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The prevalence of anterior teeth with dens invaginatus in the western mediterranean region of Turkey

Z. Kirzioğlu & D. Ceyhan

Faculty of Dentistry, Department of Paedodontics, Süleyman Demirel University, Isparta, Turkey

Abstract

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Aim To assess the prevalence and type of dens invaginatus in anterior teeth of a selected population and to report associated dental complications.

Methodology The records of patients examined in the Department of Paedodontics, Faculty of Dentistry, Süleyman Demirel University, Isparta, Turkey between 1999 and 2006 were screened and a total of 2477 patients who had complete records with satisfactory radiographs were selected. The type of dens invaginatus and the presence of apical pathosis was determined from radiographs. Other dental abnormalities, syndromes and systemic diseases were noted. Variations in crown shape were also recorded.

Results Dens invaginatus was detected in 300 out of 2477 patients, with a prevalence of 12%; 82% of affected patients had dens invaginatus bilaterally. Maxillary lateral incisors were the most affected teeth. The majority of the teeth had normal crown morphology (95%). The most commonly seen type of dens invaginatus was type I (94%). Overall 33% of the patients with type III dens invaginatus and 4% of the patients with type II dens invaginatus had apical pathosis. No associations with other systemic diseases and syndromes and some limited association with hypodontia and dens evaginatus were detected.

Conclusion A carefull oral examination, radiographs, a suitable treatment plan and follow-up programme are crucial for early diagnosis and treatment for teeth with dens invaginatus.

Keywords: dens invaginatus, developmental abnormalities, lesion, prevalence.

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Introduction

Dens invaginatus is an enamel lined developmental malformation that occurs through an invagination of the dental papilla during the soft tissue stage of tooth development. (Hülsmann 1997). External forces on the tooth germ during development such as adjacent tooth germs (Segura *et al.* 2002), trauma (Gustafson & Sundberg 1950) and infection (Fischer 1936, Sprawson 1937), focal growth retardation on the tooth bud (Kronfeld 1934), focal growth acceleration on the tooth bud (Rushton 1937) and restriction of the dental arch on the enamel organ (Atkinson 1943) are the causal elements for the aetiology of invaginated teeth. Synonyms of this malformation are: dens in dente (Thomas 1974), dilated composite odontome (Hunter 1951), gestant odontome (Colby 1956), invaginated odontome, tooth inclusion, dentoid in dente (Hülsmann 1997).

Dens invaginatus may occur in permanent, deciduous and supernumerary teeth (Jiménez-Rubio *et al.* 1997, Holan 1998) and appears mostly in the maxillary lateral incisors and less frequently in the central incisors (Thomas 1974, McNamara *et al.* 1998). Teeth with dens invaginatus may have normal morphology

Correspondence to: Professor Dr Zuhal Kirzioğlu, Süleyman Demirel Üniversitesi, Diş Hekimliği Fakültesi, Pedodonti Anabilim Dalı, Çünür Kampüsü, Isparta, Türkiye (Tel.: 0 246 211 32 28; fax: 0 246 237 06 07; e-mail: zuhal@med.sdu.edu.tr).

(Tarján & Rózsa 1999) but different variations in the crown morphology may be seen including peg shaped (Tsurumachi 2004), barrel shaped (Rodekirchen *et al.* 2006), conical (Sauveur *et al.* 1997), a greater labiolingual diameter (de Sousa & Bramante 1998) and talon cusp (McNamara *et al.* 1998, Gonçalves *et al.* 2002).

Different classifications have been suggested in order to describe dens invaginatus. The most commonly used classification was proposed by Oehlers (1957), who classified dens invaginatus into three categories according to the depth of penetration and communication with periapical tissue or periodontal ligament. Type I, an enamel lined minor invagination occuring within the coronal part of the crown without an extention beyond the cemento-enamel junction; type II, an enamel lined invagination extending into the root, beyond the cemento-enamel junction and remaining as a blind sac; type III, invagination penetrating through the root to form an additional apical or lateral foramen.

Dens invaginatus is usually detected by accident on the radiograph. Radiographically, affected tooth has an enamel-dentine access extending into the pulp chamber, root and sometimes root apex (Tsurumachi *et al.* 2002). Clinically, a deep foramen coecum and abnormal crown morphology may be the first sign of invaginated teeth.

