Occlusal caries diagnosis and treatment

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Abstract
The occlusal surface has been considered the most suitable site for carious attack for its complex anatomy and posterior location. These characteristics facilitate plaque accumulation and difficult clinical perception of visual changes on pits and fissures. Complementary diagnostic methods have been developed in order to achieve early and individualized diagnosis, as well as to monitor carious lesions progression. The viability of these methods in clinical practice and their capacity in predicting activity and severity of caries are decisive factors in treatment planning. This literature review aims to gather information about the controversial issue of occlusal caries diagnosis and its treatment.

Key Words
Dental caries; pits and fissures; diagnosis; treatment plan

Introduction

In the last three decades, caries world prevalence has declined[1-2]. This fact is apparently related to the wide-spread use of fluoride containing dentifrices, the fluoridated water, prevention programs in schools and clinics, and, in a lesser extent, the reduction in sugar consumption[1-2]. These factors may have contributed to change the physical presentation and behavior of carious lesion, making its diagnosis more difficult[3].
The reduction in caries, however, has not uniformly occurred in all dental surfaces. From the first reports it was noted that the largest percentage reduction occurred on smooth surfaces and the majority of new carious lesions in children are now located on occlusal surfaces[4]. Furthermore, apparently intact enamel surfaces, strengthened by the increased presence of fluoride, may mask progressing dentinal caries beneath, making more difficult to diagnose occlusal caries[5-6].
Technological advances are providing an increasing number of diagnostic options to meet the challenge of an early diagnosis, based on risk and activity evidence, compatible to a conservative treatment[3].
This literature review aims to gather information about the controversial issue of occlusal caries diagnosis and its treatment.

Diagnostic methods

Historically, detection of occlusal caries has been carried out with the use of mirror, light, and explorer probe. The decision of restoring a tooth was based solely on visual signs and tactile features of dental tissues. This diagnosis focused on the presence and extent of cavities[6].
However, with the understanding of the dynamics of carious progression, and the efficacy of preventive approaches in caries control, new non-invasive measures have been suggested[7].
In vivo and *in vitro* studies have been developed to validate new diagnostic methods and devices, and to improve traditional ones[8-10]. Fibre-optic transillumination, digital radiographs, laser fluorescence, videoscope, and electrical resistance measurements are some of the alternative diagnostic methods studied. Unfortunately, most of them are less viable to routinely clinical use, and it seems to have no significant advantage over conventional methods in the diagnostic field[11].
Validation of a caries diagnostic system is achieved by comparing the test outcomes to the true state of the lesion, often referred as the "gold standard diagnosis". The selection of the most suitable validation method is dependent on study design: histological examination or quantitative microradiographs for *in vitro* studies, and cavity preparation or subsequent extraction of teeth for *in vivo* studies[3,6]. The confirmation of those results give accuracy parameters, converted in sensitivity and specificity numerical values. A method is considered accurate if it is sensitive – detect disease in patients that are sick – and also specific – exclude disease in healthy individuals[12].
A major problem is that these diagnostic studies limit method accuracy to localized detection of presence and extension of carious lesions. These aspects are not so important as individual risk, activity and severity levels, related to treatment plan. Values of sensitivity and specificity, however, reflect some tendency of the method in giving false-positive or false-negative results. These untrue results would mislead treatment: untreatment or overtreatment.
In fact, there is no ideal diagnostic exam, which would detect the disease at any stage and define individual caries risk and activity patterns[9]. This complete diagnosis may be achieved by associating diagnostic tools available in the clinical practice.

Clinical exam

Anamnesis

Anamnesis begins when patient arrives in the dentist's office. By observing the patient's face, behavior, and psychology, a bio-emotional profile can be built, and further confirmed over the next few minutes, with an informal conversation. By talking to the patient, the dentist will discover his aims, the importance and care that he drives to his own oral health, and the contribution that this person will give to treatment success.
Information collected by anamnesis can reveal risky factors to oral diseases[9,13], life style, functional and parafunctional habits, caries related past experience, oral hygiene frequency, diet, fluoride exposure, motor deficiencies, systemic diseases, salivary flow and composition, schooling level and socio-economic conditions[9].

