

The Incipient Caries

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ABSTRACT

Caries lesion progression is highly dynamic process characterized by alternating periods of dissolution and redeposition of minerals in the dental hard tissue. When outcome of these processes overtime is a net loss of mineral, a caries lesion develops or progresses. However, when redeposition of mineral predominates, the result may be arrest of lesion progression or remineralization. Clinical observations suggest that caries lesion can be arrested at any stage of lesion development provided that clinically plaque-free conditions are maintained. Hence, the profession must become aware of the importance of identifying the early evidence of disease. The effective dentistry requires early identification of disease, early identification of individual at high risk of developing caries so that they may receive early preventive intervention. The profession needs understand pattern of disease distribution and its determinants and should put efforts for its early caries detection and preventive management strategies.

Keywords: Incipient caries, Hidden caries, Dental caries, Caries prevention, Tooth remineralization.

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INTRODUCTION

Tooth decay or dental caries is a dynamic process resulting from an imbalance between demineralization and remineralization of the dental surface.¹ It begins when bacteria in acidogenic dental plaque—mainly *Streptococcus mutans*, *Streptococcus sobrinus* and *Lactobacillus acidophilus*—ferment carbohydrate in the diet² producing organic acids such as lactic, formic, pyruvic, butyric, acetic and propionic acids. These acids act on hydroxyapatite crystals, freeing the calcium and phosphate mineral content and thereby, initiating the process that forms cavity.³

This process is generally slow, and periods of demineralization alternate with other periods at an early stage of disease that is when the layer of enamel is intact, and if oral conditions change, the incipient lesion can remineralize.³

The incipient carious lesions represent the earliest phase of tooth decay or demineralization and are capable of being reversed, arrested or progressing to cavitation. They are active lesions that are confined to the enamel and are

sometimes referred to as smooth surface caries or white spot lesions.⁴ The bacteria that invade the incipient lesion reach the deepest layers or enamel without cavities, all the way to the amelodentinal limit and may hide the lesion that penetrate dentin.³

Cavities that appear clinically healthy and apparently intact may hide lesions;³ these changes have important implications for diagnosing and managing incipient lesions. Thus, early detection and determination of depth of the lesion should be the prime consideration because they can lead to shift from surgical intervention to preventive treatment.

Modern dentistry is capable of testing for the presence of carious lesions before surface cavitation of enamel and it is suggested that routine testing should be mandatory for all patients who are at risk.⁵⁻⁷

For diagnosis of early carious lesions without cavities there should be an ideal diagnostic method that should offer a high level of sensitivity and specificity to prevent false negative and false positive findings. However, these properties are difficult to achieve using traditional diagnostic methods. More technologically advanced measures to detect incipient dental caries that are based on optical properties (fluorescence, ultrasonic system, tracer dye, and transillumination, etc) have most potential.³

The profession must become aware of the importance of identifying the early evidence of disease, rather than just seeking cavities. The effective dentistry requires early identification of disease, early identification of individual at high risk of developing caries so that they may receive early preventive intervention, as well as those at low risk so as to reduce unnecessary care and associated expenditure.⁸ Thus, the profession needs to focus on the changing pattern of caries process, should understand pattern of disease distribution and its determinants and should put efforts for its early caries detection and preventive management strategies (Fig. 1).

The objective of writing this review on incipient caries is to understand the caries disease process and its clinical stages, distribution and determinants in order to bring about identification of early caries before there is evidence of surface cavitation through various new technologies. And to gain knowledge about improved methods to arrest or reverse the noncavitated lesion while improving surgical management of cavitated lesion.

