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Geographical prevalence of dens invaginatus in the upper lateral teeth of young adult Turkish men

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ABSTRACT

Aims: Dens invaginatus, a malformation of teeth caused by infolding of the dental papilla during development or invagination of layers of the enamel organ in dental papillae. Its aetiology is unclear. The present study was conducted to investigate the characteristics of the patients with dens invaginatus anomaly.

Methods: A single-center, cross-sectional, retrospective study was conducted on male subjects aged 18 to 24 years. Dens invaginatus in maxillary lateral incisors were identified using periapical radiographs. The evaluation was performed on patients with and without abnormalities.

Results: A total of 316 records were evaluated and 296 individuals were eligible for the analysis. No abnormality was detected in 210 (70.9%) individuals, whereas 86 individuals (29.1%) had images of dens invaginatus. The abnormalities were bilateral in 59 (19.9%) and unilateral in 27 (9.1%) individuals. Among the 59 individuals with bilateral dens invaginatus, most subjects were from the Marmara region (27.1%). Unilateral dens invaginatus was most frequently detected in the Marmara, Black Sea, and Eastern Anatolia regions.

Conclusions: This study showed that up to one-third of young adult males had images of dens invaginatus on an untargeted screening. The prevalence of dens invaginatus varied across different geographical regions of Turkey.

Introduction

There have been numerous epidemiological studies worldwide to assess the prevalence of different types of dental anomalies. Dental anomalies occur during the embryological and developmental life of the tooth and usually involve a single tooth germ (1,2). Changes in the number, size, shape, structure, and eruption of teeth are associated with dental anomalies (3). While the disorders observed after the teeth complete their normal formation are called “acquired dental anomalies”, the disorders that occur during the formation process of the teeth are defined as “developmental dental anomalies” (3-5). Developmental anomalies are generally linked to genetic factors, mutations, metabolic disorders, and environmental factors including physical, chemical, and biological insults (5).

One of the dental anomalies is dens invaginatus (6). Floquet’s anomaly in a whale tooth was first noticed in 1794 (7). While efforts have been made recently to explain the cause of dens invaginatus, the underlying cause of this malformation is not exactly known (6). It is generally considered that abnormal pressure by the surrounding tissues on the tooth germ, infections occurring during tooth development, insufficient local development of enamel, stimulation of the tooth buds, epithelial developing disorders, as well as hereditary factors may play a role in the formation of dens invaginatus (7). It is commonly accepted that various genetic and environmental factors may play a role in the development of dens invaginatus (6,8,9). The interaction between mesenchymal and epithelial tissue cells during tooth development are also among the proposed mechanisms (10-12).

This interaction is regulated by different signalling proteins such as fibroblast growth factors, morphogenic bone proteins, tumour necrosis factors, Wnts and sonic hedgehog (13,14). Variations in the genes involved in these signalling pathways affect tooth formation and tooth morphogenesis (13,15,16). A 7q32.25 chromosomal deletion was also reported in a patient with dens invaginatus and multiple tooth anomalies. Although it has been suggested that dens invaginatus develops with focal excessive cell proliferation of the inner enamel epithelium and abnormal growth of the dental papilla. Affected teeth show a deep fold of enamel and dentin that begins at the foramen coecum and even the tip of the tubercles and may extend deep into the root. The most commonly affected teeth are the maxillary lateral incisors, and bilateral occurrence is not uncommon (6,17), external forces from the adjacent teeth, trauma and infections may also contribute to the cause of dens invaginatus (6,8).

Family members of the patients with dens invaginatus are also affected (18) and these lesions are associated with other genetically inherited anomalies, suggesting the heritability of the anomaly (19-21). Given the potential role of the hereditary factors that play an important role in gingiva development, a higher prevalence was observed in people with Down syndrome (22). The lowest prevalence is known to exist in Caucasians (23). Further supporting such associations, an individual lacking chromosome 7q32 was reported to present with dens invaginatus in addition to other dental anomalies such as hypodontia (24).

Dens invaginatus has been reported at a frequency of 0.04% to 10% in the general population. The variations in the prevalence may be associated with the geographical differences, unstandardized diagnostic criteria, and the methods of investigation (25). It occurs mostly in the maxillary lateral sections (42.2%), followed by the maxillary central incisors, canines, premolars, and molars (6,26). Any tooth in the maxillary and mandibular arch may be affected by dens invaginatus, but the maxillary lateral incisors are most affected (6).

