Dental Caries: Understanding the Disease Process

Definition and description of the disease process and lesion formation
- Histopathology of enamel caries and dentine caries
- Clinical appearance of caries
- Lesion activity

Dental Caries: The process and the lesion

The carious process
- Localised chemical dissolution of a tooth surface resulting from metabolic events taking place in a biofilm (dental plaque) covering the affected area

The caries lesion
- Interaction between microbial deposits and the hard tissues of the teeth may result in the caries lesion that is the sign or symptom of the process

Kidd, 2007

Caries the disease process

Susceptible tooth surface

Bacterial biofilm
- Community of microorganisms within extra cellular matrix on surface of tooth – collective physiology
- Bacteria always metabolically active
- Bacteria: Acidogenic – convert dietary sugars to acid
  Aciduric – thrive at low pH
### Bacterial biofilm
- Community of microorganisms within extracellular matrix on surface of tooth — collective physiology
- Bacteria always metabolically active
- Bacteria:
  - **Acidogenic** — convert dietary sugars to acid
  - **Aciduric** — thrive at low pH

### Sugar substrate
- Low molecular weight sugars potentially harmful
- Frequency of sugar intake
- Timing of sugar intake
- Consistency of food

### Initiation of the carious process
- **Susceptible tooth surface**
  - Pellicle formation
  - Acellular, proteinaceous film derived from saliva
  - Bacterial colonization (0-4 hours) in stagnation areas (S. sanguis, S. oralis, S. mitis, Actinomyces species, Gram negative bacteria, mutans streptococci (2%))
  - Microcolony formation (4-24 hours)

- **Demineralisation**
  - Improved OH
- **Lesion Arrest Remineralisation**
  - Poor Oral Hygiene
  - ↑ Sugar Intake
  - ↑ Frequency
  - ↓ Fluoride
  - ↓ Saliva
  - Anti-bacterial
- **Dental Caries**
  - Time
  - pH
  - Stephan curve
  - Critical pH
  - Active
  - Inactive
  - Sound
  - Sucrose Rinse

- **Sugar substrate**
  - Low molecular weight sugars potentially harmful
  - Frequency of sugar intake
  - Timing of sugar intake
  - Consistency of food
Initiation of the carious process

Streptococci (1-14 days)

Microbial Succession

Actinomyces

Cariogenic bacteria – the theories

Specific plaque hypothesis
- Approx 300 species of intra-oral microorganisms
- Specific limited number involved in carious process
- ? immunise against these

Non-specific plaque hypothesis
- Caries results from the over-all activity of the micro-organisms within the biofilm
- All plaque should be removed

Ecological plaque hypothesis
- Plaque can accumulate at all tooth sites
- Balance of microflora can change depending on local environment
  - Sugar
  - Saliva
  - Stagnation areas
- Favours aciduric and acidogenic species
- Remove plaque from susceptible sites and decrease frequency of sugar intake

Cariogenic bacteria

Histopathology of Caries

Which lesions can be treated preventively?
The initial enamel lesion

Ground section examined in polarised light - imbibition in water

Ground section examined in polarised light - imbibition in quinoline

Histopathology of caries

- “organisms do not begin to grow into the dentinal tubules until the calcium salts have been dissolved out.” CAVITATION
- “decays …. dissolved through the entire thickness of the enamel before any rods fall away” DECARIONIS BEFORE CAVITATION
- “microorganisms do not enter the tissue until the rods are loosened and fall out.” DEMINERALISATION PRECEDES BACTERIAL INFECTION IN DENTINE
Dentine caries - two zones (Fusayama, 1979)

Outer Zone
- Demineralised
- Collagen Denatured
- Infected
- Not remineralisable

Inner Zone
- Minimally infected
- Collagen fibers intact
- Remineralisable

1% acid red in propylene glycol

Courtesy of Professor Edwina Kidd
Histopathology of early root caries

From Fejerskov and Kidd, Dental Caries: The disease and its management

Cementum
Well mineralised cementum
Dentine caries

Cementum
Higher mineral content in surface zone of root caries

Tertiary dentine
Tubular sclerosis

From Fejerskov and Kidd, Dental Caries: The disease and its management

Clinical appearance of carious lesions
Smooth surface:
First visible change: white and brown spot lesions

Clinical appearance of carious lesions
Occlusal surface:
First visible change: white and brown spot lesions

Clinical appearance of carious lesions
Smooth surface:
Distinct visible change: white and brown spot lesions

Clinical appearance of carious lesions
Occlusal surface:
Distinct visible change: white and brown spot lesions

Clinical appearance of carious lesions
Occlusal surface:
Distinct visible change: white and brown spot lesions
Clinical appearance of carious lesions

Proximal surface:
Distinct visible change: white and brown spot lesions

Clinical appearance of carious lesions

Micro cavitations and undermining shadows

Clinical appearance of carious lesions

Frank cavitations exposing dentine

Caries activity

The Holy Grail of Cariology

Caries activity

Single examination

Is this lesion active or inactive/arrested?
Is this lesion likely to progress?
Targeted prevention

Caries activity

History – picture built up over time

- Number of new lesions
- Number of progressive lesions – ICDAS II role in assessing this
- Lesions in areas of high salivary flow
- Risk assessment

Do not have the benefit of this on patient’s first visit, epidemiological surveys or clinical trials
Determining the clinical appearance of active and inactive/arrested lesions

**Provoked lesions**
- Spaced orthodontic bands placed
  - 1 week
  - Macroscopically no change
  - Ultrastructural level dissolution outer enamel
  - 14 days
  - Macroscopically visible white spot lesion when air dried
  - 3-4 weeks
- Macroscopically visible white spot lesion marked dissolution of enamel

**Holmen et al., 1987**

**Provoked lesions after 4 weeks**
- **Active white spot lesion**
  - Dull/matt/ chalky in appearance
  - Rough to blunt probe drawn gently across surface
  - 1 week
  - Signs of clinical regression
  - 2-3 weeks
- **Inactive lesion**
  - Glossy/shiny in appearance
  - Smooth to blunt probe drawn gently across surface

**Holmen et al., 1987**

Signs of clinical regression

Can a dentist accurately assess the activity of early naturally occurring enamel lesions?

**Visual and tactile assessment of arrested initial enamel carious lesions: An in vivo pilot study.**

**Ekstrand et al., Caries Res, 2005**

10 high caries risk children
- Each with 4 similar lesions
- 3 lesions randomly selected for professional daily cleaning for a 3-4 weeks period
- One lesion not professionally cleaned
- Presence/absence of cariogenic plaque over lesion tested with: Clinpro Carlo Diagnosis Full arch Lactic Acid Locator (3M ESPE)
Ekstrand et al., Caries Res, 2005

Dentists then examined each lesion blindly
• Lesion active or inactive
• Lesion rough or smooth to ball ended probe run gently over surface
• Lesion matt or glossy

Gold standard
• Cleaned lesions – inactive
• Plaque covered lesions - active

Findings
- The accuracy in deciding whether natural carious lesions were active or inactive was poor based on purely visual/tactile criteria
- Reproducibility of visual, tactile and activity assessment was extremely poor
- Difficulty in interpretation of subtle, subjective features of early lesions

Activity assessment
- Visual tactile appearance
- Is lesion in plaque stagnation area?
- Is the inter-dental papilla inflamed?
  – Bleeding on perio probing associated with lesion progression. Ekstrand et al., 1998
- Smooth surfaces – distance from gingival margin
- Occlusal lesions - ? In functional occlusion
- Pits and fissures - morphology