THE CLINICAL CHARACTERISTICS OF INCIPIENT LESIONS

- Incipient lesion appears as a white or brown spot as the increase in porosity below the enamel surface results in the scattering of light and loss of enamel translucency and thus white chalky appearance, particularly when dehydrated. When rehydrated, the white chalky appearance will disappear.⁷
- The porosity of enamel surface determines if a lesion is actively progressing or has been arrested.⁷
- Active lesions are likely to be in plaque stagnation areas and close to gingival margin.
- Clinically, arrested lesions tend to have smooth surface that reflect light, giving shiny appearance, which also may accumulate pigmentation.⁷
- A fragile surface layer of active lesion is susceptible to damage from probing, particularly in pits and fissures.^{6,7}

COMMON SITES OF OCCURRENCE OF INCIPIENT LESIONS

1. White spot lesions are most frequently detected on the accessible cervical third of a tooth. They are also commonly located in high susceptibility areas, such as pits, fissures, and some smooth surfaces of teeth and seen on root surface of the tooth.^{6,7}
2. Studies in patients with prosthodontic restorations suggest that they may have incipient caries in cervical margins.⁹
3. Carious white spots are commonly seen on vestibular tooth surfaces after orthodontic treatment with multibonded appliances.^{10,11}

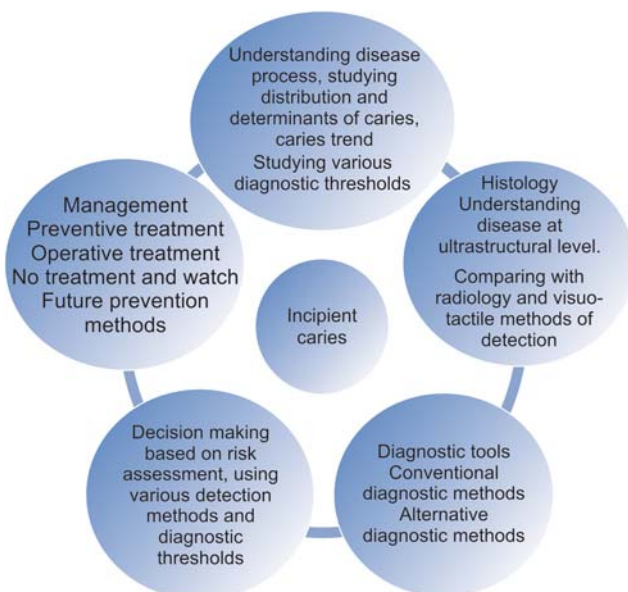


Fig. 1: Early caries detection and preventive management strategies

HIDDEN CARIES

Hidden caries are caries that are undetectable by visual exam, but detectable by radiographic exam. Hidden caries is a term used to refer to a condition where a deep dentinal lesion is clinically misdiagnosed because it is covered by an ostensibly sound tooth surface. The prevalence of this condition has varied from as low as 1.2% to as high as 15% for approximal surfaces, and as high as 38% in occlusal surfaces.⁴

The main concern in detecting hidden caries is that by the time a lesion is detectable on a radiograph, demineralization has already made a huge impact on the tooth, and invasive procedures are recommended. Thus, it would be beneficial to the patient to detect these lesions before they become apparent on a radiograph.⁴

The disease commences well before the development of surface cavitation, and the profession has a responsibility to make an early diagnosis of the hidden disease.

WHY SHOULD DENTISTS DETECT PRECAVITATED CARIOUS LESIONS

First, precavitated carious lesions are significantly more prevalent than cavitated carious lesions.^{12,13}

Second, while a large proportion of precavitated carious lesions on smooth surfaces in children regress or progress slowly during a 1 year period, the pattern of progression early in life may be different (64%) of such lesions in infants and young children progressed to cavitation between the ages of 2.5, 3 and 5 years. Hence, detection of precavitated carious lesions in infants and young children may predict high caries activity.¹²

Third, the mental model that currently exists in dental education, dental insurance and dental practice must change from one that reward dentists based upon their ability to detect and restore 'cavities' to one that reward the promotion of oral health and preserving dental tissues. Data on the prevalence, incidence, and fate of precavitated lesions are needed to provide empirical evidence to aid in promoting these long overdue changes.¹²

CARIES DETECTION SYSTEMS/THRESHOLDS

One should first establish which diagnostic threshold(s) should be used in detection of caries in epidemiologic or clinical setting. And then see how the information obtained might be used to assess needs for preventive, nonoperative and operative care.

