ORIGINAL ARTICLE

Prevalence of Pre-eruptive Intracoronal Resorption in Yemeni Children and Adolescents: A Cross-sectional Study

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ABSTRACT

Introduction: Early detection of pre-eruptive intracoronal resorption/radiolucency(PEIR) helps in early management and treatment before and during tooth eruption. Therefore, this study aimed to assess the prevalence of PEIR and coexisting dental factors using archived digitalized panoramic radiographs of unerupted permanent teeth in Yemeni children and adolescents. **Materials and methods**: A cross-sectional study of 4927 unerupted teeth from 487 archived digitalized panoramic radiographs (males 243 and females 244) of children aged 6–15 years old were examined to assess the presence of PEIR. The prevalence of PEIR and associated factors as ectopic position, supernumerary teeth or fused teeth, hyperdontia or hypodontia, impaction, dense in dente, and taurodontism, the presence of dental caries, root canal treatment, restoration and/or periapical infection in the predecessor primary teeth were checked by two independent calibrated examiners. **Results**: After examination, 14 /4927 teeth and 14/487 patients had PEIR defects, which accounted for 2.9% of overall subject prevalence and 0.28% of overall tooth prevalence. A statistically significant difference was noted in PEIR defects with regard to age, dental arch type, arch side, and dentation stage. The second premolar was the most affected tooth in the maxillary and mandibular arches. Most lesions were located in less than 1/3 of the dentin thickness(50%). Most of the lesions were located on the mesial aspect of the crown(35.7%). The ectopic position was the most coexisting factor with PEIR(41.18%). **Conclusion**: Although PEIR is one of the detected lesions in the unerupted teeth of Yemeni children and adolescents with low prevalence, its early detection helps dentists to be aware of this hidden lesion and allows them to have an early treatment plan with few complications.
Malaysian Journal of Medicine and Health Sciences (2026) 22(3): 1-9.doi:10.47836/mjmhs.v22i3.1582

Keywords: Pre-eruptive, Intracoronal, Resorption, PEIR, Radiolucency, Yemen

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INTRODUCTION

Pre-eruptive intracoronal resorption/radiolucency (PEIR) is a well-circumscribed, radiolucent defect frequently identified within the coronal dentin of unerupted teeth, typically near the dentinoenamel junction (DEJ). (1,2) These defects are detected by a chance during routine dental radiographic examinations. (3)

Radiographically, lesions exhibit similarities to dental caries, leading to the use of various terms in the past to describe this condition. These terms are "pre-eruptive caries", "idiopathic external resorptions of unerupted permanent teeth", intrafollicular caries", "pre-eruptive intracoronal resorption or defects ", and "radiolucent lesions resembling caries". (4,5) Although the exact etiology of PIER is still undefined, it has been proposed that defects may occur as a result of developmental disturbances of dentin, periapical inflammation of deciduous teeth, dental caries and coronal resorption. Most studies have reported that lesion is probably resorptive in nature, in which inflammatory resorptive cells such as osteoclasts and odontoclasts invade the developing dentin of unerupted teeth via enamel defects or the cemento-enamel junction (CEJ).(6)

Regardless of the etiology, dentists should have thorough understanding of this condition since it can assess them in early diagnosis, offer effective treatment and prevent PIER associated complications. (7) The reported PEIR defect prevalence was reported in several studies as a range from 0.7% to 27.3% at the subject level and from 0.32% to 3.5 % at the tooth level. Several studies assessed the prevalence of PEIR in the reported studies in various populations (Table 1).

