Ministry of Higher Education

And Scientific Research

University of Baghdad

College of Dentistry

Topical Fluoride in Caries Prevention

A project submitted to College of Dentistry , Baghdad University

Department of Pedodontic and Preventive Dentistry in Partial Fulfillment of the Requirement for B.D.S Degree

By

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2018 A.D. **1439 A.H.**

Acknowledgment

- I want first to thank **"Allah"** for help me and giving me strength, willingness and patience to finish what I have started.
- I would like to extend my deepest respect and gratitude to the Dean of College of Dentistry, University of Baghdad Prof***. Dr. Hussain F. Al-Huwaizi***.
- I would like to thank my dear assistant ***Prof. Dr. Nada Jafer MH,*** the head of department of pedodontics and preventive Department, for its scientific support and advice.
- We are grateful and special thanks and respect to my supervisor **Assist. Prof. Dr. Nibal Mohammed** for her extraordinary support, help and expert advice throughout this project.
- I would like to thank and appreciate all persons who help me in carrying out this work.

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Introduction

Dental caries is a major dental disease affecting a large proportion of a population It impairs the quality of life for many people causing pain and discomfort in addition it places a heavy financial burden on public health survices .It's very high morbidity potential has brought this disease into the main focus of dental health professionals (Peter , 2004) .Among various caries – preventive strategies , which include education in oral health , chemical and mechanical control of dental biofilms the use of fluoride to be the most effective clinically according to large number of clinical trials , literature review and more recently meta –analyses involving the use of rinse ,gels , varnish and dentifrices (Marinho et al , 2002 ; Marinho et al , 2003) . Fluoride increase the tooth resistance to acid attach that gives hardness and durability to the tooth enamel and protect against caries (murray, 2003) . Due to its effective in caries reduction, efficacy and cost – effectiveness in preventing caries the use of fluoride in various forms thus remains cornerstone of most caries prevention programs (Marya , 2011). topical fluoride which is a type of fluoride contain products has been the major factor for reduction of caries prevalence , and nowadays there is overwhelming evidence that the primary caries preventive mechanism of action of fluoride are post eruptive topical effect for both children and adults (Shashikaran et al , 2006) . It was suggested that the predominant beneficial effect of fluoride occur locally at the tooth surface and the systemic effect of fluoride are of less importance as fluoride incorporated tooth development is insufficient to play significant role in caries protection (Formon et al , 2000 ; Featherstone , 2000) . Indeed the use of fluoride in toothpaste and other oral products is believed to be the major reason for the substantial decline in caries incidence in many developed countries (Murray, 2003).

1. Fluoride

Fluoride is a member of halogen family and it is physiologically essential element for normal growth and development of human beings. It's highly reactive and, in nature is rarely found in its elemental state (Peter, 2004). Scientist have discovered that fluoride helps to protect teeth from dental decay; most of the work in caries prevention has been based on some type of fluoride use (Marya, 2011).

Fluorid is the 13th most abundant element in the earth crust , , it's most electrongatie and reactive element , it react with surrounding as fluoride compound and rarely found in free state in nature (Horowitz , 2005).Fluoride levels of about 3 parts per million (ppm) in the enamel are required to shift the balance from net demineralization to net remineralization (Summit et al , 2001) . it has been recognized globally that fluoride has an anti caries benefit , with one meta-analysis concluding an average reduction of 24% in DMFS with appropriate fluoride dentifrice use (Al-Jundi et al ,2006) .

The use of fluoride has proved to be the most clinically effective according to a large number of clinical trials demonstrate for it anti caries effect (Limeback, 2012).

1.2 Mechanism of Action of Fluoride

By the early 1990s it was well understood that fluoride is most effective in caries prevention. It is accepted that fluoride action in preventing caries is multifactorial. Fluoride increase enamel resistance and rate of post eruptive maturation , interfere with plaque microorganisms, remineralization of incipient lesion and modify tooth morphology (Peter,2004) .

