ASSESSING *IN VIVO* BITEWING RADIOGRAPH, FOTI AND CLINICAL EXAMINATION FOR OCCLUSAL CARIES DIAGNOSIS*

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■ ABSTRACT: Three diagnostic methods were used to detect occlusal caries: fiber-optic transillumination (FOTI), bitewing radiographs (XR), and clinical examination (CE). The premolars and first molars of 58 subjects (aged 12-37 years) were examined by three gauged examiners. Radiolucency in enamel and/or dentine for XR; shadow in enamel and/or dentine for FOTI were considered as cavity. The restored or radiographically unreadable surfaces were excluded. The results observed for occlusal surfaces were: XR without radio-lucency (w.r.) and CE sound (s) = 88,39%; not sound (n.s.) = 6,13%; XR with radiolucency and CE s. = 0% and n.s. = 5,48%; XR w.r., FOTI s. = 91,2% and n.s. = 0%; XR with radiolucency and FOTI s. = 1,17% and n.s. = 7,63%; FOTI s. and CE s. = 87,61% and n.s. = 5,6%; FOTI n.s. and CE s. = 0,86% and n.s. = 5,9%. A high degree of agreement among the methods assessed was observed in dentine, particularly between FOTI and XR, that presented the highest concordance. Although not able to diagnose lesions confined to enamel, FOTI and XR may be considered important complementary means for occlusal caries diagnosis.

■ KEYWORDS: Dental caries; oral diagnosis; occlusal surface.

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Introduction

Undoubtedly, in spite of the evident development of Operative Dentistry, dental caries still constitute the major concern of oral health in many areas around the world. For the last decades, the efforts have been focused on preserving tooth structure stimulating the use of non-invasive preventive measures instead of proceeding a healing treatment. On the other hand, the importance of early diagnosis of dental caries has been strongly emphasized since it is widely known that incipient carious lesions can be arrested and the remineralization process can take place.[5] The success of this proceeding is directly related to detecting the disease in its reversible stage, using every diagnostic me-thods available to observe and record the maximum carious process present, as well as to determine the development stage of the patholo-gic process.[12]

However, identifying the lesion in its initial phase and determining an appropriate conservative treatment remains a challenge for clinical practice, whereas the earliest stages of the carious process – when the lesion is limited to enamel (microscopical) demineralization[5] – are cli-nically undetectable. Therefore, for great majority of cases, the carious lesion is diagnosed only if some degree of dental structure destruction is clinically established. The problem is further compounded for occlusal caries because of the peculiar and complex anatomy of this surface.[4,9,15]

This way the purpose of this study was to compare *in vivo* the accuracy of three diagnostic methods – clinical examination (light and mirror); bitewing radiographs, and fiber optic transillumination – for detection of occlusal carious lesions in permanent teeth.

Materials and methods

Bitewing radiographs taken during clinical treatment at the Bauru School of Dentistry were previously selected from the patients' records in a first trial. Fifty-eight subjects of both sexes aged 12 to 37 years were chosen, and signed a written consent to participate in the study. The occlusal surfaces (n = 696) of premolars and first molars were examined using three different methods for occlusal caries diagnoses: clinical examination, ra-diographic examination and fibber-optic transillumination. Each diagnostic method was conducted by a single gauged examiner. The diagnostic criteria are shown in Table 1.

Table 1 – Clinical criteria and codes in radiograph, clinical and FOTI examinations

Code	Radiograph exam	FOTI exam	Clinical exam
0	Without radiolucency (sound)	Without shadow (sound)	Without caries (sound)
1	Radiolucency in enamel and up to amelodentinal junction	Shadow in enamel	Initial caries (precavitation) white or brown spot lesions
2	Radiolucency < 2 mm in dentine	Shadow < 2 mm in dentine	Cavitation in enamel
3	Radiolucency > 2 mm in dentine (without pulpal involvement)	Shadow > 2 mm in dentine (without pulpal involvement)	Cavitation in dentine (without pulpal involvement)
4	Probable pulpal involvement	Probable pulpal involvement	Probable pulpal involvement
A	**A**bsent tooth	**A**bsent tooth	**A**bsent tooth
R	**R**estoration surface	**R**estoration surface	**R**estoration surface
E	**E**xcluded surface in examination	**E**xclude surface in examination	**E**xclude surface in examination
B	**B**lank - code was not registered	**B**lank - code was not registered	**B**lank - code was not registered

The clinical examination was proceeded in dental chair in the supine position with overhead light and dental mirror. The teeth were carefully cleaned with pumice in a rubber prophylactic cup, rinsed and gently air-dried, and a probe was employed only to remove eventual debris.