Most reports of dens invaginatus are case based in the literature. Only a few studies have assessed the prevalence of dens invaginatus (27,28). Moreover, dens invaginatus malformations are usually detected accidentally on radiographs ordered for other causes (29). It is generally not discovered unless the clinical signs appear, such as an acute dentoalveolar or sinus tract abscess. Currently, the general characteristics of subjects remain weakly described among Turkish young adults.

The aim of this study was to investigate the prevalence and geographical differences of dens invaginatus among subjects admitted to a tertiary outpatient clinic.

Methods

A cross-sectional retrospective, single-centre study was conducted using the radiographs and patient files. The study

included 316 subjects initially, and the final analysis included 296 patients between the ages of 18 and 24 years admitted to the Gulhane Military Hospital outpatient dental clinic from January through September 2010. The sample size was calculated as a minimum of 191 individuals at medium effect level (0.03), 80% power and 0.05 significance level. The study protocol was approved by the Institutional Review Board (50687469-1491-144-16\1648-453).

Subjects with incomplete records or low-quality radiographs were excluded. Individuals with carious, restored, and fractured teeth, function apical foramen formation, undetectable furcation, and fused roots were also excluded. The presence of dens invaginatus in the maxillary lateral teeth was investigated on periapical radiographs. Radiographs were examined independently by two experienced dentists in a dark room, using an X-ray viewer. Each radiograph exhibiting dens invaginatus was re-examined carefully by both examiners, and a decision was made by consensus.

For each patient with dens invaginatus, demographic variables including age, sex, birth of place within the seven geographical regions of Turkey were retrieved from the medical records.

Statistical Analysis

Descriptive statistics were used to display the prevalence (proportion of subjects) of dens invaginatus in the overall sample and subanalyses.

Results

Of the 296 individuals studied, no abnormalities were detected in 210 (70.9%) individuals, dens invaginatus was found in 86 individuals (29.1%). These included bilateral abnormalities in 59 (19.9%) individuals and unilateral abnormalities in 27 (9.2%) individuals (Table 1).

When the geographical origin of individuals without dens invaginatus were evaluated, most (21.9%) originated from Eastern Anatolia, while the lowest occurrence was 4.3% in the Aegean region (Table 1). Among the 59 individuals with bilateral dens invaginatus, most subjects were from the Marmara region (27.1%), while central Anatolia (8.5%), the Mediterranean region (8.5%), and South-Eastern Anatolia (8.5%) had the lowest frequency of bilateral dens invaginatus (8.5%; Table 1). Unilateral dens invaginatus was most frequently detected in the Marmara (18.5%), Black Sea (18.5%), and Eastern Anatolia (18.5%) regions. The lowest unilateral prevalence was in the South-Eastern Anatolia region, with a ratio of 3.7% (Table 1).

Taken together, dens invaginatus occurred most frequently in the Marmara region, and least prevalence was in South-Eastern Anatolia (Table 1).

Table 1. Prevalence of dens invaginatus anomaly in maxillary lateral teeth according to different regions of Turkey

Region		In upper lateral teeth dens invaginatus			Total
		Without DI	Bilateral DI	Unilateral DI	
Marmara	N	38	16	5	59
	% within teeth	18.1	27.1	18.5	19.9
Black Sea	N	35	9	5	49
	% within teeth	16.7	15.3	18.5	16.6
Central Anatolia	N	33	5	3	41
	% within teeth	15.7	8.5	11.1	13.9
Aegean	N	9	9	4	22
	% within teeth	4.3	15.3	14.8	7.4
Mediterranean	N	24	5	4	33
	% within teeth	11.4	8.5	14.8	11.1
Eastern Anatolia	N	46	10	5	61
	% within teeth	21.9	16.9	18.5	20.6
South-Eastern Anatolia	N	25	5	1	31
	% within teeth	11.9	8.5	3.7	10.5
Total	N	210	59	27	296
	% within teeth	70.9	19.9	9.2	100.0

DI: Dens invaginatus

Discussion

The cause of dens invaginatus is uncertain, however, it appears that both genetic and environmental factors play a role. Although the findings from previous studies that examined the influence of genetic factors have suggested that primitive races had fewer anomalies than "civilized" humans, and higher prevalence of dens invaginatus was observed in ancient Chinese teeth 2000 years ago than in modern humans (30). Researchers have also identified that dental anomalies varies by race, with a higher prevalence in Mongoloid people, lower prevalence in Negroid people, and a very low frequency in Caucasians (30).

Oehlers has suggested that it dens invaginatus is the result of external forces exerting an effect on the tooth germ during development (23). Such forces could originate from the adjacent tooth infections, for example, the central incisor or canine, which develop at least 6 months before the lateral incisor (31). Other external factors, such as trauma and infection, have also been suggested as potential causes (6,32).