Today the most important anti-caries effect is claimed to be due to the formation of calcium fluoride (CaF_2) in plaque and on the enamel surface during and after rinsing or brushing with fluoride. CaF_2 serves as a fluoride reservoir. When the pH drops, fluoride

and calcium are released into the plaque fluid. Fluoride diffuses with the acid from plaque into the enamel pores and forms fluoroapatite (FAP). FAP incorporated in the enamel surface is more resistant to a subsequent acid attack since the critical pH of FAP (pH=4.5) is lower than that of hydroxyapatite (HA) (pH=5.5). Fluoride decreases the demineralization and increases the remineralization of the enamel between pH 4.5–5.5, and hence the demineralization period is shortened. It is suggested that fluoride has antibacterial actions. In an acidic environment, if fluoride is present, hydrogen fluoride (HF) is formed. HF is an undissociated, week acid that can penetrate the bacterial cell membrane. The entry of HF into the alkaline cytoplasmic compartments results in dissociation of HF to H+ and F–. This has two separate, major effects on the physiology of the cell. The first is that the released F– interacts with cellular constituents, including various F– sensitive enzymes. The second effect is an acidification of the cytoplasmic compartment caused by the released protons. Normally protons are pumped out of the cell, but fluoride inhibits these processes. The decreased intracellular pH will make the environment less favorable for many of the essential enzymes required for cell growth (Harris, et al., 2014).

3. Types of fluoride :

Fluoride has two types depending on the delivery method used :

A. Systemic fluoride Type of fluoride that come from ingesting fluoridated water, supplements in addition to food processed with fluoridated water. It plays a predominant role when it has become incorporated into structure of developing teeth resulting in fluoroapatite crystals ;once ingested , the fluoride ion is continually excreted in saliva , with the salivary glands acting as fluoride reservoirs (Levy and Coebeil , 2007). These teeth under effect of systemic fluoride may have shallower pits or grooves especially molar teeth, allowing less trapping of oral bacteria and food particles (Halverson, 2010) .

B- Topical fluoride

The term topical fluoride therapy refers to the use of systems containing relatively large concentrations of fluoride that are applied locally or topically, to the erupted tooth surface to prevent the formation of dental caries. Because of the fluoridated water is available to only a few percent of the population, hence alternative methods for the fluoride therapy is required (Marya , 2011) .

Advantages of topical fluoride that it's does not cause fluorosis, Cariostatic for people of all ages, Easy to use, Available only to people who desire it. and it's disadvantage is Person must remember to use , Per capita cost is high compared to water fluoridation , More concentrated professional use products can cause short-term side effects like nausea immediately after us (murry, 2008) .

Topical fluoride Include two main types:

Professionally applied Topical Fluoride : is atype of topical fluoride in which Fluoride can be applied professionally by the dentist in he dental clinic in the form of gels (acidulated phosphate fluoride (APF), APF foams, and varnishes. APF gels and foams are not currently widely available and, in any case, are considered unsuitable for preschool children because of the risks of over-ingestion (Richard et al , 2012) .

Self applied topical fluoride: Self application of fluoride is usually carried out with groups of persons, usually children at one time, under only general supervision . At the time of tooth eruption, the enamel is not yet completely calcified and undergoes a post eruptive period, approximately 2 years, during which enamel calcification continues [enamel maturation period] so the Application of topical fluorides immediately after eruption hastens fluoride uptake and makes enamel more resistant to dental caries(Marya , 2011) .

4 Indications of topical fluoride

There are many indication of topical fluoride including (Marya , 2011) :

• Patients who are at high risk for caries on smooth tooth surfaces

• Patients who are at high risk for caries on root surfaces

• To reduce tooth sensitivity

• White spots

• Special patient groups, such as: – Orthodontic patients – Patients undergoing head and neck irradiation – Patients with decreased salivary flow

• Children whose permanent molars should, but cannot be sealed

• Additional protection if necessary for children in areas without fluoridated drinking water .

