

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SUMMARY The aim of the present study was to investigate putative relationships between different malocclusions such as Class III and Class II division 1, and congenital tooth anomalies. Two-hundred Class III and 215 Class II division 1 patients were examined for the presence of any of the following congenital tooth anomalies: maxillary incisor hypodontia, maxillary canine impaction, transpositions, supernumerary teeth, and tooth agenesis. Their occurrence rates were then calculated as a percentage of the total sample and were compared for statistical differences.

The results revealed no statistical difference ($P > 0.05$) in the occurrence rates of upper lateral incisor agenesis, peg-shaped laterals, impacted canines, or supernumerary teeth between the Class III and the Class II division 1 malocclusions. When the occurrence rate of all congenital tooth anomalies was compared between the two malocclusions, Class III subjects showed significantly higher rates ($P < 0.05$). Comparison with published surveys on general populations showed similar occurrence rates.

It can be concluded that subjects with Class III and Class II division 1 malocclusions show patterns of congenital tooth anomalies similar to those observed in the general population. Congenital tooth anomalies may represent another criterion for the study of malocclusion, with respect to their origin and development.

Introduction

Craniofacial and occlusal relationships have been used over the years to describe and categorize malocclusions. Congenital anomalies of the teeth, such as hypodontia, impactions, and transpositions, often appear together with craniofacial discrepancies generating complicated therapeutic problems. Do these congenital tooth anomalies relate to malocclusions and in what way? In other words, do some types of congenital tooth anomalies appear more frequently in some types of craniofacial anomalies? Despite extensive analyses of various malocclusions, studies relating congenital tooth anomalies to specific malocclusions are scarce. The Class II division 2 malocclusion, a highly heritable craniofacial type (Markovic, 1992; Mossey, 1999), has recently been related to small teeth (Peck *et al.*, 1998). Basdra *et al.* (2000) examined the association of congenital tooth anomalies to Class II division 2 malocclusions, and concluded that this was closely related to hypodontia, impacted canines, malformed laterals, and transpositions.

There are reports associating congenital tooth anomalies to growth characteristics: Dermaut *et al.* (1986), reported on the relationship of tooth agenesis to anteroposterior and vertical growth patterns, and Stellzig *et al.* (1994) related maxillary canine impaction to horizontal growth characteristics.

The present study examined putative relationships between specific types of malocclusion to specific types of congenital tooth anomalies. Patients with Class II division 1 and Class III malocclusions were examined for the co-existence of congenital tooth anomalies, such as tooth agenesis, impacted canines, peg-shaped laterals, transpositions, and supernumerary teeth.

Subjects and methods

The subjects of the present study were 200 Class III (110 females, 90 males) and 215 Class II division 1 (101 females, 114 males) patients. No patients had a history of orthodontic treatment and the diagnosis for each craniofacial anomaly was based on clinical, cephalometric, and dental cast data. Patients with craniofacial syndromes were not included. The age of the patients ranged from 7.2 (minimum) to 42.8 (maximum) years in the Class III group and from 8.1 (minimum) to 45.8 (maximum) years in the Class II division 1 group.

For identification and recording of congenital tooth anomalies the orthopantomograms, dental casts, and dental history were used. The congenital tooth anomalies included: agenesis of maxillary lateral incisors, peg-shaped anomalies of maxillary lateral incisors, impaction of maxillary canines, transposition of teeth, tooth agenesis, supernumerary teeth.

The criteria for identification of the congenital tooth anomalies have been reported previously (Basdra *et al*., 2000). For the identification of impacted canines and third molar agenesis patients above 14 years of age were included. The congenital tooth anomalies were then recorded according to the location (left or right side) and gender (male or female), and the percentage of the total sample in each group was calculated. A Chi-squared test was used to determine the statistical significance of the findings.

Results

Agenesis of the maxillary lateral incisors (Table 1)

Class III. Upper lateral incisor agenesis was observed in 11 patients or 5.5 per cent, seven males (3.5 per cent) and four females (2 per cent). Unilateral and bilateral location was almost equally represented. No differences between left and right side were noted.

Class II division 1. Agenesis of the upper incisor was observed in four patients (1.9 per cent), all of whom were female and the location was either bilateral or on the right side.

Peg-shaped maxillary lateral incisors (Table 2)

Class III. Peg-shaped laterals were observed in six patients (3 per cent), three female (1.5 per cent) and three male (1.5 per cent). Again, there was no difference in the distribution between left and right side or unilateral and bilateral location.

