CALCULUS

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READER

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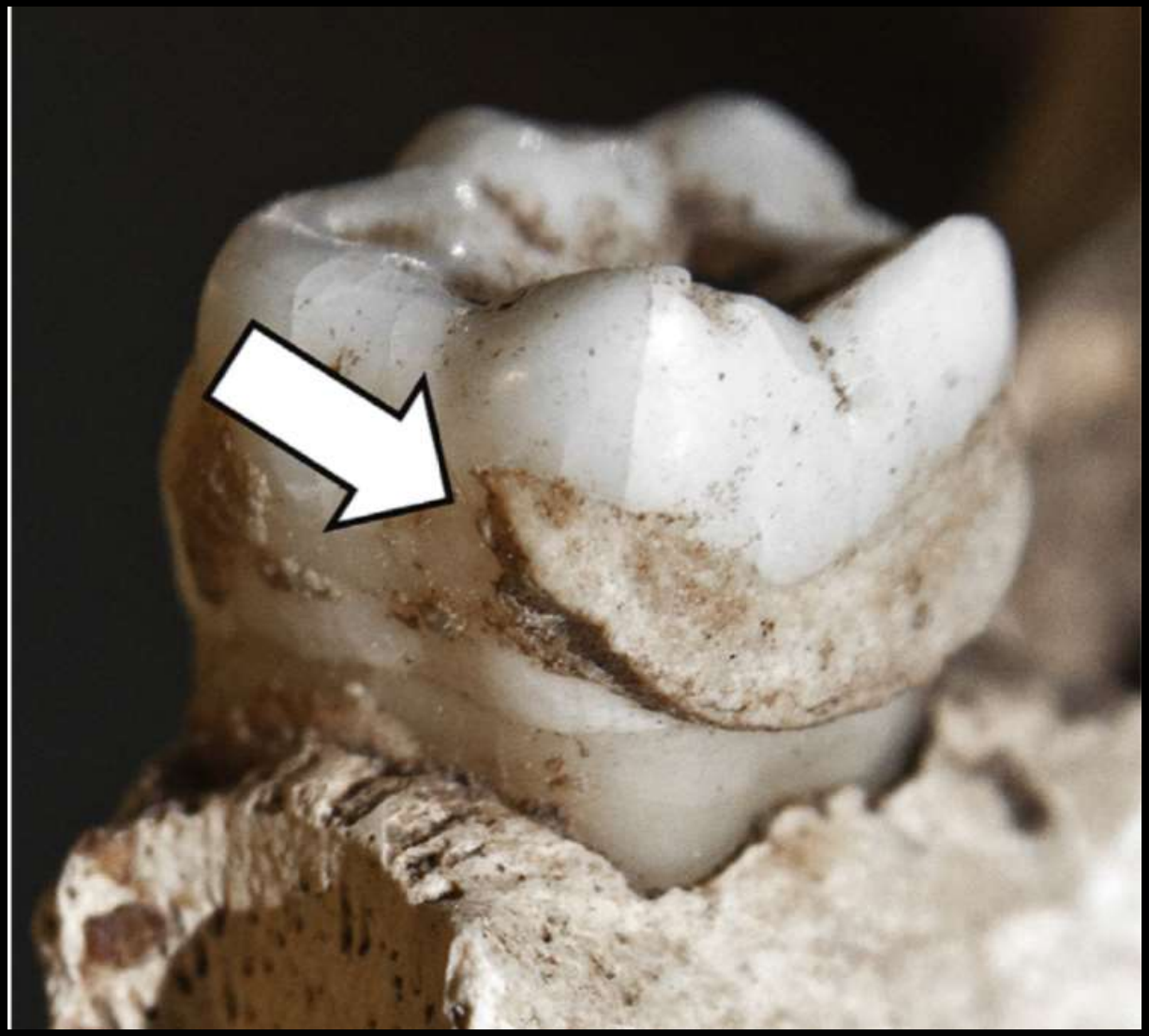
INTRODUCTION:

Calculus is a form of calcified dental plaque

caused by the continual accumulation of minerals from saliva on plaque on the teeth.

can result in a number of clinical manifestations, including bad breath, receding gums and chronically inflamed gingiva.