5. Mechanism of action of topical fluoride

The presence of elevated concentration of fluoride in enamel surface makes tooth surface more resistant to development of dental caries. Fluoride ions when substituted into the hydroxyapatite crystals fit more perfectly than do hydroxyl ions. Also the greater bonding potential of fluoride makes the apatite crystals more compact and more stable, thereby more resistant to the acid dissolution. When concentrated topical fluoride agent reacts with enamel there is formation of calcium fluoride:

$$Ca10\ [PO4]6[OH]\ 2 + 20F^- \leftrightarrow 10\ CaF2 + 6[HPO4^-]\ 3 + 2[OH]$$

Hydroxyapatite Calcium fluoride

Most topical fluoride agents have a fluoride ion concentration of between 10,000–20,000 ppm which leads to the formation of calcium fluoride and eventually Fluor hydroxyapatite. Commonly used topical fluoride agents include Sodium fluoride, Sodium monofluorophosphate. Stannous fluoride and Amine fluoride (Marya , 2011).

6. Professionally Applied Topical Fluoride

Bibby in 1942 was the first to domenstrate that the repeated application of sodium or potassium fluoride to teeth of children significantly reduce their caries prevelance . This finding was the forerunner of numerous studies designed to test the effectiveness of various topical agent and the best mode of applying them to teeth . Topical fluoride application by a dentist, hygienist or othe dental auxiliary has become an established caries – preventive procedure in most dental office (Peter, 2004) . And this type contain two technique for application:

A. Tray Technique

The tray procedure allows simultaneous application to both maxillary and mandibular teeth (Figure 1) , and is the most appropriate method for gels and foams (Marya , 2011) .

B .Paint on Technique

For patients who cannot tolerate tray application, the paint on technique is indicated. While more time consuming, the gag reflex is greatly reduced. It is the most appropriate method when fluoride solutions are used, but may also be used with gels and foams as seen in Figures (2 ,3 ,4 and 5) (Marya , 2011) .

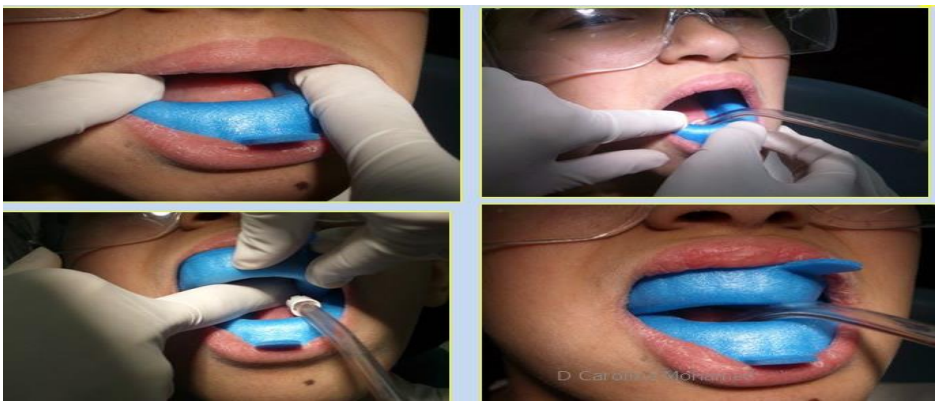

Figure 1 : tray technique (Harris, et al., 2014)

