



RECENT ADVANCEMENTS IN TREATMENT OF DENTAL CARIES

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ABSTRACT

This study throws light on the recent advances in treatment of dental caries. The treatment consists of two modalities namely preventive and therapeutic. Former further includes methods to prevent demineralization and methods to promote remineralization. Novel preventive approaches to prevent demineralization includes newer Chemoprophylactic agents, antimicrobial peptides, probiotics, replacement therapy, bacteriophage therapy, photodynamic therapy, sugar substitute, immunization

whereas preventive approaches to promote remineralization includes newer remineralizing agents, ozone therapy and recent advances in fluorides. Therapeutic treatment is focused on the concept of minimally invasive dentistry. By reestablishing the optimal oral health through these various approaches, dentist can preserve tooth structure and avoid costly & extensive dental treatments.

KEYWORDS: Dental caries, Demineralization, Remineralization.

INTRODUCTION

Commonly referred to as cavities or tooth decay, dental caries is one of the most common chronic infectious, communicable, multifactorial oral disease in the population worldwide, which is not self-limiting type of disease and without proper care it would lead to destruction of tooth by acidic by-products formed from the bacterial fermentation of dietary carbohydrates.

Most prevalent oral disease of several Asian and Latin American countries is dental caries which affects primary & permanent teeth.^[1] Dental caries is a major problem affecting 60-90% of school children & almost 100% of adult population.^[2] Prevention of caries is necessary as it affects persons self-esteem, quality of life & also indirectly contributes to decrease in Nation's productivity.^[3] Hence proper preventable measures should be taken to reduce these high prevalence rates of dental caries.

In the present article the recent trends in treatment of caries will be discussed under two broad categories namely A) Preventive B) Therapeutic.

A) PREVENTIVE TREATMENT

Modern dentistry focuses on novel techniques for preservation of healthy tooth with help of various preventive approaches.

a) Measures to prevent demineralization

Acid accumulation in plaque on non-shedding tooth surface is driving source for demineralization & development of caries. So valuable measures have been undertaken for controlling this demineralization which is discussed below:

1. *Newer Chemoprophylactic agents*

Traditional agents include chlorhexidine, triclosan etc, but their drawback is its retention time which is very short in oral cavity. Recently, a mineral binding micellar drug delivery system was developed, which not only binds fast within tooth surface, it also releases encapsulated drug over a longer period of time. This was accomplished by covalently conjugating the tooth binding moieties to the ends of pluronic copolymer using "click

chemistry”.^[4] Recent advances in novel active plant extracts includes water soluble component of Labiatae family (Mezine et al); berry juice of Vaccinium plant (Ofek et al),an essential oil composition from Coleus forskohlii(Majeed et al); they all showed significant inhibitory action against *S.mutans*.^[5,6,7]

2. Anti microbial peptides (AMP's)

Recently AMP's have gained attention due to their robust killing activity against a wide spectrum of bacteria's, including drug resistant strains. These peptides are amphiphatic mixture of alpha helical & beta sheet & has overall cationic charge. They bind to LPS (negatively charged) of microbial membrane, and then they penetrate inside the cell & kill by intracellular mechanisms. Reynolds et al, recently found AMP's can be derived from milk protein casein.^[8] Leung et al discovered novel AMP which is more stable & easy to synthesize at lower cost.^[9] Bobek discovered new AMP's which are more stable & resistant to proteolysis.^[10] Eckert R et al stated that AMP's are target specific antimicrobial agent which are potent against *S.mutans* but didn't alter other oral streptococci.^[11]

3. Probiotics

They are live micro-organisms which when administered in adequate amount, confer a health benefit on the host (WHO). It acts by either disrupting plaque biofilm or production of antimicrobial compounds that inhibit oral bacteria. Long term consumption of milk containing *L.rhamnosus* GG strain reduces initial caries. Ingestion of *L. reuteri* ATCC 55739, *Bifidobacterium* DN-173 010 reduces *S.mutans* in saliva. Mollstam et al , discovered new strains of *Lactobacillus* , including *L.reuteri* CF2-7F (ATCC PTA-4965) ,MF2-3(ATCC PTA-4964), FJ “Prodentis” (ATCC PTA-5289) & FJ3 (ATCC PTA-5290), that have good antimicrobial action on *S.mutans*.^[12] Chilcott et al disclosed novel *S.salivarius* strain which have antimicrobial action against dental caries causing organisms.^[13]

4. Replacement therapy

The so-called replacement therapy is a measure that has emerged with advances in gene engineering & DNA recombinant technology, which has

shown to reduce pathogen in oral flora. Mutated strains of *S.mutans* lack ability to metabolize carbohydrates into acids. Non-acid producing *S.mutans* strain BCS3-L1 is developed which is active against other *S.mutans* strain to replace naturally occurring cariogenic strains in oral cavity. This strain is less cariogenic & more stable and is currently awaiting evaluation for its efficacy in humans. In another study, the ability of *S.mutans* to produce extracellular glucans is blocked in a mutation by deleting the GTF-C gene.^[14]