There are various diagnostic thresholds which have been introduced. Which are as follow: The iceberg of dental caries (Pitts, 1997).⁸ The new caries diagnostic criteria which

differentiate between active and inactive carious lesions at both cavitated and noncavitated levels (Nyvad B, 1999).¹⁴ Dundee selectable threshold method for caries diagnosis (DSTM) codes (Fyfee et al 2000).¹⁵ The international caries detection and assessment system (ICDAS); (Ismail AI, 2007),¹⁶ WHO + IL diagnostic threshold (Assaf AV et al an adaptation of the criteria according to Nyvad et al¹⁴ and Fyffe et al).¹⁵

DIAGNOSTIC PROTOCOLS

Conventional diagnostic methods: (a) Sharp eyes and magnification, (b) visual detection incipient lesion.

Alternative Diagnostic Methods^{4,7,8}

Physical principle	Application in caries diagnosis
X-rays	Digital image enhancement Digital subtraction radiography Tuned aperture computed tomography
Visible light	Optical caries monitor (OCM) Quantitative fiberoptic transillumination (FOTI) Quantitative light-induced fluorescence (QLF)
Laser light	Laser-fluorescence measurement (DIAGNOdent)
Electrical current	Electrical conductance measurement (ECM) Electrical impedance measurement
Ultrasound	Ultrasonic caries detector

DECISION MAKING FOR EARLY ENAMEL CARIES

Decisions fall into two category:

- Decision regarding which diagnostic information is to be acquired.
- Decision concerning which interventions, if any, are to be employed.⁸

While decision making one should record the severity of all the lesions using following classification: E0 (no enamel lesion), E1 (lesion in outer half of enamel, E2 (lesion in inner half of enamel, D1 (outer third of dentin), D2 middle-third of dentin, D3 (inner third of dentin). This classification will allow judgment of lesion progression or lesion arrest to be made overtime and efficacy of caries management treatment to be analyzed.¹⁷

It is suggested by Foster in 1998 that teeth with lesions penetrating 0.5 to 1.0 mm into dentin (D1) should be restored. However, if the caries risk level is low and the tooth surface is noncavitated, the decision to restore may be premature.^{8,18}

Identification of Treatment Choices

For incipient caries management situation the following treatment options should be considered:

- No treatment
- Monitoring of demineralized, noncavitated tooth surface

- Preventive, nonsurgical treatment
- Surgical intervention of incipient lesions.

Each of these treatment options will depend on several key patient variables, including risk level, the patients desires and expectation of treatment, oral hygiene status, diet management by the patient, ability to be sufficiently motivated to ensure adequate compliance to home care requirements, commitment to assisting in disease management.⁸

BENEFITS AND RISKS OF EARLY CARIOUS LESION DETECTION

- Increased potential to ‘remineralize’ demineralized, noncavitated tooth surfaces
- Diseased risk of progression to the cavitated stage
- Reduced probability of tooth sensitivity associated with deeper lesion
- Maintenance of natural occlusion
- Preservation of natural esthetic appearance of tooth enamel
- Reduced treatment cost associated with false negative diagnosis.⁸

Caries Risk Assessment

It is necessary to study caries risk assessment since it is an integral component of modern caries management. Caries risk is the probability that a lesion will develop or that an existing lesion will progress during a specified period.