Class II division 1. Peg-shaped upper lateral incisors were observed in two female patients (0.9 per cent) and were located bilaterally or on the left side.

Impaction of maxillary canines (Table 3)

Class III. Canine impaction was found in 11 patients (9 per cent). Five patients (4.1 per cent) were male and six were female (4.9 per cent).

Class II division 1. Impacted canines were observed in three patients (3.3 per cent). Two were male and one was female (1.1 per cent).

Table 1 Maxillary lateral incisor hypodontia according to location and gender.

	Class III (n = 200)			Class II division 1 (n = 215)		
Location	Female	Male	Total	Female	Male	Total
Bilateral (12 + 22)	3	3	6	3	0	3
Right side 12	1	2	3	1	0	1
Left side 22	0	2	2	0	0	0
Total	4 (2%)	7 (3.5%)	11 (5.5%)	4 (1.9%)	0	4

Chi-square test $x^2 = 2.964$, $P > 0.05$ not significant.

Table 2 Maxillary lateral incisor peg-shaped anomalies according to location and gender.

	Class III (n = 200)			Class II division 1 (n = 215)		
Location	Female	Male	Total	Female	Male	Total
Bilateral (12 + 22)	1	0	1	1	0	1
Right side (12)	1	1	2	0	0	0
Left side (22)	1	2	3	1	0	1
Total (%)	3 (1.5%)	3 (1.5%)	6 (3%)	2 (0.9%)	0	2

Chi-square test $x^2 = 1.37$, $P > 0.05$ not significant.

Table 3 Impaction of maxillary canines according to location and gender.

	Class III (n = 122)*			Class II division 1 (n = 92)*		
Location	Female	Male	Total (%)	Female	Male	Total (%)
Bilateral (13 + 23)	2	0	2 (1.6%)	1	0	1 (1.1%)
Right Side (13)	1	1	2 (1.6%)	0	2	2 (2.2%)
Left Side (23)	3	4	7 (5.7%)	0	0	0
Total	6 (4.9%)	5 (4.1%)	11 (9%)	1	2	3 (3.3%)

Chi-square test $x^2 = 1.97$, $P > 0.05$ not significant.
*For the identification of impacted canines only patients over 14 years of age were included.

Transposition of teeth

Class III. Transpositions were found in one patient (0.5 per cent). The patient was female and the site was 13/14.

Class II division 1. No transpositions were found in the Class II division 1 group.

Tooth agenesis

Class III. Tooth agenesis (third molars included) was observed in 32 patients (16 per cent) and was almost equally distributed between males and females (Table 4). Three patients (1.6 per cent) were found with agenesis of all third molars. Table 5 shows the exact agenesis for each tooth type.

Class II division 1. Tooth agenesis was observed in 27 patients (12.5 per cent) and again males and females were equally affected (Table 4). Agenesis of all four third molars was observed in two patients (1 per cent).

Supernumerary teeth

Class III. Supernumerary teeth were found in seven patients (3.5 per cent). A detailed description of the location of the supernumerary teeth is given in Table 6.

Class II division 1. Supernumerary teeth were found in three patients (1.4 per cent).

Analysis of the data (Chi-squared test) revealed no statistical significance for the prevalence of the above congenital tooth anomalies between the two malocclusion groups ($P > 0.05$) when examined separately. When the congenital tooth anomalies were examined together, statistical differences were found using the Chi-square (Table 7).

Discussion

Patients exhibiting the clinical and diagnostic criteria of Class III and Class II division 1 malocclusions were examined for their association

Table 4 Frequency of tooth and third molar agenesis in the Class III and the Class II division 1 groups.

Malocclusion	Female	Male	Total
Tooth agenesis (third molars included)			
Class III (n = 200)	18	14	32 (16%)
Class II division 1 (n = 215)	12	15	27 (12.5%)
Third molar agenesis			
Class III (n = 189)*			
18.28.38.48			3 (1.6%)
18.28			5 (2.6%)
38.48			3 (1.6%)
Class II division 1 (n = 200)*			
18.28.38.48			2 (1%)
18.28			2 (1%)
38.48			11 (5.5%)

Chi-square test $x^2 = 0.74$, $P > 0.05$ not significant.
*For the identification of third molar agenesis only patients above 14 years of age were included.