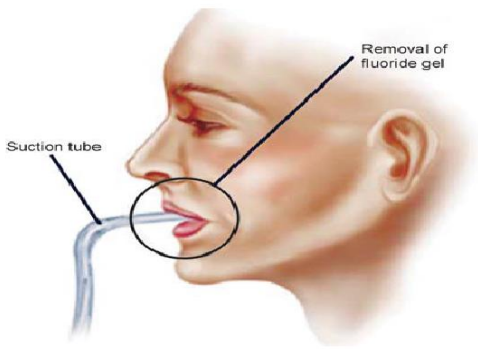

Figure. 2 Residual fluoride removal with saliva ejector

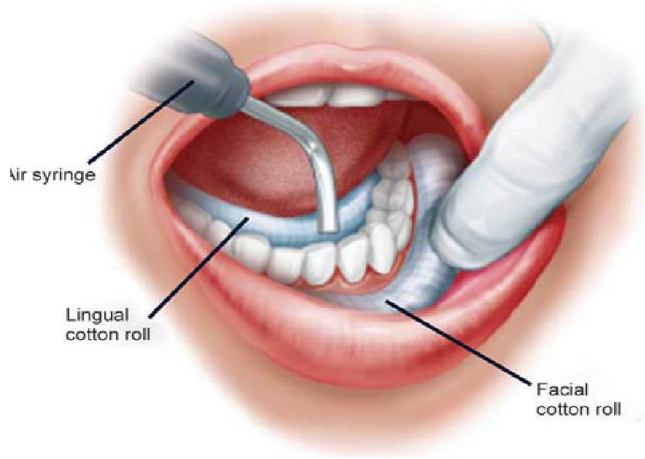

Figure. 3: Drying of teeth with air syringe

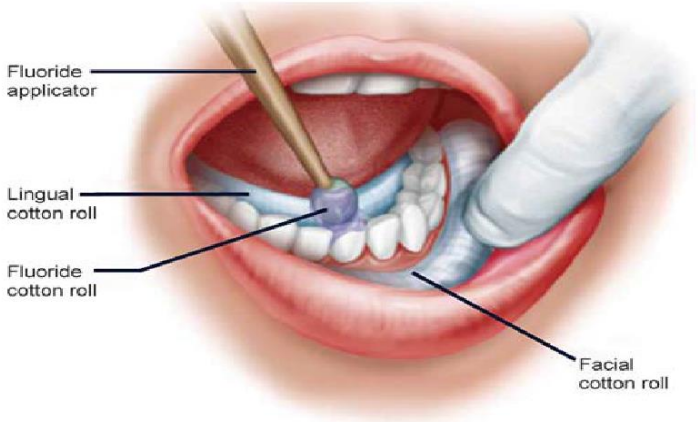

Figure.4: Application of fluoride with cotton tip applicator

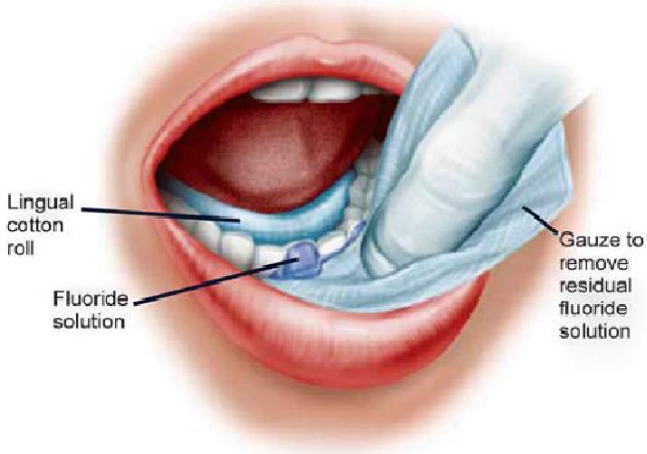

Figure. 5: Cleaning with gauze to remove residual product

6.1 Aqueous Solutions

Topical application of concentrated sodium fluoride or stannous fluoride solution was practiced some decades ago, but, because of safety concerns, this is no longer common (Chu *et al*., 2010). Application of silver fluoride or silver diamine fluoride (SDF) solution at concentrations of 38 to 40% to arrest active cavitated caries lesions in primary teeth has been practiced in Australia and Japan for many years (Chu and Lo, 2008). A recent systematic review found that a prevented fraction of around 70% for

new caries in both primary and permanent teeth in children can be obtained through applications of SDF solution, and the success rate for caries arrest can be over 90% (Rosenblatt *et al*., 2009). Similar effects on root-surface caries in elders have also been reported (Tan *et al*., 2010).Usually, a disposable micro-applicator is used to apply a small amount of silver diamine fluoride (SDF) solution directly onto a caries lesion or a caries-susceptible tooth site. It has an unpleasant metallic taste, but this is only transient. It will not stain sound tooth surfaces, but the arrested caries lesion usually appears black. Despite these disadvantages, its significant effectiveness in arresting active dentin caries lesions makes silver diamine fluoride a valuable agent for caries arrest treatment, for managing caries in the primary teeth of young children who are less cooperative, and in field settings (Chu et al., 2002; Llodra *et al*., 2005) .

