# Prevalence and distribution of permanent canine agenesis in dental paediatric and orthodontic patients in Hungary

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SUMMARY Non-syndromic permanent canine agenesis, or combined with agenesis, or developmental absence of other tooth types, has occasionally been described in the literature, but isolated forms are rarely observed. The purpose of the present retrospective radiographic study was to provide data on the prevalence and distribution of permanent canine agenesis in the Hungarian population. Dental panoramic tomograms and the medical history data of 4417, 6- to 18-year-old children (average age 12 years, male-to-female ratio 1:1), who presented for treatment at the Department of Paediatric Dentistry and Orthodontics of the Semmelweis University Budapest, Hungary, were examined. Patients with systemic diseases were excluded. Chi-square and Fisher's tests were performed to determine statistical significance at a level of P < 0.05.

Thirteen subjects had permanent canine agenesis. The overall prevalence was 0.29 per cent. The prevalence of permanent canine agenesis was 0.27 per cent in the maxilla and 0.09 per cent in the mandible (P < 0.01). The male-to-female ratio was 1:2.2. Dental anomalies associated with permanent canine agenesis were found: 11 patients had retention of the primary canines, 10 other types of agenesis of the permanent teeth, one a primary supernumerary tooth, one a supernumerary cusp, and nine occlusal disturbances.

## Introduction

Considering the evolutionary perspective, the developmental absence (agenesio dentis) of one or more teeth is not uncommon in the modern human stomatognathic system. This tendency with regard to a reduction in tooth number, is progressive (Silverman and Ackerman, 1979). According to Bolk's theory of terminal reduction (de Beer, 1951), due to the phylogenetic evolution of mankind, the reduction of the distal element of a tooth group occurs more frequently than mesially placed teeth: so the most often absent are the second premolars, the upper second incisors, and the third molars (Muller et al., 1970; Brook, 1984; Gábris et al., 2001, 2006). These data are in accordance with the findings of Jorgenson (1980) and Schalk van der Weide et al. (1994), who stated, as a general rule, that if only one or a few teeth are missing, the missing germ will be the most distal tooth of any given type (Fekonja, 2005).

The prevalence of agenesis in the permanent dentition shows great variations between populations. Recent reports concerning the Caucasian population recorded prevalence rates between 3.9 and 11.3 per cent (Larmour *et al.*, 2005). Relatively higher prevalence rates of 15.68 per cent (Gábris *et al.*, 2001) and 14.69 per cent (Gábris *et al.*, 2006) with no significant differences between male and female patients were recorded in Hungarian retrospective radiographic studies among orthodontic and paedodontic patients in Budapest. A study in Debrecen showed a prevalence of 7.68 per cent (Szepesi et al., 2006). These variations in the statistical data are due to multiple causes, such as different sampling procedures. The sequence of agenesis for the different tooth types was as follows: upper second incisorlower second premolar-upper second premolar-lower first inscisor, but no cases of missing permanent canines (Gábris et al., 2006; Szepesi et al., 2006). These data correlate with Butler's field theory related to mammalian teeth, which states that the most mesial situated tooth is the most stable in each morphological class, and so, the canine being the sole representative element in its developmental field should be the most stable and rarely missing tooth (Butler, 1939). This theory was adapted to the human dentition by Dahlberg (1945). He stated that in each developmental field in a tooth group, there is a genetically stable 'key tooth', while at the end of the field, the teeth show less stability (Dahlberg, 1945, 1949). According to this theory, Bailit (1975) explained the distribution of agenesis in the permanent dentition by classifying the teeth into groups of stable and unstable teeth. Thus, the upper canines are considered stable along with the upper central incisors, the first premolars, and the first molars (Cabov et al., 2006).

Burzynski and Escobar (1983) suggested a trimodal classification of numeric tooth anomalies: anodontia, agenesis, and hyperdontia and a further subclassification into non-syndromic and syndromic cases. In syndromic oligodontia, the permanent canines are often reported

as missing although with a low frequency (Lombardo *et al.*, 2007). Non-syndromic permanent canine agenesis combined with congenital absence of other tooth types has been occasionally described in literature (Endo *et al.*, 2006), but isolated cases are rare (Hallet and Weyman, 1954; Robertson, 1962; Lum and Lim, 1976; Ulrich, 1989; Cho, 2004; Cho and Lee, 2004; Cho *et al.*, 2004; Altug-Atac and Erdem, 2007; Lombardo *et al.*, 2007).