Visual Inspection

After anamnesis, Huysmans et al.[14] would recommend an initial visual inspection to detect periodontal and hygienic conditions, before any professional procedure. If there is visible cariogenic plaque – gummy, thick, and well adhered to dental surface – even if no cavities are seen, it could indicate bacterial infection, possibly related to a subtle disease manifestation[15]. However, most patients clean their mouth just before dental consultation, eliminating this strong clinical evidence. However, a gengival bleeding can indicate plaque-mediated inflammation[16].
After careful pumicing, drying, and illuminating occlusal surface, another inspection is made. Opacity, translucence or enamel pigmentation, grayish-blue aspect of dentine beneath enamel, and localized breakdowns on pits and fissures are investigated[8]. These clinical features would permit differential diagnosis between dental defects and carious lesions.
According to Lussi[5], it is difficult to relate fissure pigmentation to carious progression stages. This is due to the subjective perception of colors, which depends on environment light, tooth hydration, and nature of carious lesion. Considering that during remineralization some

exogenous pigments are incorporated to the dental tissue, a darkened pit and fissure system may be a result from a controlled carious process and a more acid-resistant dental tissue (Figure 1).

***Fig. 1** - Fissure pigmentation does not mean active carious lesion. It might be a result of the incorporation of exogenous pigments during remineralisation. However, visible cariogenic plaque and gingivitis around tooth indicates bacterial infection.*

To Bader and Brown[17], enamel opacity is more relevant in determining lesion activity. Therefore, visualization of a non-cavitated opaque enamel – white spot lesion – after 5 seconds drying, suggests an incipient demineralization area, that could be considered active if it is opaque, rough, and covered by dental plaque. Visualization of the same area without drying indicates greater mineral loss and tissue porosity. Remineralization makes white lesions smooth, bright, and dark, but they rarely disappear[13]. According to Pereira et al.[10], when incipient lesions are associated with localized enamel breakdowns – micro-cavities – or grayish color from dentine beneath enamel, a radiographic complementary exam is requested to investigate dentine involvement (Figure 2). This fact draws attention to the current use of bitewing radiographs to complement clinical exam in cases that it would not be necessary.

***Fig. 2**- Fissure pigmentation, localized enamel breakdown, and grayish color from dentine beneath enamel suggest dentine carious involvement. Further radiographic exam would help clearing diagnosis.*

Cavities with brown-yellowish moist dentine and opaque margins may be in active demineralization. On the other hand, dark dentine in a cavity with defined and bright margins suggests the interruption of carious progression[13].

Tactile Inspection

Unfortunately, sharp explorer probes are still used to detect occlusal caries, supported on the belief that instrument retention would predict the presence of cavities. However, Elderton[18] stated that the explorer retention on groove-fossa system would not improve diagnostic accuracy, because of the inherent retentive characteristics of this site. Also, this instrument has the potential to destroy occlusal regions that are already weakened by carious process, turning the remineralization of that area impossible[19].

Tactile inspection should be made using a dull tip instrument, under light digital pressure to remove debris that could difficult visual inspection or investigate dentine texture in carious lesions that are already cavitated[13].

Complementary radiographic exam

Since "hidden caries" – extensive dentine demineralization beneath an apparently intact enamel surface – has increased, occlusal caries diagnosis has become more complex, and the use of radiographic exam more frequent[20]. Visual and tactile inspections, solely, seems to underestimate occlusal and approximal caries prevalence, well detected on bitewing radiographs[21]. This exam can estimate the extension of carious lesions, relating it to pulp and biological space[22].

In bitewing radiographs, caries appear like a radiolucent (dark) line that crosses enamel from the bottom of the fissure, and that can spread diffusely to dentine beneath. However, there is a tendency in visualizing radiolucencies in this area, even when no dentine lesion is present. This is a perception phenomenon that results from the contrast between light and dark areas, common along enamel-dentine junction[23]. According to Van Amerongen et al.[24], if this radiolucency extends beyond 0,5 mm from enamel-dentine junction, one can consider that carious lesion involves dentine. On the other hand, radiographic evidence of enamel lesions is difficult because of over position of mineralized structures, in a two-dimensional image[8,21-22].

The bitewing radiograph is inaccurate to detect small carious lesions because it is a specific rather than sensitive method. Overall, its accuracy is related to exposure parameters, film and its processing, viewing conditions, and observer's experience[25]. Observers have to be trained, since there is a large scale of gray colors that could represent caries absence or presence.