6.1.1 Sodium Fluoride:

The compound is recommended for use in a 2% concentration (9000 ppm fluoride), which can be prepared by dissolving 0.2 g of powder in 10 ml of distilled water. The prepared solution or gel has a basic pH and is stable if stored in plastic containers. The lack of acidity makes this product preferable when there are composite and porcelain restorations because they can be etched by acidic solutions. Ready-to-use 2% solutions and gels of NaF are commercially available. Because of the relative absence of taste considerations with this compound, these solutions generally contain little flavoring or sweetening agents (Harris *et al*., 2014).

6.1.1.1 Method of application of Sodium Fluoride

1. Cleaning and polishing of teeth is done.
2. Teeth are isolated with cotton rolls and dried with compressed air.
3. Teeth can be selected quadrant wise.

4. 2% aqueous NaF solution is applied with cotton applicator for 3 minutes.

5. Procedure is repeated for remaining quadrants until all of the teeth are treated .

6. Second, third and fourth applications are recommended at intervals of approximately 1 week and they are preceded by cleaning and polishing .

7. Patient is advised to avoid rinsing, drinking and eating for next half hour . (Marya ,2011) .

6.1.1.2 Mechanism of Action of Sodium Fluoride

When sodium fluoride solution is applied on the tooth surface it reacts with hydroxyl apatite crystals rapidly to form calcium fluoride. This initial rapid reaction is followed by drastic reduction in its rate and the phenomenon is called as 'choking off'. As a thick layer of calcium fluoride gets formed it interferes with the further diffusion of fluoride from aqueous solution to react with hydroxy apatite. The calcium fluoride reacts with hydroxyl apatite to form fluoridated hydroxy apatite. This increases the concentration of surface fluoride, making the tooth structure more stable, and surface more resistant to caries attack. It also helps in remineralization of the initial decalcified areas.
The chemical reaction involved is (Marya , 2011) :

$$Ca_{10}[PO4]_6[OH]_2 + 20\ F^- \leftrightarrow 10CaF_2 + 6PO_4 + 2OH$$

$$CaF2 + 2Ca_5[PO4]_3\ OH \rightarrow 2Ca_5[PO4]_3F + Ca(OH)_2$$

Advantages:

I. Chemically stable solution.

II. Acceptable taste, non-irritating to the gingiva and does not discolor teeth.

III. Inexpensive

Disadvantage:

Patient has to make four visits in relatively short period of time. (Srivastava, 2011) .

6.1.2 Stannous Fluoride

This compound is available in powder form, either in bulk containers or pre-weighed capsules. The recommended and approved concentration is 8%, which is obtained by dissolving 0.8 g of the powder in 10 ml of distilled water. Stannous fluoride solutions are quite acidic with a pH of about 2.4 to 2.8. Aqueous solutions of SnF2 are not stable because of the formation of stannous hydroxide and, subsequently, stannic oxide, which is visible as a white precipitate. As a result, solutions of this compound must be prepared immediately prior to use. As will be noted later, SnF2 solutions have a bitter, metallic taste. A stable, flavored solution can be prepared with glycerin and sorbitol to retard hydrolysis of the agent and with any of a variety of compatible flavoring agents, thus eliminating the need to prepare this solution from the powder and improving patient .acceptance (Harris, et al., 2014) .

6.1.2.1 Method of Application :

1. Cleaning and polishing of teeth is done.

2. Teeth are isolated with cotton rolls and dried with compressed air.

3. Freshly prepared SnF_2 solution is applied using cotton applicator. Care should be taken that all teeth surfaces are treated.

4. Repeated loading of cotton applicator should be done and swabbing is continuously
5. Patient is to expectorate after cotton rolls are removed (CM Marya , 2011).

6.1.2.2 Mechanism of Action

Stannous fluoride reacts with hydroxy apatite and in addition to fluoride the Tin of solution also reacts with enamel and forms Stannous tri-fluorophosphate, which is more resistant to carious attack.

