Professionally Applied Topical Fluorides

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Abstract

Professionally applied fluorides can be used for both primary and secondary prevention of caries. Primary prevention concerns prevention of carious lesions that develop on sound tooth structure, while remineralisation treatment of the precavitated lesion, initial lesions, and of root caries as secondary prevention. Among the topical Fuoride vehicles commonly used by dental professionals are solutions, prophylaxis pastes, gels, varnishes and rinses. These procedures are popular due to the perceived ease of use by the operator with a better financial return, acceptance by patients and the effectiveness of the procedures in caries reduction reported in the literature. Dental professionals use fluoride products that are gels and varnish, composed of a high dose of fluoride varying from 9,000 ppm to 23,000 ppm.

Keywords: Fluorides, Prevention, Varnish.

Introduction

Fluoride (F) is the cornerstone in dental caries prevention. A number of technologies and methods for application of different F compounds to the tooth surface have been developed.[1] Use of topical fluoride for caries prevention is increasing in dental practice. The American Dental Association (ADA) conducted a survey, which shows that the proportion of all patients receiving fluoride treatments from private practitioners was 4% in 1969 which increased to 10.6% in 1999.[2] The term 'topical fluoride application' is used to describe methods that provides a high concentration of fluoride to exposed tooth surfaces for a local protective effect. These can be used either individually or in combination and have been shown to significantly reduce caries. Fluoride containing toothpastes (dentifrices), gels, varnishes and mouth rinses are the most commonly used topical fluoride agents now.

Dental Caries And Fluorides

Dental caries is caused by three major factors:
Availability of teeth
Bacteria present in dental plaque
Presence of fermentable dietary sugars

Oral cavity is thrived by numerous bacteria which form a bacterial deposit onto the surfaces of the teeth i.e. dental plaque, also known as the dental bio-film. When bio-films grow out of proportion on a tooth, two processes may combine that leads to tooth decay:

- The bacteria produces the matrix of the bio-film by using sugar, which helps the bacteria to adhere to the tooth surface and shield them from outside influences.
- Sugars present in the diet are metabolized by several bacteria and thereby form acids. Due to the prolonged contact with these acids, dissolution of the enamel or dentine in teeth takes place.

Like bone, teeth are composed of the calcium phosphate mineral hydroxyapatite (HAP). The solubility of HAP depends on the pH (acidity, alkalinity), as well as on the ionic-levels of the HAP components (calcium and phosphate) of the surrounding medium. Enamel is built from periodic 'prismatic' structures. Each prismatic structure comprises millions of HAP crystallites. Sugars metabolized in oral bio-films forms acids which have a capability to dissolve hydroxyapatite. Due to porosities present in, both between the HAP crystallites and between the enamel prisms, the 'weak' organic acids formed in the plaque, penetrates in enamel rather than layer by layer dissolution of the enamel. This penetration of acids causes a selective dissolution inside the tooth, whereas the outer surface layers generally bypassed as due to the accumulation of fluoride, this is less soluble. On continuation of this demineralization process with thousands of acid challenges, gradual dissolution inside the tooth over an extended depth takes place, while its overall integrity is still maintained. However, when demineralization extends to greater depth the overall structure becomes too weak and the remaining tissue collapse, resulting in to a big cavity.

When the plaque pH returns to neutrality, formation of new enamel in the demineralization defects takes place by the deposition of calcium and phosphate ions from saliva. This natural repair mechanism is termed as remineralization.

In case of fluoride availability, 'caries attack, crystallite dissolution and repair' cycle will result in repaired tooth enamel which is more resistant to future acid challenges. Sometimes fluoride ions are present during remineralization, so fluor-hydroxyapatite mixed crystals are formed by incorporation of fluoride ions in the apatite structure. These newly formed mixed crystallites have a lower solubility than the original ones.[4]

Fluoride has several caries-protective mechanisms of action. The original belief was that fluoride's primary action was to inhibit dental caries when incorporated into developing dental enamel (i.e., the systemic route), but the fluoride concentration in sound enamel does not fully explain the marked reduction in dental caries. Fluoride when swallowed, as fluoridated water and dietary supplements, give topical effect on erupted teeth (before swallowed and afterward as a topical effect due to increasing salivary and gingival crevicular fluoride levels). Moreover, elevated plasma fluoride levels can treat the outer surface of fully mineralized unerupted, teeth topically. Similarly, topical fluoride that is swallowed may have a systemic effect.

Low levels of fluoride in plaque and saliva topically, inhibit the demineralization of sound enamel and additionally enhance the re-mineralization of demineralized enamel. Fluoride also inhibits dental caries by affecting the metabolic activity of cariogenic bacteria.

