DENTAL CARIES

DEPARTMENT OF ORAL AND MAXILLOFACIAL PATHOLOGY
& ORAL MICROBIOLOGY

CONTENT

- Introduction
- Classification of dental caries
- Etiopathogenesis of dental caries
- Clinical features of dental caries
- Histopathology of dental caries
- Diagnosis of dental caries

Definition

- Dental caries is defined as an '' irreversible disease of calcified tissue of teeth, characterized by demineralization of inorganic portion and destruction of the organic the tooth which often leads to cavitations''

Etiology of caries

- No universally accepted opinion for etiology of dental caries .
- Theories:

1. Miller's chemico -parasitic theory
2. The proteolytic theory
3. Proteolysis chelation theory
4. The sucrose – chelation theory

THE PROTEOLYTIC THEORY

- Organic or protein element of a tooth are the initial pathway of invasion by microorganism
- Enamel lamellae are pathway for organism in the process of dental caries .
- Gottlieb ,diamond and applebaum:"caries is a essentially a proteolytic process: the microorganism invade the organic pathway and destroy them in their advanced .acid formation accompanied proteolysis.

Miller's chemico –parasitic theory

- Caries is caused by acids produced by microorganism of the mouth
- Dental decay is a chemico - parasitic process consisting of two stages
- Decalcification of enamel and dentin [preliminary stage]
- Dissolution of the soften residue [subsequent stage]

Role of microorganisms

- Two gram positive coccal bacteria have been implicated in dental caries- L acidophilous and S.mutans.
- Different type of bacteria causes “initiaion” of caries and a completely different species of bacteria causes “ progression” of caries.
- Diet-bacterial interaction is involved in producing root and coronal caries.

- Miller assigned essential roles to 3 factors -
  1. Carbohydrate substrate
  2. Acid which cause dissolution of tooth mineral
  3. Oral microorganism which produce acid and also cause proteolysis

Role of carbohydrate

- Fermentable carbohydrates are responsible for increase caries incidence
- Cariogenicity of carbohydrate varies with

1.frequency of ingestion

2.physical form

3. chemical composition

4. route of administration

5. presence of other food constituents

Role of acids:-

- Acids are produced by enzymatic breakdown of sugars by cariogenic bacteria.
- Acids are-lactic acid mainly and butyric acid to some extent.
- Production of acid must be localized and retained on the tooth surface for it to cause the caries

THE PROTEOLYSIS CHELATION THEORY

- Simultaneous microbial degradation of the organic compound and the dissolution of the minerals of the tooth by the process known as chelation.
- CHELATION: Process involving the complexing of metalic ion to substance through a covalent bond which results in highly stable poorly dissociated or weakly ionized compound.

The sucrose-chelation theory

- Egglers-lura(1967) proposed that sucrose itself and not the acids derived from it can cause dissolution of enamel by forming unionized calcium saccharite .
- They postulated that calcium saccharates and calcium complexing intermediaries require inorganic phosphate which is subsequently removed from the enamel by phosphorylating enzymes .

Current concept of caries aetiology

- Dental caries is a multifactorial disease with interplay of three primary factors ,the host, the microbial flora and the substare , with time as an inevitable fourth factor .
- Conversely ,caries prevention is based upon attempts to increase the resistance of the host ,lower the number of microorganism in contact with the tooth and modify the substrate by selecting noncariogenic foodstuff and reduce the time that the substare is in the mouth

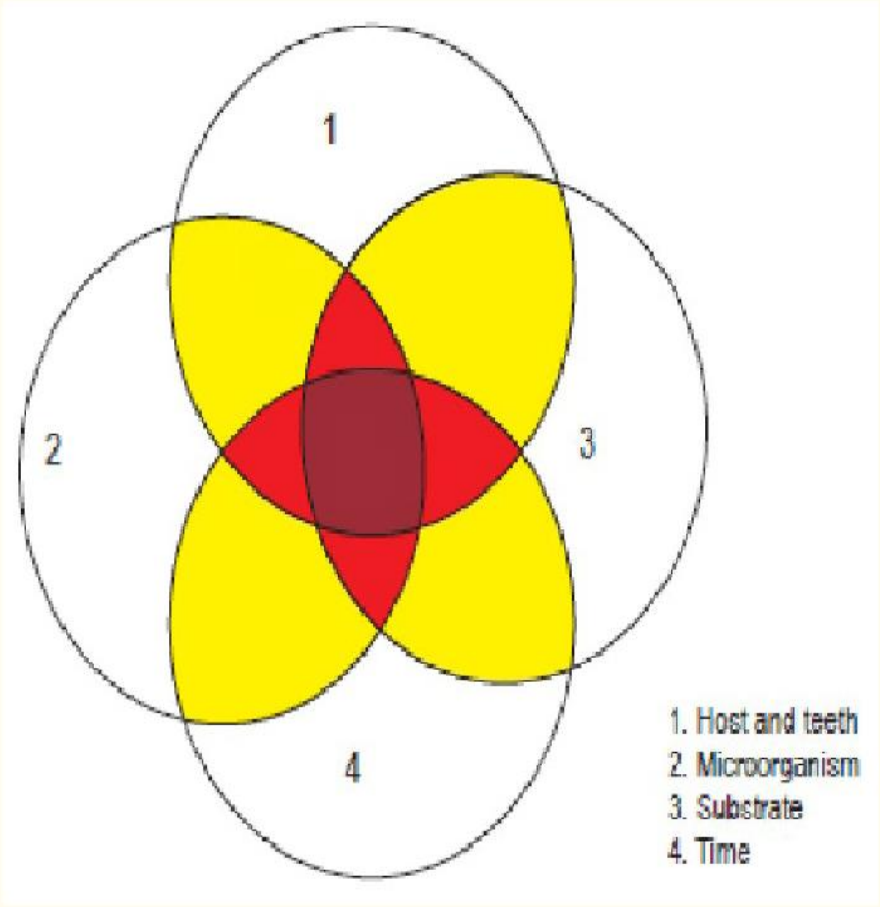


Figure 6: *Contributing factors in dental caries [24].*

Factor that influence in caries aetiology

Host factors	Components
Tooth	1. Composition 2. Morphologic characteristics 3. Position
Saliva	1. Composition (a) Inorganic (b) Organic 2. pH 3. Quantity 4. Viscosity 5. Antibacterial factors
Diet	1. Physical factors (a) Quality of diet 2. Local factors (a) Carbohydrate content (b) Vitamin content (c) Fluorine content
Systemic conditions	1. Heredity 2. Pregnancy and lactation

A . THE TOOTH FACTOR :-

1). Morphology and position in the arch

- Tooth morphology is a recognized as an important factor for initial caries
- Deep pit and fissure in any tooth make then susceptible to caries because of food impaction and bacterial stagnation
- That is why occlusal surface are more prone to caries
- Irregularities in the arch form, crowding and overlapping of the teeth also favour the development of caries
- Partially impacted third molar are more prone to caries .

