

The Class II division 2 craniofacial type is associated with numerous congenital tooth anomalies

Efthimia K. Basdra, Magdalini Kiokpasoglou and Angelika Stellzig

Department of Orthodontics, University of Heidelberg, Germany

SUMMARY The aim of the present study was to examine whether a putative relationship exists between the Class II division 2 craniofacial type and congenital anomalies of the dentition, such as missing teeth, peg-shaped laterals, transpositions, supernumerary teeth and canine impactions. Two hundred and sixty-seven untreated patients with Class II division 2 malocclusion were examined. The results show that 56.6 per cent of the patients exhibited some form of congenital tooth anomaly, 13.9 per cent agenesis of the upper lateral incisors, 7.5 per cent peg-shaped upper laterals, while impacted canines were present in 33.5 per cent of the subjects. Transpositions were present in 1.1 per cent of the patients and in all cases the canine was involved. No patient exhibited a supernumerary tooth.

Comparing the results of the present study with existing data on the percentage of congenital tooth anomalies in the general population, it can be concluded that Class II division 2 malocclusions are closely associated with congenital tooth anomalies.

Introduction

According to Angle, Class II division 2 malocclusions represent a Class II situation characterized by palatally inclined instead of proclined central incisors. Korkhaus (1953) and Hausser (1953) also extensively studied forms of malocclusion characterized by palatally inclined central incisors in Class I or II situations.

Reports in the literature on the craniofacial characteristics of patients with Class II division 2 malocclusions show the great variability in the forms of this malocclusion (Strang, 1948; Korkhaus, 1953; Codiawala and Joshi, 1972; Ingervall and Lennartsson, 1973; Fischer-Brandies *et al.*, 1985; Karlsen, 1994; Pancherz *et al.*, 1997).

It has been repeatedly suggested that heredity plays an important role in the genesis of Class II division 2 malocclusions (Korkhaus, 1953; Codiawala and Joshi, 1972; Fischer-Brandies *et al.*, 1985). Recently, Peck *et al.* (1998) stated that the Class II division 2 deep bite malocclusion may actually be polygenic and additive in nature, through combined expression of genetically determined anatomical components.

The genetic background in tooth development is becoming progressively understood. Abnormalities such as missing teeth, peg-shaped laterals, transpositions, supernumeraries, and impactions are most likely connected with defects in certain genes that are associated with tooth development.

The present study examined the relationship of the Class II division 2 malocclusion with congenital tooth anomalies (congenital missing laterals and other teeth, peg-shaped laterals, impacted canines, transpositions, supernumerary teeth) in an attempt to explore the genetic basis of this particular malocclusion.

Subjects and methods

The subjects of the present study comprised 267 patients (161 females and 106 males) from the Department of Orthodontics at the University of Heidelberg. All subjects fulfilled the following criteria:

- (1) overjet less than 3.5 mm;
- (2) overbite more than 4 mm;

- (3) retroclination of the upper incisors (U1:SN less than 98 degrees);
- (4) clinical diagnosis of a Class II division 2 type of malocclusion.

The age of the patients varied from 7 years 9 months to 44 years 10 months. For that reason, they were divided in three age groups as follows:

- Group A: patients up to 10 years 6 months (43 patients: 26 females and 17 males).
 Group B: patients 10 years 7 months to 15 years 6 months (109 patients: 69 females and 40 males).
 Group C: patients over 15 years 7 months (115 patients: 66 females and 49 males).

The orthopantomograms, dental casts, and the dental history of each patient were used to identify the existence of congenital tooth anomalies. The following anomalies were examined.

Agenesis of one or both maxillary lateral incisors

The diagnosis of maxillary lateral incisor agenesis was made from the orthopantomograms and the dental history of the patients. The calcification of the tooth germ of the upper laterals begins during the first years of life.

Peg-shaped anomaly of one or both maxillary lateral incisors

A peg-shaped upper lateral incisors was identified on the dental casts according to the criteria of Le Bot and Salmon (1977).

Impaction of one or both upper canines

The maxillary canine is the most variably positioned tooth in the human dentition. It can be displaced within the dental arch either labially or palatally. In the present study, complete records for canine impaction examination were available for 164 patients. The impacted canines were recorded independent from their location (labial or palatal).

