Prevalence of hypodontia in orthodontic patients in Brasilia, Brazil

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SUMMARY The purpose of this retrospective study was to determine the prevalence of hypodontia and associated dental anomalies in patients undergoing orthodontic treatment in Brasília, Brazil, over a 2 year period (1998–2000). The records of 1049 orthodontic patients between 10 and 15.7 years of age (507 males and 542 females) from 16 orthodontic clinics were analysed. Descriptive statistics were performed for the study variables. A chi-square test was used to determine the difference in the prevalence of hypodontia between genders.

The prevalence of hypodontia was 6.3 per cent (39.4 per cent males and 60.6 per cent females) with no statistically significant difference between the genders. One case of oligodontia was observed. The maxillary lateral incisor was the most frequently missing tooth, followed by the mandibular second premolar. All cases of hypodontia, except one, were associated with at least one other dental anomaly. These associated dental anomalies were retained primary teeth (30.3 per cent), ectopic canine eruption (25.8 per cent), taurodontism (21.2 per cent), and peg-shaped maxillary lateral incisors (16.7 per cent).

Introduction

Tooth agenesis, which is defined as the congenital absence of one or more primary or permanent teeth, is one of the most frequent human dental anomalies (Symons *et al.*, 1993; Cameron and Sampson, 1996; Vastardis, 2000). Tooth agenesis can be classified as hypodontia, oligodontia, or anodontia. The term hypodontia is used to describe agenesis of one to six teeth (excluding the third molars), oligodontia the absence of more than six teeth (excluding the third molars), and anodontia representing complete absence of teeth (Arte, 2001). The term 'severe hypodontia' is often used as an alternative to oligodontia to describe those cases with more than four teeth missing, excluding the third molars (Vastardis, 2000; Wong *et al.*, 2005; Endo *et al.*, 2006; Worsaae *et al.*, 2007). Hypodontia can be an isolated condition or part of a syndrome (Van der Weide *et al.*, 1994).

Population studies have revealed that the prevalence of hypodontia differs with regard to the permanent and primary dentitions, tooth type, and racial groups. The prevalence of hypodontia varies from 0.03 to 10.1 per cent in various populations (Mattheeuws *et al.*, 2004). In the primary dentition, the prevalence is between 0.5 and 0.9 per cent, while oligodontia is rare, with an estimated prevalence of 0.25 per cent (Vastardis, 2000). In the permanent dentition, the most commonly missing teeth are the third molars, followed by either the lower second premolars or upper lateral incisors (Lavelle *et al.*, 1970; Müller *et al.*, 1970). The following differences in prevalence between racial groups have been reported: 1.5–3 per cent in Caucasians, 6–9.2 per cent in Orientals, and 7.7 per cent in Afro-Americans (Vastardis, 2000). Hypodontia prevalence also

differs among studies of orthodontic patient (Thongudomporn and Freer, 1998; Meza, 2003; Fekonja, 2005; Endo *et al.*, 2006; Altug-Atac and Erdem, 2007).

A higher prevalence of hypodontia in females has also been suggested (Magnusson, 1977; Bäckman and Wahlin, 2001). However, other studies have not found any statistically significant differences between genders (Grahnén, 1956; Haavikko, 1971; Rølling, 1980).

Other dental anomalies have been reported in patients with hypodontia, such as peg-shaped incisors (Townsend *et al.*, 1995), taurodontism (Lai and Seow, 1989), enamel developmental defects (Symons *et al.*, 1993; Arte *et al.*, 2001), and lateral incisor–canine transposition (Peck *et al.*, 1998; Shapira and Kuftinec, 2001).

Some studies have reported the prevalence of hypodontia in orthodontic patients (Thongudomporn and Freer, 1998; Meza, 2003; Fekonja, 2005; Endo *et al.*, 2006; Altug-Atac and Erdem, 2007). Retrospective studies rely on good record keeping and orthodontic patients often have more complete records. Some Brazilian studies have investigated the prevalence of hypodontia (Castilho *et al.*, 1990; Ciamponi and Frassei, 1999), but there are no reports concerning orthodontic patients. Thus, the aim of the present study was to determine the prevalence of hypodontia and its association with other dental anomalies in orthodontic patients.

Materials and methods

The present study was approved by the Research Ethics Committee of the Faculty of Health Sciences, University of Brasília, Brazil. The records of patients, between 10 and 15.7 years of age, who initiated orthodontic treatment at 16 orthodontic practices in the Federal District, Brazil, were used in the study. The records included panoramic radiographs and study models of all patients at the beginning of treatment, between 1998 and 2000.