2) Chemical nature :

it has been observed and proved scientifically surface enamel is more caries resistance than the surface enamel.

B . Saliva

1) composition , ph ,antibacterial activity

- Caries prone individual have low calcium and phosphorus level
- The ph at which any particular saliva ceases to be saturated with calcium and phosphorous is referred to as the ‘critical ph.’
- Under normal condition the critical ph is 5.5 , below this value inorganic material of tooth may dissolve.

- 2) quantity and viscosity of flow:-
- The quantity and viscosity of saliva has definite influence on caries incidence.
- Human being suffering from decrease flow of saliva or lack of salivary secretion (xerostomia) Usually experience increased rate of dental caries.
- Certain drugs influence salivary flow and in turn results in rampant caries.
- Since there is less or no saliva to buffer and wash away fermentation products of plaque during sleep.
- The most important time for plaque removal is before sleeping to avoid caries.

- 2) the microflora:-
- It was observed that for caries to occur , bacteria played a definite role.
- Clarke (1924) discovered the species streptococcus mutans.
- Streptococcus mutans ferments manitol and sarbitol and lactic acid former which easily colonize on the tooth surface.
- The predominantly present micro – organism are lactobacilli which account for one third of the oral flora.
- Streptococcus mutans and streptococcus salivarius have been shown to produce root caries.

Localization of carious microflora in animal models and its significance to human

Type of caries	Microorganism	Human
Pit and fissure	*S. mutans*	Very significant
	S. sanguis	Uncertain
	Lactobacillus species	Very significant
	Actinomyces species	By chance
Smooth surface	*S. mutans*	Very significant
	S. salivarius	By chance
Root surface	*A. viscosus*	Very significant
	A. naeslundii	Very significant
	S. mutans	Significant
	S. sanguis	By chance
Deep dentinal caries	*Lactobacilli* species	Very significant
	A. naeslundii	Very significant
	Other filamentous rods	Very significant

- THE SUBSTARTE OR DIET :
- Physical nature of diet :
- Modern diet include refined foods , soft drinks which lead to collection of debris predisposing to more caries.

- Chemical nature of diet :
- By chemical nature of diet we are mainly concerned with the nutrient present in our meals , frequency of intake and also their cariogenic potential.
- the main ingredient is carbohydrate , which is accepted as one of the most important factor in dental caries process. Only refined carbohydrate are effective.

- For caries production following factors are responsible.
- Type of carbohydrate
- Frequency of intake
- Time of stagnation

4) TIME :-

- During the long intervals of undisturbed plaque stagnation , the plaque ph is lowered flavoring the production of organic acids that dematerialize tooth structure.

CLASSIFICATION

- According to the anatomical site

1. Pit or fissure caries
2. Smooth surface caries

- According to nature of attack

1. Primary caries
2. secondary caries

- According to the rate of caries progression
  1. Acute caries
  2. Chronic caries
  3. Arrested caries

- Based on chronology
  1. Infancy caries [rampant caries]
  2. Adolescent caries

Clinical classification of caries

1. Pit and fissure caries

- develops on the occlusal surface of molars and premolars, buccal and lingual surface of the molar and palatal surface of maxillary incisors

- deep and narrow pit and fissure favor the retension of the food debris along with microorganism

Pit and fissure caries

- **Clinical features** :
  - Appears brown or black
  - Feel slightly soft
  - Catch a fine explorer point
  - Lateral spread of caries at dentino-enamel junction
  - Penetration into dentin along dentinal tubules may be extensive.
  - Without fracturing away overhanging enamel

2 . Smooth surface caries :

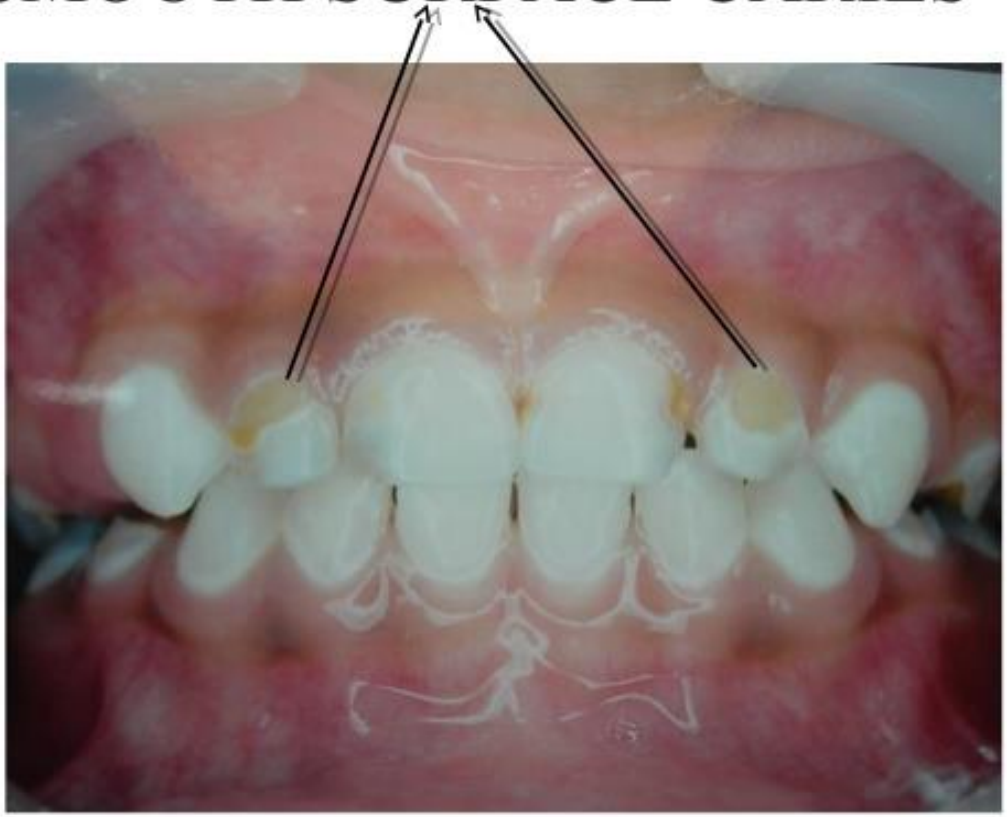
Develop on proximal surface of the teeth or on the gingival third of the buccal and lingual surface.

