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Radiological Assessment of Dens Invaginatus (DI) Using Cone Beam Computed Tomography (CBCT) in an Institution at Bengaluru City: A Descriptive Analysis

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ABSTRACT

Introduction: dens invaginatus (DI) is a developmental anomaly that increases the risk of dental caries, early pulpal and periodontal infection of affected teeth. Hence early diagnosis is very important to prevent the complications and loss of tooth structure. Aim of this study were to assess the clinical and cone beam computed tomography (CBCT) features of 18 teeth with DI in an institution at Bengaluru city

Methods: CBCT images were taken from clinical and radiology data base of department of Oral Medicine and Radiology, Vydehi Institute of Dental Sciences and Research Centre. Clinical and radiographic features were analysed in 18 teeth.

Results: Age ranged from 13 to 50 years, with male predominance. The maxillary lateral incisor was the most commonly affected tooth while, most common type of DI was Oehler's type I with periapical cyst and ERR as most common possible complication.

Conclusion: CBCT plays important role in timely diagnosis and thus helps in prompt treatment and prevents loss of tooth structure. CBCT gives 3 dimentional assessment of tooth, making easy for Endodontics easy to proceed with their treatment.

Keywords: Dens invaginatus; Cone beam computed tomography; Dens in Dente; Tooth anomalies.

Introduction

Dens invaginatus (DI) is developmental anomaly characterized by morphological alteration resulting from invagination of enamel organ into dental papilla during the tooth development stage and before calcification of dental tissues occurs. Synonyms include dens in dente, dilated composed odontoma or gestant odontoma. Presence of abnormal anatomical configuration like thin canals or fissures could lead to permeability or communication to oral cavity and provide an easy pathway for pathogens in a tooth affected by DI. It is easily overlooked increasing risk of dental caries, pulpal and periodontal infections[1,2]. Other complications include abscess formation, internal resorption, tooth displacement cyst formations and retention of neighbouring tooth[3]. Hence early diagnosis is very important to prevent the complications and loss of tooth structure.

Various classifications have been proposed based on clinical, radiographic and variety of other criteria by by Hallet (1953), Ulmansky & Hermel 1964, Vincent-Townend 1974 and Schulze & Brand (1972). The classification proposed by Oehler is most widely used because of its simple nomenclature, easy applicability and also provides the extent of tooth involvement. According to this, there are three types of DI type I (Enamel lined invagination confined within the tooth), type II (enamel lined invagination extending into pulp chamber but not communicating with the periodontal ligament.), type IIIA (The invagination communicates laterally with the periodontal ligament space) and type III B (The invagination communicates with the periodontal ligament at the apical foramen)[2].

Radiographically, DI is seen as ribbon like infolding of radiopaque enamel from cingulum into the root canal to varying extent, giving tooth within a tooth appearance[4]. Clinically, tooth may be asymptomatic, but DI detected incidentally in radiograph. Hence imaging plays very important role in diagnosis of DI. A number of factors like radiographic quality and clinician experience influence the diagnosis of DI. Conventional radiograph like IOPA and OPG provides details in two dimension, but complete extent of invagination, pulpal involvement direction of invagination, apical foramen position and associated lesion are difficult to ascertain. In this regard, cone beam computed tomography (CBCT) provides 3 dimensional reconstruction of tooth for morphological analysis of teeth. Various prevalence studies of DI using intraoral periapical (IOPA) radiographs and panoramic radiographs have been conducted[3,5,6,7]. Various case reports on evaluation of DI in CBCT have been published in literature. However, prevalence of DI in CBCT full mouth survey, or studies on 3D analysis of teeth affected by DI are rare. Assessment and complete evaluation of teeth affected by DI is essential to decide the treatment modality. Objectives of this study were to assess the clinical and CBCT features of 18 teeth with DI in patients who visited our institution.