The invagination creates a potential passage for microorganisms and irritants to the pulp and may cause inflammation and necrosis (Hamasha & Alomari 2004). Abscess formation (Ikeda *et al.* 1995, Sauveur *et al.* 1997, Brkić *et al.* 2003, Jung 2004), internal resorption (Shapiro 1970, Hülsmann & Radlanski 1994), tooth displacement (Schaefer 1955, Petz 1956), retention of neighbouring teeth (Schaefer 1955, Petz 1956, Conklin 1975) and cysts (Augsburger & Brandebura 1978, Burton *et al.* 1980, Galindo-Moreno *et al.* 2003) are other problems associated with dens invaginatus.

An invaginated tooth may present problems in clinical management. The complex anatomy of dens invaginatus makes the normal treatment modality of such teeth difficult and unpredictable; thus several treatment modalities have been described for the different types of dens invaginatus which range from conservative restorative procedures to nonsurgical root canal therapy, surgery or extraction (Oehlers 1957, Grossman 1974, Beynon 1982, Rotstein *et al.* 1987, Hülsmann & Radlanski 1994, de Sousa & Bramante 1998, Tsurumachi *et al.* 2002, Tsurumachi 2004). Prior to apical problems, an early diagnosis of dens invaginatus is important for the success of treatment modality because our treated patients with conservative restorative procedures remained asymptomatic.

The prevalence of dens invaginatus ranges from 0.04% to 10% in different studies (Hovland & Block 1977, Ruprecth *et al.* 1987). Ruprecth *et al.* (1986) found 1.7% of the examined patients to have dens invaginatus; 10% of the examined Saudi patients were found to have this anomaly. In another study, Thomas (1974) reported the prevalence of dens invaginatus to be 7.74% of the examined patients.

During tooth development, ectomesenchymal signalling systems have specific roles in the regulation of growth and the folding of the enamel organ (Kettunen *et al.* 2000). Dens invaginatus were determined in various syndromes and some of them such as Williams, Nance-Horan and Ekman-Westborg-Julin syndrome were based on genetic disorders (Mann *et al.* 1990, Pokala & Acs 1994, Oncag *et al.* 1995, Nakagawa *et al.* 1997, Suprabha 2005, Hibbert 2005). Pokala & Acs (1994) reported that an individual lacking of chromosome7q32 had dens invaginatus in addition to other dental abnormalities such as hypodontia.

Invaginated teeth have been generally presented as case reports in the literature and there are limited studies reporting the prevalence of dens invaginatus and problems encountered according to the types of this malformation. Therefore, the purpose of this retrospective study is to assess the prevalence of dens invaginatus in anterior teeth of a selected population, to classify the type of dens invaginatus present, associated dental complications and other associations in the western mediterranean region of Turkey.

Materials and methods

The dental records including radiographs of patients examined in the Department of Paedodontics, Faculty of Dentistry, Süleyman Demirel University, Isparta, Turkey between 1999 and 2006 were analysed retrospectively. Initially, a random sample of 2900 dental records including both panoramic and periapical radiographs taken for any reason were selected. Panoramic and periapical radiographs were routinely taken for patients who presented with dens invaginatus clinically, in order to screen for pathosis associated with anomalous teeth. All of the oro-dental, medical (syndromes and systemic diseases) and demographic characteristics of the patients were obtained in a standardized manner from clinical records.

The patients with incomplete records, panoramic radiographs of poor quality (distorted, elongated,

over-underexposed radiographs), those with superimpositions of the cervical vertebral column and periapical radiographs of poor quality (distorted, elongated, over-underexposed radiographs) and insufficient number for the maxillary and mandibular anterior teeth (less than six) were excluded.

A final sample of 2477 patients was selected. The ages of the patients ranged between 9 and 16 years with a mean age of 11.1 years (SD = 2.1373). Gender, presence of syndromes and systemic diseases were noted. Variations in the crown shape and other dental anomalies were also recorded by radiographs and dental records containing photographs showing the abnormal crown shapes of teeth with dens invaginatus. The relationship between dens invaginatus and gender was investigated.

Maxillary and mandibular anterior teeth were evaluated on periapical and panoramic radiographs to determine the type of dens invaginatus using Oehlers' classification (Oehlers 1957). Six periapical radiographs were evaluated per patient (one periapical radiograph for each of the maxillary and the mandibular incisor teeth and one periapical radiograph for each of the maxillary and mandibular canine teeth). Radiographic examples of the types of dens invaginatus are given in Fig. 1.

