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Cone-Beam Computed Tomography versus Rendered Panoramic Images in Determination of Dens Invaginatus Characteristics: Retrospective Cohort Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: "Dens in Dente" is another name for Dens invaginatus. It's an uncommon developmental aberration that comes in a range of shapes and sizes. Invagination begins in the crown and may go to the root. The goal of this study was to use CBCT and panoramic pictures created from CBCT scans to evaluate the existence, kind, and features of DI in full-mouth surveys in Saudi patients presenting to Qassim dental college, and to compare the findings of the imaging modalities.
Methods: This retrospective cohort study was performed by using 302 previously obtained CBCT records of patients from the database of the oral and maxillofacial radiology department of Qassim University, Saudi Arabia from yer 2016 to 2021. The research was ethically approved by the ethical approval committee of Qassim university (Code #: F-2019-3005).
Results: In the present study, the age of the patients ranged from 9 to 80 years (mean age was 44 years). Out of 302 scans, 153 patients were female, and 149 were found to be male. According to the Cohen kappa test, the inter-examiner agreement was high between the 2 assessments of the

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observers: k = 0.795, P < .000 for CBCT and k = 0.915, P < .000 for panoramic images rendered from CBCT images. On the basis of the CBCT images, DI was observed in 98 of the 302 patients (frequency, 32.5%). Type I DI was the most commonly observed type of invaginatus (93.9%), followed by type II (6.1%). However, type III was not being observed.
Conclusion: We can deduce that there is no special relationship between gender and the presence of dens invagnatus. When it comes to diagnosing and classifying dens invaginatus, CBCT images outperform rendered panoramic images. Because it provides an accurate representation of the external and internal dental anatomy, as well as appropriate visualization of associated characteristics with such cases that would be absolutely necessary in their treatment phases, CBCT can be recommended as an effective diagnostic device for identifying DI.

Keywords: Cone-beam; rendered panoramic; dens; invaginatus.

1. INTRODUCTION

"Dens in Dente" is another name for Dens invaginatus. It's an uncommon developmental aberration that comes in a range of shapes and sizes. Invagination begins in the crown and may go to the root. As a result, the enamel of the afflicted teeth is deeply infolded into the dentine, forming a pocket of biological material under the enamel surface. As a result, germs from the oral cavity are more likely to contaminate and grow within these deformities, resulting in the development of early caries and, as a result, pulp necrosis. Although these lesions normally develop behind the palatal pit or cusp tip, they can be widespread and affect the architecture of the root canal system significantly. It can occur in any tooth in both arches but it mostly affects Maxillary lateral incisors followed by central incisors, premolars, canines and less often the molars. Also, DI lesions are rare in Mandibular teeth and bilateral occurrence is common [1-6].

Microdontia, Macrodontia, Hypodontia, Oligodontia, Taurodontism, Gemination, Fusion, Supernumerary teeth, Amelogenesis imperfecta, Invagination in an odontome, Multiple odontomes, Coronal agenesis, and William's syndrome are all examples of dental malformations. There is a significant prevalence of Periapical lesions, open apices, and impaction around the DI impacted tooth, in addition to the dental abnormalities that may be present [7]. The cause of DI is a subject of debate and remains unknown. There have been several theories presented. The most commonly accepted idea, however, is that it is generated by enamel invagination into the neighboring dental papilla during tooth formation, resulting in a deep invagination of the enamel organ into the dental papilla prior to calcification of the dental hard tissues. External pressures on the tooth germ during odontogenesis, neighboring tooth germs, tooth germ fusion, infection, trauma, and growth pressure on the dental arches during odontogenesis producing infolding of the enamel are all probable causes [7].

Because understanding the categorization and structural changes of teeth with DI is critical for accurate diagnosis and therapy, many classification schemes have been proposed. Oehlers' proposal is the most widely utilized, probably because to its clear naming and simplicity of implementation [8-10]. According to the depth of invagination visible radiographically from the crown into the root, this approach divides invaginations into three groups [11]. Although DI is a prevalent illness, it is often neglected and dismissed by doctors due to the lack of obvious clinical signs and symptoms. Routine radiographs are generally the first to discover it. Some people, however, may have a tooth that is unusually formed. If DI is not recognized, the teeth that are impacted may develop caries and decay.

Thus, the early discovery of DI afflicted teeth would not only give a better prognosis for these teeth but will also eliminate the necessity for complicated and difficult endodontic operations later in life [6]. DI may be identified on practically all forms of dental X-rays, however standard radiographs are not sufficient as they offer just a 2D image of a complicated anatomy. In addition, various criteria such as 3-dimensional vision, the quality of the radiographs collected, and the clinician's personal expertise can all influence the diagnosis of DI.