Table I: Prevalence of PEIR in the previous studies in different populations

Author/Year	Type of study	Type of radiograph	Country	Age of subjects (Years)	Subject prevalence No. (%)	Tooth prevalence No. (%)
Seow et al. (1999a) (1)	Prospective	Bitewings	Australia	6–10	126/1959 (6 %)	163/9,919 (2 %)
Seow et al. (1999b) (8)	Prospective	Panoramic	Australia	3.5–25	42/1281 (3 %)	57/11,767 (0.5 %)
Nik & Abdul Rahman (2003) (9)	Retrospective	Panoramic	Malaysia	Below 20	275/1,007 (27.3 %)	309/14,554 (2.1 %)
Ozden and Acikgoz (2009) (10)	Retrospective	Panoramic	Turkey	14–73	27/9,570 (1.55 %)	28/2,922 (0.95 %)
Wang et al. (2013) (11)	Retrospective	Panoramic	China	3.6-12.5	6/707(0.85%)	6/8,171(0.7%)
Al-Batayneh et al. (2014) (12)	Prospective	Panoramic	Jordan	6–15	128/1,571 (8.1 %)	128/20,788 (0.62 %)
Uzun et al. (2014) (13)	Retrospective	Panoramic	Turkey	18-72	40/5554(0.7%)	N/A
Demirtas et al. (2016a) (14)	Retrospective	Panoramic vs. CBCT	Turkey	7-72	23/733 (3.14%) vs 70/733 (9.5%)	23/4,096(0.068 %) vs 79/4,096 (1.93%)
Demirtas et al. (2016b) (15)	Retrospective	CBCT	Turkey	N/A	42/278 (15.1%)	48/1348(3.5%)
Manmontri et al. (2018) (16)	Retrospective	Panoramic	Thailand	4-20	26/1599 (1.63%)	29/9060 (0.32%)
Konde et al. (2018) (17)	Retrospective	Panoramic	India	Below 12	136/1000 (13.6%)	136/11300 (1.20%)
Asokan et al. (2021) (7)	Retrospective	Panoramic	India	3-14	161/5012 (3.2%)	173/47660 (0.4%)
Gurd6n et al. (2023) (18)	Retrospective	Panoramic	Hungary	7-22	49/3143 (1.56%)	55/22400 (0.25%)

CBCT: Cone Beam Computed Tomography; N/A: not available; No.: number: PEIR: Pre-eruptive intracoronal resorption

Although many studies have focused on lesion prevalence worldwide, no research has investigated the prevalence of PEIR in children and adolescents in Yemen. For this reason, it is important to determine the prevalence of the lesion to increase dentist knowledge and awareness of the lesion and add study results to the pediatric dentistry curriculum. This study aimed to determine the prevalence of PEIR in unerupted permanent teeth of Yemeni children and adolescents using archived digitalized panoramic radiographs. In addition, this study represented the factors and/or dental conditions that may be associated with the lesion, which may help researchers understand the hidden etiology of the disease.

MATERIALS AND METHODS

Ethical approval

The study protocol was approved by the Institutional Review Board and Institutional Ethical Committee, Saba University, Sana'a, Yemen (approval no. 20-01) and following the STROBE guidelines. This study waived from the informed consent by the Institutional Review Board and Institutional Ethical Committee.

Sample size calculation

By using R software (version 4.2.1; packages: epiR), to calculate PEIR prevalence. A total of 385 digitalized panoramic radiographs of the unerupted permanent teeth of Yemeni children and adolescents younger than 16 years were needed. Proportion (p) = 0.50, Confidence Interval (CI) =0.95, relative error (E) = 0.1, and absolute error (d) =0.05 of the 1000 archived digitalized panoramic radiographs, only 487 radiographs were selected based on the following inclusion and exclusion criteria, as shown in the flowchart (Figure 1).

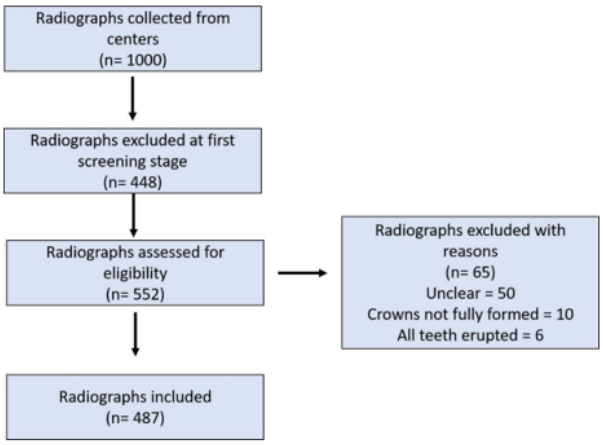

Figure 1: Flow chart shows the process of selecting digitalized panoramic radiographs.

Study design

This cross-sectional study was performed on 487 archived digitalized panoramic radiographs (males 243 and females 244) of Yemeni children and adolescents aged 6–15-year-old obtained from private scan centers in three main districts of Yemen: North (Sana'a), Middle (Taiz), and South (Aden). These private radiological scan centers are diagnostic imaging centers with facilities for radiographic imaging and had permission to share copies of digitalized panoramic radiographs.