Irregular widening of the periodontal ligament space and the presence of periapical pathosis in the invaginated teeth were assessed using the 'Periapical Index' (Ørstavik *et al.* 1986) on the radiographs taken at the time of referral to the clinic.

The calibration of both examiners took place during a period of 1 week by reading 60 radiographs containing different types of dens invaginatus in the initial phase of the study. First, the examiners worked together and evaluated 30 radiographs containing different types of dens invaginatus according to the Oehlers' classification (Oehlers 1957). An agreement concerning the types of dens invaginatus was provided in accordance with the suggestions of the more experienced investigator. Afterwards, the evaluation of another 30 radiographs containing different types of dens invaginatus was done independently by each investigator. When compared, it was seen that there was no difference between the results obtained by the independent evaluations of the two investigators leading to a full concordance of 100%.

All radiographs were reviewed in a dark room by means of an X-ray viewer (Illuminator 5000; RP Beard Ltd, London, UK) and were evaluated by two examiners independently. Initially, the assessment of the radiographs was done by each examiner seperately, then a final evaluation was done together and a collective decision was made to determine the type of dens invaginatus and whether the tooth had dens invaginatus or not.

Statistical evaluation of the presence of dens invaginatus related to gender was carried out with the the chi-squared test.

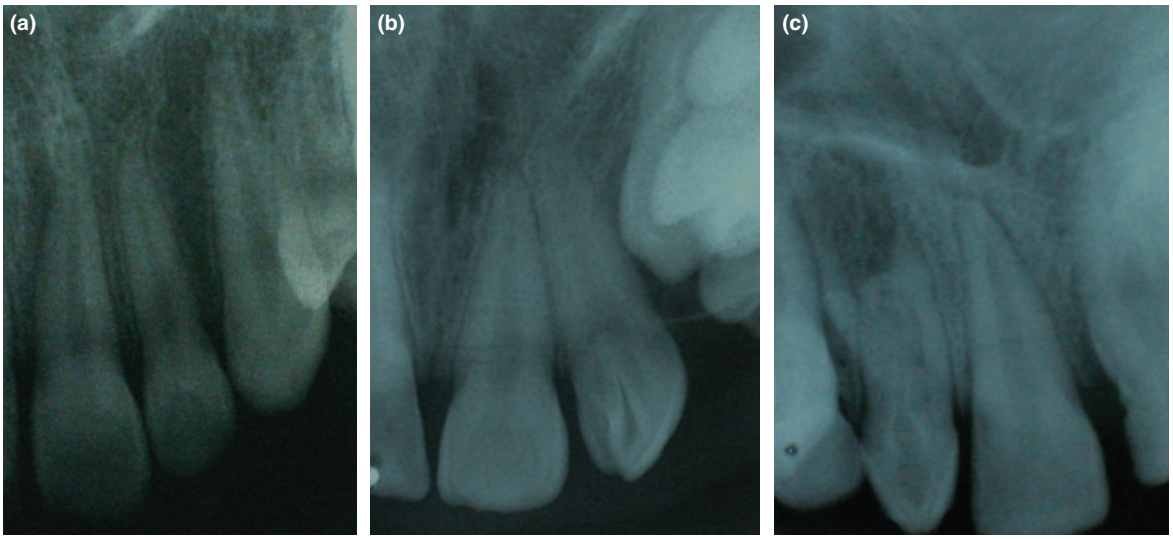

Figure 1 Examples of teeth with different types of dens invaginatus according to the classification of Oehlers; type I (a), type II (b), type III (c). Fig. 1a type I dens invaginatus, Fig. 1b type II dens invaginatus and Fig. 1c type III dens invaginatus.

Results

Dens invaginatus was detected in 300 out of 2477 patients, with a prevalence of 12%. Of the patients screened, 1077 (44%) were female and 1400 (57%) were male; 131 (12%) females and 169 (12%) males had dens invaginatus. The presence of dens invaginatus associated with gender.

The number of affected teeth for each patient is presented in Table 1. Dens invaginatus was detected on two teeth in 132 patients while six teeth were affected by this malformation in seven patients. Eighty two per cent of affected patients had dens invaginatus bilaterally (224 patients with bilateral maxillary lateral incisors, 131 patients with bilateral maxillary central incisors and nine patients with bilateral maxillary canines). Invaginated maxillary lateral incisors, central incisors and canines were observed in 90%, 50% and 4% of the affected patients, respectively. No dens invaginatus was detected in the mandibular teeth (Table 2). The majority of the teeth with this malformation had normal crown morphology (95%); the 5% with abnormal crown morphology had talon cusp (24 teeth), barrel shaped (nine teeth), peg shaped (four teeth), conical (one tooth) and a greater labio-lingual diameter (one tooth).

