Dental Research Journal

Original Article

Frequency of caries in triangular-shaped radiolucencies on periapical radiographs of maxillary deciduous second molars

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Received: 20-Feb-2021
Revised: 15-May-2021
Accepted: 03-Jun-2021
Published: 10-Dec-2021

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ABSTRACT

Background: Dentists might face various artifacts (such as triangular-shaped radiolucencies [TSRs]) during the assessment of radiographs and should be able to differentiate them from caries to avoid unnecessary treatments.

Materials and Methods: In this cross-sectional study, 109 maxillary second primary molars were evaluated in cooperative children aged 4–9 years, who had distal caries in their maxillary first primary molars. First, TSRs were recorded on periapical radiographs of each maxillary second primary molar's proximal surface. Then, after excavating distal caries in the adjacent teeth "D," a pedodontist examined the mesial surfaces of teeth "E." Chi-square test was used to compare the distribution of caries in different variables, and the kappa coefficient was applied to evaluate clinical and radiographic agreements. A $P < 0.05$ was considered statistically significant.

Results: Forty-four cases were found to be carious both clinically and radiographically, and 54 cases were noncarious by both methods, while for 11 cases, the diagnosis was controversial. No statistically significant difference was found between radiographic and clinical caries detection methods in children whose periapical radiographs contained TSRs, and most of the subjects had similar diagnoses. Value of caries detection sensitivity, specificity, positive predictive value, and negative predictive value in TSRs was 88%, 92%, 90%, and 90%, respectively.

Conclusion: Considering high radiographic sensitivity for caries detection in TSRs, clinicians should be more cautious about them being carious or not, and both radiographic and clinical examinations are necessary. Further, to avoid misinterpretation in radiographs, additional education is necessary for young dentists.

Key Words: Artifact, deciduous tooth, dental decay, dental radiography

INTRODUCTION

Dental caries is a multifactorial disease caused by an interaction between the tooth, microorganisms, and diet. Subsurface mineral loss in the outer enamel surface would result in an early carious lesion.[1] Although early diagnosis of incipient carious lesions can prevent destructive episodes, detecting incipient interdental lesions is still challenging, and clinicians tend to overlook them in routine dental examinations.[2] Considering the high diagnostic value

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Website: www.drj.ir
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www.ncbi.nlm.nih.gov/pmc/journals/1480

How to cite this article: Tabari M, Yazdizadeh M, Abesi F, Khafri S, Dozin JV. Frequency of caries in triangular-shaped radiolucencies on periapical radiographs of maxillary deciduous second molars. Dent Res J 2021;18:104.

of radiographic examinations for caries detection and progression control, and also for evaluating existing restorations and periodontal condition, 2–4 posterior bitewing radiographs (plus one panoramic radiograph and/or selective periapical radiographs) are usually prescribed for a complete dental checkup for each new patient.[3]

The requirements for a proper radiographic assessment are adequate knowledge about tooth anatomy, caries radiographic image, and alertness about possible superimposition effects.[4] During the evaluation of radiographic images, dentists might face various artifacts that should be differentiated from dental caries or anomalies to prevent unnecessary treatment or false-positive diagnosis. Cervical burnout and the Mach band effect are good examples of classical radiographic artifacts.[5]

The morphology of deciduous molars in the proximal surfaces and the concavity of these surfaces might increase the risk of developing caries. Triangular-shaped radiolucencies (TSRs) might be present in the mesial aspects of upper molars on radiographs, due to their anatomic characteristics, such as a rhomboid crown shape, mesial contact point with the adjacent teeth, having a palatal cusp, and thin mesiodistal dimension at the cervical parts of the crown as compared with the coronal parts [Figure 1]. This phenomenon's prevalence is 60.3% in maxillary deciduous second molars and 24.8% in maxillary permanent first molars.[4,6,7]

Although TSRs resemble carious lesions, they still can be differentiated from them because, unlike carious lesions, TSRs have well-outlined borders, do not follow the spreading pattern of dentinal caries toward the pulp, and do not necessarily accompany enamel caries. Considering this resemblance and the sparse knowledge about TSRs, there is an increased risk for cavity preparation in healthy molars because of false-positive diagnoses.[4,8]

Figure 1: Example of triangular-shaped radiolucency on a maxillary deciduous second molar posteroanterior radiograph.

This study aimed to determine the frequency of caries in TSRs on periapical radiographs of maxillary deciduous second molars.

