Investigation of Dens Invaginatus in a Turkish Subpopulation Using Cone-Beam Computed Tomography

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Abstract

Objective: The aim of this study was to determine the prevalence and distribution of the Dens Invaginatus (DI) using Cone-Beam Computed Tomography (CBCT) in a Turkish subpopulation.

Materials and methods: CBCT images of 2067 patients (1093 males and 974 females; mean age, 34.2 ± 7.4 years; age range, 18-74 years) were retrospectively examined for the presence of DI. The laterality and type of DI, and tooth type were determined using the CBCT images of the patients. Pearson's chi-square test was used for statistical comparisons.

Results: DI was observed in 122 out of 2067 subjects with a frequency of 5.90%, with no gender difference (p=0.224). A hundred one out of the 122 patients with DI had only one tooth affected by DI, while 19 patients had two teeth affected by DI and one patient had three teeth affected by DI. Nineteen out of the 122 patients (15.6%) with DI had bilateral DI, while the remaining patients (84.4%) had unilateral DI. Maxillary lateral incisors were the most affected teeth (86 out of 3067; 2.80%) and followed by maxillary central incisor and canine. The most commonly observed type of DI was found to be type I (86.6%; 123 out of 142), followed by type II (9.2%; 13 out of 142) and type III (4.2%; 6 out of 142).

Conclusion: DI was found to be in 5.90% of the examined subpopulation with no gender difference. It was the first study using CBCT for the investigation of DI prevalence and distribution.

Key Words: Dens invaginatus, Prevalence, Cone-beam computed tomography

Introduction

Dens invaginatus (DI) is a tooth malformation which most likely results from infolding of the dental papilla during tooth development or invagination of all layer of the enamel organ in dental papillae [1]. Affected teeth show a deep invagination of enamel and dentine starting from the foramen caecum or even the tip of the cusps and which may extend deep into the root. Other names are telescopic tooth, dilated gestant odontome, dilated composite odontome, tooth inclusion, and dens in dente [2].

DI is most frequently found in maxillary lateral incisors, where so many other developmental dental anomalies occur, but can also be found in maxillary central incisors, in mandibular incisors and in other teeth. This dental anomaly has a frequency of 0.04% to 10% in the general population [3]. Oehlers [4] classified this anomaly according to severity and characteristics: Type I, an enamel invagination in the crown only; type II, an enamel-lined form that invades the root as a blind sac and may communicate with the pulp; and type III, invagination penetrates through the root and forms a second foramen in the apex or along the root, in the periodontal tissues.

Radiographic evaluation is the most reliable method to diagnose such anomalies. However, it is difficult to assess completely the exact anatomical structure of invaginated teeth from conventional radiographs. Cone Beam Computed Tomography (CBCT) is a routine part of dental practice. This new three-dimensional imaging technique has been specially designed for imaging the dento-maxillo-facial structures. Images are obtained using significantly lower radiation doses compared to conventional computed tomography.

No study investigating the prevalence and distribution of DI using CBCT has been published and thus the present retrospective study was performed to investigate the prevalence and distribution of this anomaly in a Turkish subpopulation using CBCT.

Materials and Methods

The CBCT images used in this retrospective study were collected at the Department of Oral and Maxillofacial Radiology at Erciyes University in Kayseri, Turkey. CBCT scans of the patients included in this study were part of the diagnostic records collected for dental implants, orthodontics, maxillofacial surgery, oral pathology, orthognatic surgery; the patients were not exposed to any additional radiation for the present study. All patients had signed an informed consent form allowing using their data for scientific purposes.

According to the inclusion (CBCT showing both mandibular and maxillary teeth with good quality, no large pathologic lesions and no bone fractures) and exclusion (patients aged less than 12 years and inadequate picture quality due to artifacts caused by metallic implants or osteosynthesis plates, low resolution and patient movement during imaging) criteria, 193 images (mostly due to the age criteria) were excluded and finally the study included 2067 adult patients' (1093 males and 974 females; mean age: 34.2 ± 7.4 years; age range: 12 to 74 years) CBCT images.