Chemical reaction at low concentration is:

$$Ca_5[PO4]_3OH + 2SnF_2 \rightarrow 2CaF_2 + Sn_2[OH]PO_4 + Ca_3[PO4]_2$$

At High concentration:

$$Ca_5[PO4]3OH + 16SnF_2 \rightarrow CaF_2 + 2Sn_3F_3PO_4 \quad + \quad Sn_2[OH]PO_4$$

[Tin Trifluorophosphate] [Tin hydroxyl phosphate]

$$+ 4CaF_2[SnF3]_2$$

[Calcium trifluorostannate]

Tin hydroxy phosphate gets dissolved in oral fluids and is responsible for the metallic taste. Tin trifluorophosphate which is the main end product is responsible for making the tooth structure more stable and less susceptible to decay. Calcium fluoride [CaF2] so formed further reacts with hydroxy apatite and some fluorhydroxyapatite also gets formed (curry , 2008) .

6.2 Fluoride Gels :

Fluoride gels have been used for many years in the dental office to reduce the risk of caries. In the last 10 year there have been several reviews (meta-analyses and systematic reviews) of clinical trials showing that professional fluorides are effective in reducing caries (Sepp 2004; Petersson *et al*. 2004; Azarpazhooh and Main 2008;Ilgrom *et al*. 2009; Poulsen 2009; Marinho 2009).

However, there is also good evidence that professional topical fluoride application is not very effective for populations that are at low risk for caries (Rozier 2001;Marinho 2002; American Dental Association Council on Scientific Affairs 2006).

The American Dental Association Council on Scientific Affairs (2006) developed guidelines, based on the strength of the evidence, for the use of professional fluoride gels. The recommendations can be summed as follows: (Limeback ,2012)

1. Low risk groups for caries should not receive professional fluorides.

2. Moderate risk patients should receive professional fluorides every 6 months.

3. High-risk patients should receive professional fluorides at 3- to 6-month intervals .

Acidulated Phosphate Fluoride 1.23 percent [Brudevolds Solution] This is available as either as a solution or gel. Both are stable . Different fluoride compounds have been used in fluoride gels for years. Sodium fluoride can be used in a neutral pH environment or can be acidulated and buffered with a phosphate to form acidulated phosphate fluoride (APF). Clinical use of APF was developed in the 1960s, and the concentration commonly used in fluoride gel today is 1.23% (Newbrun, 2011). In the application, a sufficient amount of gel to cover the teeth in a dental arch is dispensed into a disposable tray and inserted into the mouth. The recommended application time is 4 min, and the patient should expectorate the gel afterward (Hawkins *et al.*, 2003). A Cochrane systematic review of fluoride gel found good evidence to support its dental caries-preventive effect (Marinho *et al*., 2003b).

The weighted mean reduction in DMFS increment in the permanent teeth of children in the 14 placebo-controlled clinical trials included in the meta-analysis was 21%. However, little information on its effectiveness in the primary dentition of young children is available. Because a relatively large amount of fluoride is present in the gel

delivered in a tray, risk of excessive ingestion by young children, leading to mild toxic side-effects, is a potential problem for its use (Adair, 2006). The content and usage of fluoride foam are similar to those of fluoride gel. Since the amount of fluoride in the foam dispensed into a mouth tray is much less than that in gel form, the risk of excessive fluoride ingestion by young children is much lower. However, little information from clinical trials on its effectiveness in caries prevention is available (Marinho *et al*., 2003b).

6.2.1 Method of Preparation

Solution: It is prepared by dissolving 20 gms of sodium fluoride in 1 liter of 0.1 M phosphoric acid. To this is added 50 percent hydrofluoric acid to maintain a pH of 3.0 and fluoride ion concentration at 1.23 percent.

Gel: for preparation of acidulated phosphate fluoride gel [APF], a gelling agent methylcellulose or hydroxyethyl cellulose is added to the solution and the pH is adjusted 4-5.

Another form of acidulated phosphate fluoride Thixotropic gels is available.

Thixotropic denotes a solution that sets in a gel like state but isnot a true gel. Upon the application if pressure, thixotropic gels behave like solutions (CM Marya , 2011) .