Cone-beam computed tomography (CBCT) has recently been widely used to examine and analyze the coronal and radicular morphologies of teeth in order to detect any abnormalities. Without a doubt, the CBCT is an effective tool for a dentist to employ because it is a non-invasive

technology that gives 3D pictures for endodontic and surgical applications, as well as morphologic examination of abnormalities for clinicians [12]. Although many studies have used traditional periapical and panoramic (OPG) radiographs to assess the incidence of DI, these two approaches are restricted in defining the specific kind and related features associated with DI. CBCT examination, on the other hand, has the benefit of being able to overcome all of these flaws [13,14].

The global prevalence of teeth impacted by DI is estimated to be between 0.04 and 10% in the general population [11]. The incidence of DI in Saudi Arabia has been studied extensively, and it was discovered to be 1.7 percent of 1581 individuals tested in full mouth surveys. In another research, it was 0.6 percent of 990 individuals who had their radiographs taken [15]. There have been no research on the prevalence of DI in the Al-Qassim region up to this point.

Therefore, the aim of the current study was to investigate the presence, type and characteristics of DI in full-mouth surveys in Saudi patients presenting to Qassim dental college by using CBCT and panoramic images rendered from CBCT scans and to compare the findings of the imaging techniques.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This retrospective study was performed by using 302 previously obtained CBCT records of patients from the database of the oral and maxillofacial radiology department of Qassim University, Saudi Arabia from year 2016 to 2021. The research was ethically approved by the ethical approval committee of Qassim university (Code #: F-2019-3005).

2.2 Data Collection

All of the images were obtained with a Galileos Sirona machine (Germany) FOV:17X17cms. CBCT images were randomly selected from the database of the oral and maxillofacial radiology department that were taken as a routine part of dental examination for diagnosis and treatment planning purposes. The acquisition process was performed by an experienced radiologist according to the manufacturer's recommended protocol, and the minimum exposure time necessary for adequate image quality was used With this device, tube potential and tube current were automatically determined from scout views by the CBCT machine. All of the oro-dental, medical history (syndromes and systemic diseases), and demographic characteristics of the patients were obtained in a standardized way from the clinical records.

2.3 Eligibility Criteria

Exclusion criteria included poor quality CBCT images, the absence of all teeth, and incomplete records. The CBCT images of the 302 patients who met the inclusion/exclusion criteria were analyzed with Galileos viewer 2010 software by using a HP laptop on windows 10.

2.4 Data Analysis

The patient's age and gender, as well as the existence of systemic disorders and syndromes, were all recorded. The program parameters were modified on a U-shaped chart for each patient. The patients' axial, cross-sectional, multiplanar reformat, and 3D reformat images were carefully evaluated after processing to determine the presence of DI, its type, and associated dental anomalies such as open apex, periapical pathosis, and the presence of any bony impaction of an adjacent tooth that was compromised because of the pathosis or condition of the DI tooth. The Oehlers classification method was used to classify DI. Two competent endodontists assessed the CBCT and panoramic pictures created from CBCT images of the patients, and in situations where a consensus could not be achieved, an oral radiologist with 7 years of expertise in CT and CBCT was requested to give a conclusive evaluation. The Cohen kappa test was used to determine the interexaminer reliability between the two observers. Using the Pearson correlation and the 2 test, the presence of DI was statistically evaluated in relation to age and gender. According to CBCT and panorex pictures, the McNemar test was used to compare the presence and kind of DI.

3. RESULTS

In the present study, the age of the patients ranged from 9 to 80 years (mean age was 44 years). Out of 302 scans, 153 patients were female, and 149 were found to be male. According to the Cohen kappa test, the inter-

examiner agreement was high between the 2 assessments of the observers: k = 0.795, P < .000 for CBCT and k = 0.915, P < .000 for panoramic images rendered from CBCT images. On the basis of the CBCT images, DI was observed in 98 of the 302 patients (frequency, 32.5%). Type I DI was the most commonly observed type of invaginatus (93.9%), followed by type II (6.1%). However, type III was not being observed.

DI was seen in 45 women (46%) and in 53 men (54%). No associations with gender and age were detected (P > .409).