Radiographic examination

Samples were collected from the archives of radiological scan centers and assessed between February 2020 and January 2021. One thousand panoramic radiographs were explored and filtered to 487 radiographs, based on the inclusion and exclusion criteria for sampling and randomization. Using a simple random sampling method, 487 radiographs were coded and used. The coding key was performed by one of the authors (MA) and concealed from the two observers who assessed and performed the measurements (SA and HS). In addition, the age, name, and gender of all scans were concealed from the observers by one of the authors (RA) prior to scan interpretation.

Inclusion criteria

Good-quality digitalized panoramic radiographs of participants from 6-15 years old with at least one unerupted tooth were included in this study. The included unerupted teeth should have complete crown formation and located below the occlusal plane or completely covered by bone and/or mucosa. No overlapping of the unerupted teeth with the adjacent structures was noted.

Exclusion criteria

Patients with any congenital conditions that can affect dental structure, such as dentinogenesis imperfecta, amelogenesis imperfecta, or bone pathology, were excluded.

Data collection

Digitalized panoramic radiographs of participants age range–6-15 years were screened for associations with patient records. The following data were reported for each radiograph: demographic details, such as age, gender, dentition stage, and the number of unerupted teeth were documented. A tooth was considered unerupted when it was covered by bone and/or mucosa and situated beneath the occlusal plane, as defined by Uzun et al. in 2015.(13) In addition, tooth type (incisors, canines, premolars, and molars) and its position in the jaw (right or left; maxilla or mandible). The location of the PEIR in the coronal dentin was recorded as either mesial, central, or distal according to the criteria outlined by Seow et al. (1999b). (8) As well, the size of the PEIR was assessed using the modified criteria based on its mesio-distal width in the coronal dentin and its extent to the adjacent structures (Ozden & Acikgoz,

2009).(10) These modified criteria categorized the size of the PEIR into 5 grades: Grade I (lesion ≤1/3 of the dentin thickness), Grade II (lesion >1/3, but <2/3 of the dentin thickness), Grade III (lesion >2/3 of the dentin thickness, but not involving enamel), Grade IV (lesion involves the enamel and dentin), and Grade V (lesion involves the pulp chamber).(10) Ectopic position which is any deviation in the PEIR-affected tooth long axis from its normal path was recorded. Supernumerary or fused teeth, hyperdontia or hypodontia, impaction, dense in dente, and taurodontism were documented. The condition of the predecessor primary tooth was assessed to evaluate the presence of dental caries, root canal treatment, restoration, and/or periapical infection.

Calibration of examiners

Digitalized panoramic radiographs were analyzed by two examiners, a pediatric dentist and an oral and maxillofacial radiologist (SA, HS) for calibration and reproducibility purposes. Calibration was performed to detect and interpret the PEIR lesions using 40 panoramic radiographs, both with and without PEIR, which were excluded from the final study. An additional set of 20 radiographs was used to assess both inter-examiner and intra-examiner agreements. The kappa values for intra-examiner agreement for each examiner were 0.86 and 0.82, and for inter-examiner agreement, the kappa value was 0.9.

Statistical analysis

IBM SPSS Statistics software (version 28.0, Armonk, NY, IBM Corp) was used for data analysis. The mean and standard deviation of the participants' ages were calculated. The subjects were then categorized into two groups: one group exhibited PEIR defects, and the other group showed the absence of these defects. To assess statistical differences between these two groups, the chi-square test was used considering gender, stage of dental development, presence of specific dental conditions, and developmental anomalies.

The same test was applied to the PEIR groups to determine any statistical differences related to the condition of the primary predecessor tooth. The significance level was set at $p \leq 0.05$.

RESULTS

One thousand digitalized panoramic radiographs from different radiological scan centers were collected; 448 radiographs were excluded in the first screening stage and 60 radiographs were excluded for different reasons, as described in the flow chart. This study included 487 radiographs (Figure 1).

Digitalized panoramic radiographs were collected from 487 patients (males=243, females=244) and included according to the study inclusion and exclusion criteria. The Mean age of males was 11.28 years with a standard deviation of 2.23, and females was 11.48 with a standard deviation of 2.46.