The bitewing radiographs were taken using a Funk X-ray equipment (10 mA and 60 kV) and bitewing films (Kodak Ektaspeed, EB-31, size 3) positioned with a specific film holder. The films were exposed for 0.4 se-conds and developed under standardized conditions within 24 hours after exposure, mounted and read on a light-box without magnification.

A Fiber Optic Transillumination equipment with a 150-watt lamp set at maximum light intensity was used to conduct FOTI examinations. Two attachments were used: a plane mouth mirror mounted on a steel cuff which allows an occlusal view of the tooth, and a 0.5-mm dia-meter fiber optic probe specifically developed to produce a narrow beam of light transillumination was placed buccally and lingually.

The examinations were randomly repeated after one week with a 10% sample to verify the intraobserver reproducibility, and the data were assessed with Cohen's Kappa statistical method.

Results

The Kappa value for intraobserver agreement was equal or higher than 0.75, which may be considered substantial[3] (Table 2).

Table 2 – Intraobserver reproducibility in different occlusal caries diagnosis methods

	FOTI	Radiographic ex.	Clinical ex
Kappa	0.75	1.00	0.83

Of the 696 occlusal surfaces examined, approximately 51% were excluded because they were radiographically unreadable or the visual exa-mination detected some clinical situation that recommended the exclusion. Tables 3, 4 and 5 show the results for occlusal caries diagnostic comparing the three methods used.

Table 3 shows the data of 341 surfaces evaluated by bitewing radiographs and FOTI. There was a high degree of agreement between the two techniques in dentine. About 91% of the surfaces (311 teeth) were diagnosed as sound (score 0) and 15 carious lesions presented the same score (2, 3 and 4) in dentine or pulp for both examinations. None of the two methods detected any enamel lesion.

Table 3 – Caries status of occlusal surfaces assessed *in vivo* by bitewing radiography and FOTI examination

Radiographic code	FOTI code					Total	
	0	1	2	3	4	n	(%)
0	311	–	5	–	–	316	(93)
1	–	–	–	–	–	0	(0)
2	4	–	2	1	1	8	(2)
3	–	–	1	3	3	7	(2)
4	–	–	–	–	10	10	(3)
Total - n (%)	315 (93)	0 (0)	8 (2)	4 (1)	14 (4)	341 (100)	(100)

Table 4 compares clinical and radiographic examinations. 93.5% of the surfaces scored 0, 1 and 2 for clinical evaluation were considered sound (score 0) by radiographic examination – half of the surfaces scored 0 for both methods. Almost all the surfaces scored 3 and 4 for visual ins-pection showed radiolucencies in dentine at different depths.

Table 4 – Caries status of occlusal surfaces assessed *in vivo* by clinical examination and bitewing radiographs

Clinical code	Radiographic code					Total	
	0	1	2	3	4	n	(%)
0	155	–	–	–	–	155	(50)
1	119	–	–	–	–	119	(39)
2	16	–	3	–	–	19	(6)
3		–	3	1	–	4	(1)
4	1	–	1	4	7	13	(4)
Total - n (%)	291 (94)	0 (0)	7 (2)	5 (2)	7 (2)	310 (100)	(100)

The comparison between clinical and FOTI examinations (Table 5) showed that almost all scores 0, 1 and 2 for clinical evaluation corres-ponded to score 0 for FOTI, representing approximately 93% of the exa-mined surfaces – about half of the surfaces were scored 0 for both me-thods. Almost all scores 3 and 4 for clinical examination corresponded to a visible shadow in dentine at different depths for FOTI evaluation.

Table 5 – Caries status of occlusal surface assessed *in vivo* by clinical and FOTI examinations

Clinical code	FOTI code					Total	
	0	1	2	3	4	n	(%)
0	172	–	1	–	–	173	(51)
1	125	–	2	–	–	127	(38)
2	17	–	2	–	–	19	(6)
3	1	–	1	2	–	4	(1)
4	1	–	–	2	13	16	(4)
Total n (%)	316 (93)	0 (0)	6 (2)	4 (1)	13 (4)	339 (100)	(100)

Discussion

The present study compared three diagnostic methods for detection of occlusal caries. To validate the results, a comparison is recommended with a gold standard (validation criteria) indicating if the lesion is truly present or not.[3] However, the criteria were not used because of the difficulty to establish a gold standard for *in vivo* studies. A validation criteria of caries diagnosis as the histologic exam of teeth, for example, is clinically impracticable, except

for teeth indicated for extraction.[8,10] In each method it is also possible that decay is diagnosed as a healthy surface (false-negative result) and a sound surface is diagnosed as a carious lesion (false-positive result).