5. Bacteriophage therapy

Bacteriophage are viruses that attack bacteria .Its characteristics include target –specificity, patients allergic to antibiotics , cost effectiveness & no side effects. Delise & Rotkowski have described bacteriophage lytic for *S.mutans*.^[15] Recently lytic phage is also discovered for *S.salivarius*. Hence, the isolation and identification of lytic bacteriophage to oral pathogens is considered to be an approach towards phage therapy of dental caries.

6. Photodynamic therapy (PDT)

They have promising results for inactivation of microorganisms related to caries. It is a treatment which utilizes light for activation of photosensitizing agent in presence of oxygen which results in reactive radical's formation inducing cell death. PDT has antimicrobial properties in a process called “photodynamic inactivation” or “photodynamic antimicrobial therapy”. For PDT against *S.mutans*; erythrosine is appropriate photo sensitizer because it acts against these Gram positive bacteria; also has hydrophilic tendency& even at low concentrations may have photodynamic effects. Considering erythrosine; there should be light source with wavelength close to 530 nm; which may be achieved with low cost LED's.^[16]

7. Sugar substitute

They are alternative sweeteners which may be artificial or natural. Recently natural sweeteners have gained prime attention; which includes Stevia. Stevia is an accepted sugar substitute of family Astereciae that contains Rebaudioside A & Stevioside which posses natural sweetening & pharmaceutical properties. Its focusing characteristics includes 0 carb , 0 glycemic index , 0 calories , 100 % natural, 300 times sweeter than sucrose &

its non toxicity . It is anticariogenic and antiperiodontopathic. It is active against *S.mutans*, *S.sorbinus*, *L.acidophilus*, and *C.albicans*. It has anti plaque effect by reducing biofilm formation & is also healing agent at periodontium level. It has numerous systemic effects too. Still implications of using Stevia in pediatric population is awaited.

8. Immunizations

Recent work has focused on using *S.mutans* antigens for initiating an antibody reaction & finally elimination of *S.mutans* colonization in the body. This is mediated by secretory IgA antibodies. The antigen I/II specific sIgA is able to inhibit *S.mutans* from its adherence to hydroxyapatite & its subsequent colonization on tooth surface (Hajishengallis).^[17] Methods like vaccine focused on glucosyltransferase enzymes & glucans binding protein of bacteria has been tested; which shows an exaggerated immune response, inhibiting aggregation of *S.mutans* in animal models to some degree.^[18]

b) Measures to promote remineralization

1. Newer remineralizing agents

Recently the focus in caries has been shifted to non invasive treatment of early lesions by the means of remineralizing agents which has potential to be a major advancement in clinical management of the caries. Newer technology includes the following:

CPP-ACP (casein phosphopeptide – amorphous calcium phosphate): Is a cariostatic complex which deposits high concentrations of ACP in close proximity to the tooth surface.

TCP (Tri calcium phosphate): Recently it was observed that when acidic gum was used to increase solubility of TCP; a substantial increase in plaque fluid & saliva calcium & phosphate would be attained in patients who chewed gum following sucrose rinse.

Pronamel: Contains 5 % potassium nitrate & 1500 ppm NaF which is helpful as desensitizing agent as well as remineralizing agent.

NovaMin: A bioactive glass material which provide calcium & phosphate upon reactions which results in hydroxyl carbonate apatite (HCP) formation. Active ingredient is Calcium sodium phosphosilicate.

Enamelon: Consists of unstabilized calcium & phosphate salts with NaF. Used for treating white spot lesions& repair & remineralization of tooth enamel.

DCPD (Dicalcium phosphate dihydrate): An abrasive which has shown to improve the effects of fluoride in mouth. More active calcium & high degree of saturation with respect to enamel exists for longer time period after use of DCPD dentifrice.

IER (Ion exchange resins): Is a suitable drug delivery technology which provides controlled release system for anticaries treatment.

2. Ozone therapy

Ozone is a powerful oxidizing & antimicrobial agent with numerous advantages in modern dentistry which includes non invasive treatment of initial caries by remineralization; root caries; as intracanal irrigant; treatment of alveolitis, avascular osteonecrosis of jaw; anti-plaque agent; as adjunct in periodontal surgical & maintenance phase; for disinfection of implant surface; to treat peri-implantitis.^[19]

It achieves its antimicrobial activity against caries because gaseous/aqueous form of ozone eliminates cariogenic bacteria by decarboxylation of pyruvic acid which is produced by acidogenic bacteria to acetic acid. This acetic acid not only results in remineralization of carious lesions; it also buffers plaque due to high pKa values. Treatment with ozone results in more reversal of noncavitated lesions than cavitated lesions. Application of ozone is capable of clinically reversing root caries too.

