

Mode of action of fluoride or mechanism of caries control of fluoride

Fluoride act in several different ways to reduce dental caries action and this multiplicity of effect is the key to this caries prevention action.

1- Enamel crystal structer or change of the tooth structer during the tooth formation.

The principle mineral substance in enamel(also dentin and bone) is the hydroxy apatite HA, however the fluoride ions has a strong affinity for mineralized tissues and hydroxy apatite can be readily converted in to flouro apatite when fluoride has replaced hydroxyl group and this takes place during period of formation and calcification of tooth. The relative proportion of FA to HA in enamel varies , with a higher proportion of FA in outer enamel in enamel exposed to F sol or covered with plaque for a long period.

A- The HA crystals tended to posses voids and such that voids were likely to increase crystal reactivity, so they dissolve more readily and easily , the F ion eliminates the voids and stabilizes the crystal structer , so enamel with FA resist to demineralization and dissolution of enamel.

B- Apatite crystals tend to be surrounded by a hydration layer which may include other ions such as magnesium carbonate and fluoride. But magnesium and carbonate , unlike F are associated with poor crystallinity and a further favorable reaction of F would appear to be the ability to replace magnesium and carbonatein the apatite crystals so making the crystal more stable.

C- Incorporation of F also tend to increase the size of the crystal, this would result in a decrease in crystal surface area per unit volume and therefore reduce the rate of enamel dissolution.

So the increase in F concentration in enamel is either while the apatite crystals of the tooth are forming (systemic F administration) or after the enamel is formed and the tooth has erupted from the mouth (topical administration), it has been found that maximum cariostatic effect will be reached when about 50 % of OH positions are reoccupied by F.

2- Bacteriostatic Effect of Fluoride

The F has inhibition effect on enzyme especially glycolytic enzyme like (enolase) inhibit glycolysis , the process by which sugar is metabolized by bacteria to produce acid .

There is also some evidence that F inhibits the production of extra polysaccharide (dextran) by cariogenic bacteria , necessary process for plaque adherence to smooth surfaces.

A further possible mechanism , there is evidence that F may have specific bactericidal action on cariogenic bacteria in the plaque especially in higher concentration and at a low PH.

The F concentration necessary for reduction of acid production it show that even a low conc. Of fluoride 1 – 2 ppm of F are able to produce detectable reduction in acid production , 10 ppm produce a moderately large reduction in acid production and 100 ppm completely inhibits bacterial growth.

The amount of available F is several times greater in F rich then in low F area in dental plaque, so the bacteria of dental plaque formed in fluoridated area when exposed to levels of F that can inhibit further

acid formation , were as those of plaque formed in non fluoridated area are not , thus the PH values of plaque formed in low fluoride plaque is much less , so loss of enamel mineral occurs when the plaque is low in F and this loss is reduced when plaque F level is high.

3- Remineralization

It may be defined as a deposit of mineral or inorganic substances in an area from which such substances were previously removed.

In early stages of carious lesion (chalky) the lesion is not simply a process of demineralization, but is characterized by alternating period of destruction and repair.

During the carious process of demineralization of enamel , apatite is reduced to simpler compounds or ions , but during a subsequent remineralization phase the apatite will again be formed .

Apatite is the most stable and least soluble of biological calcium phosphate compounds and its formation during mineralization phase is therefore desirable, one of the most important actions of fluoride is its ability to increase the formation of apatite during remineralization .

A researcher suggested that during remineralization the outer layer of the apatite crystals may take up fluoride so that it acquires the property of fluoroapatite .

Possibly due to fluoride ability to enhance remineralization of carious enamel , fluoride becomes incorporated in to the new crystal structure increased amounts over many years .

Epidemiological evidence of remineralization invivo

Many studies noted that white spot lesion of caries may become arrested or retarded under favorable oral conditions.

In a study , the examination of 184 buccal surfaces of maxillary first molars in the same children at age 8 and again at age of 15 years , of 72 surfaces with white spots at 8 years , 37 appeared sound at the age of 15 .

Evidence of remineralization from experimental caries in man .

When blocks of enamel , covered with Teflon gauze to facilitate bacterial colonization were mounted in removable partial denture in the human mouth , the enamel blocks showed surface softening as detected by microhardness test ,when the gauze was removed to expose the enamel to the saliva invivo an increase in hardness occurred in the block, this increase in hardness was thought due to remineralization.

Recently an experiment using the same method of producing experimental caries, a fluoride solution was used to encourage remineralization , subsequently the healed lesion were again covered with gauze to create a cariogenic environment, the enamel which had remineralized was now found to be more resistant to dental caries than adjacent area of sound enamel it thus seems possible that a remineralized white spot lesion may be more resistant to carious attack than sound enamel. This cycle could occur many times , each time resulting in increased concentration of fluoride in the new enamel and a reduced susceptibility to future caries attack.

Other experiment, the subject used sucrose mouth rinse for 23 days to induce caries after this time oral hygiene procedures were recommended

and subjects used daily mouth rinses with 0.2 % NaF solution for 1 month, caries scores showed regression or healing of the experimental lesion during the F mouth rinsing regime.

Remineralization evidence invitro

In this technique , the researcher used microhardness testing to measure the quantitative change in enamel surface. In these experiments , first the sound human teeth were tested for hardness and then tested after softening with an acetate buffer solution and retested again after exposure to remineralizing solution and saliva which contained calcium , phosphate and fluoride ions , in this experiment it was assumed that the rehardening of the enamel surface was indicative for remineralization .

4- Alteration in morphology of teeth

Teeth in fluoride areas had shallow fissure and well developed well rounded cusps and some times were 2 % smaller.

5- Delayed eruption of teeth in fluoridated areas

Little support for this hypothesis.

How do Topical Fluoride work

Several mechanisms have been postulated and it is entirely probable that a combination of these works together to arrest a preventive effect.

- 1- Formation of fluorohydroxy apatite which cause the enamel to become more resistant to dissolution by bacterial acids (most common hypothesis)
- 2- Fluoride enriched enamel which begins to dissolve in bacterial acids liberates a quantity of fluoride sufficient to retard the demineralization process and to promot remineralization.
- 3- The frequent application of topical fluoride can reduce the relative quantity of cariogenic microorganism in plaque especially Strepto coccus mutans ,this is due to direct action of topical fluoride agent on bacteria or due to indirect rout involving fluoride released from enamel or plaque as a result of bacterial acid accumulating.
- 4- The less important suggestion is that fluoride treatment of the teeth will lower the enamel free surface energy to make plaque accumulation more difficult or could even desorb bacteria from hydroxyapatite.