Agenesis of third molars

Agenesis of third molars (one or more) was recorded. The critical age for the diagnosis of agenesis of the third molar is 14 years or older (Garn *et al.*, 1962). In the present study, records for 255 patients were available. For the patients in groups A and B the diagnosis was made from lateral radiographs. Agenesis of the third molars was recorded according to the number and location. In addition, the agenesis of any tooth type was also noted.

Supernumerary teeth

All supernumerary teeth were recorded.

Transpositions of teeth

Although the clinical definitions concerning tooth transposition vary in the literature, in the present study the positional interchange of two adjacent teeth was recorded.

All the above congenital tooth anomalies were recorded according to the location (left or right side) and to gender (male or female), and were calculated as a percentage of the total sample.

Results

Congenital tooth anomalies and missing teeth in general (n = 267)

In the sample of 267 Class II division 2 individuals, congenital tooth anomalies in general, were found in 151 patients (56.6 per cent). Table 1 gives these findings in detail. More females (35.2 per cent) than males (21.3 per cent) showed tooth anomalies.

Agenesis of any tooth was found in 44.6 per cent of the patients (Table 2). Again, the

Table 1 Congenital tooth anomalies in Class II division 2 malocclusion.

Group (n = 267)	Female	Male	Total
A	6	3	9
B	43	27	70
C	45	27	72
Total	94 (35.2%)	57 (21.3%)	151 (56.6%)

Table 2 Congenital agenesis of any tooth type (third molars included) in subjects with Class II division 2 malocclusion ($n = 267$).

Group	Female	Male	Total
A	5	3	8
B	30	24	54
C	36	21	57
Total	71 (26.6%)	48 (18%)	119 (44.6%)

Table 3 Congenital upper lateral incisor agenesis in Class II division 2 malocclusion subjects ($n = 267$).

Location	Female	Male	Total
Bilateral (12 + 22)	14	9	23
Right side (12)	4	2	6
Left side (22)	5	3	8
Total	23 (8.6%)	14 (5.2%)	37 (13.9%)

percentage was higher for females (26.6 versus 18 per cent).

Agenesis of one or both maxillary lateral incisors ($n = 267$)

Agenesis of maxillary lateral incisors was found in 37 patients or 13.9 per cent of the sample (Table 3). Twenty-three patients were female and 14 were male. Agenesis occurred most frequently bilaterally.

A peg-shaped anomaly of one or both maxillary lateral incisors ($n = 267$)

Peg-shaped laterals were found in 7.5 per cent of the subjects, twice as many females (5.6 per cent) as males (1.9 per cent). Peg-shaped laterals were most frequently bilaterally (Table 4).

Impaction of one or both upper canines ($n = 164$)

Impacted canines were found in 55 patients or 33.5 per cent. This anomaly was located bilaterally in 25 patients (15.2 per cent), on the right side in 17 and on the left side in 13. Thirty-seven

Table 4 Upper lateral incisor malformation (maxillary 12.22 malformation, peg-shaped) in subjects with a Class II division 2 malocclusion ($n = 267$).

Location	Female	Male	Total
Bilateral (12 + 22)	11	2	13
Right side (12)	2	1	3
Left side (22)	2	2	4
Total	15 (5.6%)	5 (1.9%)	20 (7.5%)

Table 5 Maxillary impacted canines in Class II division 2 malocclusion subjects ($n = 164$).

Location	Female	Male	Total
Bilateral (13 + 23)	16	9	25
Right Side (13)	11	6	17
Left Side (23)	10	3	13
Total	37 (22.6%)	18 (11%)	55 (33.5%)

patients (22.6 per cent) were female and 18 (11 per cent) male (Table 5).

Agenesis of third molars ($n = 255$)

Agenesis of third molars (one or more) was found in 56 patients (22 per cent), 33 females (12.9 per cent) and 23 males (9 per cent). Agenesis of all third molars was diagnosed in 23 patients (9 per cent; Table 6). Table 7 gives details for agenesis of any tooth type.

Supernumerary teeth ($n = 267$)

None of the Class II division 2 patients had a supernumerary tooth.

Transposition of teeth ($n = 267$)

Transpositions were found in three patients or 1.1 per cent, one female and two males. One transposition involved a maxillary canine with the lateral incisor and the other two the maxillary canine with the first premolar. All transpositions occurred on the left side.

Table 6 Congenital third molar agenesis ($n = 255$).

