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Effect of pit and fissure sealants on caries detection by a fluorescent camera system

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ARTICLE INFO

Article history:
Received 18 February 2013
Received in revised form
6 May 2013
Accepted 7 May 2013

Keywords:
Caries
Diagnosis
Fluorescence
Sealants
Sensitivity
Specificity

ABSTRACT

Objective: The aim of this study was to evaluate the effect of sealant placement on the detection of caries by a fluorescent camera (FC), the Spectra caries detector.

Materials and methods: In a laboratory study, FC images and readings were obtained from 31 extracted teeth, before and following application of clear sealants (Shofu Clear or Delton unfilled), or opaque sealants (3M Clinpro or Delton FS). Teeth were then sectioned and examined for enamel or dentine caries. Using each tooth's true caries diagnosis, the sensitivity and specificity of the FC measurements in detecting dentine caries was calculated. In the clinical study, FC readings were obtained from 41 molars in children prior to and following application of clear sealants.

Results: Following application of Shofu or Delton unfilled there were reductions in the mean FC readings of 10% ($p = 0.5$) and 8.2% ($p = 0.009$), respectively. Application of two opaque sealants, 3M or Delton FS significantly reduced mean FC readings 16.2% and 20.8% ($p < 0.5$), respectively. Although the carious lesions could still be observed in FC images from teeth with opaque sealants there was a significant loss of sensitivity in detecting dentinal caries. Clear sealant application caused an insignificant loss of detection sensitivity. Following application of clear sealants to children's molars there was a small (4.01%) but significant ($p < 0.01$) reduction in FC readings recorded from these teeth.

Conclusions: The FC can detect caries under clear sealants with little loss of sensitivity. Although lesions can be seen through opaque sealants, loss of sensitivity precludes accurate lesion assessment.

1. Introduction

Pit and fissure sealants are a widely used means of preventing the development of occlusal caries.[1] There are many different types of sealants; most of them are composed of bisphenol-A-glycidyl-methacrylate (bis-GMA) resins. They can be classified as clear (unfilled), opaque (filled with silica particles), and nanofilled with zirconia or silica particles with size range of 5–20 nm. In addition to the clear sealants there are also a variety of colours available, including tooth colour, pink, green, grey and yellow. Ideally, pit and fissures sealants should not be placed over obvious caries, but may be placed over clinically inapparent carious lesions. Decay does not appear to progress under sealed occlusal surfaces.[2–4] Following 5-years, sealed fissures were found to harbour few viable bacteria in comparison to contralateral un-sealed molars in the same subjects.[5]

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0300-5712/$ – see front matter
http://dx.doi.org/10.1016/j.jdent.2013.05.005

The use of sealants on decayed surfaces is not without risk since the bonding of the sealant material to caries affected tooth structure is poor.[6] In clinical practice, the decision to seal a tooth is frequently based on imperfect information since clinical and radiographic examinations are not accurate methods of assessing the extent and depth of occlusal caries.[7] Since sealed teeth do occasionally decay,[8,9] dental practitioners should monitor all sealed teeth to make sure that the sealant and the tooth surfaces remain intact, and that the caries process does not show signs of initiation or progression. Monitoring sealed teeth for evidence of caries initiation and progression may be challenging, particularly in teeth treated with opaque sealants that preclude direct visualisation of the occlusal anatomy.

Several studies have attempted to evaluate the effect of pit and fissure sealants on the ability of dentists to detect occlusal caries. These studies have examined the impact of sealants on the accuracy of visual caries detection and on the performance of various devices used to detect caries. Clear sealants impede visual caries detection, resulting in fewer lesions being detected and fewer teeth being treatment planned for restorative intervention.[10] In this study the poor sensitivity of visual examination in detecting enamel and dentine caries was further deteriorated by sealant application.