Occasional case reports of developmentally missing permanent canines occur in the Hungarian literature, but there are no available data on the prevalence and distribution of permanent canine agenesis (Bakody, 1974, 1975; Bótyik *et al.*, 1977; Bakody and Balaton, 1992).

The purpose of the present retrospective radiographic study was to provide data concerning permanent canine agenesis in Hungary and to compare the finding with the international literature.

### Materials and methods

The dental panoramic tomograms (DPTs) and medical history of 4417, 6- to 8-year-old children (average 12 years), with a male-to-female ratio of 1:1, who presented for orthodontic evaluation at the Department of Dentistry for Children and Orthodontics at Semmelweis University Budapest, Hungary, were examined. Patients with systemic diseases were excluded from the survey.

The DPTs were studied for evidence of permanent canine agenesis and other associated developmental dental anomalies. The permanent teeth were classified as developmentally missing when there was no evidence in the records that they had been extracted and when there was no sign of mineralization of the tooth crown on the DPTs (Aasheim and Øgaard, 1993; Endo et al., 2006). Two examiners (NR and AS) recorded the teeth present on the radiographs separately, to avoid misdiagnosis of apparent agenesis (Alexander-Abt, 1999). It has been recommended that clinical and radiological diagnosis of agenesis in the permanent dentition should be made after 6 years of age, with the exception of the third molar (Pirinen and Thesleff, 1995). For each case of canine agenesis, a detailed dental history was obtained from the parents to exclude any possibility of the missing canines having been extracted or traumatically avulsed. The relatives (parents and/or siblings) were also interviewed about a family history of agenesis. For each radiograph showing permanent canine agenesis, persistent primary canines, if present, were examined for the degree of root resorption and recorded as recommended by Cho et al. (2004).

Data were processed using the Statistical Package for Social Sciences, version 10.0 (SPSS Inc., Chicago, Illinois, USA). Chi-square and Fisher's tests were undertaken. A value of P less than 0.05 was considered statistically significant.

#### Results

Thirteen subjects had permanent canine agenesis. The prevalence was 0.29 per cent. Permanent canine agenesis was found in the upper arch in nine patients, in the lower arch in four, and in both arches in three. The prevalence was 0.27 per cent in the maxilla and 0.09 per cent in the mandible, which was statistically significant (P < 0.01.). The male-tofemale ratio was 1:2.2. Three subjects had isolated canine agenesis: two sisters, the older, aged 18 years had all four permanent canines absent, and the primary canines were persisting and showing root resorption grade 1 (Table 1, Figure 1a). This patient also had an upper left second permanent incisor root anomaly and showed the presence of all third molar tooth germs. The younger sister, aged 17 years, had both upper permanent canines missing with the primary canines in situ. Root resorption was grade 2 on the right and grade 1 on the left (Figure 1b). No other tooth anomalies were observed. All four third molar germs were missing. No other family member was reported to suffer from any form of agenesis. The third case of isolated canine agenesis was in a 15-year-old male patient with both upper permanent canines absent. The primary canines were persisting with root resorption grade 0, and the third molar germs were also missing. There was no family history concerning any form of tooth agenesis.

There were two cases of total canine agenesis (prevalence 0.4 per cent): the first is described above among the cases of isolated canine agenesis and the second case was a 14-yearold female patient with her lower left second premolar germ also missing and a talon cusp on the upper right lateral incisor (Figure 1c). All corresponding primary teeth were retained; root resorption grade1. In that case, no other family member was affected by any form of agenesis.

Most cases were bilateral upper canine agenesis, a total of six such cases were recorded (prevalence 0.13 per cent).

Table 1Degree of root resorption of persisting primary<br/>canines.

Permanent canine agenesis	Subjects with retained primary canines, no. of cases	Degree of root resorption			
		0	1	2	
All permanent canines	2 of 2		2		
Bilateral upper permanent canines	4 of 6	1	1	2	
Unilateral upper permanent canines	3 of 3	2	1		
Bilateral lower permanent canines	1 of 1	1			
Unilateral upper and bilateral lower permanent canines	1 of 1		1		

Degree of root resorption (Cho et al., 2004): 0, no or minimal; 1, less than one-half of the root length; and 2, more than one-half of the root length.



Figure 1 Dental panoramic tomograms of an 18-year-old female patient with all four permanent canines missing (a); a 17-year-old female patient with bilateral upper permanent canine agenesis (b); and a 14-year-old female patient with all four permanent canines and lower left second premolar missing (c).