High levels of fluoride, attained with the use of topical gels or varnishes, acts by forming a temporary layer of calcium fluoride-like material on the surface of enamel. The fluoride is released when the pH drops in response to acid production and remineralizes enamel or affects bacterial metabolism.[5]

Professionally Applied Topical Flourides

World Health Organization advocated the use of both systemic and topical fluorides, as an appropriate means to prevent dental caries worldwide. Topical fluoride agents can be either self-applied, in the form of toothpaste and mouth rinse, or professionally administered, in the form of gel and varnish.[6]

Indications for professionally applied topical fluorides

- Patients with a high risk of caries on smooth tooth surfaces.
- Patients with a high risk of root surfaces caries.
- Children whose permanent molars cannot be

sealed but required sealing.

- Special patient groups, such as: Orthodontic patients, Patients with decreased salivary flow, and Patients undergoing head and neck irradiation.
- Not recommended for patients with low caries risk who reside in communities with optimal fluoridation.[7]

Gels

These gel formulations have long intervals between applications ,high fluoride concentrations, long contact time, professional application and prescription from a dentist required.[1]

There are three principal gel formulations available:

i) 2% sodium fluoride with neutral or basic pH

ii) 1.25% amine fluoride gel (0.25% of amine fluorides and 1% of sodium fluoride)

iii) 1.23% acidulated phosphate fluoride (APF) with pH around 3.5.[8]

Acidulated Phosphate Fluoride: Dr. Brudevold's discovery of a topical agent i.e. APF in caries prevention is his most significant contribution to dental research, with a major practical applications. In developing APF, he started with in vitro testing that preceded clinical demonstration of the effectiveness and utility of APF. Brudevold noticed in vitro effectiveness of the low pH of stannous fluoride in getting fluoride into enamel. Further in vitro tests proved APF solutions as three-fold superior to stannous fluoride in promoting fluoride uptake by the enamel surface. Brudevold hypothesized that an acidulated preparation that included phosphate to minimize enamel dissolution by a common ion effect would permit faster exchange of hydroxyls with fluoride. Together with his collaborators, Brudevold reported on the efficacy in reducing caries of 1.23% APF that is professionally applied for four minutes in an aqueous solution, preceded by cleaning and polishing of the teeth.[9]

Application of Fluoride Gel: Mouth trays should be tried in the patient's mouth. It may be necessary to trim trays to adapt.

Patient position should be an upright position and suction should be used during the procedure.

Teeth should be air-dried before gel application. Prophylaxis is unnecessary before gel application.

Enough gel, or foam, should be used to completely cover the teeth i.e. 2–2.5 grams per tray or 40% of the tray's volume.

Upper and lower trays should be inserted in the mouth separately.

4 minutes application of fluoride is must, not 1 minute.

After tray removal Patient should expectorate for 1–2 minutes.

Patient should not eat, drink or rinse, for at least 30 minutes after the procedure.

Note: For patients with porcelain or resin restorations, neutral sodium fluoride is the product of choice to prevent etching of restorations.[7]

Rinsing or wiping the teeth immediately after acidulated phosphate fluoride therapy reduced the inhibitory effect of fluoride on plaque acidity. The inclusion of a controlled water rinse 15 minutes after APF gel application did not seem to influence the inhibitory effect of fluoride on dental plaque acidity.[10]

Calvo AFB et al conducted a study suggesting that the application of APF gel for 4 min does not render enamel of permanent teeth more resistant to caries when compared to 1-min APF gel application.

Also, no differences between the application times were observed for deciduous enamel in this study.[11]

There were always concerns regarding the potential fluoride toxicity to children of ingesting excess gel (which contains around 10- fold more fluoride by weight than adult toothpaste), to address this issue, APF foam was developed. The 1.23% APF is now a day's available as fluoride foam, which has the advantage of requiring only 20% as much product in the application tray for equivalent fluoride deposition as the gel formulation. The smaller amount helps to limit the amount of potential ingestion. The introduction of fluoride foams, several manufacturers introduced "one-minute" topical fluoride formulations to further reduce the chance of fluoride ingestion.[12,13]

Varnishes

Fluoride varnish is a natural tree resin (colophony or rosin) containing concentrated fluoride. A key feature of varnish is the fact that the resin base in which the fluoride is suspended is tenacious in its adherence to teeth, allowing prolonged fluoride-enamel interaction over time. Most fluoride varnish products contain 2.26% fluoride from a suspension of 5% sodium fluoride (NaF) in an alcoholic solution of natural varnish substances. Approved as a "device" for use as a cavity liner and desensitizing agent, the FDA considers that varnish falls in the category of drugs and devices that "present minimal risk and is (are) subject to the lowest level of regulation." As caries prevention is a drug claim, not a device, the use of varnish in dental caries prevention is considered "off label" by the FDA. When using drugs and devices "off-label," dentists and physicians must take responsibility for their patients' safety.[14]

These formulations have long contact time, high fluoride concentrations, applied in a clinical setting, and can be applied by auxiliary [1].

Application of Fluoride Varnish

Remove excess moisture from teeth with a air syringe, cotton swab, or cotton roll. Meticulous drying of the teeth is not necessary as the varnish needs the presence of moisture to set.