Of the 487 panoramic radiographs examined, 4927 unerupted teeth were examined, with 14 of them having PEIR defects, which accounted for (14/4927) 0.28% of all examined unerupted teeth, and all of them were not in the same subject (14/ 487) 2.9% of overall panoramic radiographs. The subject prevalence of PEIR among the different Yemeni districts was described as follows: North (Sana'a) 2.3%, Middle (Taiz) 5.4%, and South (Aden) 2.9%, while tooth prevalence was described as the following: North (Sana'a) 0.21 %, Middle (Taiz) 0.57%, and South (Aden) 0.36% (Table 2).

Table II: Prevalence of PEIR according to the district-wise.

District	Male	Female	No. of subjects examined	Subject prevalence of PEIR	No. of unerupted teeth examined	Tooth prevalence of PEIR
				Present No. (%)		Present No. (%)
North (Sana'a)	182 (74.9%)	161 (66.0%)	343	8 (2.3%)	3679	8 (0.21%)
Middle (Taiz)	24 (9.9%)	50 (20.5%)	74	4 (5.4%)	694	4 (0.57%)
South (Aden)	37 (15.2%)	33 (13.5%)	70	2 (2.9%)	554	2 (0.36%)
Total	243 (100%)	244 (100%)	487	14 (2.9%)	4927	14 (0.28%)

No.: number: PEIR: Pre-eruptive intracoronal resorption

In children aged 6-12 years, 14/308 (4.5%) examined digitalized panoramic radiographs showing PEIR defects, compared to 0/179 (0%) in those over 12 years of age. There was a statistically significant difference in the prevalence of PIER between the two age groups (p=0.004). Among 243 panoramic radiographs of males (n=8, 3.3%) showed PEIR defects, whereas in 244 panoramic radiographs of females (n=6, 2.5%) showed PEIR defects. A gender-based comparison showed no statistically significant differences in PEIR defects (p=0.582).

The prevalence of PEIR defects in relation to the dental arch, arch side, location, defect size, and dentation stage was assessed. Most of the PEIR defects were detected in the maxillary arch (n=11, 78.6%) compared to the mandibular arch (n=3, 21.4%). Most of the lesions were located on the left side of dentition (n=13, 92.9%) rather to the right side (n=1,7.1%). Statistically significant differences were noted in the PEIR defects related to dental arch type (p <0.001) and arch side (p <0.001). The PEIR defect was located commonly in the mesial aspect of the crown (n=7, 43.75%) followed by central aspect of the crown (n=6, 37.5%) then the distal aspect of crown (n=3,18.75%). In this study, the most common

size of the defect was grade 1 (n=7, 50%), followed by grade II (n=5, 35.7%) and grade V (n=2, 14.3%). The location and size of the lesions showed a statistically significant difference (p<0.001) (Figure 2). Regarding the dentition stage, the majority of PEIR was observed in the mixed stage (n=11, 78.6%), followed by the permanent stage (n=2, 14.3%), then the primary stage (n=1, 7.1%). The dentition stage was significantly different between the groups (p= 0.009) (Table 3).

Figure 2: A panoramic radiograph showed size II PEIR lesion in the upper left canine.

Table III: Prevalence and comparison of PEIR in relation to the dental arch, arch side, location, size of the defect and dentition stage.

Variables		Prevalence of PEIR Present No. (%) [95% CI]	Value
Dental arch	Maxilla	11 (78.6%)	<0.001*
	Mandible	3 (21.4%)	
	Total	14 (100%)	
Arch side	Right	1 (7.1%)	<0.001*
	Left	13 (92.9%)	
	Total	14 (100%)	
Location	Mesial	5 (35.7%)	<0.001*
	Mesial & Central	1 (7.1%)	
	Mesial, Central & Distal	1 (7.1%)	
	Central	4 (28.6%)	
	Central& Distal	1 (7.1%)	
	Distal	2 (14.3%)	
	Total	14 (100%)	

CONTINUE

Table III: Prevalence and comparison of PEIR in relation to the dental arch, arch side, location, size of the defect and dentition stage. (CONT.)

Variables		Prevalence of PEIR Present No. (%) [95% CI]	Value
Defect size	Grade I	7 (50.0%)	<0.001*
	Grade II	5 (35.7%)	
	Grade III	0 (0%)	
	Grade IV	0 (0%)	
	Grade V	2 (14.3%)	
Dentition stage	Primary	1 (7.1%)	0.009*
	Mixed	11 (78.6%)	
	Permanent	2 (14.3%)	

No.: number, PEIR: Pre-eruptive intracoronal resorption

In the maxillary arch, PEIR was commonly found in the second premolar (36.36%), followed by the second molar (27.27%), whereas the third molar was affected equally the first premolar, first molar, and canine (9.09%) (Table 4). In the mandibular arch, PEIR was commonly found in the second premolar (66.67%). Moreover, second molar was the second tooth affected by PEIR (33.33%) (Table 4).