Material and Method

The study consisted of CBCT images of 11 patients showing 18 teeth affected with DI. Study was approved by institutional review board and consent regarding

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utilizing of these images for research purposes were obtained from the participants. Hence CBCT images of 18 teeth from clinical and radiology data base of department of Oral Medicine and Radiology, Vydehi Institute of Dental Sciences and Research centre were analysed. Reasons for CBCT referral and clinical findings for all the subjects were recorded and respective CBCT scans were analysed from the period of January 2018 to December 2020. CBCT images were taken in Kodak Carestream CS9300 (Carestream Health, Rochester, NY, USA.) with 90 kV at a time of 12- 20 seconds.

Clinical findings: Retrospective clinical data of all 11 patients were analysed for age, sex, morphology of crown, symptoms associated and reason for CBCT referral were recorded.

Radiological findings: CBCT images were analysed for number of teeth involved, type of teeth involved, type of DI (based on Oehlers' Classification), morphological features of teeth (length and width of crown/root) and associated periapical lesion. All the images were analysed by two maxillofacial Radiologist separately. Any disagreement between the two researches were reanalysed and discussed and final decision was made after both researches had complete agreement. Data was analysed in axial, coronal, sagittal images and reformatted panoramic were constructed for morphological analysis of crown.

Results

Clinical findings: Study participants age range from 13 to 50 years of age. Majority of the patients 14 (78%) are in their adulthood, 3(17%) were minor, 1(5%) elderly. 16 (89%) of the participants were male, while 2 (11%) were only females (Table 1). Based on the reason for referral, 16 (89%) patients sought endodontic treatment (Table 2). Morphology of the crown was similar to the normal teeth in 10 (56%) of teeth; where as normal morphology of crown with deep lingual pit were observed in 7(39%) of teeth examined. Only one tooth (5%) showed macrodontia. This macrodontic tooth had type III DI. (Table 3).

Table 1. Distribution of study participants based on gender.

Gender	N(%)
Male	16(89)
Female	2(11)

Table 2. Distribution of study participants based on referral reason.

Reasons for referral	N(%)
Endodontic	16(89)
Orthodontic	2(11)

Table 3. Distribution of study participants based on clinical and radiological features.

Clinical feature	N(%)	Radiological feature	N(%)	Clinical and radiological feature	N(%)
Normal	10(56)	Periapical cyst with external root resorption	5(28)	Normal with Periapical cyst with external root resorption	5(28)
Normal with deep lingual pit	7(39)	Periapical cyst	3(17)	Normal with Periapical lesion, pulp stone, external resorption	1(5)
Macrodont	1(5)	Periapical cyst with external root resorption and internal root resorption	1(5)	Normal with Widening Periodontal ligament and pulp stone	1(5)
				Normal with Widening Periodontal ligament space with external and internal root resorption	1(5)
		Periapical lesion, pulp stone, external resorption	1(5)	Normal with Periapical cyst	1(5)
		Widening Periodontal ligament and pulp stone	1(5)	Normal with No radiological feature	1(5)
		Periapical cyst, odontomes, Mesiodens	1(5)	Macrodont with periapical cyst	1(5)
		Widening of Periodontal ligament space, Internal resorption, External resorption	1(5)	Normal, deep lingual pit with no radiological feature	4(22)
		NIL	5(28)	Normal, deep ligual pit with Widening of Periodontal ligament space, Internal resorption, External resorption	1(5)
				Normal, deep ligual pit with Periapical cyst, odontomes, Mesiodens	1(5)
				Normal with Periapical cyst with external root resorption, internal resorption	1(5)

Radiological finding: Most common type of DI seen was type I that is in 12 (67%) followed by type II in 5 (28%) and least common was type III in 1 (5%) of the teeth included in the study. Most common teeth affected is left maxillary lateral incisor (8, 44%), followed by right maxillary lateral incisor (4, 22%). Based on the type of DI, type I was most commonly seen in lateral incisor and type II was the next common type of DI in lateral incisors (Table 4) (Fig 1 A TO F).

