Value of bitewing radiographs for detecting approximal caries in 6-year-old children in the Netherlands

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International Journal of Paediatric Dentistry 2010; 20: 336– 340

Background. When diagnosing caries using clinical judgment only, the prevalence of approximal caries is highly underestimated. Yet, surveys on this topic predominantly included adolescents and young adults.

Aim. To determine the additional diagnostic value of bitewing radiographs in 6-year-old children and to detect approximal dentin caries in the primary dentition.

Design. A total of 50 children were assessed both clinically (dmfs, oral hygiene) and radiographically by two experienced dentists. The relation between

dmfs-scores and amount of plaque was established using Pearson's correlation coefficients at a significance level of 0.05.

Results. In nine patients (18%) it was impossible to make radiographs. Bitewing radiography appeared to have an additional effect of 97% when only caries in dentin is considered. The additional value for detecting inadequate restorations was 600%. Furthermore, the dmfs was highly correlated to the amount of plaque found.

Conclusion. Although not possible to achieve in all 6-year-old children, bitewing radiographs can reveal a considerable amount of carious surfaces and inadequate restorations, which appear clinically sound or adequate.

Introduction

The use of bitewing radiography has been part of many surveys. A wide array of authors conclude that when diagnosing caries using clinical judgment only, the prevalence of both occlusal and approximal caries would be highly underestimated¹⁻⁵. Most surveys on this topic include adolescents or young adults. For example, for 12-year-old children in Lithuania it was concluded that the diagnostic yield of bitewing radiographs is higher for approximal than for occlusal surfaces⁶. An additional diagnostic value of bitewing radiographs was reported only for approximal surfaces. Another survey among 8- to 12-year-old children concluded that not using bitewing radiography additional to clinical assessment would not result in a significant information-loss on caries diagnosis⁷.

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A more recent survey among 14-year-old children reported an underestimation of approximal caries of 86.8%⁸. A survey on detection of approximal caries in primary dentitions in 5-year-old Swedish children, considered to be 'low-risk' for caries development, reported an additional gain of 1.2 approximal carious lesions into dentin or enamel using bitewing radiography additional to visual examination and concluded that 33% of this low caries-risk population benefited from bitewing radiographs9. Furthermore, in this study, no other commonly used risk-factors than the dentist's overall judgment appeared to have a caries predictive ability.

Both from an epidemiological perspective and from the viewpoint of the general dental practitioner it is important to receive, on a continuing basis, new information on the magnitude of this uncertainty to further deal with epidemiological and clinical decisions. Therefore, the aim of this study was to test the hypothesis that bitewing radiographs in children aged 6 years have an additional diagnostic value.

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Materials and methods

Subjects

Participants were 6-year-old (regular) patients of two general dental practices with affinity for paediatric dentistry in several large communities in the Netherlands. A total of 197 patients were clinically examined in their own dental practice for other study purposes. All were considered for participation in this study, but 147 were excluded as they previously had radiographs taken at 5 years of age. Thus, the remaining sample consisted of 50 children.

Clinical examination

The oral health of the participants was assessed by two experienced, calibrated dentists, who had previously participated in comparable projects. The survey was carried out on dried tooth-surfaces using compressed air, light, mirror, and probe to remove dental plaque and debris. The amount of dental plaque was recorded using the simplified debris index (DI-S)¹⁰. Subsequently, the surfaces of all present teeth were examined according to WHO-criteria and dmfs could be computed. For this study, only the distal surfaces of primary canines as well as the approximal surfaces of the first and second primary molars were taken into account. A surface was recorded as decayed when it showed a white/ grey discoloration into dentine or as a discontinuity of the enamel. The surface of a restoration was considered inadequate when the tooth needed restorative treatment due to a carious lesion neighbouring the restoration or when the restoration was missing or fractured. Criteria are shown in Table 1. Interobserver agreement was calculated using Cohen's kappa and proved to be very good $(\kappa = 0.94)$, according to a standard interpretation of Cohen's kappa^{11,12}.