Condition	Female	Male	Total
M3 agenesis (1 or more)	33 (12.9%)	23 (9%)	56 (22%)
Agenesis M3	Number of patients		
18,28,38,48	23 (9%)		
38,48	14 (5.2%)		
18,28	11 (4.1%)		

Discussion

Two-hundred-and-sixty-seven patients (161 females and 106 males) exhibiting the characteristics of a Class II division 2 malocclusion were examined for the co-existence of congenital tooth anomalies, such as hypodontia in the maxilla and mandible, peg-shaped upper laterals, impacted canines, transpositions, and supernumerary teeth.

Although it is not within the scope of this article to refer to the epidemiology of the Class II division 2 malocclusion, females exceeded males in the present sample at a ratio of approximately 1.5:1. Maj and Lucchese (1982), however, showed male dominance. In a smaller sample, but directly related to that in the present study, Peck *et al.* (1998) also showed male dominance.

One-hundred-and-fifty-one (56.6 per cent) patients exhibited some form of congenital tooth anomaly. Females presented a higher frequency (35.2 versus 21.3 per cent).

The number of congenital tooth malformations became more pronounced with age as some types of anomalies become more recognizable and are diagnosed later, such as canine impaction and agenesis of third molars. This is the reason why the results of the present study show a rather small prevalence of congenital tooth anomalies in younger Class II division 2 patients when compared with older subjects.

Agenesis of upper lateral incisors was found in 13.9 per cent of the patients with females showing a higher percentage. Side specificity, at least in the present sample, was not found, while bilateral occurrence was more frequent than unilateral. Bredy and Herman (1961) reported frequent occurrence of this tooth anomaly on the right side, while Gülzow and Peters (1977) reported it on the left side. Roth and Hirschfelder (1990) found higher bilateral than unilateral occurrence. However, it should be noted that those studies were of general population samples.

A peg-shaped anomaly was also found to be greater in females than in males. Similarly, as with the upper lateral agenesis anomalies, peg-shaped laterals were found more often bilaterally.

A high percentage of impacted canines was found in patients with a Class II division 2 malocclusion. While the prevalence of this type of tooth anomaly varies from less than 1 per cent to 3 per cent in the general population (Dachi and Howell, 1961; Grover and Lorton, 1985; Hirschfelder and Petschelt, 1986; Stellzig *et al.*, 1994), 33.5 per cent of the present sample

Table 7 Detailed presentation of congenital tooth agenesis in subjects with Class II division 2 malocclusions.

Upper right									Upper left								
<i>n</i>	55	4	1	15	8	5	28	–	–	31	5	7	15	0	3	51	
%	21.6	1.5	0.4	5.6	3	1.9	10.5	0	0	11.6	1.9	2.6	5.6	0	1.1	20	
tooth	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	
Lower right									Lower left								
<i>n</i>	62	2	1	33	5	3	4	8	8	4	3	5	24	1	3	59	
%	24.3	0.8	0.4	12.4	1.9	1.1	1.5	3	3	1.5	1.1	1.9	9	0.4	1.1	23.1	
tooth	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	

Table 8 Direct comparison of congenital tooth agenesis for all teeth (maxilla and mandible) in subjects with Class II division 2 malocclusion and the general population (Schulze, 1982; Bredy *et al.*, 1991).

Upper right									Upper left							
General																
Population (%)	28	0.2	0.09	2.2	0.33	0.29	2.9	0.5	0.5	2.9	0.33	0.29	2.2	0.09	0.19	28
Class II div. 2 (%)	21.6	1.5	0.4	5.6	3.0	1.9	10.5	–	–	11.6	1.9	2.6	5.61	–	1.1	20.0
tooth	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
Lower right									Lower left							
General																
Population (%)	28	0.14	0.09	5	0.2	0.04	0.2	1.4	1.4	0.14	0.09	0.09	5	0.09	0.2	28
Class II div. 2 (%)	24.3	0.8	0.4	12.4	1.9	1.1	1.5	3	3	1.5	1.1	1.9	9	0.4	1.1	23.1
tooth	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

exhibited impacted canines. In the present study, labial and palatal impacted canines were not separately examined. Although many investigators (Peck *et al.*, 1994; Stellzig *et al.*, 1994; Becker, 1995) have discussed the difference in the aetiology of palatal and labial impaction and the possibility that palatal canine impaction most likely represents a congenital tooth anomaly, definite conclusions have not yet been extrapolated. Females were affected more than males, while the side distribution was bilateral. The right side was affected slightly more than the left, a finding observed also by Peck *et al.* (1994) who found a rather small bilateral occurrence.