DEFINITION:

- Calculus is derived from Latin meaning “pebble or little stone”
- It is an adherent calcified or calcifying mass that forms on the surfaces of natural teeth and dental prosthesis(Carranza)
- Mineralized dental plaque that is permeated with crystals of various calcium phosphates(Schroeder 1969)

SYNONYMS:

- Tartar
- Disambiguation
- Calcis
- Odontolithiasis
- Fossilized plaque

HISTORY:

- Van Leewenhoek – 1683
- Guerini. V – 1909
- Black – 1915
- Schroeder - 1969

PREVALENCE:

- buccal surface of the maxillary molars
- lingual surface of mandibular anteriors

CLASSIFICATION:

Based on location: i)supragingival
ii)subgingival

Based on surface: i)exogeneous
ii)endogeneous

Based on source of mineralisation:
i)salivary calculus
ii)serumal calculus

Calculus formers are classified as
(based on initiation and rate of accumulation)

- Non-calculus formers
- Slight calculus formers
- Moderate calculus formers
- Heavy calculus formers

SUPRA GINGIVAL CALCULUS

- Present coronal to the gingival margin.
- Colour : white or whitish yellow
- Consistency : hard with clay like consistency.
- Location : buccal surface of the maxillary molars and lingual surface of mandibular anterior.
- Easily detached
- Rapid recurrence
- Bridge like structure

SUBGINGIVAL CALCULUS :

- Seen below the marginal gingiva.
- Colour – dark brown or greenish black.
- Consistency – hard and dense
- Only on tactile perception
- Secondary product of infection
- Difficult to remove

Morphology of subgingival calculus:

- Crusty, spiny, nodular
- Ringlike / ledgelike formations around the tooth
- Fingerlike / fernlike extensions towards bottom of the pocket
- Individual islands or spots
- Combination of this forms

COMPOSITION:

- BRUSHITE(B)
- OCTACALCIUM PHOSPHATE(OCP)
- HYDROXYAPATITE
- WHITLOCKITE(W)

INORGANIC CONTENT

Two-thirds: crystalline(calcium phosphate, calcium carbonate, magnesium phosphate)

- Calcium-39%
- Phosphorous-19%
- Carbondioxide-1.9%
- Magnesium-0.8%
- Trace- bromine, zinc, strontium, copper, manganese, tungsten, gold, aluminium, iron, silicon.

ORGANIC CONTENT:

- Mixture of protein
- Carbohydrate
- Salivary proteins(5.9-8.2%)
- Lipids(0.2%)

Subgingival CA – more magnesium W than brushite and OCP.

SALIVARY PROTEINS NOT SEEN IN SUBGINGIVAL CALCULUS.

FORMATION:

- Three phases

1)Initial attachment of bacteria to a tooth via the salivary pellicle.