Caries risk should be assessed for two principle reasons:

- Individually based caries preventive measures can be directed to the highest-risk patients who benefit most from prevention, and
- Identification of low-risk patient can delay restoration placement or replacement and may prevent unnecessary surgical intervention.⁸

Re-evaluation of Caries Risk

The recall interval is highly dependent on the risk category of the patient. Low-risk patient can be placed on recall interval as long as 1 year, whereas those at high risk are recommended to be recalled at 3-month interval. The caries risk status of patient should have a prominent place in the treatment record.^{7,8}

APPROACHES TO MANAGEMENT OF EARLY ENAMEL CARIES (INCIPIENT CARIES)

Primary Prevention of Dental Caries Initiation

Community and individual strategies for preventing caries, notably water fluoridation and use of fluoridated toothpaste, use of other remineralization strategies, oral hygiene, patient education, preventive programs (toothbrushing programs,

sealants/mouthrinses,) which have been seen very successful in last 30 years in many countries.¹⁹

Mechanical/chemical removal of plaque (oral hygiene). Traditional physical/mechanical methods of caries prevention includes oral hygiene procedures (toothbrushing, flossing, and professional tooth debridement).^{7,8}

The preventive strategies to be effective in high-risk people along with oral hygiene are also likely to be effective for arresting and reversing lesions.

The use of antiplaque agents, such as chlorhexidine, cetylpyridinium chloride, delmopinol, hexitidine, Sanguinaria extracts, triclosan, casein phosphopeptide-amorphous calcium phosphate (CCP-ACP) are proved to be effective in reversing the incipient caries. Use of fluorides in the form of community-based fluoride interventions, self-applied methods of fluoride delivery, such as (a) fluoride dentifrices, (b) fluoride dentifrices, (c) fluoride rinses, (d) fluoride gels and foams, (e) fluoride chewing gum, professional fluoride delivery methods, such as (a) fluoride gels (b) varnishes.⁸

Silicate restorative materials and glass ionomer cements, other fluoride containing dental materials, such as composite and amalgam potentially provide a fluoride reservoir to help prevent or remineralize caries in adjacent teeth or surfaces. Dietary advice also helps to prevent the progression of caries process and help to remineralize the incipient caries.⁸

Xylitol reduces plaque formation has been reported, and decrease in the number of salivary mutans streptococci and less gingivitis have been observed.⁸

Protective factors in food such as milk, foods of plant origin include organic phosphate, inorganic phosphates, polyphenols and phytate which have anticariogenic action and prevent enamel demineralization.⁸

- *Patient education:* Patients in particular at risk for incipient caries need to understand two important features of biofilm, one of which is the infection potential of dental biofilm.^{7,8}

Operative Treatment for Incipient Caries

Sealants: Preventive resin restoration, air abrasion, laser for removing incipient carious lesions.^{4,7}

No Treatment and Watch

One treatment option is to not treat the lesion surgically but to treat the factors that caused the lesion and to observe its progression or reversal.⁷

FUTURE PREVENTION METHODS

Probiotic Therapy

A natural or genetically modified effector strain is used to intentionally colonize the sites in susceptible host tissues

that are normally colonized by a pathogen.¹⁸ If the effector strain is better adapted than the pathogen, colonization or outgrowth of the pathogen will be prevented by blocking the attachment sites, by competing for essential nutrients, or via other mechanisms. As long as the effector strain persists as a resident of the indigenous flora, the host is protected potentially for an unlimited period of time.⁴

Genetically Engineered, Alkali Producing Streptococci

Oral bacteria can be genetically modified to produce alkali environments, which may be beneficial in preventing or arresting the caries process. Recent evidence suggests that alkali generation may play a major role in pH homeostasis in oral biofilms and it may moderate initiation and progression of dental caries.⁴

Caries Vaccine

Anticaries vaccines operate on the principle of reducing the population of the indigenous bacteria that are associated with the caries disease process.^{4,18}

CONCLUSION

Previously many studies has been carried out in order to find the prevalence of dental caries at D₃ threshold but the disadvantage of applying such threshold is that half of the lesions are ignored. And therefore new diagnostic thresholds having D₁ threshold should be applied. It is important to study effect of various nonoperative/preventive interventions of caries. Using the wealth of epidemiologic data, detection methods/thresholds, and preventive strategies the profession must make utilization in clinical settings and field situation. The dentists, planners, epidemiologic investigators should be thoroughly trained and calibrated prior to the survey/study.

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