MATERIALS AND METHODS

In this cross-sectional study, after obtaining informed consent, 109 maxillary deciduous second molars were evaluated in 94 pediatric patients aged 4–9 years, referring to the Department of Pediatric Dentistry, School of Dentistry, Babol University of Medical Sciences (2016–2017). Of the study participants, 50.5% were male and 49.5% were female, with a meanage of 6.25 ± 1.59 and 6.2 ± 1.14 years, respectively.

This study's inclusion criteria were cooperative children with caries in the marginal ridge and the distal surface of the upper tooth D or candidates of tooth D extraction; this would make the mesial surface of the adjacent tooth E accessible for visual examination during the preparation of tooth D. Moreover, before starting any treatment procedure on tooth D, TSRs should have been observed in the mesial aspects of tooth E on radiographs. Patients with clinical caries on mesial surfaces of teeth E or disqualified radiographs were excluded.

All the periapical radiographs were obtained under a radiologist's supervision using Mindray Soredex (Finland) and a pediatric film holder, XCP (Dentsply, Rinn Co, USA), with exposure conditions of 60 kVp and 7 mA and variable exposure time considering each patient's body mass. All the radiographs were developed by an Air-Techniques Peri-Promaintenance developer (Germany). When the presence of TSRs in the proximal surfaces of maxillary teeth E was confirmed, teeth D were either extracted or underwent distal cavity preparation. Then, the mesial surfaces of teeth E were examined by a pediatric dentist using an explorer and air syringe under the dental unit light, and then, the data were recorded. Sound enamel surfaces with brown spots or white spots were also considered noncarious.

The data were analyzed with SPSS statistics software (version 20; SPSS Inc., IBM, Armonk, NY, USA). Chi-square test was used to compare the frequency of caries among different study variables. The kappa coefficient was used to assess the agreement between radiographic and clinical measures. The level of significance was set at $P < 0.05$.

RESULTS

In this cross-sectional study, 109 maxillary deciduous second molars were evaluated in 94 pediatric patients.

Radiographic examinations showed that 45% of the subjects had caries, and 55% were caries-free, while according to clinical examinations, 45.9% of the subjects had caries, and 54.1% were caries-free. Statistical comparison between radiographic and clinical examinations revealed clinical and radiographic diagnostic agreement in 98 subjects, while there was diagnostic controversy for 11 cases.

There was no statistically significant difference between clinical and radiographic caries detection, and the two methods exhibited agreement in 80% of cases ($P < 0.001$) [Table 1].

The radiographic diagnostic sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for TSRs were as follows:

- Sensitivity: 88% (79%–97%)
- Specificity: 92% (84%–99%)
- PPV: 90% (81%–98%)
- NPV: 90% (82%–98%).

Caries conditions of the examined teeth detected radiographically and clinically are presented separately in Tables 2 and 3, considering the affected jaw side and the subjects' age and gender. No statistically significant difference was found between the maxilla's right and left sides on TSR, including radiographs, whether clinically or radiographically ($P = 0.47$ and $P = 0.81$, respectively). The participants were divided into two age groups of ≥6 and <6 years. No statistically significant difference was found between different age groups for tooth decay detection clinically or radiographically ($P = 0.72$ and $P = 0.79$, respectively). Further, no statistically significant difference was found between female and male participants, regarding caries experience on the TSR, including radiographs, whether clinically or radiographically ($P = 0.49$ and $P = 0.91$, respectively) [Tables 2 and 3].

Table 1: Agreement assessment between clinical and radiographic observations

Radiographic assessment	Clinical observation*		
	Carious, *n* (%)	Noncarious, *n* (%)	Result
Carious	True positive, 44 (88)	False positive, 5 (8.5)	Kappa=0.769
Noncarious	False negative, 6 (12)	True negative, 54 (91.5)	*P*<0.001**

*Values in table are *n* (%). Kappa coefficient was used.

Table 2: Comparison of caries frequency according to the radiographic assessments regarding different study variables

Variables	Caries*		*P***
	Carious, *n* (%)	Noncarious, *n* (%)	
Involved side			
Left (*n*=52)	24 (46.2)	28 (53.8)	0.81
Right (*n*=57)	25 (43.9)	32 (56.1)	
Age			
≥6 (*n*=63)	29 (46)	34 (54)	0.79
<6 (*n*=46)	20 (43.5)	26 (56.5)	
Gender			
Female (*n*=54)	24 (44.4)	30 (55.6)	0.91
Male (*n*=55)	25 (45.5)	30 (54.5)	

*Values in table are *n* (%). Chi-square test was used

Table 3: Comparison of caries frequency according to the clinical assessments regarding different study variables

Variables	Caries*		*P***
	Carious, *n* (%)	Noncarious, *n* (%)	
Involved side			
Left (*n*=52)	22 (42.3)	30 (57.7)	0.47
Right (*n*=57)	28 (49.1)	29 (50.9)	
Age			
≥6 (*n*=63)	28 (44.4)	35 (55.6)	0.72
<6 (*n*=46)	22 (47.8)	24 (52.2)	
Gender			
Female (*n*=54)	23 (42.6)	31 (57.4)	0.49
Male (*n*=55)	27 (49.1)	28 (50.9)	

*Values in table are *n* (%). Chi-square test was used.