2)The growth and organisation of plaque

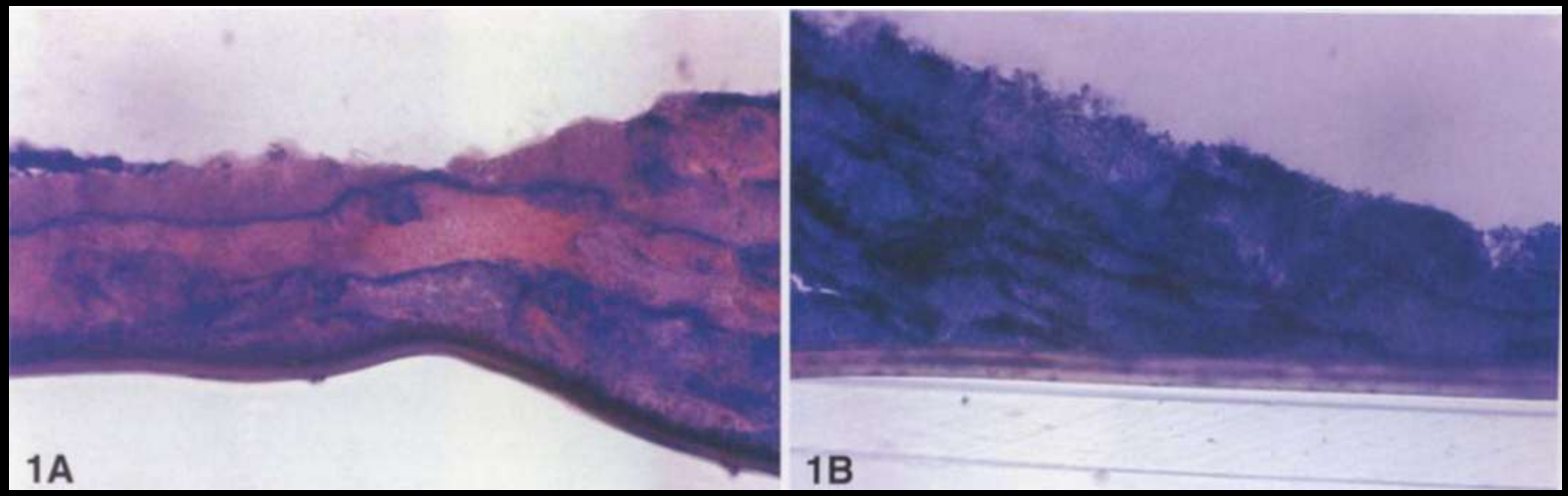
3)Mineralisation of plaque

Factors influencing:

subject age, gender, ethnic background and diet, oral hygiene, access to (and time since) last professional cleaning, mental or physically handicapped, diabetes and use of commonly prescribed medications

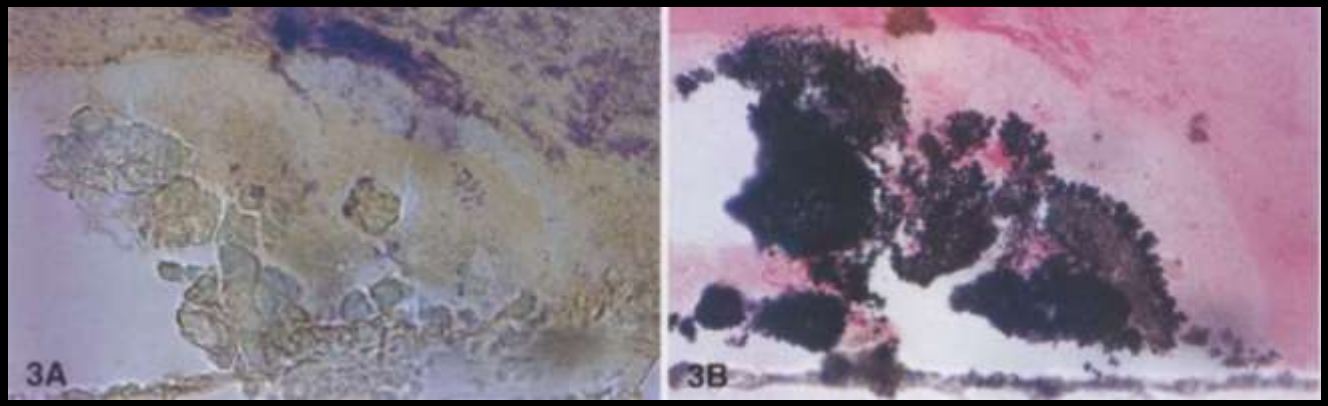
Nine-week-old calculus formation on

A) a tooth and B) a Mylar strip. These illustrations demonstrate the microscopic similarity between calculus formed on a tooth and that formed on a Mylar strip. Note the irregular layering in both deposits and the well formed cuticle between the tooth or strip and deposits. Magnification ~64



Four-week-old deposit, serial sections.

Section A is a bacterial stain of a mineralizing specimen. The mineralized area is bordered by a clearly demarcated micro- organism-free zone that is bordered by a microorganism rich area. The clear area represents a premineralizing zone that is further delineated in Section B (von Kossa stain). The mineralized, mineralizing and premineralized zones are readily discernible. Magnification x 160.