Hypodontia was recorded when a tooth was absent on the panoramic radiograph, excluding a history of loss due to trauma, caries, periodontal disease, or orthodontic extraction. All permanent teeth were investigated, excluding third molars. Hypodontia was diagnosed if one to six teeth were absent. For those records where hypodontia was noted, the presence of any syndrome or systemic disease was registered, and the presence of other dental anomalies was also verified and registered. The dental anomalies investigated were retained primary teeth, ectopic canine eruption, lateral incisor–canine transposition, peg-shaped maxillary lateral incisors, supernumerary teeth, and taurodontism.

Study models were used to determine the presence of ectopic canine eruption, lateral incisor–canine transposition, and peg-shaped maxillary lateral incisors. A maxillary lateral incisor was considered peg-shaped when the mesiodistal incisor was shorter than the cervical width of the tooth crown (Bäckman and Wahlin, 2001).

The presence of retained primary teeth, supernumerary teeth, and taurodontism of the first mandibular molars was assessed on panoramic radiographs. Taurodontism was determined according to the criteria described by Seow and Lai (1989). The tooth was considered as taurodontic when the crown body–root ratio was equal or greater than 1:1. The molars were classified as hypo-, meso-, or hypertaurodont. To establish crown–root ratios, the radiographs were digitized at a resolution of 100 dpi, and the measurements were performed by one examiner (RRG) using Image Pro-Express software, version 4.5 (Media Cybernetics Inc., Bethesda, Maryland, USA).

Descriptive statistics were performed for the study variables. Data collected were analysed for frequency, gender, tooth type, and the association with other dental anomalies. The difference in the prevalence of hypodontia between genders was tested with the chi-square test, at a level of significance of 0.05, using SAS version 8.1 for Windows (SAS Institute Inc., Cary, North Carolina, USA).

To assess measurement error to determine taurodontism, Dahlberg's formula (EM = $\sqrt{\frac{\sum d^2}{2n}}$) was applied to 20 per cent of the analysed molars which were measured twice with an interval of 15 days. The error of the method was 0.07.

Results

A total of 1049 records were analysed, 507 males (48.3 per cent) and 542 females (51.7 per cent). No systemic diseases or syndromes were registered. Hypodontia was diagnosed in 66 subjects, i.e. 6.3 per cent of the studied sample [26]

males (5.1 per cent) and 40 females (7.3 per cent)]. No significant statistical gender difference was observed ($\chi^2 = 2.25$; df = 1; P > 0.05). The mean age of the patients at treatment initiation was 13.16 years (range 10–15.7 years). Only one case of oligodontia was verified, with 18 missing teeth. The patient was an 11-year-old female.

Maxillary hypodontia was seen in 59.2 per cent of patients and in the mandible in 40.8 per cent, with an overall ratio of 1.45:1. The maxillary lateral incisors were the most frequently missing teeth, followed by the mandibular second premolars. The distribution of the missing teeth is shown in Figure 1. A total of 108 permanent teeth were found to be congenitally absent, with the number of missing teeth in each case ranging from one to five, with an average of 1.63 missing teeth per patient. One missing tooth was found in 56.6 per cent of the studied cases, two missing teeth in 33.3 per cent, and three to five absent teeth were observed in 12.1 per cent.

All individuals, except one, had at least one dental anomaly coexisting with hypodontia. The distribution of the dental anomalies associated with hypodontia is shown in Table 1. A retained primary tooth was the most commonly observed anomaly (n = 20; 30.3 per cent), while the mandibular second primary molar was the most frequently retained tooth. Ectopic eruption was found in 25.8 per cent (n = 17) of individuals, with the maxillary canine being the most frequently affected tooth. The presence of lateral incisor–canine transposition was not verified.

Peg-shaped maxillary lateral incisors were observed in 11 individuals (16.7 per cent). All peg-shaped maxillary lateral incisors were unilateral and their occurrence was observed with agenesis of the contralateral maxillary lateral incisor. The association of supernumerary teeth and hypodontia was not verified.

Taurodontism of the first mandibular molars was found in 14 individuals (21.2 per cent): 10 had unilateral taurodontism (five on the right side and five on the left side). The remaining four cases were bilateral. All teeth were classified as



Figure 1 Distribution of missing teeth by genders. Tooth notation according to the Federation Dentaire International.

Table 1Distribution and frequency (%) by gender of the dentalanomalies associated with hypodontia in the 1049 orthodonticpatients studied.