3. Recent advances in fluoride

a. Fluoride glass device

It was developed in Leeds, U.K. It slowly dissolves when moist in saliva & releases fluoride without affecting device's integrity. It is attached to buccal

surface of first permanent molar by means of adhesive resins. Earlier it was dome shaped; which was not retentive. Hence kidney shaped device (6 mm long; 2.5 mm width & 2.3 mm depth) was introduced which was effective regarding fluoride release and retention rate. Recently new device is shaped in formation of disk that is placed within plastic bracket. Concentration of fluoride in glass is 13.3 to 21.9%.

b. Copolymer membrane device

It was developed by cowsar in USA. It is membrane – controlled reservoir type designed device with inner core of HEMA/MMA copolymer (50:50 mixture) containing precise amount of NaF. Rate of fluoride release of device can vary from 0.02 to 1 mgF/ day for upto 180 days.

c. Fluoride releasing pellet

To overcome drawback of slow releasing device; Jessop et al introduced a dental bracket & associated kit for attachment of fluoride releasing pellet on tooth.^[20] Pellet may be replaced every 6 months to 2 years .Up to 20 years the bracket can be attached to patient's tooth.

d. DCPA Nano composite

Xu et al developed DCPA(Dicalcium phosphate anhydrous) nanocomposite as a restorative material which slowly releases high levels of calcium phosphate requisite for purpose of remineralization.^[21] Recently they added novel calcium fluoride nanoparticles to develop stress bearing, F releasing nanocomposite. They release F ions for more than 10 weeks at a release rate higher than resin modified GIC's. Further Xu et al disclosed class of polymerizable monomers which contain chelating groups & F exchanging metal chelates which releases F in aqueous solution; & can “recharge” by taking up of F from aqueous solution containing high F concentrations (e.g. Fluoridated mouthwash).^[22]

e. Specialized phosphonate

Faller et al, recently introduced use of specialized phosphonate containing polymers or telomeres for enhancement of F incorporation in to tooth.^[23] Effects includes 1) Desorption of pellicle proteins associated with

undesirable microbial species 2) Hydrophilic tooth surface immediate after treatment 3) Maintaining of surface conditioning effects. Thus improvement in surface properties leads to more F deposition & remineralization of tooth.

f. Hydroxyapatite-Eudragit RS 100 Diffusion Controlled F system

It is recent type of slow release F device consisting of mixture of hydroxyapatite, NaF and Eudragit RS 100. It contains 18 mg of NaF which release 0.15mg/F day. It significantly increases salivary concentration for 1 month. It is placed on labial aspects of maxillary incisors, buccal aspect of molars & lingual aspect of mandibular incisors.

g. Synergistic effect of fluoride and laser

Laser (carbon dioxide or other) they not only vaporize/remove carbonate; they also cause shrinkage of hydroxyapatite crystals too. Recently Cozean et al introduced novel laser treatment which makes tooth more acid resistant & easier binding to F ions.^[24] Thus effects was found to be synergistic.

h. Newer topical fluorides

It includes amine fluoride and stannous hexafluorozirconate. Amine fluoride is superior to inorganic fluorides in terms of reducing enamel solubility & is also surface active by means of holding F on tooth enamel for longer duration. Stannous hexafluorozirconate is developed by Indiana University which is found to be effective in reducing tooth solubility and in prevention of dental caries.

B) THERAPEUTIC TREATMENT

If dental caries is progressed beyond preventable stage, necessary therapeutic treatment of the disease should be attempted.

Minimal interventional dentistry (MID) has come into focus recently in the field of pediatric dentistry. So MID will be discussed in the present article as the means of therapeutic treatment of dental caries.

Concept of MID

Changes in caries prevalence, has brought a revolution in management of caries on microscopic level from “extension for prevention” to “minimally

invasive”. It is an approach which is focused on maximum tooth preservation by managing caries as an infectious disease, deferring operative intervention as long as possible.

