

INTRODUCTION AND REVIEW OF LITERATURE

Today, dental caries is a major health problem and one of the most common chronic diseases throughout the world. It has a great effect on people's quality of life and high indirect impact on the economy, which can result in unnecessary pain, suffering and missed work or school days.¹ Individuals are susceptible to this disease throughout their lifetime. Worldwide, approximately 36% of the populations have dental caries in their permanent teeth. In deciduous teeth it affects about 9% of the population.²

Dental caries is a dynamic process resulting from biochemical and ultra structural alterations, which present with characteristic signs and symptoms.³⁻⁵ This process, is affected by numerous modifiers tending to push the mineral equilibrium towards remineralization or demineralization.⁶ All of these interactions take place in the biofilm overlaying the tooth surface which comprises of the pellicle as well as the oral micro-flora of the plaque.⁷

Determinants of dental caries

Cariogenic Bacteria

Dental caries is a transmissible bacterial disease caused primarily by the cariogenic bacteria feeding on the fermentable

carbohydrates taken into the mouths of humans.^{8,9} It is believed that bacteria of the species *Streptococcus mutans* is the main factor that initiates caries, and the bacteria of the genus *Lactobacillus* are important in further caries development, especially in the dentin. Caries can also be caused by other bacteria, including members of the mitis, anginosus and salivarius groups of streptococci, *Enterococcus faecalis*, *Actinomyces naeslundii*, *A. viscosus*, *Rothia dentocariosa*, *Propionibacterium*, *Prevotella*, *Veillonella*, *Bifidobacterium* and *Scardovia*.¹⁰⁻¹²

Mutans streptococci

Mutans streptococci are the most cariogenic pathogens as they are highly acidogenic, producing short-chain acids which dissolve hard tissues of teeth. They metabolize sucrose to synthesize insoluble extracellular polysaccharides, which enhance their adherence to the tooth surface and encourage biofilm formation and highly aciduric which can survive and grow in acidic environment.¹³

Lactobacilli

The most common types present in the oral cavity are *L. acidophilus*, *L. casei* and *L. salivarius*. They are acidogenic and aciduric bacteria. They are considered to be the pioneering microorganisms in the caries progress, especially in dentin.¹⁴ In addition, they are a dominant part of the flora inhabiting the deep cavities, and their number correlates with the amount of carbohydrates.¹⁵

The risk and modifying factors of dental caries are well known and they include physical, biological, environmental, behavioral and lifestyle-related factors.^{16,17}

Pathogenesis of dental caries

The caries process is a continuum resulting from many cycles of demineralization and remineralization.

Demineralization begins at the atomic level at the crystal surface inside the enamel or dentine and can continue unless stopped with the end-point being cavitation.¹⁸ The bacteria responsible produce organic acids as a by-product of their metabolism of fermentable carbohydrates that cause decrease in the plaque pH. Lowering the pH of the plaque below the "critical value" (5.5 to hydroxyapatite, 4.5 to fluoroapatite, 6.7 to cement) causes dissolution of calcium phosphates included in the hydroxyapatite and initializes loss of the tooth mineral substances.^{16, 19}

A high resolution electron micrograph is a technique that only visualizes the electron dense calcium ions that show up as straight black rows of dots that each are derived from calcium ions. While phosphate, hydroxyl and fluoride ions cannot be seen with this technique.²⁰ By this technique the first stage of demineralization which is occurring at the atomic level far before it can be seen visually as gross demineralization appears

as hexagonal shaped white regions which represent areas where minerals have dissolved during acid attack (**Fig. 1**).¹⁸

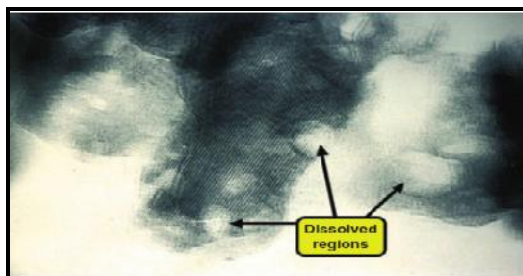


Fig. (1): A High resolution electron micrograph at 3 000 000x of natural carious lesion.¹⁸

Remineralization is the natural repair process for non-cavitated lesions, and relies on calcium and phosphate ions assisted by fluoride to rebuild a new surface on existing crystal remnants in subsurface lesions remaining after demineralization.²¹ These remineralized crystals are acid resistant, being much less soluble than the original mineral.²²

Caries classification

G.V. Black's²³ caries classification system is the earliest one and still represents the basic principle for all classification systems. This system divides dental caries into several classes on the basis of the site of the tooth (**Fig. 2**).