Periapical cyst, periapical cyst with external and internal root resorption, widening of pdl space, odontomes, mesiodens, pulp stones were radiographic lesions associated type I, II or III. Among type I, the associated lesions were periapical cyst with External root resorption in 4(22%) of teeth. However, 5 (28%) of examined teeth did not show any associated radiological pathologies. Out of these, 4 (22%) were type I, and one (5%) was type II DI (table 5) (Fig 2).

Table 4. Distribution of study participants based on type of dens in dente and tooth affected

Type of dens in dente	N(%)	Tooth affected	N(%)	Type of dens in dente and tooth affected	N(%)
Type I	12(67)	22	8(44)	Type I, 22	6(33)
Type II	5(28)	12	4(22)	Type I, 11	2(11)
Type III	1(5)	11	2(11)	Type I, 12	2(11)
		21	2(11)	Type I, 21	1(5)
		13	1(5)	Type I, 44	1(5)
		44	1(5)	Type II, 12	2(11)
				Type II, 22	2(11)
				Type II, 21	1(5)
				Type III A, 13	1(5)

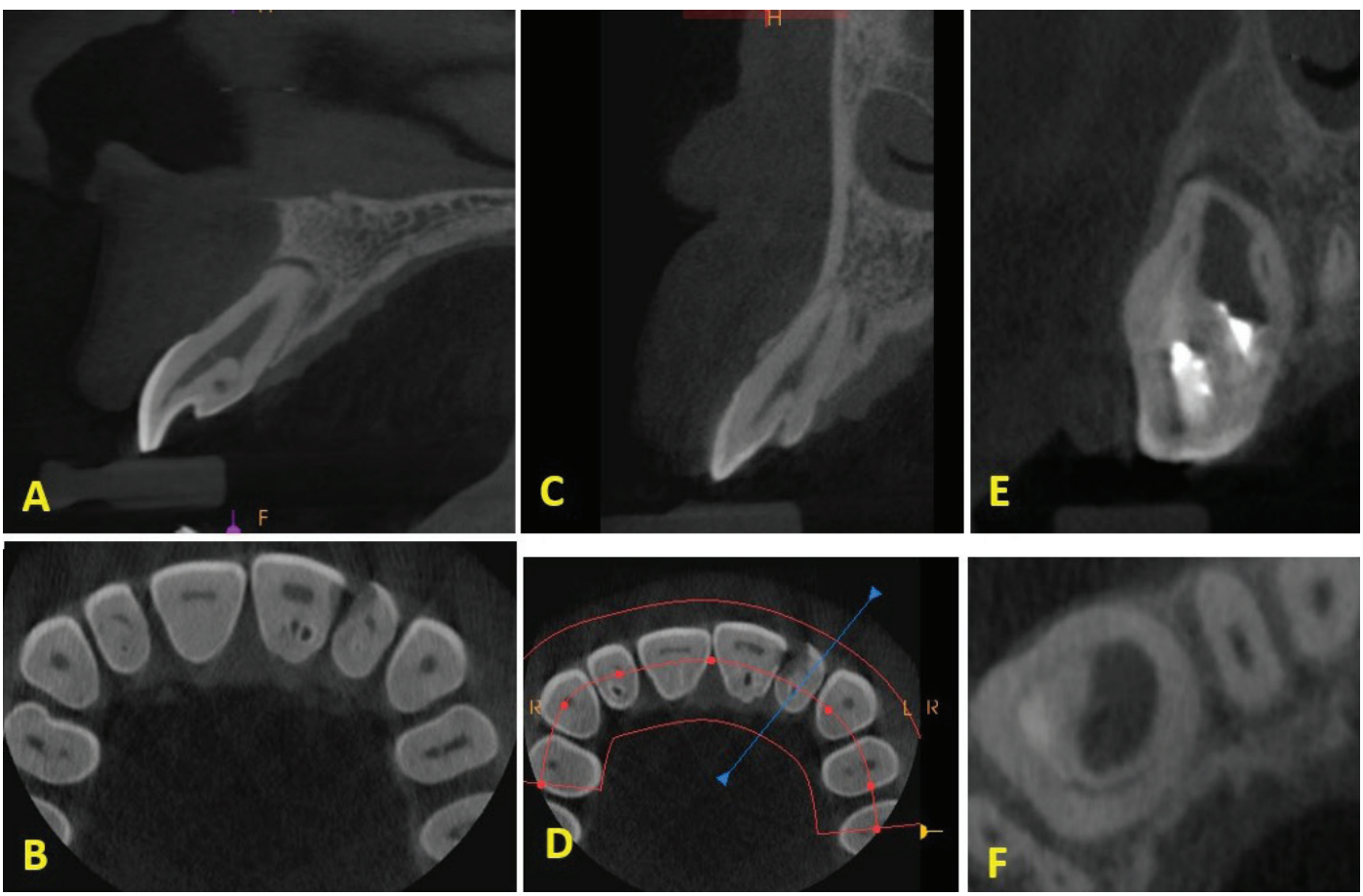

Figure 1. Oheler's types of DI (sagittal and axial views).

Table 5. Distribution of study participants based on type of dens in dente and Associated lesion.

Type of dens in dente	Type of dens in dente and associated lesion	N(%)	
Type I	Periapical cyst with external root resorption	4(22)	Type I with periapical lesion- 66.6% Type I without periapical lesion-33.4%
	Periapical cyst with external root resorption and internal root resorption	1(5)	
	Widening Periodontal ligament and pulp stone	1(5)	
	No associated lesions	4(22)	
	Periapical cyst only	2(11)	
Type II	Pulp stone, external resorption	1(5)	Type II with periapical lesion- 80% Type II without periapical lesion-20%
	Periapical cyst, odontomes, Mesiodens	1(5)	
	Widening of Periodontal ligament space, Internal resorption, External resorption	1(5)	
	Periapical cyst with external root resorption	1(5)	
	No associated symptoms	1(5)	
Type III	Periapical cyst	1(5)	
Overall= associated lesion with type I/II or III is 72%			