Table 5 Exact location of tooth agenesis in the Class III and the Class II division 1 groups.

Class III (n = 200)																
n	12	1	–	2	–	–	9	–	–	8	–	1	3	–	–	10
Maxilla	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
%	6	0.5	–	1	–	–	4.5	–	–	4	–	0.5	1.5	–	–	5
n	12	–	–	2	–	–	–	1	1	1	–	–	3	–	–	14
Mandible	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
%	6	–	–	1	–	–	–	0.5	0.5	0.5	–	–	1.5	–	–	7
Class II division 1 (n = 215)																
n	6	–	–	1	–	–	4	–	–	3	–	–	–	–	–	6
Maxilla	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
%	2.8	–	–	0.5	–	–	1.9	–	–	1.4	–	–	–	–	–	2.8
n	18	–	–	2	–	–	–	–	–	–	–	–	2	–	–	16
Mandible	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
%	8.4	–	–	0.9	–	–	–	–	–	–	–	–	0.9	–	–	7.4

Table 6 Supernumerary teeth and location in the Class III and the Class II division 1 groups.

Class III (n = 200) seven patients or 3.5%.																
n					1	1	1	4	4	–	–	1				
Maxilla	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
%					0.5	0.5	0.5	2	2	–	–	0.5				
Class II division 1 (n = 215) three patients or 1.4%.																
n					1				1			1				
Maxilla	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
%					0.5				0.5			0.5				

Chi-square test $x^2 = 1.15$, $P > 0.05$ not significant.

with congenital tooth anomalies. The anomalies under examination were: malformations of the upper laterals, impacted canines, transpositions, tooth agenesis, and supernumerary teeth.

Upper lateral incisor agenesis was observed in 5.5 per cent of the Class III and 1.9 per cent of the Class II division 1 patients, percentages not far from those described for missing upper

Table 7 Occurrence rates of congenital tooth anomalies found in the Class III and the Class II division 1 groups.

Malocclusion	Female	Male	Total (%)
Class III (n = 200)	27	23	50 (25%)
Class II division 1 (n = 215)	15	18	33 (15.4%)

Chi-square test $x^2 = 5.44$, $P < 0.05$ significant.

laterals in the general population (0.5–3 per cent; Schulze, 1982; Bredy *et al*., 1991). Frequencies of 5.5 per cent for maxillary lateral incisor hypodontia observed in the Class III group might be higher than for the general population, but are below that found in Class II division 2 patients (Basdra *et al*., 2000). Uni- and bilateral agenesis was observed equally in both groups in the present investigation, while previous studies referring to population groups report higher bilateral occurrence (Roth and Hirschfelder, 1990), on the right (Bredy and Herrmann, 1961) or left side (Güzlow and Peters, 1977). In specific malocclusions, such as Class II division 2, Basdra *et al*. (2000) reported a higher bilateral incidence.

Peg-shaped malformation of the lateral incisors was found in 3 per cent of the Class III patients and in 0.9 per cent of the Class II division 1 subjects. This was not statistically significant. Peg-shaped anomalies were found equally on the left and right, uni- or bilaterally and there were no sex differences. The prevalence rate of peg-shaped maxillary lateral incisors in the general population associated with palatally displaced canines ranges from slightly less than 1 per cent to slightly more than 2 per cent (Peck *et al*., 1996).

Impacted labial and palatal canines (Peck *et al*., 1994; Becker, 1995) were found in 9 per cent of the Class III patients and in 3.3 per cent of the Class II division 1 patients. Impaction of canines has been reported to be 1–3 per cent in the general population (Dachi and Howell, 1961; Thilander and Jakobsson, 1968), while a recent report revealed the presence of impacted canines in 33.5 per cent of Class II division 2 patients (Basdra *et al*., 2000). Class III and Class II division 1 male and female patients were equally affected, while a specific location (left or right, uni- or bilateral) of the impaction could not be found.

Transpositions, a congenital tooth anomaly with a rate for the general population of between 0.03 per cent (Thilander and Jakobsson, 1968) and 0.25 per cent (Sandham and Harvie, 1985), were found in 0.5 per cent of the Class III patients, while the Class II division 1 subjects exhibited no transposition.