The distribution of the type of dens invaginatus can be seen in Table 3. The most commonly seen type of dens invaginatus was type I (94%) followed by type II (3%) while 3% of patients had type III dens invaginatus. Type II-III dens invaginatus were mostly seen unilaterally (five patients with bilateral type II dens invaginatus, 13 patients with unilateral type II dens invaginatus, three patients with bilateral type III dens invaginatus and 18 patients with unilateral type III dens invaginatus).

Table 1 The number of affected teeth in patients with dens invaginatus

No. of affected teeth	No. of affected patients *n* = 300 (%)
1	49 (16.3)
2	132 (44)
3	8 (2.7)
4	104 (34.7)
6	7 (2.3)

Table 2 Distribution of dens invaginatus according to location

Tooth	No. of affected teeth	
Maxillary	Right	Left
Lateral incisor	256 (32.2%)	238 (29.9%)
Central incisor	138 (17.3%)	143 (18%)
Canine	10 (1.3%)	10 (1.3%)

No dens invaginatus was detected in the mandibular teeth.

Table 3 Distribution of the type of dens invaginatus

Type	No. of patients *n* = 300	No. of teeth *n* = 795 (%)
I	281	746 (93.84)
II	18	25 (3.14)
III	21	24 (3.02)

Table 4 The number of teeth with and without periapical pathosis according to the type of dens invaginatus

Type of dens invaginatus	Teeth with periapical pathosis	Teeth without periapical pathosis	Total
I	–	746	746
II	1	24	25
III	8	16	24
Total	9	786	795

According to the dens invaginatus type, the number of teeth with and without periapical pathosis is presented in Table 4. There were no periapical lesion in teeth with type I whereas 4% of the patients with type II dens invaginatus and 33% of the patients with type III dens invaginatus had apical periodontitis at the time of referral. A radiographic example of a tooth with dens invaginatus with a periapical lesion is given in Fig. 2.

Other dental abnormalities, syndromes and systemic diseases, which were seen on the patients with dens invaginatus are exhibited in Table 5. Dens invaginatus was mostly encountered with hypodontia and dens evaginatus. No associations with other systemic diseases and syndromes were detected.

Discussion

In this retrospective study, the clinical characteristics of dens invaginatus were determined using clinical records and radiographs. As all the patients did not have complete periapical radiographs for the maxillary and mandibular posterior teeth and the panoramic radiographs did not give a clear picture of the posterior teeth with dens invaginatus, only maxillary and mandibular anterior teeth were evaluated. Therefore, the results of this study do not represent a complete assessment of the mouth.

Figure 2 Example of type II dens invaginatus with periapical lesion.

The prevalence of dens invaginatus varies between 0.04–10% depending on the different diagnostic criteria, the classification system and the methods used (Hovland & Block 1977, Hülsmann 1997, Hamasha & Alomari 2004). In the present study, dens invaginatus of the anterior teeth was detected in 300 out of 2477 patients with a prevalence of 12%. Atkinson (1943) assessed 500 lateral incisors, Boyne (1952) assessed 1000 maxillary incisors, Grahnen *et al.* (1959) assessed 3020 right maxillary incisors, Fujiki *et al.* (1974) assessed 2126 lateral maxillary incisors and Gotoh *et al.* (1979) assessed 766 maxillary lateral incisors and the prevalence of dens invaginatus was found 10%, 0.3%, 2.7%, 4.2% and 9.66%, respectively. Maxillary and mandibular incisor and canine teeth were examined in this study and a possible explanation for the high frequency of dens invaginatus found might be due to regional, communal and genetic factors.

The symmetric dens invaginatus malformation was first described by Swanson & McCarthy (1947) and according to Grahnen *et al.* (1959), the bilateral occurrence of dens invaginatus is not unusual and occurs in 43% of all cases. It has been indicated that the bilateral dens invaginatus may be related with other dental abnormalities such as taurodontism, microdontia, gemination and dentinogenesis imperfecta (Ireland *et al.* 1987, Tavano *et al.* 1994). In the present current study, 82% of the affected patients had dens invaginatus bilaterally and there were also adjacent teeth affected by the dens invaginatus in some of these patients. Furthermore, no relation between the bilateral occurrence and any dental abnormalities was found.