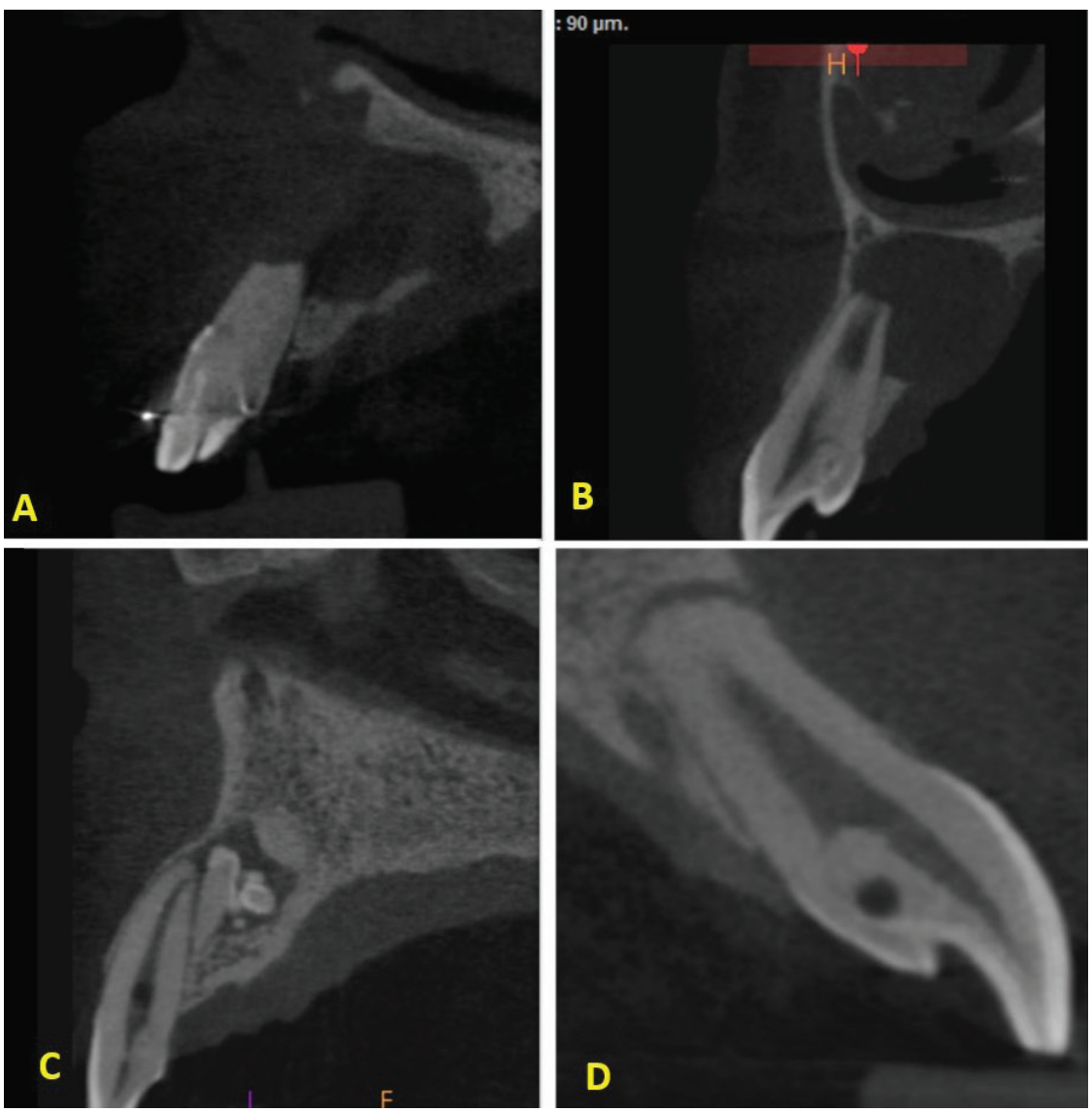

Figure 2. Associated lesions with DI

Discussion

Prevalence of DI varies in various studies. Patil S *et al* found prevalence of DI to be 0.4% in Indian population0[8]. In Turkish population, range of prevalence have been reported 0.17% (Colak H *et al*, 2012)[9]; 2.5% (Gunduz K *et al*, 2013)[10]; 5.0% (Uslo *et al* 2009)[11]; and 12% (Kirzioglu *et al* 2009)[3]. This variation could be because of variation in diagnostic technique used and possibly diagnostic difficulties, considering all these studies were done using OPG or periapical radiographs. Capar ID *et al* assessed the presence DI using CBCT images and panoramic images, and found that the presence of DI was lower on panoramic images (3%) as compared to CBCT images (10.7%). This higher frequency in CBCT images could be attributed to the 3D analysis of teeth and accurate representation of internal and external tooth structure[12]. Likewise, shin *et al* used micro CT to analyse DI and reported higher prevalence of 31% of DI in ancient Chinese population[13]. Różyło et al reported prevalence of 53.7% of DI analysed using CBCT in Polish population[14]. Kfir A et al. observed 26% of DI in maxillary anterior of Isreli population[15]. These varied prevalence could be attributed to different methods used in detection of DI ranging from IOPA to panoramic radiograph to CBCT and Micro CT. Mild cases of type I DI, may be overlooked in IOPAs and panoramic radiographs, where as can be detected in CBCT. Another reason could be different geographic locations of these studies. One more possible reason could be that few of the above mentioned studies are full mouth surveys where as others have considered only maxillary anterior teeth.