Although bitewing radiographs, associated with clinical exam, can facilitate occlusal caries diagnosis and monitor caries progression[23], this complementary exam should only be indicated for those cases when dentine involvement remains obscure (Figure 3).

Conventional Diagnostic Methods

ANAMNESIS	VISUAL INSPECTION	TACTILE INSPECTION	BITEWING RADIOGRAPH
Patient's Bio-emotional profile; Schooling level and Social-economic conditions; Oral hygiene habits; Diet; Functional and parafunctional habits; Life style; Past caries related experience; Fluoride exposure.	Primary inspection: Oral hygiene and Periodontal conditions; Secondary inspection: opacity, color, microcavities, and grayish colored dentine beneath enamel.	Dull tip instrument; Debris removal; Investigate cavity carious dentine texture.	Complementary exam; Investigate dentine carious involvement; Specific requisition.

CLINICAL EXAM

Alternative diagnostic methods

The association between conventional and alternative diagnostic methods, according to Heaven et al.[26], would improve diagnosis accuracy and facilitate treatment plan.

Digital radiographs can evidence some subtle characteristics of carious lesions, decreasing the need of repetition[3]. Image can be enlarged, vary in bright, contrast, or color, and also get a third dimension[22]. In addition, direct digital methods capture images immediately by sensors or optical plates, eliminating process errors[3]. Exposure time and radiation dose are reduced in almost 80%, a benefit for both patient and dentist[27]. However, cost-benefit ratio is considered disadvantageous for digital radiographs, since there might be no significant difference in relation to conventional radiograph diagnosis[22].

Fibre-optic transillumination (FOTI) is based on the differences of light transmission between healthy and carious dental tissues, which appear darkened[28]. This system was first developed as an auxiliary tool for approximal surface inspection. It is practical, safe and accessible for occlusal surfaces[3,10]. Nevertheless, its high costs and its accuracy on detecting enamel caries are questioned[28].

The laser fluorescence has also been reported by experimental studies, used for the detection and quantification of physical alterations on dental tissue[10]. Specific equipment (DIAGNOdent, Kavo, Biberach, Germany) emits laser toward the tooth. This light is capable of stimulating fluorescent light emission from tooth, with different wavelengths and acoustic signs that are electronically quantified[29]. Studies have demonstrated satisfactory sensitivity and specificity values for this method, and even better performance when compared to conventional radiographs in detecting "hidden caries"[30]. However, there is a tendency for false-positive results, as the system is incapable of differentiating carious lesions from dental defects, plaque accumulation and dental calculus[29]. Some authors have stated that good *in vitro* reproducibility of this method turns it useful to monitor mineral loss over time[29-30].

Another alternative would be the use of Electronic Caries Monitor (ECM, Borsboom Sensor Technology and Consultancy Group, Westerendem, Norway), because healthy enamel is not a good electrical conductor[31], whether demineralized tissues are[32]. Therefore, electrical resistance measures of the occlusal surfaces could be a useful diagnostic evidence[10], as sensible as and more reproducible than visual inspection[14,32]. However, enamel hypoplasia, fractures, defects, and immature stages of calcification can also be quantified electronically, and misinterpreted as carious lesions[14,31-32]. Besides its proved utility for longitudinal studies – particularly to monitor mineral loss – more research is necessary to assure its clinical use.

