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Fluoride – Releasing Materials

Fluoride exists only in combination with other elements as a fluoride compound.It is present in the body in bone and teeth.The fluoride's effect is to serve as an aid for both the mineralization of developing tooth enamel prior to tooth eruption and for remineralization of surface enamel. The combination of these fluoride effects greatly reduce occurrence of dental caries. Fluoride is incorporated in tooth structure when small amounts are swallowed daily while the teeth are forming. Fluoride becomes concentrated in the outer enamel surfaces when applied after teeth erupt into the mouth.Dental plaque and saliva act as fluoride reservoirs to enhance the remineralization process.

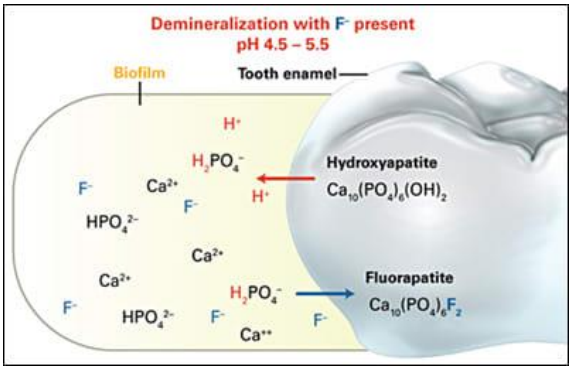
Mechanism of Action of Fluoride:

1- Inhibition of demineralization:

The mechanism is that it binds calcium and phosphate dissolving as a result of the acid penetration in to the dental tissue.

2- Enhancing remineralization:

The fluoride from topical sources enhances remineralization by speeding up the growth of a new surface on the partially demineralized subsurface crystals in the caries lesion, fluoride adsorb to the crystal surface and attract calcium ions followed by phosphate ions leading to new mineral formation.



3- Antimicrobial action:

Fluorides interfere with the decay-causing bacteria colonizing on teeth and reduce their acid production by reduce carbohydrate metabolism, thus slowing demineralization.

Fluoride Varnish:

Fluoride varnish has been found to be effective in preventing caries on permanent teeth. Fluoride varnish also has recently been shown to prevent or reduce caries in the primary teeth of young children.

How is the varnish applied?

Application is quick and easy: small droplets of varnish are applied directly to the tooth surface.

Glass ionomer cements:

Glass ionomer cements release fluoride by two mechanisms, which are the dissolution and diffusion. The large release of fluoride ion during the first few days after replacement declines rapidly during the first week and stabilizes after 2-3 month. Fluoride release normally takes place from the matrix into the adjacent environment but, in the presence of a high fluoride concentration in the month, fluoride ion can be taken up into the cement again. Glass ionomer materials, can therefore be regarded as a fluoride reservoir.

Their main characteristics are:

1. An ability to chemically bond to enamel and dentine with insignificant heat formation or shrinkage.

2. Biocompatibility with the pulp and periodontal tissues.
3. Fluoride release producing a cariostatic and antimicrobial action.
4. Less volumetric setting contraction; and a similar coefficient of thermal expansion to tooth structure.

These advantages have made them successful as luting cements and lining materials. However, as a restorative material, their sensitivity to moisture and low mechanical strength and wear resistance make them the least durable. This may be adequate for primary teeth because they will exofoliate in a number of years.

Resin-modified glass ionomer cements:

The fluoride release of the RMGICs would be affected by methacrylate-components and the polymerization systems. The contribution from the dissolution mechanism is, however very little because of the presence of the hydrophobic resin which will repel the water.

Their main characteristics are:

1. Resin-modified glass ionomer cements bond chemically to enamel and dentine with insignificant heat formation or shrinkage of material during the hardening reaction. So that the cement can firmly adhere to both enamel and dentine without signs of marginal leakage.

2. Shear bond strength of the resin-modified cement to dentine is significantly higher than that of conventional glass ionomer cement and the bond is a stable one.

3. Resin-modified glass ionomers have the advantage of being able to directly bond to resin composite, making them useful in glass ionomer/composite laminate restorations.

4. The resin modified glass ionomers are also highly biocompatible to the pulp and it has better adaptation and seal to the cavity preparation than conventional glass ionomer materials.

5. The final set structure shows a dramatic increase in compressive strength but is rather brittle and comparatively low in tensile strength and has low abrasion resistance making it unsuitable for high stress - bearing areas such as posterior teeth.