**Table 2**Dental anomalies and other complicationsaccompanying permanent canine agenesis.

Clinical findings	Male	Female	Total
Retained primary canine	5	6	11
Agenesis of other permanent teeth, excluding the third molars	4	6	10
Supernumerary primary teeth	_	1	1
Supernumerary cusps on permanent teeth	_	1	1
Malocclusions	4	5	9

Four of the patients with upper canine agenesis had the primary canines retained; the root resorption grades are shown in Table 1. There was only one case of bilateral lower canine agenesis and one of bilateral lower and unilateral upper missing permanent canines. Both patients were females. In the latter, an 18-year-old patient, the DPTs confirmed the presence of a persisting primary supernumerary lateral incisor in the lower arch.

Various complications of dental anomalies associated with permanent canine agenesis were found (Table 2): 11 of persisting primary canines, 10 of other types of agenesis of permanent germs, one of a primary supernumerary tooth, one of a supernumerary cusp, and nine of occlusal disturbances (posterior crossbite, anterior crossbite, median diastema, and Class II and Class III malocclusions).

## Discussion

Congenital canine agenesis is considered a rare condition (Lombardo *et al.*, 2007), which has described mainly in oriental populations (Lum and Lim, 1976; Davis, 1987; Cho and Lee, 2004; Cho *et al.*, 2004). Statistical data on canine agenesis differs in the literature. These differences in the prevalence are due to various causes, such as disagreement in sample analysis, as these studies are most frequently carried out on selected patient groups. Permanent canine agenesis ranged from 0.01 to 2.10 per cent. The present findings revealed a prevalence of 0.29 per cent similar to the data of Fukuta *et al.* (2004) who reported a prevalence of 0.18 per cent and Hokari *et al.* (2000) showed a prevalence of 0.23 per cent in the Japanese population. In European studies, Bergström (1977) recorded similar prevalences of 0.23 per cent in Swedish school children (Table 3).

Muller et al. (1970) found five cases of missing maxillary canines among 13 459 white American schoolchildren, a prevalence of 0.037 per cent and two cases in 1481 Afro-American children (prevalence 0.14 per cent). Fekonja (2005) recorded only one case of upper permanent canine agenesis among 212 orthodontic patients in Slovenia, a prevalence rate of 2.1 per cent. The prevalence of maxillary canines recorded in the present study was 0.27 per cent. This is similar to the data for Japanese (Hokari et al., 2000; Fukuta et al., 2004), Chinese (Davis, 1987), and Swedish (Bergström, 1977) children. All the studies in Table 3 showed a higher prevalence of permanent canine agenesis in the maxilla than in the mandible, with only Altug-Atac and Erdem (2007) reporting a prevalence of 0.07 per cent in the lower arch in Turkish patients and no case of canine agenesis in the upper arch. The results of the present study are in agreement with the literature: the difference between the prevalence in the maxilla (0.27 per cent) and in the mandible (0.09 per cent) was significant (P <0.01).

The developmental absence of permanent canines has been reported to be higher in female patients (Fukuta *et al.*, 2004), which is in accordance with the present findings of a male-to-female ratio of 1:2.2.

In the present study, bilateral upper canine agenesis was the most frequent distribution form; in six cases with a prevalence of 0.13 per cent (Table 2). Cho *et al.* (2004)

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Authors	Total patient number	Maxilla		Mandible		Total	
		Number of cases	%	Number of cases	%	Number of cases	%
Stegemann (1935)	42819	2	0.05	6	0.01	8	0.01
Dolder (1937)	10000	6	0.06	0	0	6	0.6
Werther and Rothenberg (1939)	1000	4	0.40	2	0.20	6	0.60
Nagy (1953)	3554	3	0.08	0	0	3	0.08
Bredy and Hermann (1961)	2316	13	0.56	7	0.3	20	0.86
Rose (1966)	6000	6	0.10	1	0.02	7	0.12
Volk (1963)	9533	2	0.22	1	0.05	3	0.03
Bergström (1977)	2589	4	0.15	2	0.08	6	0.23
Davis (1987)	1093	5	0.45	0	0	5	0.45
Hokari et al. (2000)	1524	6	0.20	1	0.07	4	0.26
Fukuta et al. (2004)	35927	48	0.13	23	0.06	65	0.18
Fekonja (2005)	212	1	2.10	0	0	1	2.10
Altug-Atac and Erdem (2007)	3043	0	0	2	0.07	2	0.07
Present study	4417	12	0.27	7	0.09	13	0.29

Table 3	Com	parison	of	data	of	permanent	canine	agenesis	in	the	literature
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described developmentally absent upper permanent canines in 32 Chinese children. Nine out of the 32 cases were bilateral. Fukuta *et al.* (2004) found 16 cases of multiple canine agenesis in the upper arch. These data correlate with the present findings: five of the six subjects had bilateral maxillary canine agenesis.