Pathogenesis of DI were explained by numerous authors. Failure of growth of internal enamel epithelium in focal area resulting in engulfment of this area by proliferating surrounding normal epithelium resulting in DI. Infection, trauma, genetic factors, growth pressure of the dental arch, invasion of internal enamel epithelium into the dental papilla or as a result of fusion of tooth germs are some of the other proposed etiological factors[2]. Oehler's suggested distortion of the enamel organ leading to protrusion of a part of the enamel organ during tooth development. Most of the authors believe that DI is the consequence of deep infolding of foramen caecum during development of teeth[2].

In present study, clinical data and CBCT images of 11 patients (18 teeth) were analysed. 89% of teeth affected by DI were males. This was in contrast with the study by Cakic F *et al*. who reported 1.3% of male patients and 1.3% of female patients with DI[7]. Likewise, no significant gender-related difference was found in the study conducted by Capar ID *et al*[12] Rozyło TK *et al*.[14], In other studies by Gunduz *et al* female predominance (77%) was reported.[10] These differences could be attributed to difference in the criteria of evaluation of DI in these studies and because of different race and ethnicity that the study samples were taken from.

89% of DI referred to our department were seeking evaluation of teeth before endodontic treatment. In a study by Capar ID *et al*, main reason for CBCT referral were assessment of structure and position of teeth, followed by impaction and assessment of supernumerary teeth[12]. Irrespective of the reason for referral, CBCT with precise analysis using thin slices will benefit the treatment plan[14].

DI affects permanent dentition, whereas primary dentition involvement is very rare. Only a few cases have been reported in literature. Bansal AV *et al* reported DI in left primary maxillary second molar evaluated using IOPA in a 5 year old paediatric patient. However, this tooth was extracted owing to the unfavourable delicate root morphology with wide apical foramen[16].

In present study, teeth had normal morphology or normal morphology with deep lingual pit, and macrodontia in one tooth. Most common type of DI seen was type I (67%) followed by type II (28%) and type III (5%). Similar findings were found in Turkish population by Gündüz K *et al* in in 116 DI cases with type I (69.8%) being most commonly observed DI followed by type II (26.6%) and type III (3.4%)[10]. Cakic F et found type I (81.25%) to be most common Oehelr's DI, however, type III (12.5%) was next common and least was type II (6.25%)[7].

Oehlers' classification used for classification of DI, are basically is applied to two-dimensional radiographic images. Hence while assessing DI in IOPA or OPG true extent of DI and its complexity becomes difficult to assess. A tooth may appear to have type I radiographically, but it may be type II in reality. This limitation can be eliminated by 3 dimentional imaging modality like CBCT.[10] In conventional radiograph extension of DI in the palatal/ lingual aspect may be difficult to ascertain because of overlapping.

The most commonly affected teeth were maxillary lateral incisors in our study. Gunduz K *et al* also detected the anomaly primarily in maxillary lateral incisors, followed by maxillary central incisors and maxillary canines and none were detected in mandibular teeth[10].

Periapical cyst, ERR and IRR were some of the untoward complications that we found in our observation. Rozyło *et al* assessed CBCT images of 33 teeth with DI and observed the consequences related to DI. Delayed resorption of the primary tooth root, delayed development and eruption of permanent teeth, impediment in eruption of a permanent tooth, rotation of the tooth crown and root deviation and displacement or deviation of adjacent teeth were some of the associated radiological lesions in their study population[14]. In present study, 66.6% and 80% of type I and type II were associated with periapical lesion. Gunduz K *et al* found only one periapical lesion in teeth with type I DI followed by 8.1% of patients with type II and 87.5% of patients with type III dens invaginatus[10]. Out of 16 teeth with DI, Cakici F *et al* found no periapical lesions in teeth with types I and

II, and two teeth with apical periodontitis in type III DI at the time of referral[7]. These differences could be attributed to larger sample size in their study. Higher frequency was detected possibly due to better analysis of periapical region of tooth in CBCT compared to conventional radiographs.