DISCUSSION

In this study, caries prevalence was evaluated on TSRs including radiographs. TSRs might be present in the mesial aspects of upper molars on radiographs due to their anatomic characteristics.

Few studies have focused on TSRs so far. Khayam *et al*. conducted a study on the relative prevalence of TSRs on bitewing radiographs of the first and second permanent molars, reporting that TSRs were observed

only on the mesial surfaces of maxillary teeth, and no evidence of TSRs was found on the distal surfaces of maxillary teeth or in any part of mandibular teeth. Another study by Kuhnisch *et al*. on the prevalence of TSRs on bitewing radiographs revealed that TSRs most frequently were present on deciduous maxillary second molars, deciduous maxillary first molars, and permanent maxillary first molars, respectively. However, none of the lower molars, whether primary or permanent, displayed such a phenomenon. Since lower molars do not have a rhomboid crown shape (their crown is usually rectangular) or a large lingual or Carabelli cusp-like maxillary molars, we do not expect to find TSRs in their radiographs.[4,5]

Our results showed no significant difference in tooth decay detection clinically or radiographically, regarding the patient's gender. Previous studies have shown higher caries prevalence in females in different age groups (because of several factors such as hormones, the difference in oral hygiene, cariogenic microorganisms activity, and variable age for tooth eruption), which is not inconsistent with our findings, since we conducted a descriptive study, and one of our inclusion criteria was the presence of TSRs on radiographs.[9,10]

According to our data, there was no significant difference between clinical and radiographic examination methods on TSRs containing radiographs. Movahedian *et al*. conducted a similar study on TSRs, reporting that in 79% of cases, TSRs were misdiagnosed as sound tooth surfaces or Mach band effect while only 1% of TSRs were diagnosed correctly. Although such wrong diagnoses highlight examiners' inadequate knowledge about TSRs, they would not lead to unnecessary treatments. They also reported 20% of false-positive diagnoses. Considering the 20% false-positive results in the mentioned study and 11 controversial cases (20%) in the present study, more training courses are required in this area for dental practitioners to avoid possible unnecessary and invasive treatments in the future.[11]

Several studies have evaluated interdental caries and common artifacts, including cervical burnout or Mach band effect. However, they have mostly focused on radiographic efficacy in caries or artifact detection, of which a study by Mialhe *et al*. is a good example. They reported that clinical examinations accompanied by bitewing radiographic interpretations might dramatically reduce false-positive diagnoses. Furthermore, da Silva *et al*. and de Araujo *et al*. reported that using radiographic examinations alone is not reliable for detecting incipient proximal caries, and radiographic evidence should be accompanied by clinical examinations. Foster Page *et al*. emphasized the necessity of considering bitewing radiographs in the diagnostic route to improve the management of carious lesions in young children. These findings are consistent with the present study, and since radiographic sensitivity for caries detection and the PPV rate were both high, dental practitioners should decide about treating these cases cautiously.[12-15]

Weerhejim *et al*. emphasized the importance of accompanying radiographic and clinical examinations. In age groups of 14, 17, and 20 years, 26%, 37.5%, and 50% of clinically intact tooth surfaces, respectively, were diagnosed as false positive by radiographic interpretations. A study by Espelid *et al*. revealed that 15.7% of intact tooth surfaces with caries-like radiolucencies were diagnosed as false positive. Consistent with the above studies, the last two studies also emphasize the necessity of radiographic and clinical examinations.[16,17]

Ahrari *et al*. and Todorova *et al*. evaluated the validity of laser fluorescence (DIAGNOdent pen) and near-infrared reflection for detecting early proximal cavities. Their findings showed that combined diagnostic approaches comprising clinical and radiographic examinations are still needed.[18,19]

CONCLUSION

Since radiographic sensitivity of caries detection for TSRs was high, we recommend that clinicians be more cautious about their carious or noncarious nature in cases of TSRs, and radiographic interpretations should be accompanied by clinical examinations. Further, improving clinicians' knowledge about TSRs might help prevent radiographic misinterpretations.

Financial support and sponsorship
Nil.

Conflicts of interest
The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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