Radiographic examination

On the same day of the clinical survey two bitewing radiographs were taken by one of the authors (J.V.). Kodak Insight IP-02 (double-

Table 1. Clinical and radiographic criteria.

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Clinical criteria		
0 = sound tooth (no evidence of treated or untreated clinical dentine caries)		
3 = dentine caries		
6 = filled surface without decay		
7 = filled surface with decay not connected to the restoration		
8 = filled surface with decay connected to the restoration		
9 = filled surface with decay into the pulp		
I = inadequate restoration (a missing, partly missing or fractured		
restoration, marginal over- or underextension, open approximal		
contact with chance of food impaction)		
x = missing tooth		
Radiographic criteria		
0 no radiolucency visible in enamel and/or dentine		
1 radiolucency confined to the enamel		
2 a circumscribed radiolucency visible in the dentine (D ₃ -level)		
3 an adequate restoration		
4 an inadequate restoration (a missing, partly missing or fractured		
restoration, marginal over- or underextension, open approximal		
contact with chance of food impaction)		
5 a restoration in combination with a circumscribed radiolucency		
visible in the dentine		
6 a missing tooth surface		
7 no judgement can be made (due to overlap, orthodontic		
banding or dislocated film position)		

packed) films were used, held in Kwik-Bite film holders (HAWE-Neos) using a Satelec Xmind AC long cone 70 kV X-ray device with an exposure time of 0.35 s. Films were developed using a Dürr XR-24 (Bietigheim-Bissingen, Germany) pro developing system. The bitewing radiographs were examined with an X-ray desk viewer (Clive Craig Co., Oxnard, California, USA) without magnification. Surfaces that could not be assessed with certainty due to overlap, blurring of the film, dislocated film-position, were excluded. The remaining 705 surfaces were judged by two experienced, calibrated dentists. Inter-observer agreement was calculated using Cohen's Kappa and proved to be very good ($\kappa = 0.87$).

Statistics

The restorative index was calculated as follows: fs/ds + fs. Pearson correlation coefficient was used to determine the strength of the correlations (significance level 0.05).

Ethics

This study was approved by Medical Ethical Exam Committee (METC) of the VUMC, the

	This study $(n = 50)$	Nationwide survey 5-year-olds (n = 386)
DI-S (0–3) (oral hygiene)	1.29 (0.67): 0–3	
Ds	1.25 (2.45); 0–9	3.4 (6.33); 0–56
Ms	3.73 (7.40); 0–6	0.6 (2.91); 0–38
Fs	2.99 (3.74); 0–7	0.7 (2.04); 0–19
Dmfs	7.79 (9.75); 0–14	4.6 (7.99); 0–56
Restorative index	0.71	0.17

Table 2. Clinical outcomes compared with a nationwide study.

Values are given as mean (SD); range.

Netherlands. Informed written consent by the parents was obtained prior to the dental health assessment. One copy of the bitewing radiographs was left in the dental practices to benefit the regular dental check-up of the participants.

Results

Clinical

The outcomes on ds/fs/ms/dmfs, restorative index and simplified debris index are shown in Table 2 and compared with the results of a nationwide study among 5-year-olds¹³. The amount of plaque was statistically significant correlated to ds, ms, fs and dmfs [Pearson's correlation coefficients were 0.30 (P = 0.002), 0.31 (P = 0.005), 0.24 (P = 0.010) and 0.37 (P = 0.000), respectively].

Radiographic

It was not possible to make bitewing radiographs in nine patients. This was mainly due to problems keeping the film-holder in the right position (four), a severe reflex (three), or anxiety (two). For the remaining (82% of the sample) participants the following results can be reported. No significant differences for the clinical outcomes were found between these two groups.