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The CBCT images were obtained in a standard supine position on the same device (NewTom 5G; QR, Verona, Italy), and the CBCT images were analyzed using the inbuilt software (NNT) in a Dell Precision T5400 workstation (Dell, Round Rock, TX, USA), with a 32-inch Dell LCD screen with a resolution of 1280 x 1024 pixels in a darkroom. The contrast and brightness of the images were adjusted using the image processing tool in the software to ensure optimal visualization. Selecting and moving the cursor on a CBCT image to change the center of view altered the reconstructed slices in two orthogonal planes. Tomography sections of 0.25 mm in the coronal, and sagittal planes were created. Coronal and sagittal cross-sectional images were transmitted to a personal computer in the digital imaging and communications in medicine (DICOM) format and reconstructed into multiplanar images using the DICOM viewer: NNT Viewer (QR Srl–Via Silvestrini, Verona, Italy). CBCT images were viewed on a computer screen and reformatted into multiplanar reconstructions to obtain the most appropriate sections for assessments. All DI types were recorded using CBCT (Figure 1). CBCT images were examined for the presence of DI by an experienced maxillofacial radiologist (A.E.S.) in order to reduce the inter-examiner errors.

Statistical analyses

Two authors (A.E.S. and S.K.B.) separately reassessed approximately 10% of the data (200 images) four weeks after the first examination. The intra- and inter-observer agreements were 100% between the two examinations for the presence of DI, indicating the diagnostic reproducibility.

Pearson's chi-square test was used to compare the potential difference of DI between genders. Statistical analysis was performed using SPSS 16.0 for Windows (SPSS, Chicago, IL). The level of significance for all tests was set at $P < 0.05$.

Results

A total of 2067 adult patients (1093 males and 974 females; mean age: 34.2 ± 7.4 years) and their 49198 teeth (24319 maxillary and 24879 mandibular) were examined for the presence of DI. CBCT images showed that 5.90% of the subjects (122 out of 2067) included to the study had at least one DI. It was detected in 5.31% of the males (58 out of 1093) and 6.57% of the females (64 out of 974), with no statistically significant gender difference (P=0.224) (*Table 1*).

101 out of the 122 patients with DI had only one tooth affected by DI, while 19 patients (18 had bilateral DI) had two teeth affected by DI and one patient (bilateral occurance of DI) had three teeth affected by DI. Maxillary central incisors (1.70%; 54 out of 3177), lateral incisors (2.80%; 86 out of 3067) and canine (0.06%; 2 out of 3127) were found to be affected by DI, while none of the other teeth in the maxilla and in the mandible were affected. The most commonly observed type of DI was found to be type I (86.6%; 123 out of 142), followed by type II (9.2%; 13 out of 142) and type III (4.2%; 6 out of 142) (*Table 2*).