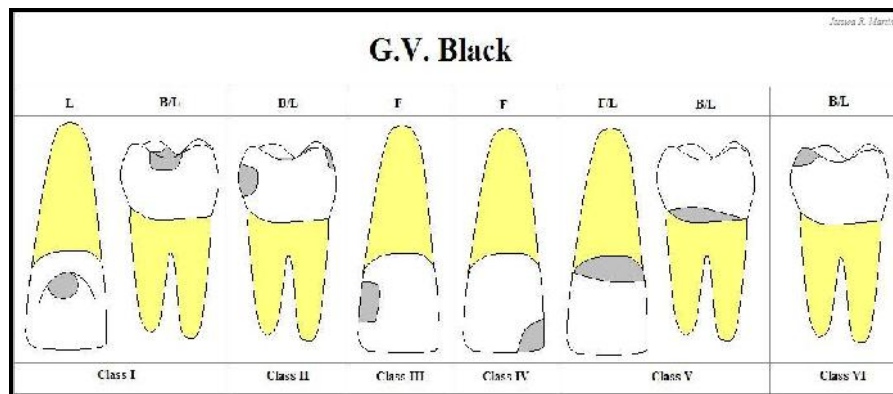


Fig. (2): G.V. Black`s classification of carious lesions.²⁴

- **Class 1:** found in pits and fissures of occlusal surface of premolar and molar, buccal or lingual pits of molars and lingual pits near the cingulum of maxillary incisors.
- **Class 2:** found on the proximal surfaces of premolars and molars.
- **Class 3:** found on the proximal surfaces of incisors and canines.
- **Class4:** found on the proximal surfaces of incisors and canines and involve the incisal edges.
- **Class 5:** found on gingival third of facial or lingual surfaces of any tooth.
- **Class 6:** involve the incisal edges of anterior teeth and the occlusal surface of posterior teeth that have been worn away due to abrasion.²⁵

GV Black classification identifies the position of a lesion and prescribes a cavity design regardless of the size and extent of the lesion. This means that there will be a standard amount of tooth structure removed whether it is involved with the disease or not.²³ This problem is taken into account in Mount and Hume classification, to the advantage of both the patient and the profession.

Mount and Hume classification

A new classification that identifies both the position and extension of a lesion to achieve the concept of minimal intervention cavity designs²⁶ (Table 1).²⁷

Lesion Site

Carious lesions occur in only three different sites on the surface of the crown of a tooth.

Site 1 - the pits and fissures on the occlusal surface of posterior teeth and other defects on otherwise smooth enamel surfaces.

Site 2 - the contact areas between any pair of teeth, anteriors or posteriors.

Site 3 - the cervical areas related to the gingival tissues including exposed root surfaces.

Lesion Size

The sizes that can be readily identified are as follows;

Size 0 – the initial lesion at any Site that can be identified but has not yet resulted in surface cavitations it may be possible to heal it.

Size 1 – the smallest minimal lesion requiring operative intervention. The cavity is just beyond healing through remineralization.

Size 2 – a moderate sized cavity. There is still sufficient sound tooth structure to maintain the integrity of the remaining crown and accept the occlusal load.

Size 3 – the cavity needs to be modified and enlarged to provide some protection for the remaining crown from the occlusal load. There is already a split at the base of a cusp or, if not protected, a split is likely to develop.

Size 4 – the cavity is now extensive following loss of a cusp from a posterior tooth or an incisal edge from an anterior.

Table (1): Mount and Hume classification.²⁷

	Size				
Site	No cavity 0	Minimum 1	Moderate 2	Enlarged 3	Extensive 4
Pit/fissure 1	1.0	1.1	1.2	1.3	1.4
Contact area 2	2.0	2.1	2.2	2.3	2.4
Cervical 3	3.0	3.1	3.2	3.3	3.4

Radiographic classification of caries

Radiographic classification of caries involve both site and depth classification.

- **According to site:** there are;²⁸

1. Occlusal
2. Interproximal
3. Buccal and lingual
4. Root caries
5. Recurrent caries
6. Rampant Caries
7. Radiation Caries.