Agenesis of the third molars was found in 22 per cent of the patients, a percentage that is similar to that reported for the general population. Again, female patients were more affected than males, which is in agreement with the findings of Bredy and Herrmann (1961), Garn *et al.* (1962, 1964), Adler and Adler-Hradecky (1963), Gülzow and Peters (1977), Godt and Greve (1980). Roth and Hirschfelder (1990) found no sex differences in relation to tooth agenesis (all the above studies refer to general population samples).

The results of the present investigation reveal an important finding: 9 per cent of the patients showed agenesis of all third molars, a rather seldom finding in the general population. The higher percentage of congenital missing third molars (all four) reported in the literature is less

than 4 per cent (Adler and Adler-Hradecky, 1963).

The percentages reported in the literature for tooth agenesis for general population samples are: Bredy and Hermann (1961) 12.8 per cent; Rinquist and Thilander (1969) 13.1 per cent; Weise and Schürhotz (1970) 13.6 per cent; and Hustadbraten (1973) 10.1 per cent. Table 8 presents a comparison of the percentage of tooth agenesis (tooth by tooth) found in Class II division 2 patients with that reported in the literature for the general population (the higher reported percentages were taken). A tooth to tooth comparison reveals a strong association of the Class II division 2 malocclusion with congenital agenesis of teeth. Except for the third molars, all other teeth were absent at least three times more often in Class II division 2 patients when compared with the general population.

Transpositions were found in three patients (1.1 per cent). In all subjects the canine was involved. Transpositions are found in the general population and occur with a frequency between 0.03 per cent (Swedish schoolchildren, Thilander and Jakobson, 1968) and 0.25 per cent (Scottish orthodontic patients, Sandham and Harvie, 1985).

It is interesting that no supernumerary tooth was found in the present sample. Baccetti (1998) in a controlled study of associated dental anomalies which included among others aplasia of second premolars, small maxillary

lateral incisors, supernumerary teeth, and palatal displacement of maxillary canines, found that, except for supernumerary teeth, all other tooth anomalies examined showed significant reciprocal associations suggesting a common genetic origin. He suggested that supernumerary teeth appear to be a separate aetiological entity with respect to all other tooth anomalies examined.

Conclusions

Summarizing the results of this study, and in agreement with Peck *et al.* (1998), it is concluded that a Class II division 2 malocclusion is closely related to congenital tooth anomalies.

Mutations in the *Otlx2* gene found in the oral epithelium at sites of future tooth formation before morphological manifestations, are associated with tooth abnormalities as observed in Rieger syndrome (Peters and Balling, 1999).

It is of great interest in view of the present clinical results (association of tooth anomalies to a specific malocclusion) to examine whether genes associated with tooth development are also involved in the development of a Class II division 2 malocclusion or any malocclusion in general.

Address for correspondence

Dr Efthimia K. Basdra
Department of Orthodontics
University of Heidelberg
INF 400
Heidelberg-69120
Germany