- **Clinical features**:

  - Appear as yellow or brown pigmented area.

  - Early white chalky spot becomes slightly roughened owing to superficial decalcification of the enamel.

SMOOTH SURFACE CARIES



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3. **Root caries** :

- Also known as cemental caries

- Soft ,progressive lesion that is found anywhere on the root surface.

- Involves both dentin and cementum.

- In the number of peoples exhibiting gingival recession with clinical exposure of cemental surface.

- **Clinical features**:
  - Usually found in mandibular molar area and premolar region.
  - Gingival recession is associated with root surface caries.

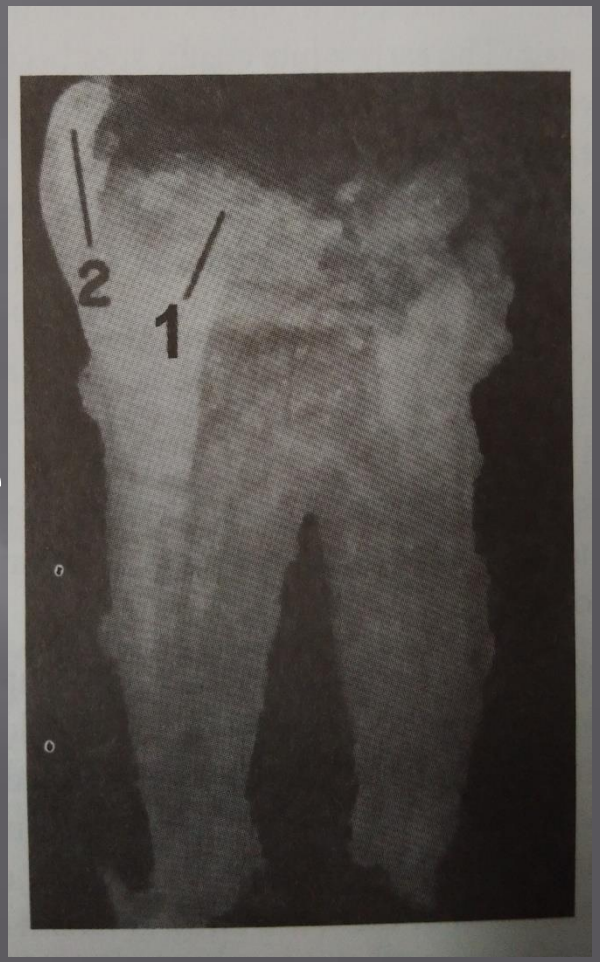
2.Based on progression

Acute dental caries:

Rapid process

Pulp exposure and sensitivity are often observed

Saliva does not easily penetrate the small opening to the carious lesion, shows little opportunity for buffering or neutralization



1.There is accumultion of soft necrotic dentin

2.And undermined enamel

Chronic dental caries:

- Progress slowly and tend to involve pulp much later than acute caries.
- Slow progress of the lesion allows sufficient time of both sclerosis of the dentinal tubules and deposition of reparative dentin in response to adverse irritation.
- Pain is not common feature because of protection afforded to the pulp by secondary dentin.

Arrested caries:

- Stationary or static caries
- No tendency for further progression
- Both deciduous and permanent affected
- Arrested caries involving dentin shows a marked brown pigmentation and induration of the lesion[the so called ‘eburnation of dentin]

Arrested caries

Other clinical varients of dental caries

Rampant caries:

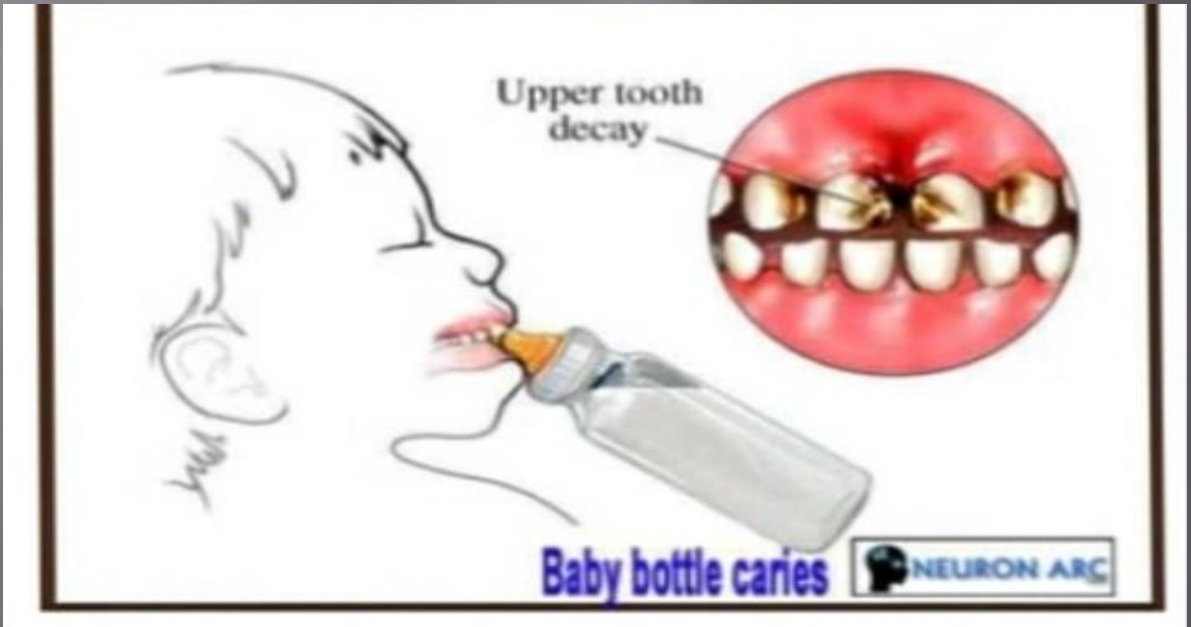
- Suddenly appearing,
- Sever destruction,
- Wide spread
- Resulting in early involvement of pulp

- Most often observed in primary dentition of young children and permanent dentition of teenager.