Several authors[4,6,9,10,11,18,21] have discussed the correlation between clinical and radiographic image examination at occlusal surfaces. In this study, comparing both methods carious lesions were better diagnosed by clinical examination. These results are coincident with those of Machiulskiene et al.,[9] Nytun et al.,[11] Verdonschot et al.,[14] Weerheijm et al.[17] and Wenzel et al.[18]

Creanor et al.,[2] Lussi,[8] Weerheijm et al.[16] and Wenzel et al.[19] emphasized that bitewing radiographs were helpful to diagnose occlusal caries in dentine, including those undetected by clinical examination. In the present study the radiographs did not help in occlusal caries detection.

For many years, transillumination has been studied and recommended as a method for early diagnostic in Dentistry, through the degree of mineralization of the dental structure. Nevertheless, detecting noncavitated enamel carious lesions by optic methods, like FOTI, requires knowledge about the nature of the enamel once the superficial morphology of the lesion is slightly different from sound enamel.[1] The more porous – but still mineralized – becomes the superficial layer, the less mineralized is the subsuperficial layer of the lesion.[1]

Incipient cavitat enamel-restricted lesions diagnosed by visual ins-pection were hardly detected by radiographic and FOTI methods in the present study. Detecting occlusal caries in teeth without breakdown of the outer enamel surface and with dentine involvement, is still a challenge for clinicians.[10,20,21] Wenzel et al.[19] observed a substantial improvement when conventional radiography was used combined with clinical examination showing high specificity to diagnose cavitation in dentine. However, this method has a low sensitivity (0.45) to evaluate the true dentine caries extension. Weerheijm et al.[16] in an *in vivo* study, indicated the bitewing radiograph as a complementary method for occlusal caries diagnosis, associated to clinical examination. In the present study, it was observed that the radiograph examination showed the same amount of carious dentine as the clinical examination. However, these data must be analyzed carefully, because of the low number of images (radiolucencies) compatible with detected carious lesions.

In this study a great concordance between radiographic and FOTI exams was observed. These results are similar to those presented by different authors,[7,14] despite the fact that some authors found better results with FOTI to

diagnose dentine carious lesions, when compared to radiographic methods.[21] Both methods showed to be effective in dentine.

Comparing clinical examination and FOTI, there was not a high correlation between these two methods for lesions confined enamel; in these cases, the tooth was considered sound by FOTI. However, when the surface was scored 3 (shadow greater than 2 mm in dentine) and 4 (probable pulpal involvement) for FOTI, indicating dentine involvement to a great extension, the methods presented a high degree of agreement. According to results showed by Verdonschot et al.,[14] FOTI should be used associated with clinical examination.

Verdonschot et al.,[14] studying the performance of clinical diagnostic methods – radiographs, FOTI, fissure morphology, discoloration, and electric strength measured – verified that FOTI showed superior results when compared to other methods investigated for detecting dentine occlusal caries. These authors also suggested that this method could be considered the best for the diagnostic of these lesions. Comparing Tables 4 and 5, we observe that the results for FOTI and radiograph exams were very similar, when compared to clinical examination.

The impact of a diagnostic method on occlusal caries detection rate depends on the diagnostic threshold. Therefore, it is essential that clinicians improve their skills to use the methods available with accuracy, thus avoiding undesirable mistakes,[13] and correctly recommending the most appropriate treatment.

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■ *RESUMO: Três métodos de diagnóstico foram utilizados para detectar cárie oclusal: fibra óptica de transiluminação (FOTI), radiografia interproximal (rX) e exame clínico (EC). Os pré-molares e molares de 58 pacientes, com idades entre 12 e 37 anos, foram examinados por três examinadores calibrados. Radiolucência em esmalte e/ou dentina para o RX, sombra em esmalte e/ou dentina para o FOTI foram considerados como cavidade. As superfícies restauradas ou radiograficamente ilegíveis foram excluídas do estudo. Os resultados observados foram: rX sem imagem (s.i.) e EC saudável (s) = 88,39; c/cavidade (c.c.) = 6,13; rX c/imagem (c.i.) e EC s. = 0 e c.c. = 5,48; rX s.i., FOTI s. = 91,20 e c.c.= 0; rX c.i. e FOTI s. = 1,17 e c.c.= 7,63. FOTI s. e EC s. = 87,61 e c.c. = 5,60. FOTI c.c.*

e EC s. = 0,86 e c.c. = 5,90. Os dados foram analisados e permitiram as seguintes conclusões: um alto grau de concordância foi observado entre todos os testes; a radiografia interproximal e o FOTI são importantes meios complementares no diagnóstico de cáries oclusais.

■ *PALAVRAS-CHAVE: Cárie dentária; diagnóstico bucal; superfície oclusal.*

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