The dens invaginatus is seen mainly on the maxillary lateral incisors followed by the central incisors and the canines. The occurrence of this abnormality in the mandibular arch is rare (Thomas 1974, McNamara *et al.* 1998). The results of this study are comparable with the previous reports (Grahnen *et al.* 1959, Bimstein & Shteyer 1976, Tarján & Rózsa 1999), as the

Table 5 The number of patients with other dental abnormalities, syndromes and systemic diseases

Dental abnormalities	No. of patient	Syndromes	No. of patient	Systemic diseases	No. of patient
Hypodontia	28[a]	Ectodermal dysplasia	1	Mental retardation	4
Dens evaginatus	19[a]	Papillon-Lefevre syndrome	1	Thalassemia	3
Supernumerary teeth	8	Williams syndrome	1	Leukaemia (ALL)	1
Gemination-fusion	6	Fragile-x syndrome	1	Epilepsy	2
Ectopic eruption	3	Amelogenesis imperfecta	1	Insufficiency of Zn	1
Taurodontism	1	Nanofagositic syndrome	1	Glycogen storage disease	1
Enamel-dentine aplasia	1			Asthma	5
Developmental defects of teeth	12				
Structural abnormalities of root	16				

[a]Dens invaginatus was mostly encountered with hypodontia and dens evaginatus.

most frequently affected anterior teeth were the maxillary lateral incisors (62%) followed by the maxillary central incisors (35%) and the maxillary canines (3%). Dens invaginatus was not found in the mandibular incisors and the canines. Therefore, the maxillary anterior teeth, particularly the lateral incisors with a deep foramen should be examined carefully for the presence of dens invaginatus even in the absence of any clinical symptoms. Because of the frequent bilateral occurrence of this malformation, the symmetrical teeth must also be included in the clinical examination.

Dens invaginatus may occur in the coronal part of the tooth or occasionally within the root (Beynon 1982). Since the invagination usually occurs in the coronal part of the tooth and occasionally within the root, the proportions of affected patients for type I, type II and type III were estimated to be 94%, 3% and 3%, respectively. Thirty three per cent of the patients with type III dens invaginatus and 4% of the patients with type II dens invaginatus had periapical pathosis at the time of referral. The periapical lesion was determined mainly in the teeth with type III dens invaginatus. One patient with type II dens invaginatus had apical periodontitis. Several reports on histological, microscopic, ultrastructural and microradiographic investigations of teeth with dens invaginatus confirmed the macroscopic variety of this malformation (Beynon 1982, Hülsmann 1997, Ridell *et al.* 2001). Oehlers' system is based on a two dimensional radiographic image and there are limitations associated with the use of conventional radiography in the classification, true extent and complexity of the invagination. In respect of above data, it was considered that a tooth that appeared to be type II dens invaginatus radiographically might have been type III dens invaginatus histologically.

The treatments of teeth with dens invaginatus were completed at the time of data gathering and eight teeth (seven teeth with type III dens invaginatus and one tooth with type II dens invaginatus) with periapical lesion received with nonsurgical root canal therapy and one tooth (type III dens invaginatus) with a periapical lesion had been extracted because of the failure in the root canal treatment; others had been treated with conservative restorative procedures.

The patients with dens invaginatus had various dental abnormalities and were encountered mostly with hypodontia and dens evaginatus. The combination of these abnormalities in the same patient indicates common factors in the aetiology (O'Sullivan 2000). It has been proposed that the dental abnormalities such as dens invaginatus, dens evaginatus, fusion, gemination and agenesis occurred because of the degeneration or hyperactivity of dental lamina is more frequently seen in the anterior region (Rantanen 1971, Ireland *et al.* 1987, Tavano *et al.* 1994, Hülsmann & Hengen 1996, Jiménez-Rubio *et al.* 1997). The multiple dental abnormalities were detected in patients who had the chromosomal abnormalities (Gorlin *et al.* 1990).

Conclusion

Dens invaginatus is a relatively rare malformation. Type I is the most common and it has limited impact on dental disease. A carefull oral examination, radiographs, a suitable treatment plan and follow-up programme are crucial for early diagnosis and treatment for teeth with dens invaginatus.

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