RESEARCH

Frequency of non-carious triangular-shaped radiolucencies on bitewing radiographs

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Objectives: The assessment of bitewing radiographs requires knowledge of radiographic anatomy and pathology, and the comprehension of possible effects of superposition which may lead to false positive diagnoses. Based on a clinical case report in which non-carious radiolucencies were discovered on the mesial surfaces of upper molars, this phenomenon, which has not been reported before, was explained. Due to the anatomical characteristics of the rhombic tooth, in particular the crown’s receding mesial surface from the mesiobuccal towards the distopalatal side, which is combined with an often prominent palatal cusp and a smaller mesiodistal diameter at the cervical neck, radiolucencies – normally typical caries indicators – can sometimes be observed on the mesial surfaces of upper primary and first permanent molars on bitewings. These triangular-shaped radiolucencies (TSRs) can therefore be attributed to the effects of superposition. The aim of the present epidemiological study was to assess the radiographic frequency of TSRs.

Methods: As part of a clinical–radiographic follow-up examination involving 11–12 year old children (n = 113), both the caries status (World Health Organization (WHO) standard) and the frequency of TSRs were recorded.

Results: TSRs were most frequently present on upper second primary molars (60.3%). 35.5% of the upper first primary molars and 24.8% of the upper first permanent molars displayed TSRs. However, none of the lower primary and/or permanent molars displayed this phenomenon.

Conclusion: In the mesial surface of upper primary and permanent molars where the frequency of TSRs was fairly high, it may be essential to distinguish this change from approximal caries.

Keywords: bitewing radiographs; caries diagnosis; false positive results

Introduction

Thanks to their high diagnostic information value, bitewing radiographs are used in order to help detect both occlusal and approximal caries lesions, and are considered a principal diagnostic examination method for children and adolescents, along with visual examination.1 During the evaluation of bitewings, dentists frequently have to deal with artefacts that conflict with the pathological findings and may lead to unnecessary treatment after false positive diagnoses. Known artefacts are the burn-out and Mach band effects.2–4 We observed radiolucencies otherwise linked with caries on the mesial surfaces of upper primary molars that cannot be attributed to either of the two effects while still not bearing an obvious relationship with any carious process. The phenomenon was first discovered in a 5-year-old girl of whom bitewing radiographs had been taken to investigate some incipient carious lesions on interproximal surfaces (Figure 1). On the mesial surface of the maxillary right primary second molar (tooth 55), a distinct radiolucency but no corresponding enamel lesion was registered. In addition, the sharply defined occurrence, triangular in shape and in the direction of

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the pulp, by all means mismatched the location of a lesion that – if present – would have stretched along the dentin tubules towards the pulp. The right/left comparison revealed a different situation for the maxillary left primary second molar (tooth 65). Here, in addition to the triangular radiolucency, an enamel caries lesion was present. But again the mark was inconsistent with the expected caries extent. We therefore opted for additional fibre optic transillumination (FOTI) in order to examine the affected tooth surfaces. The greyish translucency observed in connection with tooth 65 unambiguously indicated a dentin involvement of the carious process; the restorative therapy that followed confirmed this diagnosis. For tooth 55, the result was negative, making a false positive diagnosis likely to be obtained from the radiographs.

Figures 1  Clinical-radiographic situation of a 5-year-old patient. (a) The teeth of the upper jaw seem clinically to be caries-free; the primary central incisors were lost due to trauma. (b) The bitewing radiographs show triangular-shaped radioluences on the mesial surfaces of the upper right molars. (c) In addition, the upper left primary second molar has a carious dentin lesion on the mesial surface.
So, how can this effect be explained? While relevant publications failed to give evidence, the interdisciplinary exchange finally defined the described radiolucency as an effect of superposition, which must be blamed on the particular anatomy characterizing the clinical crown of maxillary molars. However, several aspects have to be taken into account: rhomb-shaped from an occlusal point of view and with the mesial surface running from the mesiobuccal to the distopalatal side, the crown has just a small contact point with the neighbouring tooth on the mesial surface. In addition, the mesiodistal width is significantly smaller at the cervical neck than it is at the crown and the radiographic technique used to obtain bitewing radiographs causes exposure of the crown’s mesial portion, which therefore appears more radiolucent than the rest of the crown. From the occlusal to the approximal side, the borderline of the radiolucency is generally well marked by the more or less prominent palatal cusp whose mesial edge superposes the crown in the radiographic image. The non-caries-associated radiolucencies witnessed on upper primary as well as upper permanent molars – so-called triangular-shaped radiolucencies (TSRs) – are therefore the result of the mesial surface’s exposure caused by X-ray beam movements on the one hand and the palatal cusp superposing the crown on the other (Figure 2). As we will be describing TSRs for the first time, we further aimed to investigate their frequency from bitewing radiographs taken in a child population.