Rampant caries

Nursing bottle caries:

- Other names: nursing caries , baby bottle syndrome and bottle mouth syndrome
- Prolonged use of nursing bottle containing milk or milk formula, fruit juice or sweetened water , breast feeding and sugar or honey sweetened pacifier.



- Most commonly involve in for maxillary incisors followed by first molar and then the cuspid.

Recurrent caries:

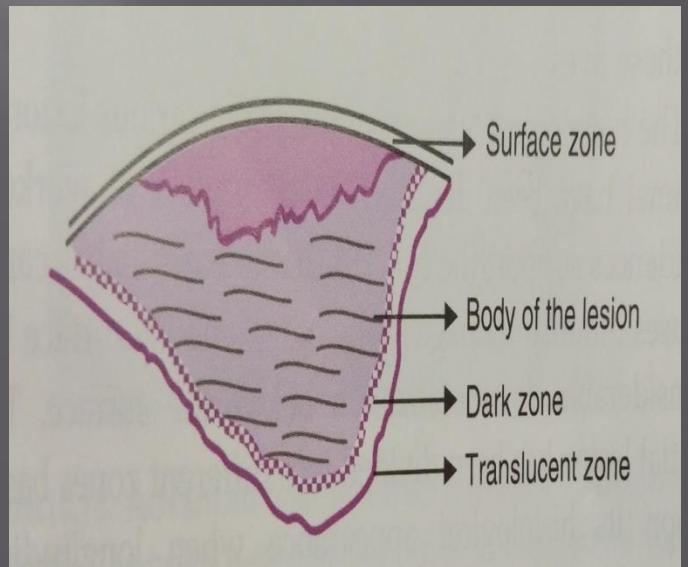
- Which is occur in the immediate vicinity of restoration .
- Recurrent caries occur beneath the restoration where the carious dentin is not removed before inserting the filling

Radiation caries:

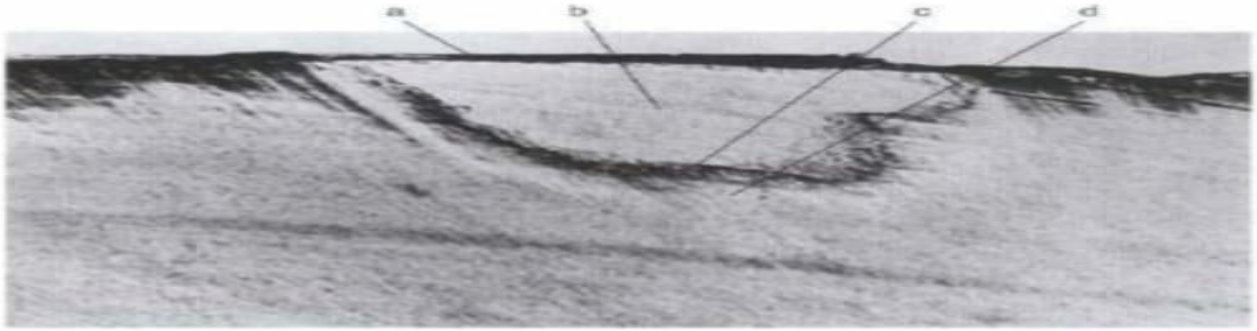
- Development of rampant caries in patients undergoing radiation therapy in head and neck region is referred as a radiation caries.
- Xerostomia is one of the complication of the radiation.

Zone of enamel caries

- **Translucent zone:--**
  - First recognizable zone of alteration
  - Advancing front of the lesion
  - Half the lesion demonstrate TZ, not always present
  - Seen in longitudinal ground section in clearing
  - TZ appears structureless
  - Pore volume-1%(compared to 1%of enamel)



Enamel caries (contd.)



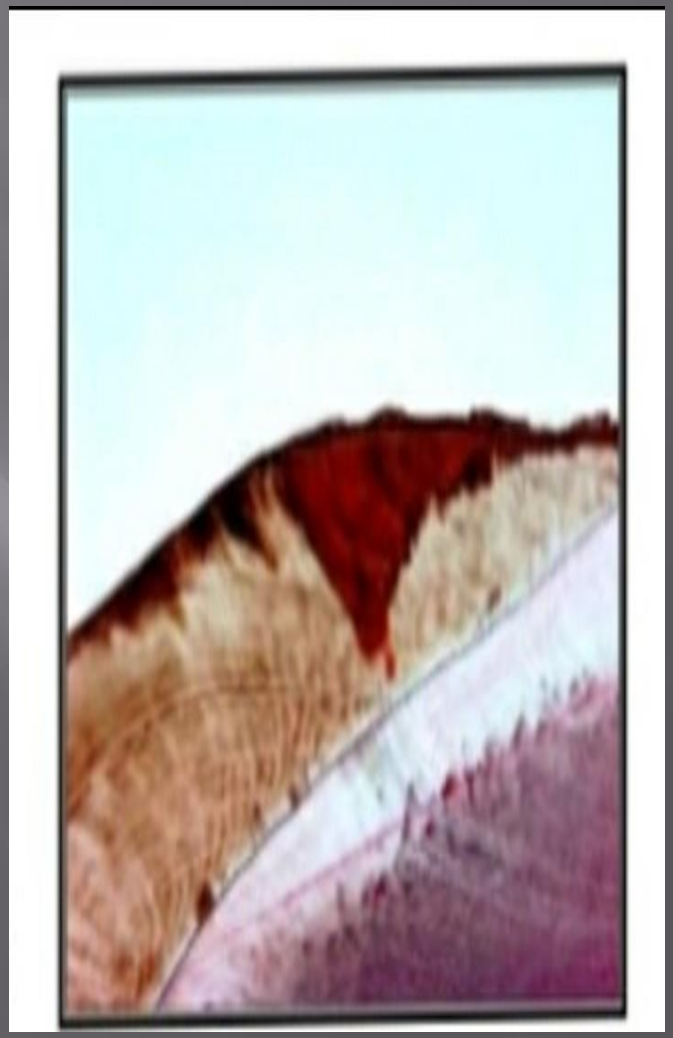
Surface (a) appears to be intact. Body of lesion (b) shows enhancement of striae of Retzius. Dark zone (c) surrounds body of lesion while translucent zone (d) *is evident over entire* advancing front of lesion.

