A Clinical and Radiographic Comparison of Caries Diagnosed in Approximal Surfaces of Posterior Teeth in a Low-Risk Population of 14-Year-Old Children

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Introduction: The prevalence of caries, and its preferential location, has changed in recent years. The percentage reduction in caries has been lower in pits and fissures than in other locations, making it necessary to use more sensitive diagnostic procedures than visual inspection for approximal lesions.

Objectives: The objective of this study was to compare the amount of overlooked proximal caries by bitewing X-rays versus clinical in patients who were completing a public oral health program at the age of 14 years.

Methods: 162 children aged 14 years were clinically examined by a dentist as part of the systematic six-monthly dental check-ups of the children. The survey was carried out on dried teeth using a light, plane mouth mirror and blunt probe. All molar and premolar surfaces were examined in order to determine the presence of caries or restorations. In addition, two bitewing radiographs of each patient were obtained using a Klauser plastic parallelizer.

Results: Caries lesions were diagnosed better by the X-rays than clinically (Δ X-ray = 0.61), whereas clinical examination was better at diagnosing the presence of fillings (Δ X-ray = - 0.03). Clinical examination diagnosed all occlusal caries but underestimated the interproximal lesions by 86.84%.

Conclusions: In the context of public oral health programs, the authors consider it necessary to obtain two bitewing X-rays of the children's teeth before discharging them, as otherwise they could be told that they are healthy whereas, in fact, they present interproximal caries that could be treated by remineralization or restorative methods.

Key words: bitewing radiography, approximal caries diagnosis, dental caries

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The prevalence of caries, and its preferential location, has changed in recent years. The percentage reduction in caries has been lower in pits and fissures than in other locations, making it nec-

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essary to use more sensitive diagnostic procedures than visual inspection for approximal lesions (Bohannan et al, 1984). These modifications in location are probably attributable to the generalized utilization of fluorides, which exert a decisive effect upon enamel remineralization and decreased solubility. Likewise, the lesion progression rate is reduced as a result of fluoride use; indeed, it is even possible to observe dentinal lesions with apparently clinically healthy superficial enamel (Kidd, 1984). This decrease in the prevalence of caries may, at least theoretically, lead to a drop in the sensitivity of the diagnostic techniques employed (Ruiken et al, 1986).

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(Ruiken et al, 1982) and (Hintz, 1993) found proximal lesions in the permanent dentition to be infrequent in children under 12 years of age with a low prevalence of caries. Likewise, they observed that the omission of bitewing radiographs beyond this age can lead to an important loss of information, resulting in a considerable incidence of diagnostic error. Bitewing radiography is the most widely accepted imaging technique for the diagnosis of proximal caries. In this context, clinical and particularly epidemiological studies based on the diagnostic criteria of the World Health Organization (WHO) generally underestimate the actual number of lesions - especially when patients with permanent dentition are studied (World Health Organization, 1977). Pitts et al (1995) concluded that clinical evaluation can underestimate approximately 50% of all proximal caries, while bitewing radiographs can detect 90% of such lesions (Creanor et al, 1990), Kidd et al (1992) and Hintz et al (1994) estimated that in young adults only 1.2% and 32.2% of all occlusal caries extending to the dentin are not detected by clinical examination; when clinically non-cavitated occlusal lesions were identified and a bitewing radiograph was obtained, they were able to discover lesions that in some cases had already affected the dentin.

Based on reference to histological findings, the specificity of clinical and radiological techniques is found to exceed their sensitivity in both occlusal and approximal caries (Machiulskiene et al, 1999). On the other hand, digital radiography or programs developed to help diagnose approximal caries afford results similar to those of bitewing radiographs (Forner et al, 1999; Haak et al, 2001).

In Spain, public oral health programs are implemented from six to 14 years of age. They include individual prevention measures based on health education, the application of fluorides, pit and fissure sealing and dental restoration. Caries prevalence in this population is very low (DMF = 2.02), so we need to use more accurate diagnosis tools; then the aim of this study was to compare the amount of overlooked proximal caries by bitewing X-rays versus clinical in patients who were completing the public oral health program at the age of 14 years.

MATERIALS AND METHODS

The study comprised 162 fourteen-year-old children who had completed a public oral health program in

which they had taken part since the age of six, which included two dental visits a year and professional application of preventive measures depending on individual caries risk.

A clinical examination was carried out by a dentist as part of the systematic six-monthly dental check-ups on the children. The survey was carried out on dried teeth using a light, plane mouth mirror and blunt probe. All molar and premolar surfaces were examined. The clinical appearance of the surfaces was scored according to the following criteria: 0 = sound, 1 = suspect caries (suspect cavitation), 2 = caries (cavitation), 3 = filling, 4 = recurrent caries in connection with a filling and 5 = missing teeth or surface. (Hintze et al, 1993).