The occurrence of bilateral lower permanent canine agenesis is even rarer. Cho and Lee (2004) presented six cases of agenesis involving only the lower permanent canine. All subjects were Chinese. Two cases were bilateral. Fukuta *et al.* (2004) described among Japanese children six cases of bilateral permanent canine agenesis. The present findings revealed a single case of bilateral lower canine agenesis, with a prevalence of 0.02 per cent.

In the literature, single canine agenesis is more predominant than multiple canine agenesis and mostly occurs combined with other types of agenesis. Fukuta *et al.* (2004) reported a total of 37 cases of single canine agenesis, 26 in the upper, and 11 in the lower arch.

Altug-Atac and Erdem (2007) found two cases of unilateral mandibular canine agenesis; a prevalence of 0.07 per cent. Cho and Lee (2004) reported four cases of unilateral lower permanent canine agenesis in six Chinese children. In the present series only three cases of unilateral upper permanent canine agenesis were recorded. No unilateral lower canine agenesis case was found. The prevalence of upper unilateral canine agenesis was 0.06 per cent.

Fukuta *et al.* (2004) recorded 10 cases with all four permanent canines missing, four males and six females. None were isolated canine agenesis, and the primary canines were retained. Huggare (1984) described one isolated case of total canine agenesis. Bótyik *et al.* (1977) presented one case of a Hungarian patient with isolated complete agenesis of the permanent canines. The present findings revealed two cases of complete canine agenesis in the permanent dentition; a prevalence rate of 0.02 per cent.

Fukuta *et al.* (2004) found a prevalence of three canine agenesis of 0.008 per cent. The present study recorded a prevalence of 0.02 per cent.

There seems to be a correlation between fusion and agenesis in the primary dentition and developmental absence of the permanent successor (Fukuta *et al.*, 2004). In the present study, 10 cases were combined with other types of missing permanent tooth germs.

Ramaraj and Mirza (1995) described one case of bilateral developmentally missing madibular canines associated with a supplementary lower incisor. Another case with a single missing canine and concomitant multiple supernumerary teeth was presented by Sharma (2001). The radiological findings of the present study revealed one subject with bilateral lower and unilateral upper missing permanent canines and a supernumerary primary lower lateral incisor. Numerical anomalies in the primary dentition are very rare. Further clinical examination was required in order to identify the persisting supernumerary incisor as a supplemental type (Rajab and Hamdan, 2002). The upper primary canine was retained with root resorption grade 1. Another case was found with upper left canine agenesis, combined with persistent primary canine-root resorption grade 1-lower left second premolar agenesis and a supernumerary talon cusp on the left upper lateral incisor. Fukuta et al. (2004) described a similar case of a missing permanent canine associated with a talon cusp. This type of supernumerary cusp has a tendency to be related to other dental abnormalities (Mader, 1981; Mavrodisz et al., 2007).

In the present study, malocclusions were found in nine patients (69 per cent). This is much higher than the 23 cases with an orthodontic anomaly (10 per cent) reported by Fekonja (2005) and the results of Fukuta *et al.* (2004) who found six cases of occlusal disturbances (9.2 per cent). The discrepancies in these results can be attributed at least in part to the sampling criteria. The population in

the present study was to some extent selected as patients were referred for orthodontic evaluation.

Agenesis in the permanent dentition is usually accompanied by retention of primary teeth. According to Haselden et al. (2001), persisting primary canines are more likely to show minimal root resorption. Retaining the primary canines is of value in treatment planning. Retained primary teeth with minimal root resorption can preserve the dental arch integrity, providing good potential for later prosthetic rehabilitation. Another therapeutic choice is the extraction of the primary canines, orthodontic space closure followed by second incisor and first premolar coronoplasty (Lombardo et al., 2007). In the present study, retained primary canines were present in 11 cases. The most frequently recorded degree root resorption was 0 in four cases and 1 in five cases, with only two cases showing advanced primary root resorption (Table 3). Thus, these teeth could be taken into consideration in treatment planning.

## Conclusion

The prevalence of canine agenesis in Hungary is in line with reports on Asians and Europeans, but not North American children. The differences in prevalence are most likely due to patient selection criteria. In agreement with most investigations, a significantly higher rate of upper than lower canine agenesis was found in the present study. The proportion of female patients was also higher, in agreement with the findings in Japanese patients.

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