Discussion

There have been no studies published investigating the

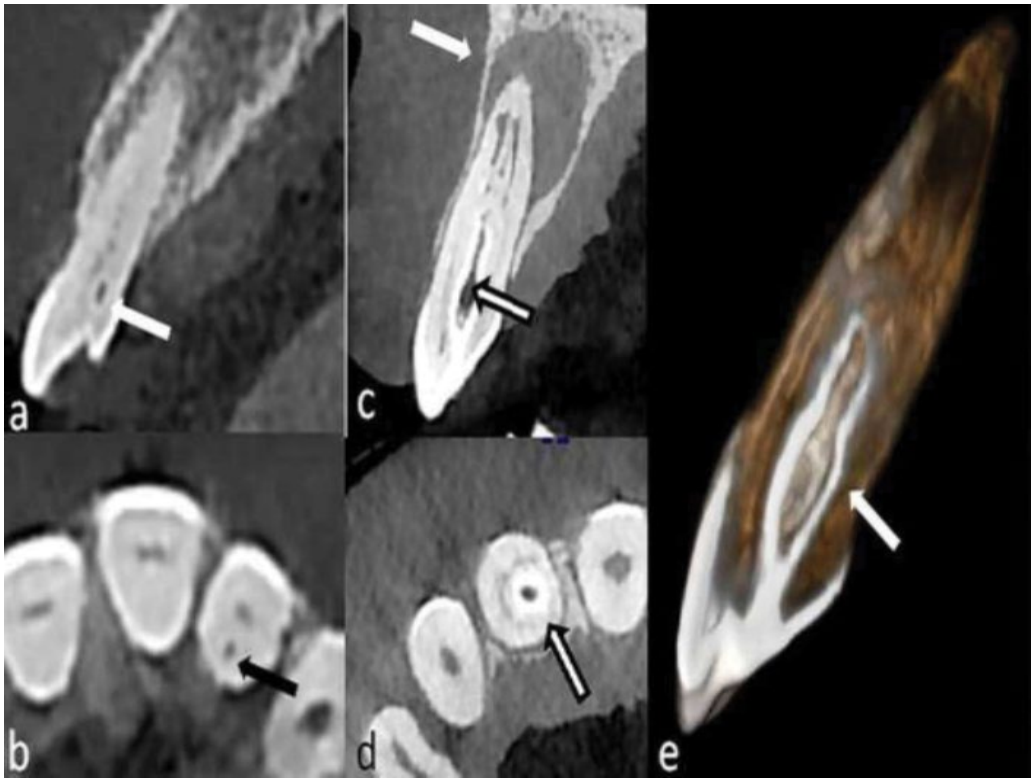

Figure 1. *Maxillary left lateral incisor affected by Type II dens invaginatus (a,b) (arrow). Maxillary right canine with periapical lesion affected by Type III dens invaginatus (c,d) and three dimensional view (e) of same tooth (arrow).*

Table 1. *The distribution of the subjects with dens invaginatus.*

	Female (%)	Male (%)	N (%)	P value
Subjects with DI	64 (6.57)	58 (5.31)	122 (5.90)	0.224
Subjects without DI	910 (93.43)	1035 (94.69)	1945 (94.10)	
Total	974 (100)	1093 (100)	2067 (100)	

DI: Dens Invaginatus; P: Results of Pearson's chi square test comparing the gender distribution.

Table 2. *The distribution of the teeth with dens invaginatus.*

			Number of teeth examined	Number of teeth with dens invaginatus	Prevalence (%)
Tooth Type	Maxillary	Central incisor	3177	54	1.70
		Lateral incisors	3067	86	2.80
		Canine	3127	2	0.06
		First premolar	3104	0	0.00
		Second premolar	3098	0	0.00
		First molar	3029	0	0.00
		Second molar	2983	0	0.00
		Third molar	2734	0	0.00
		Subtotal	24319	142	0.58
	Mandibular	Central incisor	3121	0	0.00
		Lateral incisors	3387	0	0.00
		Canine	3449	0	0.00
		First premolar	3267	0	0.00
		Second premolar	3234	0	0.00
		First molar	2921	0	0.00
		Second molar	2946	0	0.00
		Third molar	2554	0	0.00
		Subtotal	24879	0	0.00
Total			49198	142	0.29
				Number of teeth with dens invaginatus	Prevalence (%)
Type of Dens Invaginatus		Type I		123	86.6
		Type II		13	9.2
		Type III		6	4.2
		Total		142	100

prevalence and distribution of DI using CBCT. The studies [5-7], published in our country, evaluated only anterior teeth and thus not representing the complete assessment of the mouth. The reported prevalence of patients with DI was 1.3-12.0% of the examined patients in Turkey [5-7]. In the present study, it was found to be 5.90%, with no gender difference. Although no statistically significant gender difference was also reported by several authors [5,7,8], the findings of Gunduz et al. [6] showed that females presented statistically higher prevalence of DI.

Kirzioglu and Ceyhan [7] and Gunduz et al. [6] reported that 82% and 67.5% of the cases were bilateral, while this frequency was 23.1% in the study of Cakici et al. [5]. In the present study, 19 out of the 122 patients (15.6%) with DI had bilateral occurance, while the remaining patients (84.4%) had unilateral DI. Since the bilateral occurance of DI was reported to be high in the literature, the clinicians to treat these patients should examine the teeth bilaterally. In addition, bilateral DI was reported to be related with other dental abnormalities such as taurodontism, microdontia, gemination and dentinogenesis imperfecta [9,10]; however, no associated dental anomaly was observed in the present study.

Oehlers' classification was the most commonly used classification method for DI, based on a two-dimensional radiographic image and might underestimate the true extent and anatomy of invagination [11]. Using Oehlers' classification, type I was the most common type of dens invaginatus with a prevalence of 86.6%, followed by type II (9.2%) and type III (4.2%). Type I was the most commonly observed type in previous studies [5-7,11-13], and our finding was very close to the type I prevalence reported by Cakici et al. [5] (81.25%) and Alani and Bishop (79%) [11].

The results indicated that maxillary lateral incisors (86/3067; 2.80%) were the most commonly affected teeth by DI and followed by maxillary central incisors (54/3177; 1.70%) and canine (2 out of 3127; 0.06%). It was comparable with the previous studies [5-8], which reported the maxillary lateral incisors to be mostly affected by DI. Controversy, no DI was observed in the maxillary central incisors by some authors [12] and rarely in the mandibular teeth [5-8,10,12] and the present study found no mandibular tooth affected by DI. According to the findings of Colak et al. [12], which assessed the panoramic films of 6912 adult patients for DI prevalence and distribution, maxillary lateral incisors (80%) were followed by maxillary canine teeth (20%). However, maxillary canine teeth affected by DI were rarely found in the present study (0.06%).