Following the clinical examination and after obtaining informed consent from the child and parents (who were always present during the examination), two bitewing radiographs of each patient were obtained using a Klauser plastic parallelizer, the Hawe Quick-bite (Hawe Neos, Switzerland). The film used was Kodak Ultraspeed (Size 2) (Kodak Ultra-speed, USA). The X-ray source was a Trophy CCX Digital (Trophy, France), and triggering was always performed at 70 kV for a period of 0.53 seconds. The film was developed manually. Radiographs affording insufficient quality due to image overlapping, plate malpositioning or development defects were repeated a single time in an attempt to secure optimum image quality. In the event of failure, the patient was excluded from the study. All patients were protected with a leaded apron during the exploration. The radiographs obtained were assessed under ambient illumination without magnification. The radiological criteria for diagnosing caries were: 0 = sound (absence of radiolucency), 1 = enamel caries (radiolucency in enamel), 2 =dentinal caries (radiolucency in dentine, less than half-way to pulp), 3 = dentinal caries (radiolucency in dentine more than half-way to pulp), 4 = fillingand 5 = unreadable surface (Hintze et al, 1993).

For the purposes of analysis, the results of the clinical and radiological explorations were grouped separately according to the following criteria: 0 = sound teeth or surface, 1 = caries, 2 = filling, 3 = missing teeth or surface. The corresponding indices were only calculated for molars and premolars, since the study focused on lesions affecting the approximal surfaces of these teeth.

Ten per cent of the clinical and radiological examinations were duplicated on a random basis, thereby obtaining the Kappa index of intra-observer

Table 1	Mean and standard deviation of decayed and filled molar and premolar teeth and surfaces
diagnosed	I clinically and radiologically and the difference in the number of teeth and surfaces diagnosed
through ra	adiography

	DFT	DT	FT	DFS	DS	FS
Clinical	1.20 (1.88)	0.45 (0.99)	0.75 (1.66)	1.63 (2.70)	0.64 (1.63)	1 (1.23)
X-ray	1.77 (2.42)	1.06 (1.08)	0.72 (1.59)	2.22 (3.25)	1.31 (2.51)	0.92 (2.10)
Δ X-ray	0.57 (1.45)	0.61 (1,47)	- 0.03 (0.23)	0.59 (1.81)	0.67 (1.72)	- 0.08 (0.68)

Table 2	Number of decayed approximal surfaces per tooth								
	17	16	27	26	37	36	47	46	Total
Mesial Distal	0 1	8 1	1 3	16 2	2 2	10 8	1 0	10 3	48 20
	15	14	25	24	35	34	45	44	
Mesial Distal	4 5	0 2	3 7	0 4	2 1	0 1	3 7	2 2	18 25

agreement, to assess reliability. The means comparison test was used to compare the radiologically identified rise in caries by sex and the Wilcoxon test for paired analysis of the number of clinically and radiologically diagnosed surfaces.

RESULTS

A total of 162 children aged 14 years underwent clinical and radiological examination of their molars and premolars, following the criteria indicated under Materials and Methods. The teeth and surfaces examined were as follows: 12,960 permanent tooth surfaces, of which 2,592 were occlusal surfaces, 5,184 approximal surfaces, and 5,184 buccal/palatal surfaces.

The sample was composed of 83 girls and 79 boys (51.23% and 48.76% respectively). 56% of the teeth examined were premolars and 44% were molars.

The intra-observer agreement was Kappa = 0.98 for the clinical examination and Kappa = 0.95 for the bite-wing X-ray evaluation; almost total coincidence was observed in both cases.

The average number of DFT molars and premolars was 1.25 (DFS = 1.72) when based solely on the clinical examinations and 1.76 (DFS = 2.38) when the radiologically-diagnosed approximal lesions were considered in addition to the clinical findings. A greater number of decayed teeth (DT) and surfaces (DS), 0.61 and 0.67 respectively, was found by X-ray diagnosis, whereas clinical examination was better than radiology for detecting fillings, as may be seen in Table 1.

The approximal surfaces most often affected by caries were the mesial surface of the first molars, followed by the distal surface of the second premolars. The mesial surface of 26 was that in which caries lesions were most often found (Table 2).

On analyzing the result by sex, the number of decayed surfaces identified by bitewing radiography was significantly greater in the girls than in the boys, as shown in Table 3.