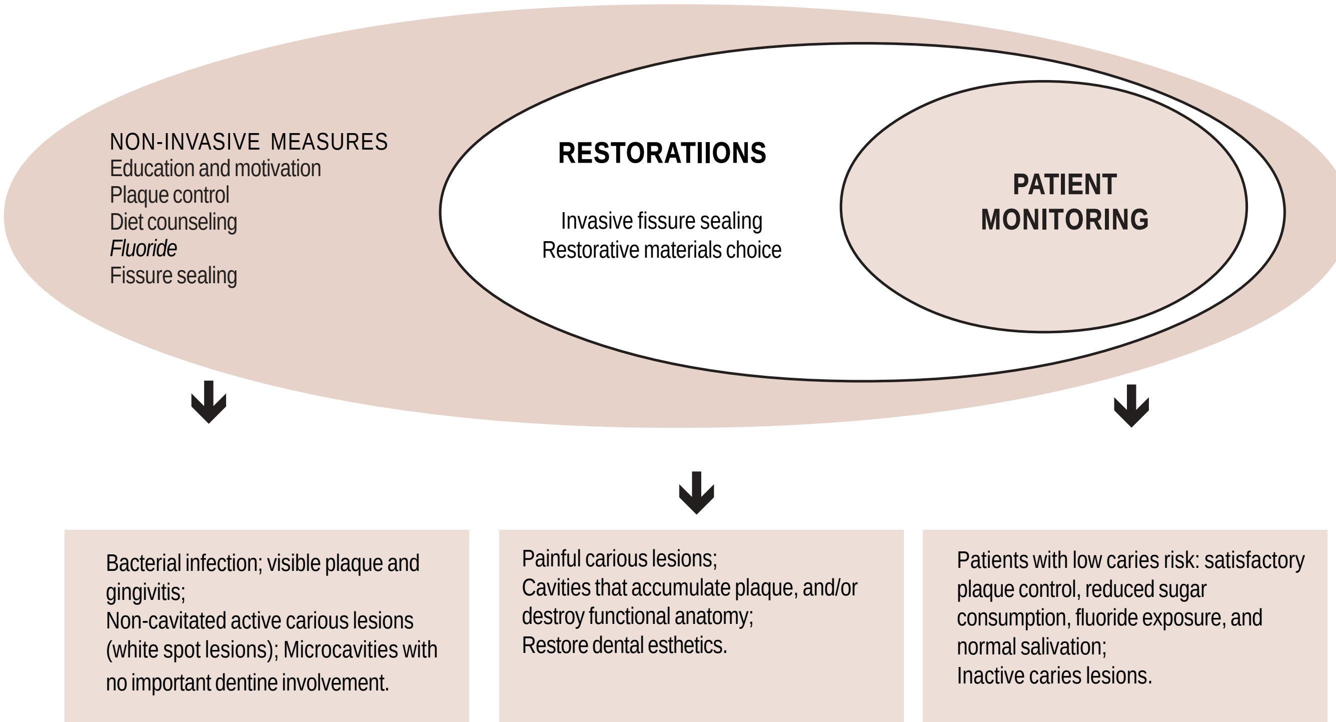
A recent review[33] has shown the limited number of publication about emerging diagnostic methods, all *in vitro* studies. These investigations are important to verify the potential of new technologies on detecting carious lesions, and to serve as a basis to subsequent clinical studies that would validate those diagnostic methods.

Treament decision

Although caries has declined, it has not been eliminated and it continuous to be a major problem in public health. Vehkalahti et al.[34] described the polarization of caries, defined as the proportion of high caries groups, both in terms of caries experience and current untreated caries. This phenomenon indicates the need of providing and targeting preventive treatment for youth populations according to subject's individual needs within each age cohort.

Recent studies suggest that caries can be controlled within any stage of progression, since one can maintain clinical conditions free of cariogenic plaque accumulation[35]. Therefore, education and oral hygiene, plaque control, diet counseling, fluoride use, and fissure sealing are non-invasive measures capable of interrupting disease cycle and restoring patient health[7,15].

Figure 4 - Treatment Plan



Dental restorations are often necessary to reduce bacterial infection and restore dental anatomy, but should always be associated with non-invasive methods. Cavities or hidden caries, which respectively accumulate plaque or resist to remineralization, should be restored and receive non-invasive treatment[36]. However, there are specific clinical situations, where cavity form permits hygiene access and the lesion rarely progresses[9,15]. If this cavity is not in esthetic areas; does not interfere on occlusal function; and does not offer any risk for tooth fracture or any pain, it can avoid restorative treatment. Different treatment plans – non-invasive measures solely, or associated with restorative interventions, or even absence of treatment – will depend on the pattern of individual disease progression[9,15,18] (Figure 4). Then, treatment plan should be based on a complete and individualized diagnosis, capable of detecting caries disease and determine its characteristics and its potential for progression.

Although complementary exams give information not directly related to the dynamics of the process, when associated with conventional diagnostic methods they can help define patient real condition. Therefore, analysis of caries risk, disease clinical signs, symptoms and patterns of activity and severity should be focused to achieve early and accurate diagnosis, essential to treatment plan.

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