MICROBIOLOGY:

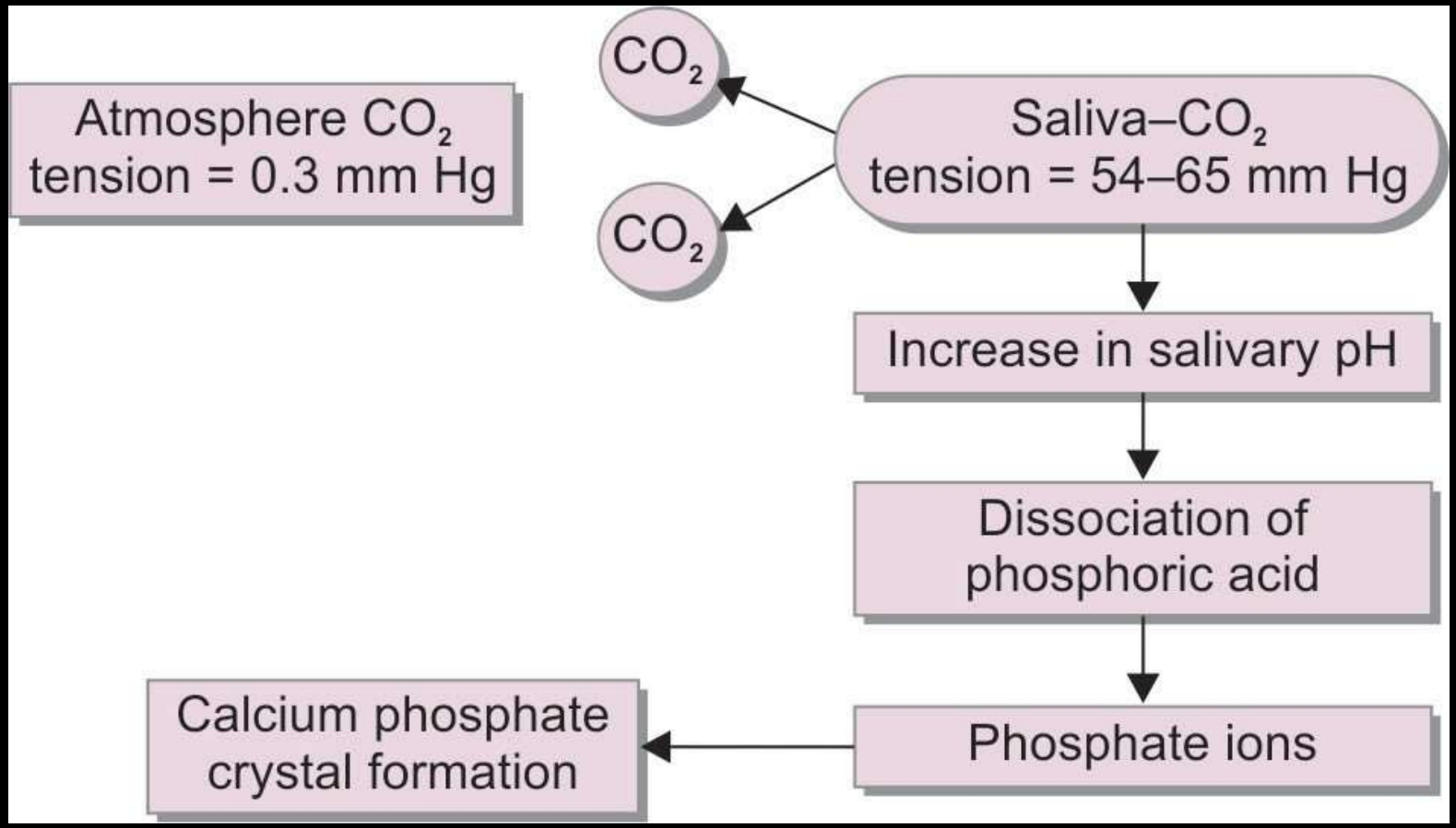
- Average microscopic count of bacteria in unmineralized dental plaque has been calculated to be upto 2.1 × 10 mg wet weight.
- supragingival calculus - viable aerobic and anaerobic bacteria detected
- *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, and *Treponema denticola*
- not essential for calculus formation, but they enable its development.