Materials and methods

The study included 113 healthy adolescents aged between 11 years and 12 years (mean age 11.9 years). All subjects were participants in a longitudinal caries risk assessment study and familiar with annual clinical examinations. In 2001, the children were invited to take part in a radiographic investigation of their teeth, mainly to assess the prevalence of clinical–radiographic caries. After the study protocol had been explained in detail, the subjects and their parents gave their informed consent for participation in the research project. The study was approved by the Ethics Committee of the Friedrich-Schiller-University of Jena.

Prior to visual examination, all tooth surfaces were professionally cleaned with the Cavitron Jet airflow device (Dentsply DeTrey, Constance, Germany). All examinations were carried out under standardized conditions in a professional dental unit, using a dental light, mirror and air syringe. The surface heated decayed, missing, filled (DMF) index as well as the presence of initial caries lesions were recorded for each tooth surface in the entire dentition by a trained and experienced dentist (RHW) who used a 3.5-fold dental magnifying glass. Bitewing radiographs were captured from primary and permanent molars on E-speed films (EP 21 P; Eastman Kodak Company, Rochester, NY) with a Philips Oralix 65 kV X-ray unit (Philips, Eindhoven, The Netherlands). A film holder system (Kwik-bite; Hawe-Neos, Switzerland) was used. Exposure time was 0.4 s. The film was developed under standard conditions (Perimat Machine; Dürr Dental, Bietigheim-Bissingen, Germany). All bitewing radiographs were assessed independently by two calibrated examiners (JK, RHW) under standard conditions of illumination (exclusion of ambient light) at twofold magnification (X-Scope Lupe; Jordi Röntgentechnik AG, Basel, Switzerland). When the examiners came to different conclusions, they reassessed the corresponding radiograph(s), discussed their points and modified the diagnosis accordingly. The following criteria were used to assess the caries progression on the basis of bitewing radiographs: D0, sound; D1, a caries radiolucency in the outer half of the enamel; D2, a caries radiolucency in the inner half of the enamel; D3, a caries radiolucency in the outer half of the dentin; D4, a caries radiolucency in the inner half of the dentin. In cases where classification was impossible, the surface was discarded for the purpose of the study. In addition, the presence of TSRs was recorded for each approximal surface in the upper and lower primary and permanent molars from bitewing radiographs. The data were analysed with SPSS 12.0 (SPSS Inc., Chicago, IL) and Excel 2000 (Microsoft Corporation, Redmond, WA).

Results

The clinical–radiographically based caries prevalence amounted to 1.2 dfs and 0.8 DMFS for the whole dentition. Additionally, 1.2 initial caries lesions were recorded in the primary dentition under inclusion of the radiographically detected lesion; 1.8 surfaces of the permanent dentition also showed a D1 or D2 lesion. A TSR was present in 60.3% of the upper second primary molars, and in 35.5% and 24.8% of the upper first primary and permanent molars, respectively (Table 1). None of the lower primary and/or permanent molars showed this phenomenon. It was likewise not observed on the distal surfaces of primary and permanent molars.

Discussion

Given the recorded frequency, it becomes obvious that the impact of TSRs on the evaluation of bitewing radiographs should not be underestimated. Due to their higher occurrence in connection with first and second primary molars, however, specialists in paediatric dentistry will come across the phenomenon most often. Nevertheless, general dental practitioners should also be aware of it as it occurs on about one in four permanent first molars and because radiography with bitewing radiographs constitutes an important method of caries detection.
Figures 2. Examples of the anatomical characteristics of the maxillary right primary second molar (tooth 55): Due to (a) the rhombic crown shape, (b) the mesial surface diverges from the mesiobuccal corner to the distopalatal side. Superposition of the palatal cusp of tooth 55: (c) the often prominent palatal cusp causes (d) superposition of the crown and the palatal cusp. Triangular-shaped radiolucency on tooth 55: the previously mentioned factors as well as the significantly smaller mesiodistal diameter at the cervical neck compared with the crown (white arrows in (f)); the mesio-occlusal edge appears more radiolucent (black arrows in (e) and (f)).
In the differential diagnosis, TSRs are essentially distinguished by the configuration of the occurrence. In radiodiagnostics, the main criteria for differentiating between an approximal lesion of the dentin and a TSR are (1) the presence or absence of an approximal enamel lesion and (2) the spreading of a dentinal lesion towards the pulp as typical for caries and/or a well-defined TSR. Difficult cases are those in which both a carious lesion and a TSR are present. An involvement of the dentin is unlikely here if the enamel–dentin junction remains intact. If instead the enamel lesion stretches further, restorative measures will probably need to be taken.

In conclusion, after a description and explanation of TSRs, this epidemiological study has shown that the phenomenon is present frequently in upper primary and permanent molars. In the differential diagnosis it is possible to unambiguously distinguish triangular radiolucencies from carious lesions with the necessary knowledge of radiographic anatomy and pathology.

References