Dark zone:-

- Lies adjacent and superficial to translucent zone
- Positive zone ,it is always present.
- Shows positive birefringence (in contrast to sound enamel)
- Pore volume of 2-4%(polarized light)
- Presence of small pores , large molecules of quinoline are unable to penetrate.
- Micro pore system-gets filled with air and become dark
- Medium light water may penetrate.

- Body of lesion:-

- Between unaffected surface and dark zone
- Area of greatest demineralization, having a pore volume 5% near the periphery to about 25% in the center of intact lesion
- Quinoline imbibition – positive birefringence compared to sound enamel
- Striae of Retzius- prominent



- Surface zone:-

- Quantitative studies-partial demineralization of 1-10%
- Pore volume-less than 5% of spaces
- Negative birfriengences –water imbibitions
- Positive birfriengences - porous subsurface

Early dentinal caries

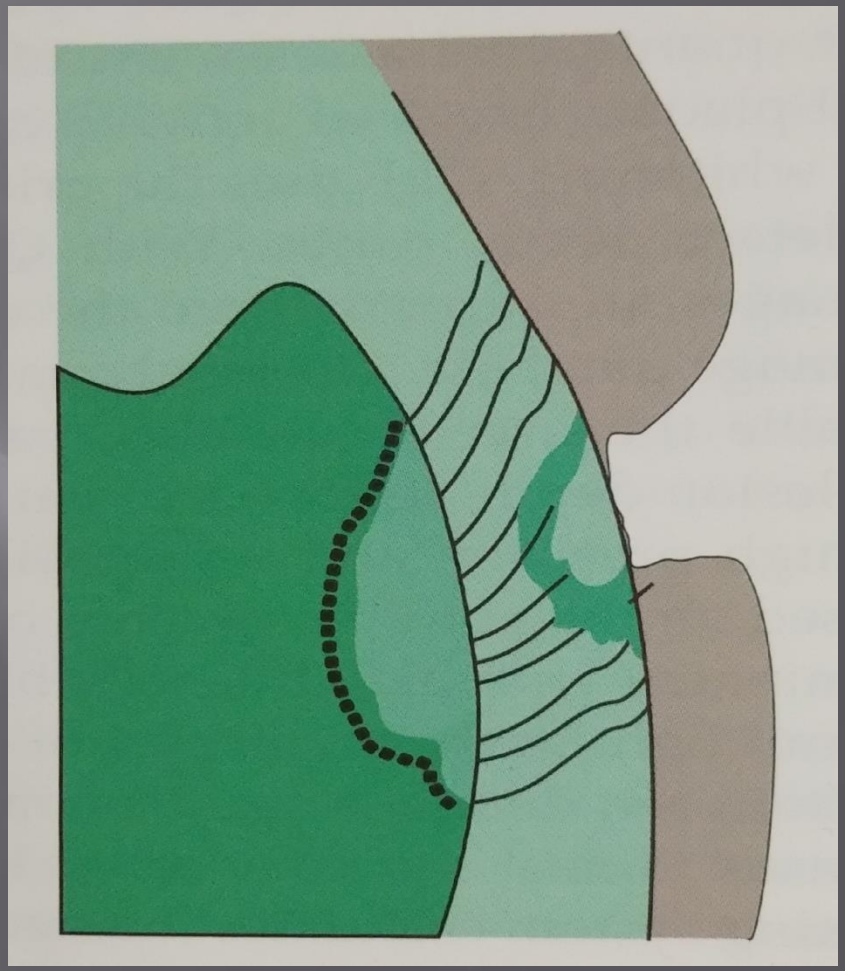
1.Fatty degeneration of odontoblast process:-

- Deposition of fat globules-precedes early sclerotic changes
- Special stains –sudan red
- Significance-fat contributes to impermeability
- -Predisposing factor for dental sclerosis

2. Sclerotic dentin:

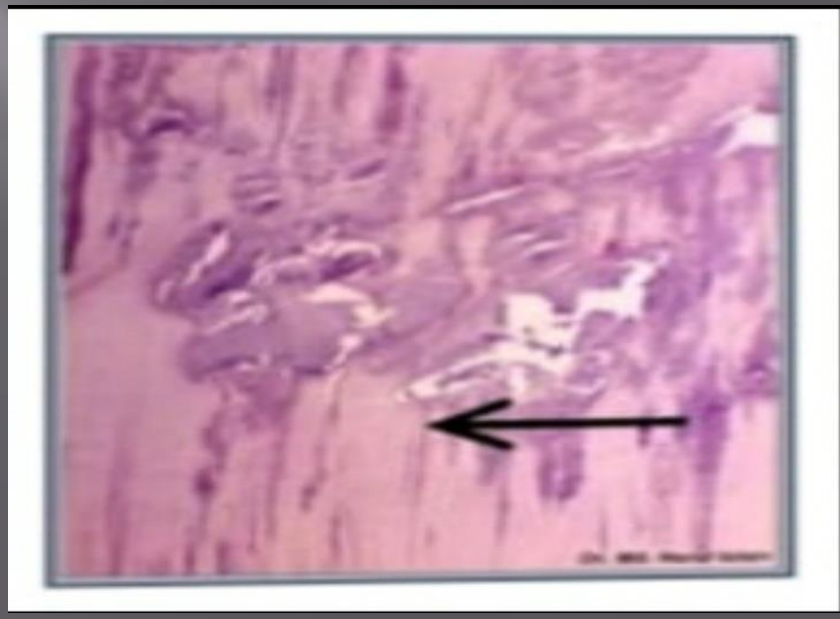
- Reaction of vital pulp-calcification of dentinal tubules
- Seals of dentinal tubules from further penetration of microorganism
- Minimal in rapidly advancing caries
- Prominent in slow caries
- Sclerotic dentin-appear white in transmitted light