1. Minimal surgical intervention of cavitated lesions

When surgical treatment is indicated, it should be minimally invasive. It includes:

a. Air abrasion (Micro abrasion & kinetic cavity preparation)

It is an alternative pseudo-mechanical, non rotary method to remove dental hard tissues which involves bombarding tooth surface with high velocity particles carried in a stream of air. This method reduce the problem of heat generation , vibration and other mechanical situation which resulted in pain free procedures as compared to dental drill .Used in G.V Black’s Class I, II, III, IV, V cavity preparations in form of sealants and preventive restorations.

b. Atraumatic restorative treatment (ART) - “An Atraumatic alternative“

It is a curative type of treatment which causes no trauma to the patient nor to the tooth. Suitable for the patients who has high fear and anxiety levels to dental drill. It uses manual instruments like spoon excavator for caries removal and restoration by glass ionomer cements.

c. Ultrasonics

Nielsen et al suggested use of ultrasonic’s to cut the tooth surface.^[25] More harder the tissue, the more easy was to cut. Soft carious dentin apparently could not be removed. He further attempted to investigate the various parameters of ultrasonic’s but his results were inconclusive.

d. Sonoabrasion

It uses high frequency, sonic air scalers with modified abrasive tips for removal of soft carious dentin.

2. Minimal cavity designs

The focus is on maximum conservation of demineralized, noncavitated enamel and dentin. In this, G.V Black’s concept of “extension for prevention” is replaced by “minimally invasive” concept. Cavity preparations

designed to conserve maximum enamel can eliminate the need for macro mechanical retention.

3. Minimal intervention tooth preparation

a. Burs used

Fissurotomy kit (SS WHITE)

It includes 3 unique burs namely Original fissurotomy, Micro STF, Fissurotomy Micro NTF. Fissurotomy Micro NTF & Original fissurotomy has 2.5 mm head lengths which limits its entry just below DEJ and not further into the dentin whereas Micro STF has 1.5 mm head length which is used for primary teeth. They are anatomically designed burs to enlarge the fissures & eliminate small caries without excessive removal of healthy enamel/dentin

Micro diamond prep system (BRASSELER USA): It is a set of 8 burs especially for MID.

No: 889m 007: for initial preparation & also for creating bevels on small preparation.

No.830 RM, 830 M, 935 AM: Removes defects like white spots.

No.838 M 007: creates ideal trough incisal edge preparation while maintaining integrity of labial & lingual walls.^[26]

Polymer caries removal burs (SMART BURS)

These recently introduced burs namely RA no.2, no.4, no.6 have metal shaft and polymer blades instead of metal body and cutting blades. Polymer blades have KHN of 50; hence only diseased dentin (KHN of 30) will be removed not the sound dentin (KHN of 70-90).

b. Preparation designs for primary teeth

Tunnel cavity preparation

It is designed by accessing the carious dentin from the occlusal surface, and at the same time marginal ridge is preserved. These designs are difficult to prepare because of accessibility and visibility and also very small amount of tooth structure is removed. These designs preserve the marginal ridge and the proximal surface enamel. Recently study has shown that after three years,

tunnel preparations had better results when compared to slot class II restorations.

Proximal Approach

It is a conservative approach used when proximal surface of tooth is accessible at time of cavity preparation in adjacent tooth. Only broken down enamel is removed which can't be remineralized and residual demineralized enamel around circumference of lesion is retained for purpose of remineralization. It is then restored with GIC.

Slot cavity preparation

These boxes or a saucer shaped cavity is designed for a small lesion which involves area of or below marginal ridge only in deciduous teeth. It removes the marginal ridge and at the same time do not include occlusal pits and fissures if there removal is not necessary which is then restored with composite or amalgam. They have 70 percent survival rate with an average of seven years.

4. Laser cavity preparation

Er-YAG & Er-Cr:YSGG lasers selectively remove soft caries and hard tissues. Benefits include no vibration, little noise, no smell and no numbness associated with anesthesia. When lasers are used correctly, excessive heat generation and its detrimental effects on pulp can be avoided.

5. Chemomechanical caries removal (CMCR) System

It involves chemical softening of carious dentin followed by its gentle excavation for apprehensive children. Traditional CMCR includes Caridex, Carisolv, and Papain gel.

Most recently introduced is the Carie care gel which contains active ingredient as papaya extract-an endoprotein, chloramines and dyes.^[27] It also contains essentials oils which was not included in any earlier preparation including Papain gel . It does not contain sodium hypochlorite or any other strong chlorinating agent which was used by earlier CMCR agents. It

removes carious dentin as well as provides anti-inflammatory activity & aroma due to presence of essential oils.

6. Enzymes: It is seen that with help of enzymes it is possible to remove the caries. Recently the enzyme pronase is seen to remove carious dentine. It is a specific proteolytic enzyme. It is originated from *Streptomyces griseus*.

CONCLUSION

An increased amount of technologies are aimed at promoting tooth remineralization, but fluoride remains the most widely used agent because of its strong clinical evidences. Combining the preventive therapies (reducing demineralization and promoting remineralization) and therapeutic therapy (Minimally invasive dentistry) can lead to pronounced results. Novel technologies should only be considered as an adjunct to treatment until their anticaries activity is demonstrated in randomized controlled clinical trials.

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