Preventive dentistry

Role of bacteria in caries development

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Role of mutans streptococci in dental caries

includes the following correlations of mutans streptococci counts in saliva and plaque with the prevalence and incidence of caries

• mutans streptococci can often be isolated from the tooth surface immediately before development of caries

• positive correlation between the progression of carious lesions and 'S. mutans' counts

• production of extracellular polysaccharides from sucrose (which help to cement the plaque organisms together and to the tooth surface)

• most effective streptococcus in caries studies in animals

ability to initiate and maintain microbial growth and to continue acid production at low pH values

• rapid metabolism of sugars to lactic and other organic acids

• ability to attain the critical pH for enamel demineralization more rapidly than other common plaque bacteria

• ability to produce intracellular polysaccharides (IPS) as glycogen, which may act as a food store for use when dietary carbohydrates are low
immunization of animals with specific S. mutans serotypes significantly reduces the incidence of caries

The role of lactobacilli

were previously believed to be the causative agents of dental caries. They were candidate organisms for caries because of:

• their high numbers in most carious lesions affecting enamel (many studies have now shown its high prevalence in root surface caries too)

• the positive correlation between their numbers in plaque and saliva and caries activity

• their ability to grow in low-pH environments (below pH 5) and to produce lactic acid

• their ability to synthesize both extracellular and intracellular polysaccharides from sucrose

• the ability of some strains to produce caries in gnotobiotic (germ-free) rats

• the fact that their numbers in dental plaque derived from healthy sites are usually low.

On the negative side, however, lactobacilli are rarely isolated from plaque before the development of caries and they are often absent from incipient lesions.

Although the role of lactobacilli in the carious process is not well defined, it is believed that:

• they are involved more in the progression of the deep enamel lesion (rather than the initiation)
• they are the pioneer organisms in the advancing front of the carious process, especially in dentine.

**The role of Actinomyces spp**

Root lesions differ from enamel caries in that the calcified tissues are softened without obvious cavitation. The evidence for the involvement of A. viscosus in root surface caries is based on:

• association studies in vivo

• in vitro experimental work with pure cultures

• experimental work in gnotobiotic rodents.

Even though Actinomyces spp. (especially A. viscosus) predominate in most plaque samples taken from root surface lesions, some studies have reported both mutans streptococci and Lactobacillus spp. in these lesions. Furthermore, the sites from which these organisms were isolated appeared to have a higher risk of developing root surface caries than other sites. The role of Actinomyces spp. in caries is therefore not clear.

**The role of Veillonella**

is a Gram-negative anaerobic coccus that is present in significant numbers in most supragingival plaque samples.

As Veillonella spp. require lactate for growth, but are unable to metabolize normal dietary carbohydrates, they use lactate produced by other microorganisms and convert it into a range of weaker and probably less cariogenic organic acids, e.g. propionic acid. Hence this organism may have a beneficial effect on dental caries.
This protective effect has been demonstrated in vitro and in animal experiments, but not in humans.

**Patient evaluation**

1. microbiological analysis
2. assessment of dietary habits
3. determination of salivary flow rate and buffering capacity

1. Microbiological tests in caries assessment. Saliva samples can be used to establish the numbers of *Streptococcus mutans* and *Lactobacillus* spp. in the oral cavity, as follows:
   1. A paraffin wax-stimulated sample of mixed saliva is collected.
   2. In the laboratory the saliva is appropriately diluted and cultured on selective media (*mitis salivarius* bacitracin agar for *S. mutans*; *Rogosa SL* agar for *Lactobacillus* spp.)
   3. The number of typical colonies (colony-forming units or CFU) is then quantified and extrapolated to obtain the count per millilitre of saliva:
      - high caries activity: >10^6/ml *S. mutans* and /or
        >100 000/ml *Lactobacillus* spp.
      - low caries activity: <100 000/ml *S. mutans* and
        <10 000/ml *Lactobacillus* spp.

2. assessment of dietary habits

The major approaches to prevention of caries are:

- stopping or reducing between-meal consumption of carbohydrates, or substituting non-cariogenic artificial sweeteners (sugar substitutes), e.g. sorbitol, xylitol or Iycasin
- making the tooth structure less soluble to acid attack by using fluorides
• using sealants to protect susceptible areas of the tooth (e.g. pits and fissures) that cannot easily be kept plaque free by routine oral hygiene measures
• reducing cariogenic flora so that even in the presence of sucrose, acid production will be minimal (e.g. oral hygiene aids, antimicrobial agents and possibly immunization)
• replacement of cariogenic bacteria by organisms with low or no cariogenic potential.

3- determination of salivary flow rate and buffering capacity
An appropriate flow of saliva is essential for the maintenance of oral health. It is evident that the oral bacteria are subjected to several important salivary functions, which affect their colonization, survival, and metabolism.

The most important mechanisms by which saliva can affect caries are:
  □ Mechanical cleansing of debris and plaque bacteria
  □ Antibacterial activity against the oral microflora, i.e., lysis and aggregation
  □ Buffering and neutralization of plaque acids
  □ Enhancement of remineralization

The buffering capacity of saliva is important for the maintenance of normal pH levels in saliva and plaque. A low secretion might indicate a low buffering effect and a weak inverse relationship to caries has been noted by several investigators. Both the saliva secretion rate and buffer capacity differ however at different parts of the mouth. The composition and acidogenicity of plaque may be affected differently when situated close to a salivary duct or hidden deep down in a fissure. Nevertheless, unfavorable values of buffer capacity and salivary flow rate should be considered as risk factors for the individual. The tests commonly used are based on the titration technique with the final pH determined by a dye color change.
Control of cariogenic plaque flora: Control may be achieved by

- mechanical cleansing (e.g. tooth brushing)
- antimicrobial therapy (e.g. mouth rinse)
- immunization and
- replacement therapy.
- Probiotic therapy

**Active immunization against dental caries.**

Using either cell wall-associated antigens (antigen I/II) or glucosyltransferases (extracellular enzymes) from mutans streptococci is effective in reducing experimental dental caries in rats and monkeys. The vaccine may produce its protective effect by:

- inhibition of the microbial colonization of enamel by secretory immunoglobulin A (IgA)
- interference with bacterial metabolism
- enhancement of phagocytic activity in the gingival crevice area due to the opsonization of mutans streptococci with IgA or IgG antibodies.

**Passive immunization**

Experimental studies indicate that when the natural levels of oral mutans streptococci are suppressed by chlorhexidine, topical application of monoclonal antibodies against antigen I/II of mutans streptococci prevents recolonization by the organisms. Transgenic plants could be used to produce dimeric antibodies with specificity to antigen I/II of streptococci that are stable in the mouth and persist for longer periods than the monomeric antibody.

These new developments have heightened the hopes of an alternative caries-preventive strategy for the future
Replacement therapy
Experimental studies indicate that genetically engineered, low-virulence mutants of mutans streptococci that are deficient in glucosyl transferase or deficient in lactate dehydrogenase activity can be 'seeded' into the oral environment organisms can replace their more virulent counterparts and prevent their re-emergence

Probiotic therapy
The term probiotic therapy or probiotics is now used for approaches where the offending pathogen is replaced artificially by innocuous commensals that can obtain a permanent foothold in the locale (e.g. oral cavity, intestines).

It is feasible that replacement therapy of this nature may be exploited to control cariogenic flora in the future. However, assurances of the safety of these replacement strains are needed by both the public and the authorities before these methods are realized.