- Decalcification of dentinal tubules:
- Above dentinal sclerosis – zone of decalcification
- Occurs in advance of bacterial invasion of microrganisms
- Pioneer bacteria
- The initial decalcification – only the walls of dentinal tubules
- Study of tubules – pure form of microorganisms



3. Zone of microbial invasion:

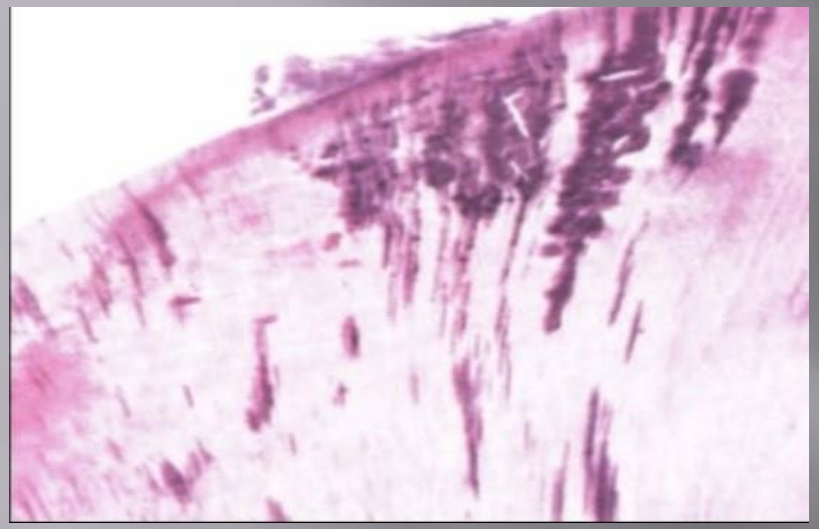
- Proteolytic organisms – predominent in deeper layers
- Acidogenic microorganisms – more in early caries
- Supporting the hypothesis that initiation and progression are to distinct processes and must be differentiated



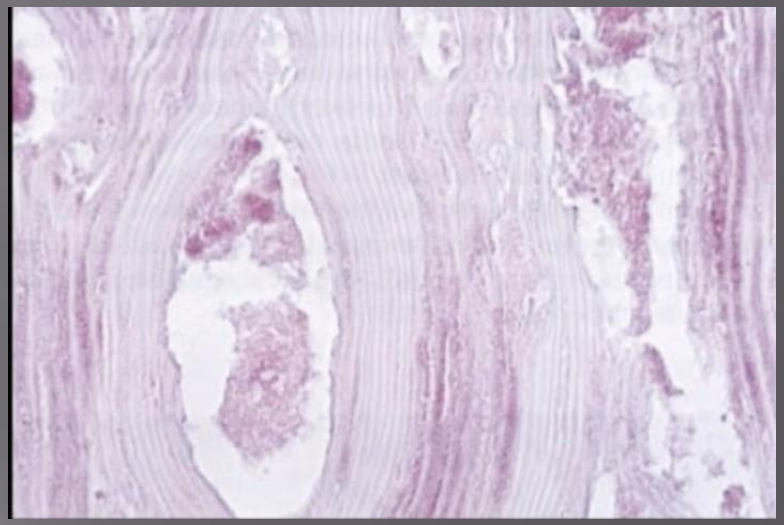
Advanced Dentinal caries

- Decalcification of the walls dt – confluence
- Thickening of sheath of neumann – along its course
- Increase in the diameter of DT – microorganisms
- Focal coalescence of adjacent tubules and ovoid area of destruction – Liquefaction foci
- Acidogenic organisms – initial decalcification
- Proteolytic organisms – matrix destruction
- Multiple areas of destruction
- Necrotic mass of dentin (leathery consistency)
- Formation of transverse clefts
- Extend at right angles to DT and parallel contour lines
- Peeling away of carious dentin

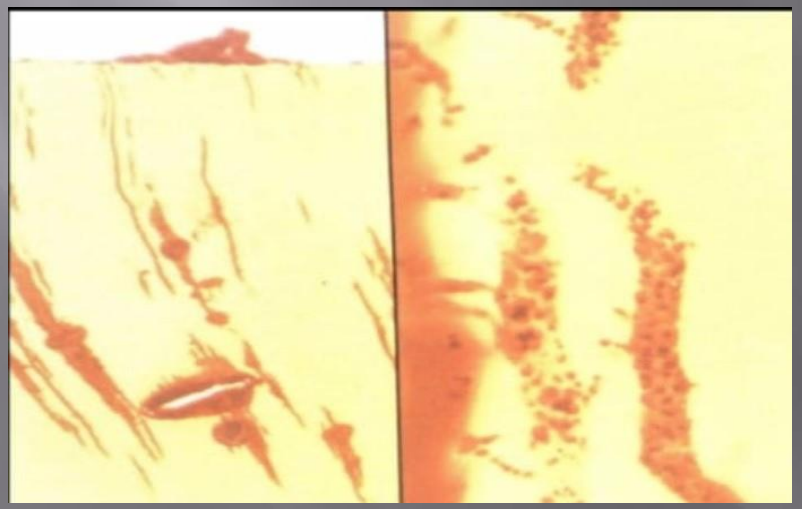
Liquefaction foci-dentinal caries



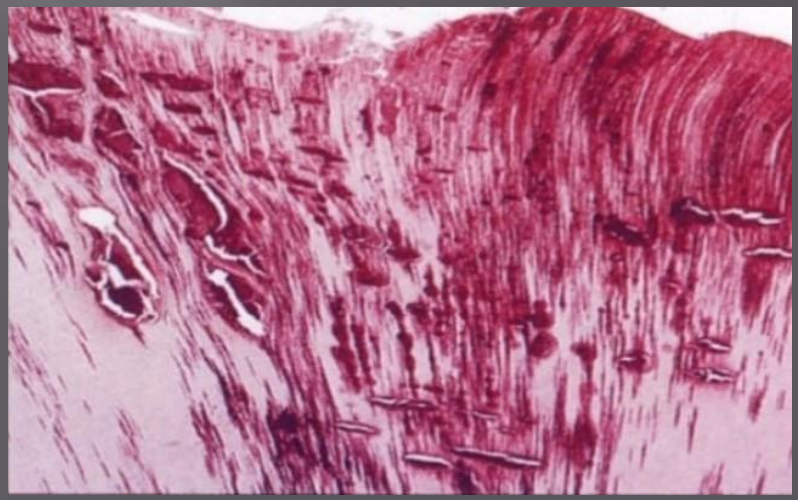
Expansion & fusion of tubules-liquefaction foci



