Diagnosis of Occlusal Caries: Part I. Conventional Methods

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Abstract

Accurate diagnosis of the presence or absence of disease is a fundamental requirement in health care. The diagnosis of non-overt occlusal decay is challenging and can be highly subjective, and its inherent uncertainties can lead to widely differing treatment decisions. The development of more sensitive, specific and reproducible diagnostic tools for occlusal surfaces would contribute greatly to more precise planning of preventive and operative therapy. The purpose of this 2-part paper is to review current knowledge concerning conventional and new diagnostic methods for occlusal caries. Part I looks at established diagnostic methods for occlusal surfaces. Conventional visual, tactile and radiographic examinations provide less-than-ideal diagnostic sensitivity. Neither fissure discolouration (black or brown) nor the use of an explorer has been shown to improve diagnostic accuracy. However, the combination of careful visual examination with optimal radiographic examination affords better diagnostic performance. The best visual indicators involve precise features associated with the presence of disease, such as opaque fissure demineralization and the presence and extent of localized breakdown of the enamel. For best results, teeth should be clean, thoroughly dry and well illuminated. Part II will examine new and emerging technologies, including the DIAGNOdent laser fluorescence device, which are being developed for the diagnosis of occlusal decay.

MeSH Key Words: *dental caries/diagnosis; observer variation; sensitivity and specificity*

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Both the overall decline in the prevalence of caries and the greater reduction in the prevalence of smooth-surface caries are well documented.[1] Epidemiological surveys since the early 1970s have shown age-specific reductions in the prevalence of caries, particularly in children of all ages, and evidence of a cohort effect into adulthood. A 50% reduction was documented for 17-year-olds over the period 1971–1985, along with a 36% reduction in the coronal DMF surfaces of people under 34 years old. The reported decline in proximal involvement of decayed and filled posterior teeth has revealed a shift away from smooth-surface caries and has implications for the causal role of fluorides. The greater reduction in smooth-surface caries has resulted in an increase in the proportion of primary caries in susceptible pits and fissures. Decay on occlusal surfaces currently accounts for the majority of new lesions in the dentition of the younger, post-fluoride generation.[2]

Although accurate diagnosis of occlusal caries has always been regarded as more difficult than the diagnosis of smooth-surface caries, clinicians have recently suggested that fluoride has slowed the progress of occlusal lesions and strengthened occlusal enamel, such that a sound enamel surface may mask relatively large dentinal caries that is discovered only on bite-wing radiographs.[3] The terms "occult," "hidden" and "covert" caries, as well as "fluoride syndrome," have been used to describe such presenting scenarios.[3] Whether this is an entirely new phenomenon is a subject of debate,[4,5] but the relative significance is greater in populations with lower overall prevalence of caries.

Accurate diagnosis of the presence, extent and activity of a disease process is a fundamental requirement in health care. The optimal approach is to attempt to identify high risk of caries before disease occurs, to allow initiation of appropriate preventive services. Fissure sealants are indicated for occlusal surfaces at risk. If sealants have not

been used, a secondary approach is to diagnose the caries early, before operative treatment is indicated, which would again allow preventive intervention. Enamel caries, both occlusal and proximal, can generally be managed without operative intervention.[6] There is consensus that the minimum stage at which surgical intervention is indicated is the carious disease of dentin.[6]

Accurate diagnosis of dentinal decay is more challenging on occlusal than on proximal surfaces. The diagnosis of occlusal decay is highly subjective,[7] and there is considerable variation in opinion among clinicians as to appropriate diagnosis and treatment of early carious lesions on occlusal surfaces. The inherent diagnostic uncertainties have led to differing treatment decisions by clinicians. Exploratory operative intervention and restoration on the basis of inadequate or poorly understood diagnostic information, undertaken in an effort to avoid the risk of "hidden" caries, could lead to substantial overtreatment. Conversely, inadequate detection precludes appropriate management. It is generally accepted that, especially in an era of lower disease prevalence, unnecessary restorations are unacceptable. Such restorations increase health care costs for patients and health care systems, and submit patients and their teeth to the ongoing re-restoration cycle over their lifetime, which may compromise long-term tooth survival. As stated by Downer,[8] "Caries in industrialized countries is a disease of slow progression and it is unlikely that a missed borderline dentinal lesion will pose an early threat to the viability of the tooth." Further, there is increasing expert opinion that early involvement of the dentin should not indicate a need for immediate operative intervention in all circumstances.[9] Significant clinical evidence is accumulating that optimum sealing can prevent the progress of dentinal decay.[10,11] Operative care is generally required only when dentinal caries cannot be arrested or reversed. Individual factors such as case history, age and probability of disease activity must be considered in all decisions concerning preventive and restorative care.

Visual and Tactile Diagnosis

To ensure that maximum information is obtained during a visual examination, the teeth should be clean, completely dry and well illuminated. Even so, in vitro visual examination of macroscopically intact occlusal surfaces in an effort to detect caries generally has limited sensitivity (i.e., the ability to accurately determine the presence of true disease), below 30%.[12] With experience and specific training, sensitivity greater than 60% (60% accurate detection of true disease) and specificity greater than 80% (80% accurate determination of absence of disease) are possible for diagnosis of borderline dentin caries lesions, those in the zone of diagnostic doubt.[8] In a whole population, where larger lesions and sound teeth are included, the sensitivity of visual diagnostic methods is much higher. Use of more precise, specific visual diagnostic criteria leads to more accurate detection of "hidden caries" and provides substantially better diagnostic sensitivities.[13] Such criteria necessitate clean teeth and involve discernment of fissure opacity or changes in translucency, with or without prolonged air drying, plus differentiation of the presence and extent of localized breakdown of the enamel (cavitation).