Published surveys on general populations have shown the prevalence rate of hypodontia (excluding third molars) to range from 1 (lowest) to 10.1 per cent (highest) (Grahnén, 1956; Volk, 1963; Hustadbraten, 1973; Güzlow and Peters, 1977). Studies on orthodontic populations show higher prevalences up to 13.6 per cent (Bredy and Herrmann, 1961; Ringquist and Thilander, 1969; Weise and Schürholz, 1970; Gogt and Greeve, 1980). Although absent third molars (at least one) appear in ≈25 per cent of the general population (Garn *et al*., 1962, 1964; Adler and Adler-Hradecky, 1963; Gogt and Greeve, 1980; Schulze, 1982), absence of all third molars is rare and its occurrence rate drops to less than 4 per cent in the general population (Schulze, 1982), but it remains high, more than 9 per cent, in certain malocclusions (Basdra *et al*., 2000). Agenesis of all third molars was found in 1.6 per cent of the Class III subjects and in 1 per cent of the Class II division 1 patients, percentages within the normal range. Moreover, agenesis with third molars included, was found in 16 per cent of the Class III and in 12.5 per cent of the Class II division 1 patients, with males and females showing almost the same occurrence rate.

Supernumerary teeth were found in 3.5 per cent in the Class III group and in 1.4 per cent in the Class II division 1 subjects, percentages also within the observed rates for the general population (Luten, 1967). All the supernumerary teeth were in the maxilla, and more than half of them were found in the premaxilla as mesiodens, similar to previously described incidences (Stellzig *et al*., 1997). No supernumerary teeth were found in the mandible in the Class III subjects.

Summarizing the results of the present study it is clear that both Class III and Class II division 1 subjects exhibit congenital tooth anomalies similar

to rates observed in the general population. Descriptive statistics show a slight tendency for a Class III to be associated with congenital tooth anomalies. Chi-square analysis on the occurrence rates of all congenital tooth anomalies together revealed a statistical difference between Class III and Class II division 1. It is likely that the Class III malocclusion is somehow related to congenital tooth anomalies compared with Class II division 1. It seems that this relationship is not as close as with Class II division 2 because comparison of the present findings to those observed in Class II division 2 subjects (Basdra *et al*., 2000) revealed statistical significance (data not shown) between Class II division 2, Class III, and Class II division I.

It might have been expected that a divergence in the results between the Class III and Class II division 1 subjects is due to differences in the two craniofacial types, but careful examination of the occurrence rates of congenital tooth anomalies in Class II division 1 subjects and a direct comparison to those with Class II division 2 malocclusions reveals that the two Class II malocclusions exhibit totally different patterns of congenital tooth anomalies. Class II division 1 malocclusions do not seem to be related to congenital tooth anomalies, while Class II division 2 malocclusions show a close relationship. Class II division 1 shows occurrence rates for various tooth anomalies close to those observed in the general population, whilst Class II division 2 show at least a three-fold frequency compared with data from general populations.

It is noteworthy that there was no statistical significance in the tooth anomalies studied between Class III and Class II division 1 subjects, but there was statistical significance when compared with the findings from Class II division 2 subjects (data not shown), except for supernumerary teeth. Supernumerary teeth according to Baccetti (1998), appear to have different genetic origins from other congenital tooth anomalies.

The observed relationship of Class II division 1 and Class II division 2 malocclusions to specific congenital tooth anomalies could imply that the two Class II groups do not share the same genetic defects in relation to congenital tooth anomalies. They probably do not share any other characteristic apart from their anteroposterior discrepancy. Peck *et al*. (1998) recently pointed out this difference, stating that studies combining Class II division 1 and Class II division 2 into a single generic Class II category most likely have drawbacks in their research design.

It seems that, apart from craniofacial characteristics, other factors such as congenital tooth anomalies are related to malocclusions. The present research together with previous work (Peck *et al*., 1998; Baccetti, 1998; Basdra *et al*., 2000) provides evidence for the existence of a specific relationship of certain congenital tooth anomalies with specific malocclusions.

The biological mechanisms for physiological tooth development are slowly becoming understood. Deviations from the physiological route and subsequent onset of congenital tooth anomalies is also under investigation (Peters and Balling, 1999). Association of certain congenital tooth anomalies to certain malocclusions may open up a different approach to the way malocclusions are observed and examined. Data from molecules and molecular mechanisms operating in the craniofacial region during tooth development may aid in answering questions regarding the origin and development of malocclusions.

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