Dental anomaly	Subjects with hypodontia $(n = 66)$		
	Male (%)	Female (%)	Total (%)
Retained primary teeth	7 (10.6)	13 (19.7)	20 (30.3)
Ectopic eruption	7 (10.6)	10 (15.2)	17 (25.8)
Taurodontism	6 (9.1)	8 (12.0)	14 (21.1)
Peg-shaped upper lateral incisor	5 (7.6)	6 (9.1)	11 (16.7)
Incisor-canine transposition	0 (0.0)	0 (0.0)	0 (0.0)
Supernumerary	0 (0.0)	0 (0.0)	0 (0.0)

hypotaurodontic, except one, which was classified as a mesotaurodontic first molar.

Discussion

The sample in this study represented 0.6 per cent of the Federal District population in the age range studied (www.codeplan.df.gov.br). Since local public health policies do not include orthodontic treatment, the sample studied represents those requesting orthodontic treatment. Orthodontic patients do not necessarily reflect the number of individuals in the population with hypodontia; this will be dependent on the availability of orthodontic treatment and its uptake in this particular population.

The results of the present study showed a prevalence of 6.3 per cent of hypodontia in orthodontic patients in the Federal District of Brazil. This prevalence is lower than that reported in other similar studies. The prevalence of hypodontia observed in Australian orthodontic patients was 8.1 per cent (Thongudomporn and Freer, 1998), whereas in Japanese orthodontic patients the prevalence was 8.5 per cent (Endo et al., 2006). On the other hand, the prevalence in Mexican orthodontic patients was 2.7 per cent (Meza, 2003), lower than the prevalence observed in the present study. There are important differences among countries in the organization of orthodontics for children and as such there will be differences in the availability and uptake of orthodontics. The wide range of prevalence values (1.6-9.6 per cent) observed in population studies has indicated geographic differences (Haavikko, 1971; Seow and Lai, 1989; Townsend et al., 1995; Kotsomitis and Freer, 1997; Arte and Pirinen, 2003). Nevertheless, these reports are mainly for European, Australian, and North American populations, indicating the need for studies in other geographic regions in order to verify these differences.

Females presented a higher prevalence of hypodontia, but no significant statistical difference was observed, which is in accordance with the majority of reports (Grahnén, 1956; Haavikko, 1971; Lai and Seow, 1989; Thongudomporn and Freer, 1998; Fekonja, 2005; Endo *et al.*, 2006). A few studies have found significant difference between genders (Bäckman and Wahlin, 2001; Brook, 1984).

In the present study, of the individuals identified with hypodontia, 87.9 per cent had one or two missing teeth. Other studies have reported a higher frequency of one or two missing teeth (Haavikko, 1971; Rølling, 1980; Davis, 1987; Fekonja, 2005).

The maxillary lateral incisor was found to be the most frequently missing tooth in the current study. There is some variation in the literature concerning the description of the most frequently missing tooth, excluding third molars. The mandibular second premolar is normally the most frequently missing tooth reported (Rølling, 1980; Thongudomporn and Freer, 1998; Bäckman and Wahlin, 2001; Polder et al., 2004; Mattheeuws et al., 2004; Endo et al., 2006). However, other studies have also shown the permanent upper lateral incisor to be the most affected tooth (Müller et al., 1970; Ciamponi and Frassei, 1999; Meza, 2003; Fekonja, 2005). Müller et al. (1970) observed that in a North American population, the maxillary lateral incisor was the most frequently missing tooth in individuals with agenesis of only one or two teeth, while in those with more than two absent teeth, the second premolar was most commonly missing tooth. These variations probably reflect the fact that although populations in various countries have been studied (Castilho et al., 1990; Thongudomporn and Freer, 1998; Ciamponi and Frassei, 1999; Bäckman and Wahlin, 2001; Meza, 2003; Mattheeuws et al., 2004; Polder et al., 2004; Endo et al., 2006), some research has focused on patients undergoing orthodontic treatment (Thongudomporn and Freer, 1998; Meza, 2003; Fekonja, 2005; Endo et al., 2006) and on the overall population (Castilho et al., 1990; Ciamponi and Frassei, 1999; Polder et al., 2004; Mattheeuws et al., 2004). In addition, differences between populations of patients seeking orthodontic treatment may possibly reflect different psycho-social aspects between regions. It is thus probable that in countries where smile aesthetics are highly valued, lateral incisor hypodontia may motivate parents and patients to seek orthodontic treatment.