Fissure morphology and discolouration (black or brown) are unreliable for definitive diagnosis of caries. After analyzing the results of different diagnostic methods used by 26 dentists who examined extracted, mounted teeth under standard dental operatory conditions, Lussi[12] concluded that "using these [discolouration] parameters for diagnosis of dentinal caries, at least 55% of sound teeth would be misclassified (false positive)." Again, discernment of enamel opacities at the entrance of the fissures allowed better diagnosis. Other studies have also found that the presence of stain is not necessarily indicative of caries.[14,15]

The use of an explorer does not appear to greatly improve diagnostic accuracy.[12] A "sticking" probe is not necessarily indicative of decay and may be due entirely to local anatomic features. The advisability of applying pressure with a sharp explorer has been called into question, particularly in Europe and Scandinavia, because of documented damage to surface integrity and possible implantation of organisms, both of which may increase lesion susceptibility.[16,17] Although this issue is somewhat contentious, the evidence suggests that an explorer should be used lightly or not at all on occlusal surfaces.

The presence of visible cavitation of the enamel surface is, in most cases, synonymous with dentinal involvement. When definite cavitation is present, the question generally becomes not if, but how far, the carious process has penetrated into the dentin. In one study of 60 molars with small visible cavitations, caries had reached the dentino-enamel junction in 25% of the teeth. For the remaining 75%, the caries process extended far into the dentin.[18]

Accurate diagnosis of the presence or absence of occlusal caries remains challenging for the clinician. Visual and tactile methods alone, in the absence of cavitation, generally have relatively poor diagnostic capability for occlusal surfaces under general practice conditions.

Radiographic Diagnosis

The sensitivity of visual inspection can be augmented with radiography. Findings on bite-wing radiographs are useful indicators of dentinal decay on occlusal surfaces, and it is well recognized that the prevalence of occlusal caries may be underestimated without such imaging.[19] In one study involving young air force recruits, only one-third of occlusal dentinal lesions were diagnosed visually, whereas two-thirds were discovered on bite-wing radiographs.[20] Another study reported that bite-wing radiographs revealed

obvious lesions into the dentin in 15% of apparently sound occlusal surfaces.[21] Of some concern is the significant number of 17- and 20-year-old patients who had received sealants but in whom later radiography revealed underlying radiolucencies; these findings suggest that the sealants were placed without prior diagnostic radiography.[22] Of additional concern is the evidence that radiographs considerably underestimate lesion size.[23] In vitro experiments have shown that, once an occlusal lesion is clearly visible on radiographs, demineralization has extended to or beyond the middle third of the dentin.[24] On the other hand, false positives can occur with radiographic diagnosis, and specificities of 66% to 98% have been recorded in vitro.[25,26]

Because of the superimposition of buccal and lingual enamel, caries of the occlusal enamel are not generally visible,[23] and early dentinal involvement is difficult to ascertain with radiographs. In vitro bite-wing radiography alone resulted in a sensitivity of 58%, higher than that of visual inspection, and a specificity of 87% (i.e., 13% false positives), lower than that of visual inspection, according to histological validation.[25] The use of digital contrast enhancement shows promise in improving the early radiographic diagnosis of lesions.

Combined Visual and Radiographic Diagnosis

An investigation of the validity of diagnosis by means of optimal bite-wing radiography combined with careful visual clinical examination has shown that the majority of carious lesions and nearly all sound teeth can be correctly identified.[19] The validity of each diagnostic method (visual and radiographic), used separately and together, was investigated for extracted teeth with questionable or borderline caries. Together, these methods had a sensitivity of 75% and a high specificity (90%), fulfilling the current recommendations to provide diagnoses that reduce the risk of unnecessary operative intervention when diagnostic uncertainties exist. However, the 75% sensitivity indicates that there remains a significant risk of missing early dentinal lesions, in teeth with non-overt disease, when conventional visual and radiographic diagnostic methods are used. Some diagnostic uncertainty is inherent in health care, and optimal patient care decisions should take into account all patient factors, including the probability of disease and the relative risks of delaying treatment versus undertaking unnecessary operative intervention.

Conclusions

Accurate diagnosis of occlusal dentinal caries is challenging unless cavitation or radiographic evidence is present. As radiographs tend to reveal only significant caries, there is a need for diagnostic methods that can more accurately detect dentinal involvement at an earlier stage. The accurate diagnosis of the presence or absence of disease is paramount for appropriate care. More precise methods for definitive diagnosis of lesion presence, activity and size would significantly improve caries management decisions with respect to operative intervention or preventive care.[20] The development of new diagnostic technologies for occlusal surfaces, including the DIAGNOdent laser fluorescence device (KaVo, Biberach, Germany), will be discussed in Part II of this 2-part article. ◆

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