References

- Adler P, Adler-Hradecky C 1963 Die agenesis des Weisheitszahnes. *Deutsche zahnärztliche Zeitschrift* 18: 1361–1369
- Baccetti T 1998 A controlled study of associated dental anomalies. *Angle Orthodontist* 68: 267–274
- Becker A 1995 Palatal canine displacement: guidance theory or an anomaly of genetic origin? A letter, with response from Peck *et al.* *Angle Orthodontist* 65: 95–98
- Bredy E, Hermann H 1961 Form und Häufigkeit der Anomalie der Zahnzahl. *Deutsche zahnärztliche Zeitschrift* 16: 929–941
- Bredy E, Erbing C, Hübenthal B 1991 Häufigkeit der Zahnunterzahl bei Anlage und Nichtanlage von Weisheitszähnen. *Deutsche Zahn-Mund-Kieferheilkunde* 19: 357–363
- Codiawala R N, Joshi M R 1972 A cephalometric comparison between Class II division 2 malocclusions and normal occlusion. *Angle Orthodontist* 44: 262–267
- Dachi S F, Howell F V 1961 A study of impacted teeth. *Oral Surgery, Oral Medicine, Oral Pathology* 14: 1165–1169
- Fischer-Brandies H, Fischer-Brandies B, König A 1985 A cephalometric comparison between Angle Class II division 2 malocclusion and normal occlusion in adults. *British Journal of Orthodontics* 12: 158–162
- Garn S M, Lewis A B, Vicinus J H 1962 Third molar agenesis and reduction in number of other teeth. *Journal of Dental Research* 41: 717–719
- Garn S M, Lewis A B, Kerewsky R S 1964 Third molar agenesis and variation in size of the remaining teeth. *Nature* 201: 839 (Abstract)
- Godt H, Greve R 1980 Beitrag zur Unterzahl der Zähne einschliesslich der dritten Molaren. *Zahnärztliche Praxis* 31: 265–270
- Grover P S, Lorton L 1985 The incidence of unerupted permanent teeth and related clinical cases. *Oral Surgery, Oral Medicine, Oral Pathology* 59: 420–425
- Gülzow H J, Peters R 1977 Zur epidemiologie der Zahnunterzahl im bleibenden Gebiss. *Deutsche zahnärztliche Zeitschrift* 32: 545–549
- Hausser E 1953 Zur Ätiologie und Genese des Deckbisses. *Fortschritte der Kieferorthopädie* 14: 154–161
- Hirschfelder U, Petschelt A 1986 Retention von Zähnen aus kieferorthopädischer Sicht. *Deutsche zahnärztliche Zeitschrift* 41: 164–170
- Hustadbraten K 1973 Hypodontia in the permanent dentition. *Journal of Dentistry for Children* 40: 115–118
- Ingervall B, Lennartsson B 1973 Cranial morphology and dental arch dimensions in children with Angle Class II division 2 malocclusion. *Odontologisk Revy* 24: 149–160
- Karlsen A T 1994 Craniofacial characteristics in children with Angle Class II div. 2 malocclusion combined with extreme deep bite. *Angle Orthodontist* 64: 123–130
- Korkhaus G 1953 Über den Aufbau des Gesichtsschädels beim Deckbiss. *Fortschritte der Kieferorthopädie* 14: 162–171
- Le Bot P, Salmon D 1977 Congenital defects of the upper lateral incisors (ULI): conditions and measurements of the other teeth, measurements of the superior arch, head and face. *American Journal of Physical Anthropology* 46: 231–244
- Maj G, Lucchese F P 1982 The mandible in Class II division 2. *Angle Orthodontist* 52: 288–292
- Pancherz H, Zieber K, Hoyer B 1997 Cephalometric characteristics of Class II division 1 and Class II division

- 2 malocclusions: a comparative study in children. *Angle Orthodontist* 67: 111–120
- Peck S, Peck L, Kataja M 1994 The palatally displaced canine as a dental anomaly of genetic origin. *Angle Orthodontist* 64: 249–256
- Peck S, Peck L, Kataja M 1998 Class II division 2 malocclusion: a heritable pattern of small teeth in well-developed jaws. *Angle Orthodontist* 68: 9–20
- Peters H, Balling R 1999 Teeth—where and how to make them. *Trends in Genetics* 15: 59–65
- Ringquist M, Thilander B 1969 The frequency of hypodontia in an orthodontic material. *Svensk Tandläkare Tidskrift* 62: 535–541
- Roth P, Hirschfelder U 1990 Zahnunterzahl bei Anlage aller vier Weisheitszähne. *Deutsche zahnärztliche Zeitschrift* 45: 267–269
- Sandham A, Harvie H 1985 Ectopic eruption of the maxillary canine resulting in transposition with adjacent teeth. *Tandlägebladet* 89: 9–11
- Schultze Ch 1982 *Lehrbuch der Kieferorthopädie*, Bd. 3. Quintessenz Berlin
- Stellzig A, Basdra E K, Komposch G 1994 Zur Ätiology der Eckzahnverlagerung. *Fortschritte der Kieferorthopädie* 55: 97–103
- Strang R H W 1948 Class II division 2 malocclusion. *Angle Orthodontist* 28: 210–214
- Thilander B, Jakobson S O 1968 Local factors in impaction of maxillary canines. *Acta Odontologica Scandinavica* 26: 145–168
- Weise W, Schüerholz B 1970 Nichtanlage, Verkümmern, Spätanlage und Überzahl von Zähnen. *Deutsche zahnärztliche Zeitschrift* 25: 641–649