Table 1. Data statistics

Presence & Type		Gender		Total	P-Value
		Male	Female		
Type I	Count	51	41	92	0.409
	% of Total	52.0%	41.8%	93.9%	
Type II	Count	2	4	6	
	% of Total	2.0%	4.1%	6.1%	
Total	Count	53	45	98	
	% of Total	54.1%	45.9%	100.0%	

Table 2. Presence & Type (CBCT)

Presence & Type (CBCT)	Male	Female	Total	P-value
Type I	51 (52%)	41 (41.8%)	92 (93.9%)	0.409
Type II	2 (2%)	4 (4.1%)	6 (6.1%)	
Total	53 (54.1%)	45 (45.9%)	98 (100%)	

Table 3. Gender wise variability

Type		Gender		Total		P – Value
		Male	Female			
	Not Visible	Count	36	21	57	0.041
		% of Total	36.7%	21.4%	58.2%	
	Type I	Count	17	24	41	
		% of Total	17.3%	24.5%	41.8%	
Total	Count	53	45	98		
	% of Total	54.1%	45.9%	100.0%		

Table 4. Data variability

Presence & Type (OPG)	Male	Female	Total	P-value
Not Visible	36 (36.7%)	21 (21.4%)	57 (58.2%)	0.041
Type I	17 (17.3%)	24 (24.5%)	41 (41.8%)	
Total	53 (54.1%)	45 (45.9%)	98 (100%)	

Table 5. Affected teeth

Affected teeth		Gender :		Total	P – value
		Male	Female		
Unilateral	Count	12	9	21	P = 0.809
	% of Total	12.2%	9.2%	21.4%	
Bilateral	Count	41	36	77	
	% of Total	41.8%	36.7%	78.6%	
Total	Count	53	45	98	
	% of Total	54.1%	45.9%	100.0%	

On the basis of the panoramic images rendered from CBCT images, DI was observed in only 41 of the total 302 patients (frequency 13.6%). P-value =0 .041 which is significant. Which means the cases has been diagnosed with the panoramic images alone is lesser than the full views of CBCTs. Only type I has been found.

Bilateral DI was found in 78.6% (77) of the total affected patients, out of which 41.8% were males and 36.7% were females. Since P value = 0.809 so association between distribution of teeth and gender is non-significant. Bilateral DI was found in 77 of the affected patients. The distribution, type and associated anomalies of the teeth are shown in. DI was not observed in the molar teeth. The teeth most commonly affected were Lateral incisors, followed by Central incisors Furthermore, no periapical lesions were evident like open apices or apical pathosis in teeth with DI.

An impacted tooth was found near the tooth with DI in about 14.3% of the patients, whereas 8.2% of the patients had other anomalies h such as Dilacerations, calcification, pulpal stones, mesiodens and supernumerary teeth. However, no associated systemic diseases or syndromes were detected. Without any doubt there wasn't a clear view for associated characteristics except for impactions using rendered panoramic images. The p-value is .407 which is non significant.

Table 6. Data statistics

Affected teeth	Male	Female	Total	P-value
Unilateral	12 (12.2%)	9 (9.2%)	21 (21.4%)	0.809
Bilateral	41 (41.8%)	36 (36.7%)	77 (78.6%)	
Total	53 (54.1%)	45 (45.9%)	98 (100%)	

Table 7. Apical pathosis

Characteristics		Gender		Total	P-Value
		Male	Female		
None has been noticed	Count	39	35	74	0.407
	% of Total	39.8%	35.7%	75.5%	
Impaction	Count	9	5	14	
	% of Total	9.2%	5.1%	14.3%	
Dilacerations	Count	3	1	4	
	% of Total	3.1%	1.0%	4.1%	
Calcification / Pulpal stones	Count	1	2	3	
	% of Total	1.0%	2.0%	3.1%	
Mesiodens	Count	1	0	1	
	% of Total	1.0%	0.0%	1.0%	
Caries	Count	0	2	2	
	% of Total	0.0%	2.0%	2.0%	
Total	Count	53	45	98	
	% of Total	54.1%	45.9%	100.0%	

Table 8. Data statistics

Characteristics	Male	Female	Total	P-value
None has been noticed	39 (39.9%)	35 (35.7)	74 (75.5%)	0.407
Impaction	9 (9.2%)	5 (5.1%)	14 (14.3%)	
Dilacerations	3 (3.1%)	1 (1%)	4 (4.1%)	
Calcifications / pulpal stones	1 (1%)	2 (2%)	3 (3.1%)	
Mesiodens	1 (1%)	0	1 (1%)	
Caries	0	2 (2%)	2 (2%)	
Total	53 (54.1%)	45 (45.9%)	98 (100%)	

Table 9. Cone beam computed tomography

Cone beam computed tomography		Panoramic		Total	P-Value
		Not Found	Found		
Not Found	Count	2	0	2	P = 0.000
	% of Total	2.0%	0.0%	2.0%	
Found	Count	55	41	96	
	% of Total	56.1%	41.8%	98.0%	
Total	Count	57	41	98	
	% of Total	58.2%	41.8%	100.0%	

Table 10. Data statistics

CBCT	OPG		Total	P-Value
	Not Found	Found		P = 0.000
Not Found	2 (2%)	0 (0%)	2 (2%)	
Found	55 (56.1%)	41 (41.8%)	96 (98%)	
Total	57 (58.2%)	41 (41.8%)	98 (100%)	

According to the McNemar test, DI detection was lower on panoramic images rendered from CBCT images (41.8%) compared with on CBCT images (56.1.7%) (P < .000). All Panoramic images shows only type I DID.