Transverse cleft



Caries in dentinal tubules



Advanced dentinal changes

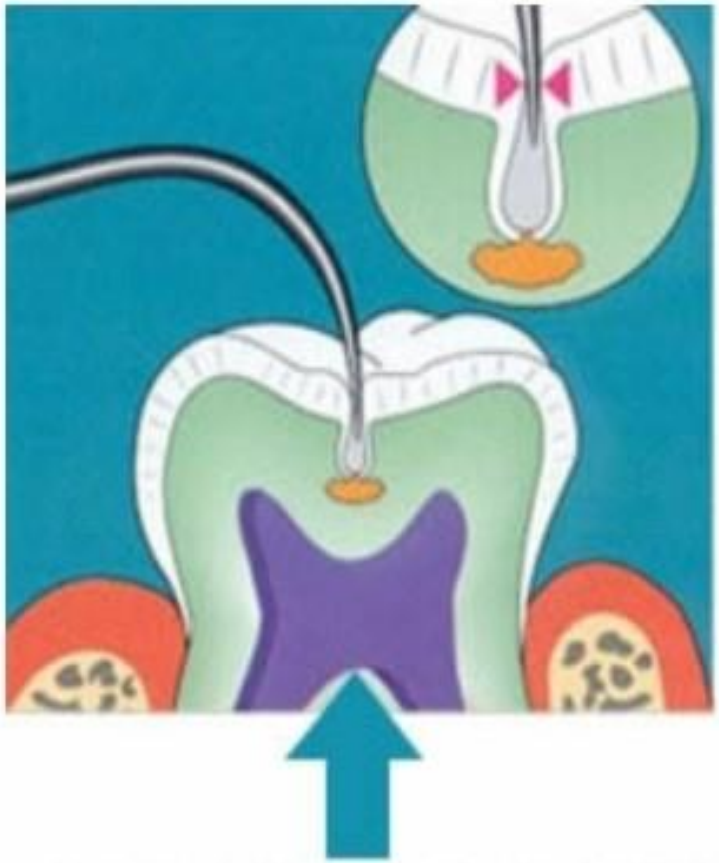
- Zone 1: zone of fatty degeneration of odontoblast process
- Zone 2: zone of dentinal sclerosis characterized by deposition of calcium salts in dentinal tubules
- Zone 3: zone of decalcification of dentin , a narrow zone , preceding bacterial invasion
- Zone 4 : zone of bacterial invasion of decalcified but intact dentin
- Zone 5: zone of decomposed dentin

Diagnosis of dental caries

- Radiographic diagnosis
- Infrared laser fluorescence
- Digital imaging fiber-optic transillumination
- Quantitative light fluoroscences
- Caries activity test

Infrared laser flourescence

- Instrument was developed for the detection and quantification of dental caries of occlusal and smooth surface.
- Uses of laser light source and fiberoptic cable that transmit the light to a handheld probe with fiberoptic eye at the tip.
- The light is absorbed and induced infra red fluorescence which is collect at probe tip and transmitted through ascending fibers' , and processed and presented on display window as an integer between 0 and 99.



Dental Explorer Trying to detect tooth decay. Note the tip is too small, it won't be detected untill the cavity is much larger.

Same area being detected by DIAGNOdent. The cavity may be treated while the decay is in it's early stages!

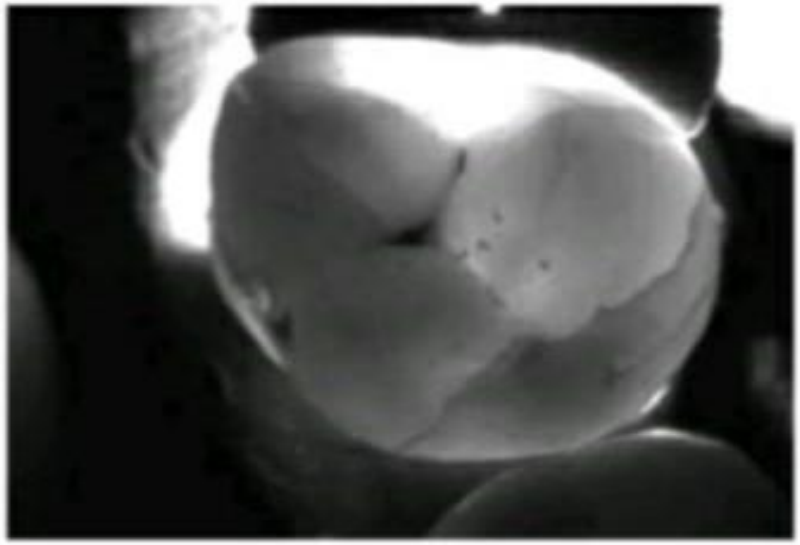
- Radiographic diagnosis:
  - Radiograph may reveal 50%more cavities than may be found by visual examination alone
  - The interproximal carious lesion is most easily recognized on the radiograph and appears in early lesion as a small triangular radiolucent area of enamel

Digital imaging fiberoptic transillumination

- Fiberoptic transillumination has become available for clinical use
- It provides an intense light beam that is transmitted through a fiberoptic cable to a specially design probe to permit the use of transillumination on the proximal surface of posterior tooth

Caries Diagnosis (contd.)