Table IV: Prevalence of PEIR according to location.

Unerupted teeth	No. teeth with PEIR in each location						Total No. (%)
Location	Mesial	Central	Distal	Mesial & central	Mesial & central& distal	Distal & central	
Maxilla							
Canine	-	-	1	-	-	-	1 (9.09%)
First premolar	1	-	-	-	-	-	1 (9.09%)
Second premolar	1	1	-	-	1	1	4 (36.36%)
First molar	-	-	1	-	-	-	1(9.09%)
Second molar	2	1	-	-	-	-	3 (27.27%)
Third molar	-	-	-	1	-	-	1 (9.09%)
Mandible							
Second premolar	1	1	-	-	-	-	2 (66.67%)
Second molar	-	1	-	-	-	-	1 (33.33%)
Total	5 (35.71%)	4 (28.57%)	2 (14.29%)	1 (7.14%)	1 (7.14%)	1 (7.14%)	14 (100%)

No.: number: PEIR: Pre-eruptive intracoronal resorption

Among the coexisting factors, ectopic positioning of the affected tooth/adjacent teeth (41.18%) and dense in dente of other teeth (23.53%) were the most commonly detected factors. Other factors were found as carious preceding primary teeth (11.76%), restored primary teeth (5.88%), impacted teeth (5.88%), and periapically infected preceding primary teeth (5.88%). No coexisting supernumerary teeth, fused teeth, hypodontia, hyperdontia, endodontically preceding primary teeth, microdontia, or odontome were observed.

DISCUSSION

This study aimed to determine the prevalence of PEIR in Yemeni children and adolescents ages 6-15 years by using archived digitalized panoramic radiographs. PEIR is one of the most difficult lesions to be detected and diagnosed clinically. Radiographic examination is an important diagnostic tool that allows the early detection and identification of hidden lesions, such as PEIR. In agreement with our results, there were no obvious differences in the prevalence of intracoronal resorption with regard to gender.(1,7-18)This could be explained by the fact that this disease is not affected by gender.

Regarding to age, participants' ages was from 6-15 year-old which was similar to the study of Al-Batayneh et al., 2014.(12) In terms of the prevalence of PEIR in different age groups, the current study had a higher prevalence of PEIR in children of 6-12 years old age compared with those in the age group >12 years old. The explanation for this result could be that there is a better chance to detect the most unerupted teeth in the 6-12 years old age in the other age groups. In addition, children less than six years of age were not included, as some of the permanent crowns were not fully formed. Moreover, according to The American Academy of Pediatric Dentistry (AAPD) guidelines, a panoramic radiograph is recommended mostly for mixed dentition; otherwise, bitewings and occlusal would be better in the primary dentition.

In this study, the subject prevalence of PEIR in a sample of the Yemeni population was 2.9%. This result was consistent with the results of other studies (7,8,14) which reported a subject prevalence of 3.2%, 3%, and 3.14%, respectively. While other studies were inconsistent with this study with a subject prevalence of 27.3%, 1.55%, 0.85%, 8.1%, 0.7%, 1.63%, 13.6% and 1.56%,

respectively. (9-13,16-18) While some other studies showed different subject prevalences 6%, 9.5%, and 15.1%, respectively, because of their use of different radiographic methods that have different image clarity as CBCT and bitewing. (1,14,15)

Regarding the tooth prevalence of PEIR, the current study showed 0.28 %, which was within the range reported in previous studies. (7,8,10-12,16,18) Their reports on the tooth prevalence of the PEIR were ranged from 0.25%-0.95%. They also reported variations in the prevalence of panoramas, bitewings, and CBCT. The reason behind these results was that panorama, which is 2 dimensional images, showed a less clear image of the anterior teeth and more overlapping of posterior teeth.(3) Moreover, CBCT provides high-resolution and three-dimensional images without structure overlapping.(14) The use of a panoramic radiograph is relatively easy, requiring less cooperation from the child, which offers a view of the maximum number of unerupted teeth in the child. (3) Also, panoramic radiographs have less radiation exposure than CBCT, as it follows the principle of As Low As Reasonably Achievable (ALARA). (19)