6. The fluoride release from and uptake by the resin-modified products was higher than or the same as that of conventional glass ionomers and has no adverse effect on the bond strength.

7. resin-modified glass ionomers have greater curing shrinkage than the conventional chemically-cured cements. Incremental placement techniques should always be used to ensure complete curing at depth and to minimize polymerization shrinkage.

Clinical use

Usually came as two-paste system . It has a longer working time. It sets sharply once the polymerization reaction is initiated by light. Most manufacturers state that immediate polishing can be carried out after light-curing. However, the setting reaction will continue slowly for at least 24 hours and the best result can be obtained if finishing is delayed. When immediate polishing is required, care must be taken not to overheat the restoration as this may cause excessive drying and cracking and may prevent setting of the ionomeric component. Highly desirable, alternative to amalgam for restoring primary teeth, and as a liner/base material.

Composite

In recent years, resin composite has been formulated to release fluoride. A slow release of small amount of fluoride from composite resin would be advantageous even more than periodic high concentration of fluoride applications.

Resin cements

It consists of a resin matrix with inorganic fillers that are bonded to the matrix with monomers. Polymerization of resin cement is achieved either by chemical reaction (self cure), light activation (light cure), or both (dual cure). The self cured composite cement are typically two pastes system (base and catalyst), while the light cure cement is a single component system. In some products fluoride is added to act as anti cariogenic factor, and reduce the resin cement sensitivities.

Polyacid-modified resin composites (compomers)

Recently, other resin-ionomer hybrid restoratives have been marketed as multipurpose materials or are resins that may release fluoride but have only limited glass ionomer properties. One such new material is the 'compomer' which contains the major ingredients of both composites (resin component) and glass ionomer cements (polyalkenoate acid and glass fillers component) except for water. The fluoride release from compomers has been demonstrate, more than composite but at lower level from that of GICs. Although low, the level of fluoride release has been reported to last at least 300 days.

Their main characteristics are:

1. It have two different mechanisms are responsible for the formation of adhesive bonds to the cavity wall. One of these is the self-adhesive property of the restorative itself, it can bond to both enamel and dentine without acid etching by carboxyl (-COOH) groups, the functional carboxyl groups can form ionic bonds with the calcium ions of the tooth surface. The second mechanism is adhesion to the tooth surface through the primer/adhesive system.
2. Can only be hardened through light-curing.
3. It has a significantly less bond strength to dentine than other resin-modified glass ionomer cements and chemically cured glass ionomer.

4. Often one component with an adhesive system.
5. Little is known about the clinical wear performance on the recently marketed compomer restorative materials.
6. Recently, studies have found that the release of fluoride by compomers was significantly less than resin modified glass ionomer cement more than other fluoride releasing resin composite. However, the antibacterial action decreased significantly over time. In addition, the caries inhibition effect of compomer restorative material was higher than the conventional type of resin composite.
7. Radiopacity of compomers is differing from that of dentine and it slightly higher than that of enamel. This value is considered to be desirable for radiographic detection of recurrent caries and offers an easy method for documentation of dental work.

Clinical use:

Ease of manipulation is another advantage of the compomer restoratives. Similar to resin composites, since the adhesive can provide sufficient bond strength for retention, no acid etching procedure is required prior to placement of the restorative. The consistency makes it easy to apply and contour without stickiness and, therefore, less time will be required for final finishing. These properties are especially beneficial in treating children because restorations usually can be completed much faster and within the tolerance of the child patient. A recent study has shown that curing shrinkage is similar to that of the conventional hybrid resin composites. Therefore, placement in increments of 3 mm or less is recommended for Dyract AP, 2 mm or less for other newer compomers, and then each to be cured for at least 40 seconds. Finishing can be undertaken immediately after curing using fluted tungsten carbide finishing burs or polishing discs.

They may or may not have the typical features of true glass ionomers such as chemical adhesion to tooth structures and long-term fluoride release.

Therefore, they should be used carefully, closely following the instructions of the manufacturers because different handling methods may influence their clinical behavior. It is used as liner/base, restoration, fissure sealant.

Amalgam

Fluoride containing amalgams have been shown to have anticaries properties that is sufficient to inhibit the development of caries in cavity walls. Studies have shown that the concentration of fluoride in the saliva by fluoriden releasing amalgams is sufficient to enhance remineralization. Therefore, fluoride releasing amalgam restorations may have a favourable effect on initial demineralization in the mouth. Restorative materials show an initial release that is significant. However, this release of fluoride decreases to minor amounts after 1 week.