Digital Imaging Fiber-Optic Transillumination (DIFOTI)



The DIFOTI (Electro-Optical Sciences Inc.) uses white light, a CCD camera, and computer-controlled image acquisition and analysis to detect caries

Quantitative light fluorescence

- It is dental diagnostic tool for quantitative asscement of dental caries lesion , dental plaque , bacterial activity , calculus , staining and tooth whitening .
- QLF uses the principle of fluorescence to detect dental caries .

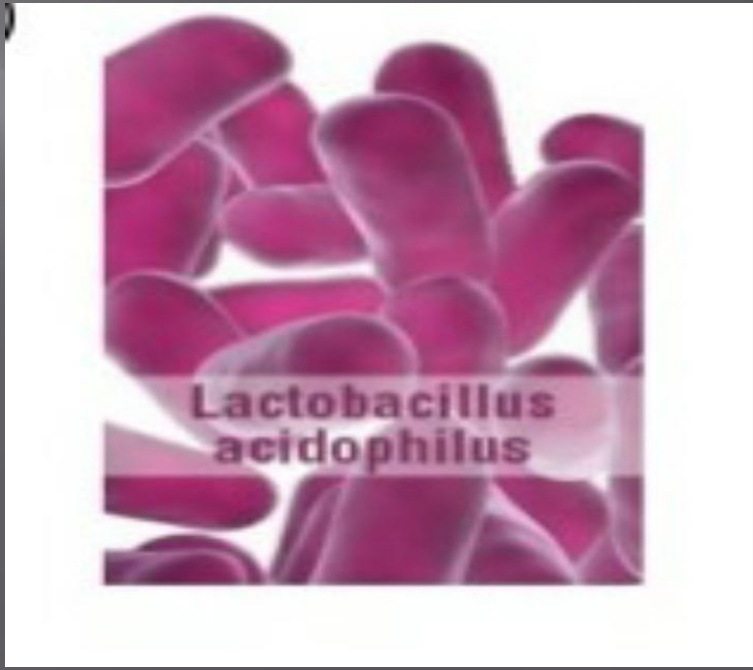
- With QLF real time fluorescent are captured in to the computer and store in images image data base.
- Optional quantitative analysis tools enable the user to quantify parameters like mineral loss , lesion depth , lesion size , stain size and severity with high precisions and rapidability.

CARIES ACTIVITY TEST

- Caries activity refers to increment of active lesion (new or recurrent lesion) over a slated period of time.
- Caries susceptibility refers to the inherent tendency of the host and target tissue , the tooth to be afflicted by caries process.
- Caries activity measures the degrees to which the local environment challenge (e.g dietary effect on microbial growth and metabolism)favors the probability of carious teeth.

- Caries activity test helps to:
  - Identify high-risk groups and individuals.
  - Determine the need for personalized preventive measures and motivate the individual.
  - Monitor effectiveness of oral health programs by establishing an initial base line level of cariogenic pathogens as a basis of future evaluation.
  - Ensure low level of caries activity before starting any extensive restoration procedure.

- Lactobacillus colony test:
  - Oldest and most widely used method
  - First proposed by Hadley,
  - Principle involved:
  - Measures the aciduric bacteria in a patient's saliva by counting the number of colonies.
  - was inoculated with selective media(tomato peptone agar plates) with ph 5.0 was used and incubated Patients saliva.



- Rogosa's medium is an improved selective media that is highly selective growth for lacto bacilius.
- It is the medium with an acidic ph having amount of acetate , salts and lower surface tension and which is inoculated with patient saliva and incubated.
- The colonies grown on media upon incubation reflect the number of aciduria flora in patient saliva.
- The number of lactobacillus/ml saliva of is calculated by multiplying the number of colonies.

Colorimetric synder test :

- Developed by synder in 1951.

- Principle:

  Measures the ability of salivary microorganisms to form organic acids from carbohydrate medium.

- Based on rate of acid produced when stimulated patient saliva is inoculated in a glucose and agar containing medium with ph 4.7-5.0.

- The medium has colour indicator such as bromocresol green , which changes from green at ph 4.7-5.0 to yellow at ph 4.0

	24 hrs	48 hrs	72hrs
Color	: yellow	yellow	yellow
Caries activity:	marked	definite	limited
Color	: green	green	green
Caries activity:	continue test	continue test	continue test

- It indirectly detect the presence of acidogenic and aciduric microorganisms.

- The acid produced by oral acidogenic flora is detected by change in ph indicator , and compared to un-inoculated control tube after 24,48 and 72 hours of incubation.

- Tube 1:un-inoculated synder tube
- Tube 2:no color change indicates , little or no susceptibility to forming dental caries.
- Tube 3:slight color change indicates mild susceptibility to forming dental caries.
- Tube 4:significant color change indicates moderate susceptibility to forming dental caries.
- Tube 5:complete color change indicates high susceptibility to forming dental caries.

Swab test:

- Principle is same as synder test.
- Both acidic and acidogenic elements of oral flora are measured by recording the ph directly on a ph meter after appropriate incubation periods by employing a colour indicator in the test medium.
- Test involves sampling the oral flora by swabbing buccal surfaces of teeth with cotton application and incubated in medium for 48 hours.
- 48 hours incubation is read on ph meter or colour change is read.

PH	CARIES ACTIVITY
Ph 4.1	marked
Ph 4.2-4.4	Active
Ph 4.5-4.6	Sighty active
Ph 4.6 and over	Inactive

- Salivary s.mutans level test:
  - S.mutans constitute less than 1%of the total oral flora of plaques and these concentration may be extremely variable even from the same site.
  - S.mutans also ascertain its location on teeth or assess its degree of infection at a given site.
  - It is also difficult to distinguish a carrier state from a cariogenic infection based on s.mutans.

- Principle:
  - The number of s.mutans forming units per unit volume of saliva is the fundamental basis of this test.
- Sites:
  - plaque is collected. for the plaque sample collection pits & fissure or from proximal surface are more appropriate for detecting and quantitating s.mutans that have colonized on teeth.
  - sample is collected using tongue blades or wooden spatula

- Media used : mitis salivarius agar (MSA) a selective streptococcal medium with:-
- Increased concentration of sucrose (20%) and 0.2U bacitracin/ml
- Bacitracin suppresses the growth of non s.mutans colonies.

- then , agar plates are incubated at 37.c for 48 hours 95% N2 .5%co2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