Damage to predentin layer and outermost protective odontoblastic layer leads internal root resorption. Invaginations provide easy permeability or communication with the oral cavity, causing predentin layer damage and chronic pulpal inflammation resulting in IRR in DI. Alfayate RP *et al* reported three cases of DI associated with IRR and suggested that deep invagination led to pulpitis in the three lateral incisors possibly resulted in IRR in these cases[17]. Invaginated enamel is often hypo-mineralized, making enamel weak and susceptible for deterioration. Enamel and dentine are thinner in invaginated region of tooth resulting in early pulpal involvement, infection and necrosis, sometimes even before root completion[15].

Presence of dental anomalies may complicate dental treatment. Uslu A et al in their study, found that 40.3% patients undergoing orthodontic therapy had at least one dental anomaly and DI was prevalent in 5% of study population[11]. Other Dental anomalies such as supernumerary teeth, microdontia, macrodontia, hypodontia, oligodontia, taurodontism, fusion and gemination have been reported to occur with DI[18]. In present study, one such case was present, where odontoma and mesiodens was present in one type II DI. Syndromes associated with DI are Ekman-Westborg-Julin syndrome, Williams syndrome and Nance Huran syndrom[18]. In our study population, none of the patients had syndromic manifestations.

Preventive treatment modalities for DI include sealing or restoration of invagination, thus preventing microbiological invasion. Others may include nonsurgical and surgical endodontic treatment intentional replantation, regenerative endodontic and extraction. Presence of inaccessible nature of anomaly, tortuous pit, proximity to pulp chamber, incomplete root formation may pose difficulty in endodontic treatment[19]. Endodontic therapy, is challenging through or next to enamel lined passages[15]. Hence complete evaluation of teeth is required for success of the treatment. Besides, type of DI affects treatment modality ranging from minimal restorative treatment to extensive and aggressive management in type III DI[1,18]. In this regard, CBCT completely evaluates the tooth structure, treatment may change from nonsurgical to surgical and vice versa. Also follow up of the treatment can also be assessed using CBCT[20].

The assessment of DI in Indian population is rare, that too in CBCT[8]. Keeping this in mind, we undertook this study to assess DI in 18 teeth of patients who visited our institution. CBCT gives 3 dimensional assessment of tooth, making easy for endodontists easy to proceed with their treatment. Decurcio DA *et al* reported challenges faced by 2 dimensional imaging and treatment planning changed by 3 dimensional CBCT image in a tooth affected by DI and concluded that success of endodontic treatment depends on accurate diagnosis[20]. CBCT provides complete 3 dimensional analysis of DI, information regarding type of DI, communication with pulp cavity, associated periapical changes, extent of defect and any other complication associated with DI. Hence accurate preoperative analysis makes decision regarding treatment more precise. Hence, we recommend CBCT for the teeth affected by DI.

Conclusion

DI is a developmental tooth anomaly resulting in morphological variation of affected teeth. Timely diagnosis helps in prompt treatment and prevents loss of tooth structure. CBCT plays important role in this regard. In present study, we observed the following.

DI most commonly affected male population and maxillary lateral incisors was the commonly affected tooth.

We also found that Oehelr's type I DI was most prevalent with periapical cyst and external root resorptions were the complications in the study participants.

If DI is recognised early, pulpal necrosis, root resorptions and periapical lesions can be avoided, preventing extensive surgical procedure. The detailed anatomical information of DI provided by CBCT helps dental practitioner to anticipate technical difficulties associated with endodontic treatment.