Very few studies have addressed the prevalence of dens invaginatus in different populations, most of which have been case reports. Overall, the prevalence of dens invaginatus varies across different populations. An earlier study has reported worldwide prevalence of dens invaginatus as 7.74% ranging from 0.04% to 10% (33). Cakici et al. (29) and Kirzioğlu and Ceyhan (34) reported a 1.3% and 12% prevalence of dens invaginatus, respectively, among Turkish dental patients. Hamasha and Alomari (27) reported the prevalence of dens invaginatus 0.65% per individual and 43.2% for all teeth among

Jordanian individuals. In our study we observed dens in 29.1% of the participants in the maxillary lateral incisors of 296 Turkish men. The teeth in both the maxillary and mandibular arches may be affected by dens invaginatus, but the permanent maxillary lateral incisors are the most involved teeth (35,36). In the study by Cakici et al. (29) dens invaginatus was observed in 13 (1.3%) of 1012 teeth on anterior teeth and in 16 of 2011 (0.8%) maxillary lateral incisors. Additionally, in the study by Boyne (37), the prevalence of teeth with dens invaginatus was 0.3% in 1000 maxillary lateral incisors (38).

When only the anterior teeth are considered, the prevalence of dens invaginatus has been reported by 0.02% (39). This number was considerably lower than the findings by Cakici et al. (29) (0.8%) and by Kirzioğlu and Ceyhan (34) (0.8%) among the Turkish population. The rate of dental invaginatus of anterior teeth among Iranian subjects was also found higher by 5.8% in a study by Poyton and Morgan (40), whereas much lower prevalence of 0.25% was reported by other authors in the same population (41). These variations in the prevalence of dens invaginatus in different populations may be due to ethnic variations but may also be influenced by differences in the criteria used for interpretation of dens invaginatus, as well as the specific teeth examined, and geographical differences (25,38,42). According to previous studies conducted in the Turkish population, dens invaginatus occurs equally in men and women (29,33).

In the literature, there are numerous studies indicating that the dens invaginatus abnormality is generally observed under

a bilateral condition (26). The appearance of symmetric dens invaginatus was considered as a common finding by some authors. However, it has also been reported that bilateral dens invaginatus may be related to other dental anomalies, such as germination, gemination, fusion, and taurodontism (43). Colak et al. (39) found that bilateral dens invaginatus occurred in 25% (3 of 15) of cases, and Çakıcı et al. (29) observed that it was 23.1% among the Turkish population and 24.5% among the Jordanian population (27). In the current study, dens invaginatus was observed bilaterally in 59 of 296 individuals (19.9%). The variation may be explained by marked differences in the sample size, case selection, and the methods used. Thus, further investigations are necessary to clarify this issue.

Our results have shown that there are regional and ethno-racial variations in the prevalence of dens invaginatus anomalies. The highest prevalence among the 59 affected individuals was detected in the Marmara region (27.1%). Central Anatolia, the Mediterranean region, and South-Eastern Anatolia showed a lower frequency of bilateral prevalence (8.5%). When we examined the rate of unilateral dens invaginatus, a higher rate was observed in the Marmara region (18.5%), Black Sea (18.5%), and Eastern Anatolia (18.5%), when compared with the other regions. The lowest rate in unilateral dens invaginatus rate was in the South-Eastern Anatolia (3.7%) region, like the prevalence of bilateral dens invaginatus. Marmara region is a developed and densely populated region of Turkey. On the other hand, the potential causes of higher rates of dens invaginatus in this region need to be investigated.

This study was limited by its retrospective design, single center design, small sample size, and poor generalizability of results to a larger population.

Conclusion

This study showed that up to one-third of young adult males had images of dens invaginatus on an untargeted screening. The prevalence of dens invaginatus varied across different geographical regions of Turkey. On the other hand, due to the relatively small sample size of this study, the prevalence of dens invaginatus should be considered with caution, as they may not be representative of the overall Turkish population. Further large-scale multicentre studies are therefore required to assess its prevalence in the general population.

Ethics

Ethics Committee Approval: The study protocol was reviewed and approved by the Academy Research Ethics Committee (50687469-1491-144-16\1648-453).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: E.A.O., A.A., Design: E.A.O., Data Collection or Processing: S.K., N.A., A.A., B.E., Analysis or Interpretation: N.A., Literature Search: E.A.O., A.A., Writing: E.A.O., S.K., N.A., B.E.

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