THEORIES OF CALCULUS FORMATION

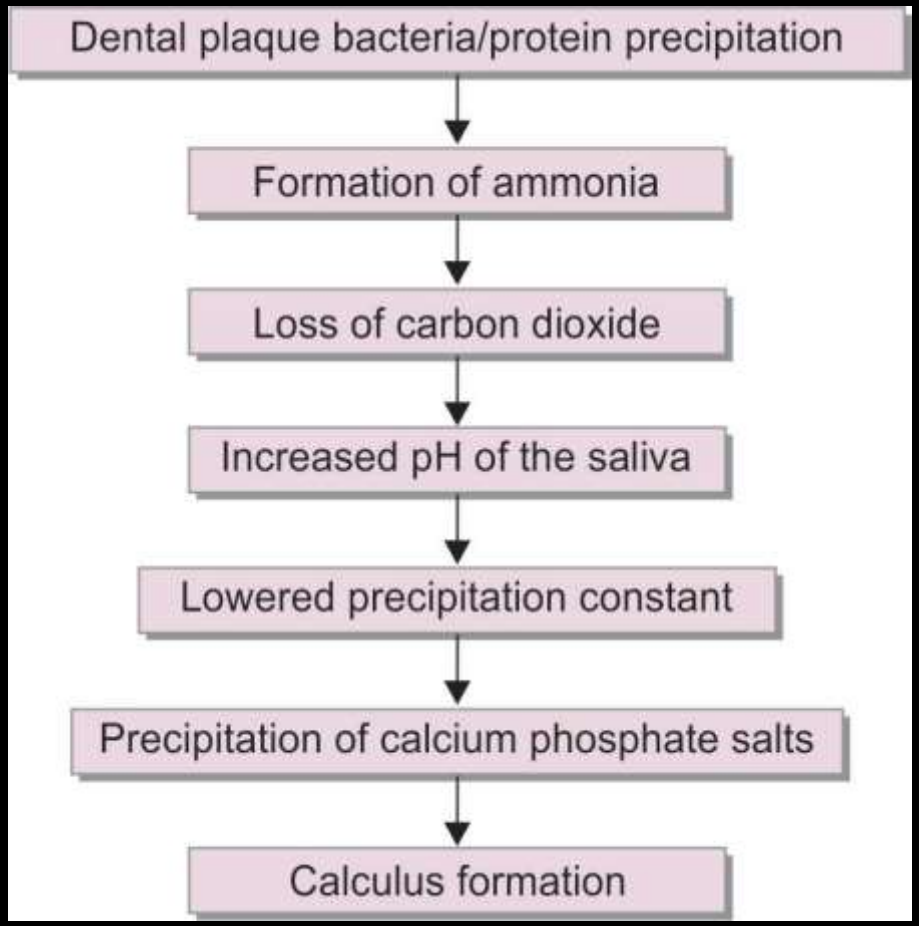
- Booster mechanism
- Epitactic concept
- Inhibition theory
- Transformation theory
- Bacterial theory
- Enzymatic theory

Booster Mechanism

Mechanism 1



Mechanism 2


Dental plaque bacteria/protein precipitation
Formation of ammonia
Loss of carbon dioxide
Increased pH of the saliva
Lowered precipitation constant
Precipitation of calcium phosphate salts
Calculus formation

Epitactic Theory

- crystal formation through seeding by another compound which is similar to hydroxyapatite crystals, leading to precipitation of calcium salts from the metastable solution of saliva.
- Seeding agents provoke small foci of calcification enlarge and coalesce to form the calcified mass.
- Calcification will be initiated by a carbohydrate/protein complex.