The reported differences even in the same country might be due to the several factors including the differences in the study samples, geographic locations, distribution of genders and chronological ages, and radiographic methods. The previous studies used periapical and panoramic radiographs, while the present study used CBCT data. Although previous case reports [14-17] showed the importance of CBCT in the treatments of invaginated tooth with different types, these images were firstly used to determine the prevalence and distribution of patient and teeth with DI in the present study.

Conclusions

DI was found to be in 5.90% of the examined subpopulation with no gender difference. Maxillary lateral incisors were the most affected teeth and followed by maxillary central incisor. The most commonly observed type of DI was found to be type I (86.6%), followed by type II (9.2%) and type III (4.2%).

References

1. Hulsmann M. Dens invaginatus: aetiology, classification, prevalence, diagnosis, and treatment considerations. *International Endodontic Journal.* 1997; **30**: 79-90.

2. Sedano HO, Ocampo-Acosta F, Naranjo-Corona RI, Torres-Arellano ME. Multiple dens invaginatus, mulberry molar and conical teeth. Case report and genetic considerations. *Medicina Oral, Patología Oral y Cirugía Bucal.* 2009; **14**: 69-72.

3. Hovland EJ, Block RM. Nonrecognition and subsequent endodontic treatment of dens invaginatus. *Journal of Endodontics.* 1977; **3**: 360-362.

4. Oehlers FA. Dens invaginatus (dilated composite odontome). I. Variations of the invagination process and associated anterior crown forms. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology* 1957; **10**: 1204-1218.

5. Cakici F, Celikoglu M, Arslan H, Topcuoglu HS, Erdogan AS. Assessment of the prevalence and characteristics of dens invaginatus in a sample of Turkish Anatolian population. *Medicina Oral, Patología Oral y Cirugía Bucal.* 2010; **15**: 855-888.

6. Gunduz K, Celenk P, Canger EM, Zengin Z, Sumer P. A retrospective study of the prevalence and characteristics of dens invaginatus in a sample of the Turkish population. *Medicina Oral, Patología Oral y Cirugía Bucal.* 2013; **18**: 27-32.

7. Kirzioglu Z, Ceyhan D. The prevalence of anterior teeth with dens invaginatus in the western Mediterranean region of Turkey. *International Endodontic Journal.* 2009; **42**: 727-734.

8. Hamasha AA, Alomari QD. Prevalence of dens invaginatus in Jordanian adults. *International Endodontic Journal.* 2004; **37**: 307-310.

9. Ireland EJ, Black JP, Scures CC. Short roots, taurodontia and multiple dens invaginatus. *The Journal of Pedodontics.* 1987; **11**: 164-175.

10. Tavano SM, de Sousa SM, Bramante CM. Dens invaginatus in first mandibular premolar. *Endodontics & Dental Traumatology.* 1994; **10**: 27-29.

11. Alani A, Bishop K. Dens invaginatus. Part 1: classification, prevalence and aetiology. *International Endodontic Journal*. 2008; **41**: 1123-1136.

12. Colak H, Tan E, Aylikci BU, Uzgur R, Turkal M, Hamidi MM. Radiographic study of the prevalence of dens invaginatus in a sample set of Turkish dental patients. *Journal of Clinical Imaging Science.* 2012; **2**: 34.

13. Ridell K, Mejare I, Matsson L. Dens invaginatus: a retrospective study of prophylactic invagination treatment. *International Journal of Paediatric Dentistry.* 2001; **11**: 92-97.

14. Durack C, Patel S. The use of cone beam computed tomography in the management of dens invaginatus affecting a strategic tooth in a patient affected by hypodontia: a case report. *International Endodontic Journal.* 2011; **44**: 474-483.

15. Kfir A, Telishevsky-Strauss Y, Leitner A, Metzger Z. The diagnosis and conservative treatment of a complex type 3 dens invaginatus using cone beam computed tomography (CBCT) and 3D plastic models. *International Endodontic Journal*. 2013; **46**: 275-288.

16. Patel S. The use of cone beam computed tomography in the conservative management of dens invaginatus: a case report. *International Endodontic Journal*. 2010; **43**: 707-713.

17. Vier-Pelisser FV, Pelisser A, Recuero LC, So MV, Borba MG, Figueiredo JA. Use of cone beam computed tomography in the diagnosis, planning and follow up of a type III dens invaginatus case. *International Endodontic Journal*. 2012; **45**: 198-208.