The effect of clear and opaque sealants on laser fluorescence (LF) measurements of caries, using the DIAGNOdent (KaVo, Biberach, Germany), has been assessed in several in vitro studies. It appears that all types of sealants effect LF detection of carious lesions. When a pigment powder was used as the fluorescent signal source, opaque sealants reduced the LF signal strength to a greater extent than clear sealants.[11] Other studies where LF measurements were obtained from teeth with carious lesions demonstrate the same trend that both clear and opaque sealants interfere with the ability of LF devices to detect caries with opaque sealants having a greater effect.[12–15] Although these studies demonstrated variable reductions (or small increases in the case of clear sealants) in LF readings following sealant application, they did not examine the effect of sealants on the diagnostic performance of this device in correctly identifying teeth with enamel and dentine lesions. When the accuracy of the LF device's determination of a tooth's caries diagnosis was verified by histological examination of the teeth, clear sealants were observed to have a modest adverse effect on the sensitivity of LF-detection.[16,17] In contrast, the application of opaque sealants to the occlusal surface resulted in a considerable loss of detection sensitivity.[18] A similar trend, showing the preservation of diagnostic sensitivity following clear sealant application and loss of sensitivity in opaque sealant treated teeth was observed in a study where occlusal caries was detected using optical coherence tomography.[19] Taken together, these studies highlight the difficulties encountered in detecting occlusal caries in sealed teeth particularly when opaque sealants are used. The results of these studies indicate that it may be possible to use certain caries detectors to monitor teeth with clear sealants for signs of lesion progression.

The Spectra™ (Air Techniques, Melville, New York) is a recently introduced fluorescence camera (FC) caries detection device that detects both enamel and dentine lesions. This device is equivalent to the VistaProof caries detector (Dürr Dental AG, Bietigheim-Bissingen, Germany). The FC handpiece emits a violet-blue light at a wavelength of 405 nm. This light stimulates porphyrins from cariogenic bacteria to fluoresce red and healthy tooth structure to fluoresce green. This FC images alterations in the tooth's intrinsic fluorescence as a means of detecting enamel demineralisation and bacterially derived fluorescence arising in carious dentine. When interfaced with a computer, the tooth's fluorescent image can be stored along with numerical values based on the fluorescence and compared to images and readings obtained at subsequent examinations.

In an in vitro study performed on third molars that were either caries free or had small occlusal lesions,[20] FC-based caries diagnosis was compared to clinical assessment using the ICDAS (International Caries Detection and Assessment System)[21] and radiographic methods. In this study, a histological assessment of each tooth's caries status was performed. This allowed the sensitivity and specificity of each diagnostic method in determining the presence of enamel and dentine caries to be calculated. The results of this study indicated that the Spectra's performance in detecting both enamel and dentine lesions was superior to radiographic diagnosis and comparable to visual diagnosis using ICDAS criteria. The results of this study agree with other in vitro studies, examining occlusal caries in permanent molars, undertaken with the VistaProof caries detector. In addition to having satisfactory sensitivity and specificity, FC measurements also show good reproducibility with studies demonstrating high levels of intra and inter-examiner measurement agreement.[22–26] In a clinical study where the true caries status of the teeth was unknown, a positive correlation was observed between readings made with various caries detector devices, including the FC and the ICDAS scores of the teeth.[27] When the clinical accuracy of FC and LF devices were compared against a histological determination of the tooth's caries status made following extraction, the LF was judged to be more accurate than the FC. Both devices were judged to be adjuncts to visual examination.[28] Analysis of results of both in vitro and clinical evaluations of the FC device indicate that the manufacturer-suggested diagnostic thresholds used for the detection of enamel and dentine lesions are not optimal and that adjusting these cut-offs could improve diagnostic performance.[23,26,28,29]

To date, no studies have evaluated the effectiveness of FC devices in detecting caries under commonly used pit and fissure sealants. The purpose of this study was to assess the effect of sealant placement on FC readings obtained from teeth where the clinical examination indicated early caries. In one part of the study, the effect of clear and opaque sealant placement on the FC readings obtained from extracted teeth was determined. The presence and extent of caries in these teeth was verified by histological examination of these teeth following removal of the occlusal surface. By employing a ''gold standard'' histological determination of each tooth's caries diagnosis we could determine the impact of sealant placement on the sensitivity and specificity of the FC's diagnostic performance. In a second part of the study, FC readings were obtained from children's permanent molars prior to and following the application of clear sealants. In this clinical portion of the study, the selection criteria and protocol