Inhibition Theory

- Russell and Fleisch 1970
- Only at specific sites
- Possible inhibiting substances - Pyrophosphatase
- Prevents the initial nucleus from growing and inhibits their calcification possibly by poisoning the growth centers of the crystals.

Enzymatic Theory

- Action of phosphatases on some salivary phosphate containing complex, most probably phospheric esters of the hexophosphoric group.

Transformation Theory

- Most noticeable hypothesis
- Octa calcium phosphate is formed by the transformation of amorphous noncrystalline deposits and brushite and then transformed to hydroxyapatite
- Eanes et al 1970

Bacteriological Theory

- Primary cause of calculus formation is oral microorganisms
- Leptotrichia (long, thick, unbranching filaments, which they called Leptothrix) and actinomyces

CALCULUS ATTACHMENT

- Attachment by means of organic pellicle on enamel
- Mechanical interlocking in cemental resorption lacunae
- Close adaptation of calculus undersurface depressions to gently sloping mounds on the unaltered cementum surface
- Penetration of calculus bacteria in cementum. (not acknowledged)

Factors governing rate of mineralization

- Elevated salivary pH.
- Elevated salivary calcium concentration.
- Elevated bacterial protein and lipid concentration.
- Elevated concentration of protein and urea in submandibular salivary gland secretions.
- Low individual inhibitory factors.
- Higher total salivary lipid levels.

ATTACHMENT OF CALCULUS ON IMPLANT

- Less intimate to pure titanium
- Smooth machined implants have less micro porosities for retention.
- calculus may be chipped off from implants without affecting it.

CALCULUS DETECTION

Visual examination

- Gentle air blast
- Trans illumination
- Gingival tissue color change

Good lighting
Supra gingival calculus can be dried using compressed air

Tactile examination

- Probe
- Explorer

Fine pointed explorer or probe
Vertical direction - light exploratory strokes

Radiographs

Radiopaque projections protruding into the interdental space

ADVANCE DIAGNOSTIC AIDS

Calculus Detection Systems Only

- PERIOSCOPE– Fiberoptic endoscopy-based technology
- DETECTAR – Spectro-optical technology
- DIAGNODENT – Auto fluorescence-based technology