- **According to depth (severity):** ²⁸

1. Incipient < ½ enamel
2. Moderate = ½ enamel
3. Advanced < ½ dentin
4. Severe = ½ dentin

Incipient caries

It is also known as white spot lesion which represents the earliest clinical sign that dental caries is in progress in the mouth. It is capable of being reversed, arrested or progress to cavitations. The bacteria that invade the incipient lesion reach the deepest layer of enamel and dentin without cavities producing a hidden caries lesion under clinically apparent incipient lesion.²⁹

Criteria of incipient caries

Incipient lesion appears as a white or brown spot as the porosity below the enamel surface results in scattering of light and loss of enamel translucency with white chalky appearance when dehydrated.³⁰ In addition the porosity of enamel surface determines if a lesion is actively progressing or has been arrested. Active lesion has fragile rough surface and more susceptible to damage with sharp probing while arrested lesion has hard smooth surface that reflect light giving shiny appearance.³⁰

Cross-sections through these early lesions can be visualized under an optical microscope as illustrated in (**Fig. 3**). As these lesions progress into enamel they can then be detected clinically by radiographs.³¹ At this stage in the process, prior to cavitations, therapeutic intervention can arrest or reverse the process by remineralization.³²

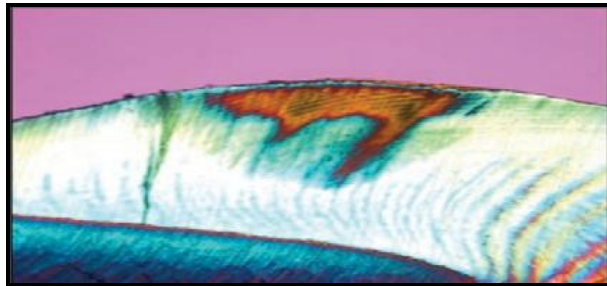


Fig. (3): A cross-section of an early non-cavitated natural early carious lesion in enamel viewed under polarized light microscope showing the body of the lesion (brown area) and the apparently intact surface layer overlying it (blue area). Image provided by: Dr. James Wefel.³³

White spot lesions are most frequently detected on the cervical third of a tooth particularly in patient with prothodontic appliance or after orthodontic treatment with multibonded appliance.³⁴ They are also commonly located in high susceptibility areas such as pits, fissures, smooth surfaces and root surface.³⁰

Proximal caries

Proximal caries is a smooth surface lesion that develops between the contacting proximal surfaces of two adjacent teeth. Just below the contact point and above the top of the free

gingival margin.³⁵⁻³⁷ Radiographically, it is classified as incipient, moderate, advanced and severe.³⁸ Incipient proximal caries presents a big challenge for the dentist and the patient concerning early detection and preservation of tooth structure, function and esthetics.

- **Incipient proximal caries;** extends less than half way through the thickness of enamel which appears as a radiolucent notch (**Fig. 4**).

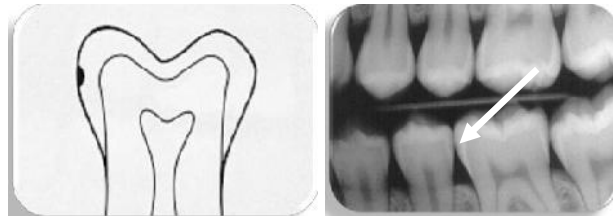


Fig. (4): Diagram and bitewing radiograph of incipient proximal caries.³⁹

- **Moderate proximal caries;** extends more than half way through the thickness of enamel but does not involve the dentino-enamel junction (DEJ) which appears cone-shaped with the base toward the periphery (**Fig. 5**).



Fig. (5): Diagram and bitewing radiograph of moderate proximal caries.³⁹

- **Advanced proximal caries** extends through the DEJ and into dentin but not more than half the distance toward the

pulp. At the DEJ the caries spreads out forming a second cone with the base towards the DEJ and the apex towards the pulp (**Fig. 6**).