Dispense 0.5–1 ml of varnish in a dappen dish. This quantity should be enough for the entire dentition.

A thin layer of varnish should be applied using a disposable brush, or cotton pellet.

The entire tooth surface must be treated. Avoid applying varnish to gingival tissues because of the risk of contact allergies.

Drying is not required after application because varnish sets in a few seconds.

Hard foods should be avoided. Patients can only have fluids or soft foods during the next four hours.

Patients should not brush their teeth for the rest of the day to enhance the uptake of fluoride into the tooth structure.

Note: Varnish is contraindicated for persons with a history of allergies or asthma.[7]

Recommendations for Professional Fluoride Application

	12 months to <10 years	10 to 18 years	18+ years
Low risk	–	–	–
Moderate risk	Varnish at 6 monthly intervals	Varnish or gel at 6 monthly intervals	–
High risk	Varnish at 6 monthly intervals	Varnish or gel at 6 monthly intervals	Varnish or gel at 3-6 monthly intervals[15]

Effectiveness

The average reduction in caries found in 16 studies in which topical APF was applied to children living in areas with fluoride-deficient water supplies was 28%. For comparison, the average caries reduction with neutral sodium fluoride (four applications) is about 29%, and that with fluoride varnishes is about 38%.[9]

Mouth Rinses

Fluoride mouthrinses (FMRs) have frequently been used to prevent dental caries. FMRs are indicated for young and adult individuals at increased caries risk or with caries activity. The procedure is rinsing the mouth daily with 10ml of 0.05% Na F (23PPM F) solution or weekly with a solution of 0.2% sodium fluoride (900ppm F) for 1-2 minutes. Flouride rinses are not recommended in children under the age of 6 years because of risk of fluoride ingestion.[16]

These formulations have shorter contact time, low fluoride concentrations, short intervals between applications, and can be implemented by auxiliary dental or non-dental personnel in non-clinical settings.[1]

Antimicrobial Effects

Gels are indicated for intensive prophylaxis and supportive treatment of caries, and for the treatment of sensitive teeth necks. In dentistry, fluoride gels are oftenly used for enamel decalcification below removable appliances, orthodontic appliances, partial prosthesis, and for fluoridation of abraded or damaged enamel areas. Fluorides as weak acids are also capable to inhibit lactate production of S. mutans. If amine flouride gels are combined with antimicrobial compounds, they can also be implied in gingivitis prophylaxis, in the treatment of stomatitis due to prosthesis wear, oral soar, and reduction of Streptococcus mutans. The antimicrobial efficacy of gels is determined by their pharmacological formulation. The antimicrobial effect of amine fluoride is based on a decreased acidity tolerance of the bacterial cell, and on the disruption of the enzyme dependent glucose transport of the bacterial cell and its consecutively metabolism. As a result, plaque formation is impaired. In contrast, sodium fluoride shows only a bacteriostatic effect at high concentrations.[17]

Fluoride Toxicity

The German society for nutrition recommends a daily fluoride intake of about 3,5 mg for an adult. The lethal dose ranges between 32 and 64 mg F-/kg body weight which would imply 3,500 mg F- (3,5 mg) for an adult of 75 kg. There needs to be a distinction between chronic and acute toxicity.

Acute Toxicity

Acute toxicity describes the immediate toxic effects after a single ingestion. The minimal fluoride dose which may cause toxic signs and symptoms and which requires an immediate therapeutic intervention is found to be 5 mg/kg body weight.

Chronic Toxicity

The chronic toxicity relates to effects which appear slowly as a consequence of slight over dosage over a long period. If fluoride is ingested in elevated doses over longer time-periods, changes in teeth and bone can result. These changes are called fluorosis.

In teeth, they are the result of some mineralization disturbance, resulting in a higher organic proportion. Dental fluorosis can only occur during tooth formation. Over-mineralization may lead to fluorosis of the bones which can occur during the entire life. Initial signs of skeletal fluorosis can be observed after the ingestion of more than 10 mg F-/day over a period of at least 10 years.[18]

Emergency action for fluoride overdose

Amount F ingested	Recommendation
< 5 mg/kg body weight	1. Give calcium orally (milk). Observe for few hours
> 5 mg/kg body weight	1. Give oral calcium 2. Admit to hospital and observe for few hours[15]

Conclusion

Professional application of fluoride products have been used successfully in dental surgeries for many years. Professional applications of fluorides play a valuable role in the prevention and management of dental caries in moderate- and high-risk patients, but use should be restricted. The average clinical effectiveness of the aqueous topical fluoride agents (NaF, SnF2, and APF) closely approximates one another, falling within a range of 28 to 32% caries reduction. A major concern in relation to fluoride varnishes (and gels) is the high fluoride concentration and the possibility of fluorosis or more serious toxicity.

References

References are available on request at editor@healtalkht.com