Calculus Detection + Removal Systems

- PERIOSCAN – Ultrasound technology
- KEYLASER – Laser-based technology

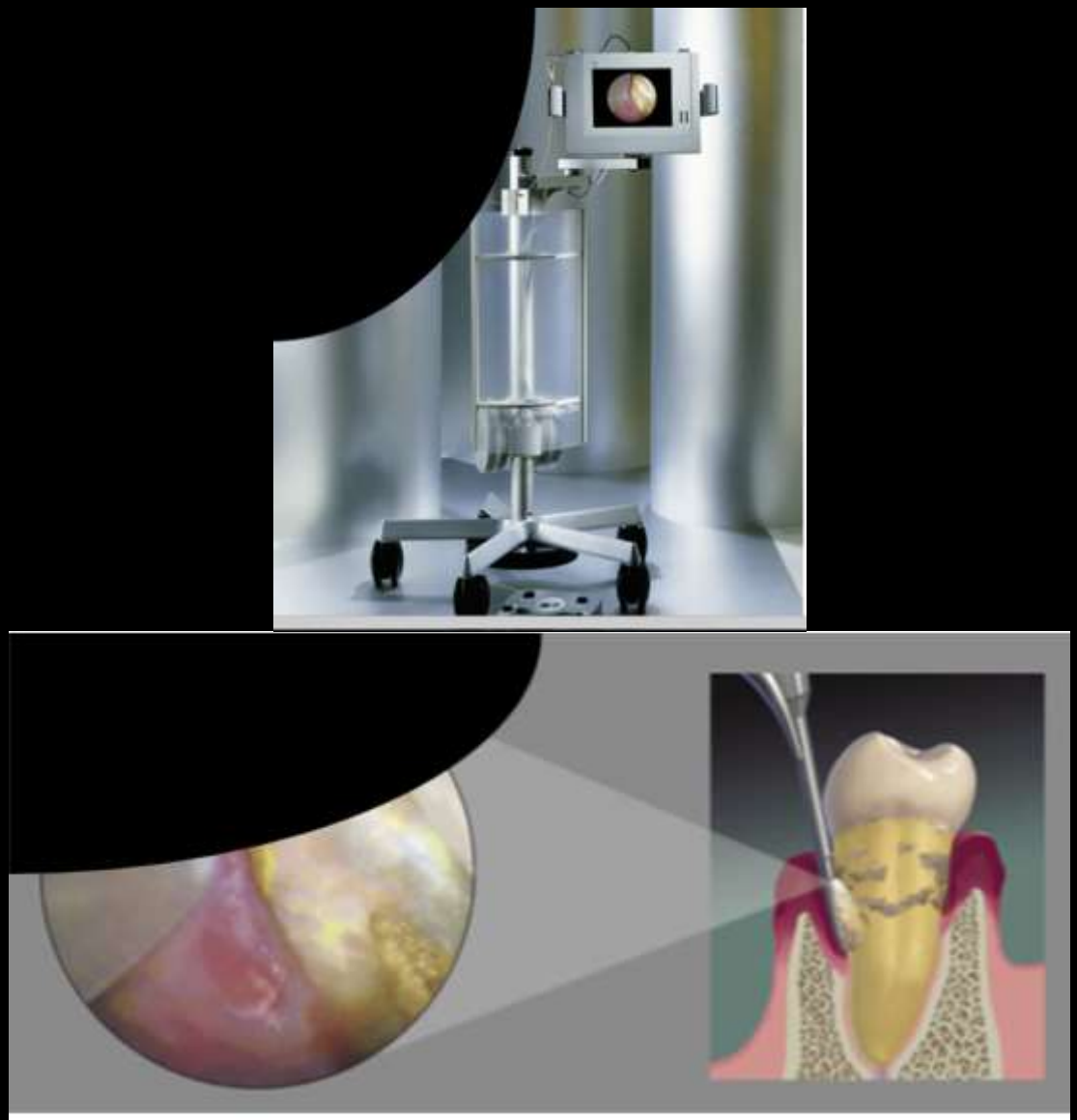


Figure 1b Visualization of subgingival calculus using perioscopy system.

Merits:

1. Subgingival visualization of the root surface
2. Decreases chair side time efficient scaling
3. Its miniature nature causes minimal tissue trauma
4. Avoid overzealous instrumentation
5. Non invasive method for diagnosing

Demerits

1. Calculus has to be re identified by the instruments that are used to remove it.
2. Expensive instrument.
3. Complete removal of subgingival bacterial biofilm and calculus remain a challenge.

VARIOUS INDICES USED FOR THE ASSESSMENT OF CALCULUS ARE

- Calculus surface index-CSI
- Calculus surface severity index-CSSI
- Marginal line calculus index-MLCI
- Volpe manhold index-VMI
- Calculus component of the periodontal index-PDI
- Oral hygiene index-calculus index-OHI-CI
- Oral hygiene index simplified-OHIS-CI

Oral Calculus Index (OCI) (Greene and Vermilion, 1964)

component of the oral hygiene index.

An explorer is used to estimate the surface area covered by supragingival calculus and to probe for the subgingival calculus

Scores are assigned according to the following criteria:

- No calculus
- Supragingival calculus covering more than one-third of the exposed tooth surface
- Supragingival calculus covering more than one-third but not more than two-thirds of tooth surface
- Supragingival calculus covering more than one-third but not more than two-thirds of tooth surface and/or a continuous band of subgingival calculus.

After the scores for debris and calculus are recorded, the index values are calculated. For each individual, the debris scores are totaled and divided by the number of surfaces scored

Calculus Index – CI (Ramfjord, 1959)

The following teeth were selected as indicators 16, 21, 24, 36, 41, and 44. Calculus recorded as follows:

- No calculus
- Supragingival calculus extending only slightly below the free gingival margin (not more than 1 mm)
- Supragingival calculus covering more than one-third but not more than two-thirds of tooth surfaces
- Supragingival calculus covering more than two-thirds of exposed tooth surfaces.