Caries was detected in 111 of the 5184 approximal surfaces studied (2.14%), of which 86.48% could only be detected radiologically. Of the total caries detected, only three (6.97%) of the lesions detected in premolars and only 12 (17.64%) of those in molars were visible in the clinical examination (Table 4). Г

Table 3Mean and standard deviation, by sex, of decayed and filled molar and premolar teeth and surfacesdiagnosed clinically and radiologically and the difference in the number of teeth and surfaces diagnosedthrough radiography								
			BO	YS				
	DFT	DT	FT	DFS	DS	FS		
Clinical	1 (1.69)	0.43 (0.91)	0.56 (1.56)	1.32 (2.20)	0.55 (1.27)	0.77 (2.12)		
X-ray	1.34 (2.20)	0.77 (1.41)	0.56 (1.56)	1.53 (2.49)	0.86 (1.63)	0.67 (1.95)		
Δ X-ray	0.34 (0.99)	0.34 (0.99)	0	0.21 (1.28)	0.31 (0.88)	- 0.10 (0.90)		
	GIRLS							
Clinical	1.39 (2.04)	0.46 (1.06)	0.92 (1.73)	1.92 (2.95)	0.71 (1.91)	1.21 (2.31)		
X-ray	2.19 (2.56)	1.32 (2.09)	0.86 (1.60)	2.89 (3.77)	1.73 (3.06)	1.15 (2.21)		
Δ X-ray	0.80 (1.76)	0.86 (1.78)	- 0.06 (0.32)	0.97 (2.15)	1.02 (2.20)	- 0.06 (0.39)		
p (∆ X-ray)	0.01	0.00		0.00	0.000	0.43		

Table 4Absolute values and percentage of decayed surfaces inmolars and premolars							
	Approximal decayed surfaces	Premolars	Molars				
Clinical X-ray Total	15 (13.51%) 96 (86.48%) 111	3 (6.97%) 40 (93.02%) 43 (38.73%)	12 (17.64%) 56 (82.35%) 68 (61.26%)				
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Table 5Mean number (Standard Deviation) of decayed and filledsurfaces per child							
	Caries	Filled	DFS				
Occlusal	0.39 (0.90)	0.71 (1.56)	1.10 (1.79)				
Approximal	0.66 (1.56) Cl 0.12 (0.42) X-ray 0.54 (1.41) p = 0.00	0.06 (0.30)	0.72 (1.62)				
Buccal/Palatal	0.16 (0.46)	0.21 (0.69)	0.35 (0.81)				
Total	1.21 (2.51)	0.98 (2.10)	2.17 (3)				

As can be seen in Table 5, an average of 0.66 approximal surfaces per child were found to be affected by caries and of these, 0.54 were only detected by the X-rays. The average number of decayed occlusal surfaces per child was 0.39, and all were detected by the clinical examination.

DISCUSSION AND CONCLUSIONS

A study to assess the efficacy of bitewing radiography in diagnosing caries (Machiulskiene et al, 1999) shows that clinical examination remains the most effective exploratory method for identifying occlusal caries, particularly when the lesions are confined to the enamel layer. These observations coincide with the results of this study, where radiography was seen to afford no help in diagnosing occlusal caries. However, in vitro studies involving bitewing radiography and histological 'gold standard' validation have shown that 25% and 44% (Forner et al, 1999; Ricketts et al, 1997) of approximal caries lesions in enamel and dentin, respectively, can be detected with this technique. A review by Pitts (1996) of 29 clinical studies concluded that clinical examination could only detect 50% of all proximal lesions, a figure that jumped to 90% when radiography was used. In our study, 86.48% of the approximal lesions could only be detected by X-rays. As regards the mean approximal surfaces affected, 0.54 surfaces per child would not have been diagnosed without bitewing radiography. These results coincide with those of other authors in populations with a similar prevalence of caries in the same age group (de Vries et al. 1990; Poorterman et al, 2002; Poorterman et al, 1999). In populations with higher caries indices, the mean number of proximal surface lesions detectable by bitewing radiography is somewhat greater - although the number of clinically detectable surfaces is much higher (Machiulskiene et al, 1999).

No agreement is found in the literature regarding the increased diagnostic efficacy of bitewing radiographs in relation to the consumption of fluoridated water (Poorterman et al, 2000); nevertheless, diagnostic difficulty has been shown to increase as the prevalence of caries decreases, thus warranting the application of more sensitive techniques, particularly for detecting minimal lesions (Ludlow et al, 1997).

This study shows that the prevalence of interproximal caries is underestimated considerably in this group of patients when only clinical examination is employed, as only 13.52% of the interproximal lesions present were detected by this method.

Certain studies employ a correction factor to clinical exploration to avoid diagnostic bias. Mann et al (1989), for instance, found that 53% of decayed premolar and molar surfaces in a population aged between 14 and 18 years could only be detected by radiography and therefore determined a multiplication factor of 1.59 to correct diagnostic deviation when using only clinical examination. However, the use of a correction factor is influenced by caries prevalence, the age of the population studied, the systematic use of fluorides, and so on. This study detected only 2.14% of interproximal surfaces with caries, but almost 90% of the patients considered clinically free of caries had one or more interproximal lesions. Consequently, in the context of public oral health programs, the authors consider it necessary to obtain two bitewing X-rays of the children's teeth before discharging them, as otherwise they could be being told that they are healthy whereas, in fact, they present interproximal caries, invisible on clinical examination, that could be treated by remineralization or restorative methods.

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