Concerning the prevalence of PEIR in the maxillary and mandibular arches, there was a significant difference between the maxilla and mandible, where maxillary teeth were included more than mandibular teeth. This could be explained by the fact that most coexisting dental factors were found in the maxillary arch; therefore, most PEIR defects were found in the maxilla. This is in agreement with the results of previous studies.(9,10) However, other studies (1,12-18) had more prevalence in the mandible. However, another study showed no significant differences between the arch type. (7)

With respect to the arch side, the results of the present study showed a significant difference between the right and left sides. Most PEIR defects were observed on the left side. These results were consistent with studies that showed a higher prevalence on the left side of the dentition. (10,16) However, this was inconsistent with the results of other studies (12,13) who reported that most of the studied lesions were on the right side. Moreover, some studies reported a midline involvement. (10,13,15)

Concerning the PEIR location, most of the lesions were located on the mesial surface which was similar to other studies. (7-9,12,17) In contrast to these results, the central part of the crown was the most involved in many studies. (1,10,13-16) This could be explained by the direction of the forces exerted by ectopic teeth. Another study showed that most defects were located on the centroocclusal surface. (18)

Following the for mentioned modified criteria proposed by Ozden & Acikgoz, 2009 to determine the size of PEIR which are similar to the study of Manmontri et al., 2018 which gave more grades of the lesion sizes.(16) The current study reported that most of the lesions were less than 1/3 of dentin thickness which was similar to most of studies in the literature.(7,8,9,12,15-18) It was notable that no PEIR defects were identified in the mandibular incisors and maxillary incisors. This phenomenon can be explained by several factors that influence the accuracy of landmark identification in children: the clarity of the landmark definition, resolution and sharpness of images, anatomical complexity of tissues, and experience of observers, particularly in pediatric dentistry. (20) In addition, the absence of PEIR defects in this area could be attributed to the fact that they were outside the focal trough region of the panoramic radiograph. (7)

Regarding dentition stage, this study selected samples with mixed or permanent dentition. Most of the defects were in mixed dentition. This could be explained by the fact that many unerupted teeth need to be evaluated during mixed dentition.

In the present study, the second premolar was the most frequently affected tooth in both the maxilla and the mandible. This observation can be attributed to the abnormal forces exerted by ectopic teeth. However, previous studies have reported different PEIR positions. (8,10,12,13,16-18)
The result was similar to Asokan et al., 2021. (7)

The prevalence of coexisting dental factors was reported as follows: ectopic positioning of affected tooth/ adjacent tooth (41.18%) and dense in dente of other teeth (23.53%), both factors were the most common seen. While, the prevalence of carious preceding primary teeth, restored primary teeth, impacted teeth, and periapically infected preceding primary teeth was reported as (11.76%), (5.88%), (5.88%) and (5.88%), respectively. PEIR was mostly found in the ectopic position of the successor or the adjacent tooth. This can be explained by the fact that resorptive cells may be pushed into the protective layer of the tooth leading to intracoronal radiolucency/resorption. (7)

The findings of this research contribute to the knowledge of dental practitioners, encouraging them to thoroughly examine and assess panoramic radiographs of their patients. This study, along with a limited number of similar studies, investigated associated factors with PEIR. Moreover, it can help to understand why some recently erupted teeth have cavities with insufficient time to be affected by dental caries. It is important to acknowledge the limitations of this study, including the diagnostic challenges posed by panoramic radiographs, particularly in the maxillary arch where overlapping structures can hinder interpretation. A larger sample size would have increased the strength of the present study. Additionally, although CBCT could have yielded more accurate results, its limited availability in dental radiographic centers restricted this option. Furthermore,

especially in Yemen, the small number of CBCT scans available for the chosen age group made it difficult to obtain, as full-mouth CBCT has limited use in dentistry and its high cost and dose restrict its application.

CONCLUSION

Although the subject prevalence and tooth prevalence of PEIR were 2.9%and 0.28%, respectively, it is important that dentists evaluate the unerupted teeth on the radiographs. Therefore, understanding the prevalence of PEIR increases the awareness of early detection, management, and early treatment of lesions, which would decrease the time and cost of treatment for patients in the future.

ACKNOWLEDGEMENT

Thank you for Dr Abeer Al-Mashrqi and Dr Abdullah Al-hadi for their help.

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