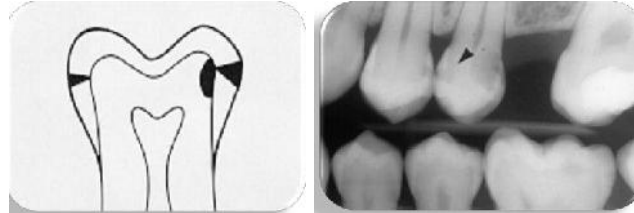


Fig. (6): Diagram and bitewing radiograph of advanced proximal caries.³⁹

- **Severe proximal caries** extends through enamel, dentin and more than half the distance toward the pulp, where the outline of the caries is poorly demarcated (**Fig. 7**).

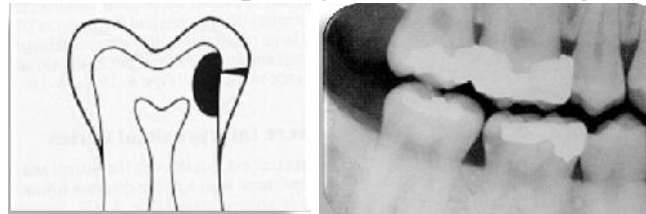


Fig. (7): Diagram and bitewing radiograph of severe interproximal caries.³⁹

Management of dental caries

Accurate diagnosis of dental caries is very critical as it determines the line of treatment. Actually management of dental caries is usually divided into two main pathways; prevention and treatment.

As a preventive strategy, there is a need to implement health education program for maintaining good oral hygiene and it is recommended to start a school-based program.¹⁷ In

addition to water fluoridation that still a viable option to prevent dental caries in communities in South Africa.⁴⁰

Diet modification is another method to prevent caries; there is a wide range of sugar substitutes have low or no cariogenic potential such as, sucralose is a high-intensity non cariogenic sweetener, and xylitol has been reported to have anticariogenic properties.^{41, 42} it is also approved that chewing sugar-free gum after meals can reduce caries risk.⁴³ Some food additives may have protective properties that reduce cariogenicity; for instance, cranberries can reduce bacterial adherence and glucosyltransferase activity of *S.mutans*,⁴⁴ and tea extracts inhibit salivary amylase activity.⁴⁵ Eating cheese after exposure to sugar rapidly neutralizes plaque acidity.

Sealants prevent food from collecting in molar pits and fissures and, therefore, prevent dental caries.⁴⁶ The placement of sealants over carious lesions arrests the disease process and is cost-effective compared with routine restorative care.⁴⁷⁻⁴⁹

Remineralization (non surgical treatment); incipient caries could be repaired by saliva when fluoride application is combined with regular removal of overlying plaque.⁵⁰ Calcium-containing preparations such as amorphous calcium phosphate (ACP)⁵¹ and preparations of casein derivatives (casein phosphopeptide-ACP complex) are commercially available and have remineralizing properties.^{52, 53}

Surgical intervention of incipient caries lesion; it is indicated when the lesion exceed the level of remineralization using simple cavity preparation and restorative treatment.

As accurate diagnosis of incipient caries is a matter of high significance, so that there are several methods of caries detection.

Caries detection methods

Beside the conventional methods of caries detection such as visual, tactile, radiographic examination, there are several new methods for caries detection with different physical principles;

I. Visual and tactile examination

II. Laser and visible light techniques

1) Fluorescent techniques

a. Detection of bacteria porphyrin

- DIAGNOdent
- Vista Proof (VP)
- The SoproLife® Camera

b. Detection of demineralization

- Quantitative light induced fluorescence (QLF)
- The canary system

2) Light transmission and scattering techniques

- Fibre optic transillumination (FOTI)
- The Digital Imaging Fiber-Optic Transillumination (DIFOTI)

III. Electrical techniques

- Electronic caries monitor (ECM)
- CarieScan

IV. Ultrasound technique

V. Radiographic caries detection

I. Visual and tactile examination

Visual inspection and clinical examination by mirror and explorer are the most universal caries detection system,^{54, 55} because it is an easy technique that is routinely performed in clinical practice. Visual examination has presented high specificity (proportion of sound sites correctly identified), but low sensitivity (proportion of carious sites correctly identified), and low reproducibility⁵⁶; As they include Assessment of features such as color and texture which are qualitative in nature and subjective. These assessments provide some information on the severity of the disease but fall short of true quantification.^{57, 58}

Therefore there is a recommendation of using detailed visual indices to improve sensitivity and being an important factor in minimizing the examiner's interpretation of the clinical characteristics of a lesion, and thus improving