The scores on calculus for each individual tooth examined are added and the sum divided by the number of the teeth examined to yield the index on calculus.

Calculus Surface Severity Index (CSI) (Ennener et al, 1961)

- The CSI assesses the presence or absence of calculus on the four surfaces of the four mandibular incisors.
- Each surface is given a score of 1 for the presence of calculus or 0 for the absence of calculus.
- Maximum score for each subject is 16.
- In applying the scoring method, calculus was considered to be present in any amount, supragingival or subgingival, and it could be detected either visually or by touch.
- If the examiner was uncertain about the presence of calculus on a given surface, the surface was called calculus free.

Calculus Rating (Volpe and Manhold, 1962)

- Calculus formation *in vivo* is performed using a colored periodontal probe placed against the lingual surface of the anterior tooth that will be scored with the probe and placed at the most inferior border of any calculus present.
- When the different colors at the probe end represent units, the amount of calculus present can be measured:
- U – No calculus
- U – 1 mm of calculus
- U – 2 mm of calculus
- U – 3 mm of calculus
- U – 4 mm of calculus

Marginal Line Calculus Index (MLC-I) (Muhlanann and Villa, 1967)

- No calculus
- Calculus observable, but less than 0.5 mm in width and/or thickness
- Calculus not exceeding 1 mm in width and/or thickness
- Calculus exceeding 1 mm in width and/or thickness.

CALCULUS GRADING SCALE

0 No calculus

1 **TRACE**
Trace levels of calculus at gingival margin or between teeth

2 **SLIGHT**
Calculus deposits 1 mm or less

3 **MODERATE**
Calculus deposits 1 to 2 mm, but covering less than one third of the tooth surface

4 **HEAVY**
Calculus deposits greater than 2 mm, may extend over soft tissues, or may bridge teeth

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Clinical Implications:

- Brings plaque bacteria close to the supporting tissues
- acts as a niche which harbors bacterial plaque
- acts as an irritant to the periodontal tissues
- Interferes with local self-cleansing mechanism
- Acts as a reservoir for irritating substances such as endotoxins, antigenic materials, bone-resorbing factors

Procedures to remove calculus

- **Scaling**:

  The meticulous removal from the root surfaces of the teeth to remove plaque calculus and stains from these surfaces.

- **Root Planning:**

  A treatment procedure designed to remove cementum or surface dentin that is rough impregnated with calculus or contaminated with toxins or microorganisms.

- **Periodontal Debridement:**

  This includes the removal of plaque and calculus both above and below the gingiva.

Prophylaxis:

A preventive procedure to remove local irritants to the gingiva including debridement of calculus and removal of plaque.

ANTICALCULUS AGENTS:

ZINC CITRATE

ZINC CHLORIDE

PYROPHOSPHATES

GANTREZ ACID

- The necessary effective concentration in a toothpaste of 2% is generally unacceptable for reasons of taste
- Combining zinc salts, at concentrations of 0.5%, with the antimicrobial triclosan, in toothpaste was shown to reduce calculus by comparison with a fluoride control toothpaste (Stephen et al. 1990)
- Studies using 3.3% pyrophosphate toothpastes: calculus reductions ranged from 26%)-32% (Zacherl et al. 1985, Mallett et al. 1985
- Studies using 3.3%t< pyrophosphate/poiyvinyl methyl ether maleic acid (Gantrez) toothpastes: calculus reductions ranged from 36-51% (Lobene 1986)
- Evidence to date indicates that anticalculus toothpastes based on the pyrophosphate system result in some patients who normally form calculus remaining calculus free during evaluation periods of 3 and 6 months.

CONCLUSION:

Calculus plays a key role in maintaining and accentuating periodontal disease by withholding the plaque in close contact with the tooth surface and gingival tissue, leading to various pathological changes thereby creating areas where plaque removal is impossible.

Therefore, adequate skill of the clinician is essential to remove the calculus and other irritants, which forms the basis for adequate periodontal and prophylactic therapy.

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