Previous studies have demonstrated that hypodontia may be related to other dental anomalies such as microdontia, peg-shaped incisors, taurodontism, enamel defects, and lateral incisor-canine transposition (Lai and Seow, 1989; Symons *et al.*, 1993; Townsend *et al.*, 1995; Peck *et al.*, 1998; Arte *et al.*, 2001; Shapira and Kuftinec, 2001). The results suggest that ectopic canines, peg-shaped lateral incisors, and taurodontism are associated with hypodontia.

The percentage of peg-shaped maxillary lateral incisors observed in the individuals studied was higher than previously reported (Grahnén, 1956; Meskin and Gorlin, 1963; Lai and Seow, 1989). It has been suggested that hypodontia and peg-shaped lateral incisors are different forms of genotypic manifestation of the same gene (Alvesalo and Portin, 1969; Jorgenson, 1980; Brook, 1984). These data suggest that if a patient with hypodontia undergoes orthodontic treatment, careful attention must be given to the analysis of the possible existence of Bolton's discrepancies in the maxillary anterior region (Carreiro *et al.*, 2005).

In the present study, taurodontism was observed in 21.2 per cent of individuals with hypodontia, confirming previous reports (Lai and Seow, 1989; Arte *et al.*, 2001). Lai and Seow (1989) observed that the occurrence of taurodontism was higher in individuals with hypodontia (34.3 per cent) than in a control group (7.1 per cent). These findings may also suggest that there is an association between hypodontia and taurodontism. Complementary studies must be conducted to better understand the impact of these morphological alterations on orthodontic treatment. Alterations in crownroot ratio are probably followed by other subtle morphological differences that hamper the successful conclusion of orthodontic treatment (Casko *et al.*, 1998). Moreover, the tendency to root resorption is greater in dentitions in which hypodontia and taurodontism occur (Kjær, 1995).

The most common dental anomaly associated with hypodontia was found to be retained primary teeth. This was expected since the absence of permanent teeth is related to persistence of the primary predecessor (Bjerklin and Bennett, 2000; Ith-Hansen and Kjær, 2000).

Tooth morphogenesis is a complex process that involves epithelial-ectomesenchymal interactions. Numerous transcription factors, growth factors, and their receptors, as well as extracellular matrix components, have been associated with early tooth development (Thesleff and Nieminen, 1996; Jernvall and Thesleff, 2000; Miletich and Sharpe, 2003). The genetic basis of tooth development is supported by the identification of mutations in genes that participate in dental development (Vastardis et al., 1996; Mostowska et al., 2003). Mutations in transcription factors MSX 1 (Mostowska et al., 2006b) and PAX 9 (Stockton et al., 2000; Nieminen et al., 2001) have been identified in families with autosomal dominant oligodontia. More recently, a mutation in the AXIN2 gene was identified in families with oligodontia and colorectal cancer suggesting that tooth agenesis might be an indicator of colorectal cancer susceptibility (Lammi et al., 2004). Although mutations in these genes have not yet been associated with hypodontia and its genetic origin remains unknown, polymorphisms in the 5' flanking region of the PAX9 gene (Peres et al., 2005) and AXIN2 (Mostowska et al., 2006a) have been associated with hypodontia in humans.

Some studies have demonstrated other dental anomalies in association with hypodontia (Lai and Seow, 1989; Symons *et al.*, 1993; Townsend *et al.*, 1995; Peck *et al.*, 1993, 1996, 1998, 2002; Baccetti, 1998; Arte *et al.*, 2001; Shapira and Kuftinec, 2001), suggesting that these associated anomalies are controlled by similar genetic mechanisms (Svinhufvud *et al.*, 1988; Baccetti, 1998; Peck *et al.*, 1998; 2002; Camilleri, 2005). Nevertheless, at present, there is no available data concerning the molecular aetiology of other dental anomalies in association with hypodontia.

Conclusions

The prevalence of hypodontia in Brazilian orthodontic patients was 6.3 per cent, with no statistically significant difference between genders. The maxillary lateral incisor was the most frequently missing tooth, followed by the mandibular second premolar. The associated dental anomalies were retained primary teeth (30.3 per cent), ectopic canine eruption (25.8 per cent), taurodontism (21.2 per cent), and peg-shaped maxillary lateral incisors (16.7 per cent).

Further studies are necessary to verify the aetiology of dental anomalies associated with hypodontia. A detailed description of these dental anomalies, when characterizing families with tooth agenesis, is essential to better correlate phenotype with genotype.

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