4. DISCUSSION

DI must be recognized early to minimize the need for costly and time-consuming endodontic operations later in life. DI has been shown to impact teeth in between 0.3 and 12% of the population [16-21]. The varied cohorts analyzed, variations in the diagnostic procedures utilized, and diagnostic issues might all explain the vast range of prevalence found [17]. DI was found in 10.7% of the patients in our study, which matches the findings of Kirzioglu and Ceyhan [21] in a survey of Turkish dental patients.

DI was observed in 1.3 percent, 2.95 percent [22], and 2.5 percent [20] of Turkish dental patients during panoramic radiography exams. This study's modest prevalence of panoramic vision (3.3%) was within the range previously reported in the literature. The increased frequency of DI identified in the current study using this approach might be explained by the fact that CBCT offers an accurate picture of the exterior and interior anatomy.

Dental anomalies such as taurodontism, microdontia, gemination, and dentinogenesis imperfecta have all been linked to the development of symmetric DI [23, 24]. In this research, 31.3 percent of DI cases were bilateral, with some participants having additional dental defects (Table 1). Several earlier research looking at the prevalence of DI revealed DI in the maxillary incisors but not the mandibular incisors [20, 21].

DI was seen in the maxillary first premolars and third molars, as well as the maxillary incisors. DI was identified in the maxillary incisors, maxillary canines, mesiodens, mandibular canines, and mandibular premolars in the current study. There were no results in a PubMed search for screening studies on the prevalence of DI in mesiodens.

On the other hand, Mesiodens DI has been documented [25, 26]. In a study of the clinical relevance of DI [27], 11 individuals with DI of the mandibular teeth were documented in the literature: one in a primary canine [28], and two in permanent canines [29]. DI has been seen in the mandibular incisors [30], mandibular canines [31] and mandibular third molars in several recent case reports [32].

The cause of DI is unknown, and a number of ideas have been offered to explain it. According to Kronfeld, DI is caused by the stalling of a specific group of cells while the surrounding cells continue to develop normally [33] According to Atkinson [34] external forces acting on the tooth germ during development produce DI. The presence of an impacted tooth near the DI tooth was found in 11.6 percent of DI patients in this investigation, validating Atkinson's idea. DI can affect the tooth's coronal region or, in rare situations, the root section [35]. The Oehlers classification has been used in several investigations to evaluate the prevalence of each form of DI [20, 21], with type I being the most common.

The most prevalent form of invaginatus in our sample (65.9%) was Kind I invaginatus, which is consistent with prior studies. The intricacy and genuine degree of the invagination may be overestimated since the Oehlers categorization is based on a 2-dimensional (2D) radiography picture. In endodontic epidemiological surveys and clinical outcome research, 2D radiographs gave insufficient information [18]. This is the first research to detect the existence of DI using CBCT pictures. CBCT should be employed in larger research with larger study populations in the future. Diagnostic imaging may not correlate with the presence of DI histologically, which was one of the study's flaws.

As a result, future studies should focus on creating a connection between CBCT imaging and histologic sections. Despite the benefits of CBCT scanning for root canal anatomy research, current recommendations advise that whether the benefits exceed the hazards of CBCT's much greater radiation dosage than normal radiography should be the deciding factor [36]. As a result, when conventional imaging fails to offer clear evidence on severe endodontic problems, CBCT should be used sparingly [36]. We employed CBCT images that had been taken earlier for a number of objectives, including implant placement, surgical planning, and orthodontic therapy, among others, in the current investigation.

5. CONCLUSION

We may deduce that there is no unique relationship between gender and the presence of dens invagnatus. When it comes to detecting and identifying dens invaginatus, CBCT pictures outperform generated panoramic images. Because it provides an accurate representation of the external and internal dental anatomy, as well as appropriate visualization of associated characteristics with such cases that would be absolutely necessary in their treatment phases, CBCT can be recommended as an effective diagnostic device for identifying DI.

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SUPPLEMENTARY

Supplementary file available in this link:https://www.journaljpri.com/index.php/JPRI/libraryFiles/downloadPublic/31

CONSENT

It is not applicable.

ETHICAL APPROVAL

The research was ethically approved by the ethical approval committee of Qassim university (Code #: F-2019-3005).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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