Half of the carious lesions into dentin (49.3%) were discovered by radiographs only, 44.8% were discovered both clinically and radiographically and 6.0% were discovered only clinically and were assessed as caries-free radiographically. So, radiography appeared to have an additional effect of 97% when only d₃-caries is considered.

Of the 59 restored surfaces, two (3.4%) were clinically and radiographically scored as inadequately restored. With the use of radiographs, $23.7\%^{14}$ of all restored surfaces were considered to be inadequately restored. None of the surfaces was scored radiographically sound and clinically inadequate restored. The additional value of radiographs for this matter is 600% (14 instead of two).

A visualization of the results is presented in Figs 1 and 2.

Discussion

This study indicates that the prevalence of approximal caries lesions at the d_3 -level was



Fig. 1. Surfaces diagnosed as carious clinically, radiographically and by both methods (total number of unrestored surfaces 641).



Fig. 2. Surfaces diagnosed as inadequately restored clinically, radiographically and by both methods (total number of restorations 59).

considerably underestimated on the basis of clinical examination only, at least in this age group. About 50% of the approximal dentinal lesions and 86% of the inadequate restorations passed the investigators' eves without detection. These results have serious consequences regarding the outcome of clinical and epidemiological research in which no bitewing radiographs are used. In these reports reference is usually made to the possible undervaluation of the presence of approximal caries, but to what extent this phenomenon interfered with their results is reported to be unknown or at the most assumed to be small. Based on these figures it can be postulated that results and conclusions with respect to the prevalence of caries and inadequate restorations from clinical observations alone should be met with reserve.

Taking bitewing radiographs in young children of 5 to 6 years old is not without challenges. In this study it was impossible to take bitewings in 18% of the young patients. Furthermore, 14% of the surfaces were unreadable. These difficulties were comparable to other studies^{14,15}. In an English study of caries on bitewing radiographs among 5-yearolds around 85% of the surfaces were unreadable¹⁴. However, despite the deficiencies seen, the bitewing radiographs proved to be useful in diagnosing caries in this age group. Alternative approaches additional to clinical examination, like FOTI, may prove useful in these situations.

In a study on the relationship between caries in the primary dentition at 5 years of age and the permanent dentition at 10 years of age, Skeie *et al.* found a significant correlation between the primary second molars at baseline and the permanent teeth at 10 years¹⁵. More than two surfaces with caries experience in these primary second molars were suggested as clinically useful predictor at 5 years of age for being at high risk at 10. In this study bitewing radiographs were used as an additional tool to the clinical examination. When using predictors such as the caries status in the primary dentition, the accuracy of the diagnosis at that age is very important. As our study results showed, like others, using bitewing radiographs to maximize the diagnostic power is a condition *sine qua non*.

For general dental practice the figures found in this study contain a serious warning. Of the 6-year-olds in this study, 13 youngsters (25%) were clinically caries free. But diagnosing more intensively, using bitewing radiographs, revealed that five (38%) of the children who were apparently caries free, had in fact one or more lesions in the dentine. Furthermore, our results are confronting with respect to the substantial amount (over 80%) of restorations judged to be inadequate. The majority of these judgements were based on the bitewing radiographs. These findings are supported by other studies that showed that in Swedish and Norwegian populations with an overall low caries prevalence, more than one third of 5-year-olds had approximal caries lesions that could not be detected by visual inspection alone^{16,17}. In addition from this study it can be concluded that at least for this age group clinically sound approximal surfaces and apparently adequate restorations should not be taken at face value. So, it is not without reason that the European Association of Paediatric Dentistry (EAPD) guidelines for use of radiographs in children, recommend to consider taking bitewings for each 5-year-old child, even without any visible caries or restoration¹⁸.

What this paper adds

• This paper describes the usefulness of radiographic information compared with clinical judgement alone in 6-year-old children.

Why this paper is important to paediatric dentists

• Paediatric dentists should be aware of the additional value of bitewing radiographs in detecting dental caries.

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