References

1. Dineshshankar J, Sivaraman S , Yasmeenahamed S , Tamilthangam P. Dens Invaginatus: History, Etiology, Classification, Clinical Feature Radiographic Feature, Histological Findings and Management Saudi J. Oral. Dent. Res 2016;1(3):151-55.
2. Alani A, Bishop K. Dens invaginatus. Part 1: classification, prevalence and aetiology. Int End J 2008; 41:1123–36.
3. Kirzioglu Z, Ceyhan D. The prevalence of anterior teeth with dens invaginatus in the western mediterranean region of Turkey. Int Endod J 2009;42:727–34.
4. Hamasha AA, Alomari QD. Prevalence of Dens invaginatus in Jordanial adults. Int Endod J 2004;37: 307-10.
5. Hulsmann M. Dens invaginatus: aetiology, classification, prevalence, diagnosis and treatment considerations. Int Endod J. 1997;30:79-90.
6. Segura JJ, Hattab F, Ríos V. Maxillary canine transpositions in two brothers and one sister: associated dental anomalies and genetic basis. ASDC J Dent Child. 2002;69:54-8.
7. 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. Med Oral Patol Oral Cir Bucal. 2010;15:e855-8.

8. Patil S, Doni B, Kaswan S, Rahman F. Prevalence of dental anomalies in Indian population. J Clin Exp Dent. 2013;5(4):e183-6.
9. Çolak H, Tan E, Aylikçi BU, Uzgur R, Turkal M, Hamidi MM. Radiographic Study of the Prevalence of Dens Invaginatus in a Sample Set of Turkish Dental Patients. J Clin Imaging Sci 2012;2:34.
10. Gündüz K, Çelenk P, Canger EM, Zengin Z, Sümer P. A retrospective study of the prevalence and characteristics of dens invaginatus in a sample of the Turkish population. Med Oral Patol Oral Cir Bucal. 2013;18 (1):e27-32.
11. Uslu O, Akcam O, Evirgen S, Cebeci I. Prevalence of dental anomalies in various malocclusions. Am J Orthod Dentofacial Orthop;135: (3):328-36.
12. Capar ID,Ertas H, Arslan H, Ertas ET. A Retrospective Comparative Study of Cone-beam Computed Tomography versus Rendered Panoramic Images in Identifying the Presence, Types, and Characteristics of Dens Invaginatus in a Turkish Population. J Endod 2015;41:473–78.
13. Shi, S., Duan, X., Shao, J., Duan, Q. & Peng, S. Dens invaginatus in ancient Chinese teeth of 2,000 years ago. Anat. Rec 2013; 296:1628–33.
14. Rozyło K, Kalinowska IR, Piskorz M. Cone-beam computed tomography for assessment of dens invaginatus in the Polish population T. Oral Radiol 2018; 34:136–142.
15. Anda Kfr, Salem NF, Natour L, Metzger Z , Sadan N, Elbahary S. Prevalence of dens invaginatus in young Israeli population and its association with clinical morphological features of maxillary incisors scientific reports. (2020) 10:17131 | https://doi.org/10.1038/s41598-020-74396-z.
16. Bansal AV, Bansal A, Kulkarni VK, Dhar RS. Dens Invaginatus in Primary Maxillary Molar: A Rare Case Report and Review of Literature. Int J Clin Pediatr Dent 2012;5(2):139-141.
17. Pérez-Alfayate R, Mercadé M, Vera J. Relationship between internal root resorption and dens in dente. J Clin Exp Dent. 2020;12(8):e800-4.
18. Kallianpur S, Sudheendra US, Kasetty S, Joshi P. Dens invaginatus (Type III B). J Oral Maxillofac Pathol 2012;16:262-5.
19. Alenazy MS, Murwahi AE, Altwaijri SM, Mosadomi HA. Endodontic management of dens invaginatus of maxillary lateral incisor: Report of two cases. Saudi Endod J 2017;7:194-8.
20. Decurcio DA, Silva JA, Decurcio RA, Silva RG, Pécora JD. Influence of cone beam computed tomography on dens invaginatus treatment planning. Dental Press Endod. 2011 apr-june;1(1):87-93.

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