6.2.2 Application of Fluoride Gels and Foams

The commonly used and convenient technique for providing treatments with fluoridegels and foams involves the use of a soft, styrofoam tray. These trays can be bent to insert in the mouth and are soft enough to produce no discomfort when they reach the soft tissues. These trays, as well as some of the previous types of trays, allow simultaneous treatment of both arches. As with the use of topical fluoride solutions, the treatment can be preceded by a prophylaxis if indicated by existing oral conditions. With the tray application technique,

the armamentarium (equipment and pharmaceutical agents) consists simply of a suitable tray and the fluoride gel or foam. Many different types of trays are available; selection of a tray adequate for the individual patient is an important part of the technique. (Lavigne, , 2000) . Most manufacturers offer sizes to fit patients of different ages. An adequate tray should cover all the patients dentition; it should also have enough depth to reach beyond the cementoenamel junction and to contact the alveolar mucosa to prevent saliva from diluting the fluoride gel or foam. If a prophylaxis is given, the

patient is permitted to rinse, and the teeth of the arch to be treated are dried with compressed air. A ribbon of gel or foam is placed in the trough portion of the tray and the tray seated over the entire arch. The method used must ensure that the gel/foam reaches all of the teeth and flows interproximally. If, for instance, a soft pliable tray is used, the tray is pressed or molded against the tooth surfaces, and the patient can also be instructed to bite gently against the tray.

Some of the early trays contained a sponge-like material that "squeezed" the gel against the teeth when the patient was asked to bite lightly or to simulate a chewing motion after the trays were inserted. It is recommended that the trays be kept in place for a 4-minute treatment period for optimal fluoride uptake, even though some systems recommend a 1-minute application time. As noted previously, the patient is advised not to eat, drink, or rinse for 30 minutes following the treatment (Harris, *et al*., 2014) .

6.3 Fluoride Varnish :

Fluoride varnish is a non-aqueous form of topical fluoride and was developed in the 1960s to promote a longer retention of the fluoride agent on tooth surfaces (Chu and Lo, 2006). It is quick and easy to apply directly onto tooth surfaces with a mini-brush. It adheres to tooth surfaces even in the presence of saliva. Several compounds, including difluorosilane and sodium fluoride, have been used at different concentrations, but the most studied varnishes contain 5% sodium fluoride in an alcoholic solution of natural varnish substances. Results of the meta-analysis of pooled data from 7 clinical studies in a Cochrane systematic review of fluoride varnish showed an average reduction of 46% and 33% in caries increment in the permanent and primary teeth of children, respectively (Marinho *et al*., 2002). Advantages of using fluoride varnish include its safety and ability to be applied to specific tooth surfaces or sites with higher caries risk. The amount of fluoride applied is controlled by the operator, making it safe for use in young children below the age of 6 years (Miller and Vann, 2008) and appropriate for

people with special needs (Weintraub, 2003). Clinical studies have shown that fluoride varnish application can prevent caries in the pits and fissures of permanent molars (Hawkins *et al.*, 2003). However, in a recent Cochrane systematic review, no conclusion could be drawn as to whether it can serve as an alternative prevention method to fissure sealant placement (Hiiri *et al.*, 2010). Besides preventing new dental caries, regular applications of fluoride varnish to active caries lesions can lead to remineralization and caries arrest in children (Chu *et al*., 2002). A practical problem with promoting the use of fluoride varnish is its higher material cost *per* application to multiple teeth compared with that of other topical fluoride therapies, such as fluoride foam (Hawkins *et al*., 2004).

There are two types of fluoride varnish:

1. *Duraphat [NaF]:* It was first fluoride varnish to be tested. It contains 2.26 percent NaF or 22.6 mgF/ml. It is a viscous, resinous lacquer which should be applied to dry, clean tooth. Duraphat hardens into a yellowish brown coating in the presence of saliva. Majority of clinical trials conducted to see the efficacy of Duraphat during 1970 have reported the effectiveness between 30% to 45% .

2. *Fluor protector [Silane fluoride]:* It was developed in 1970. It contains Silane fluoride 0.7 percent [7000 ppm fluoride] in polyurethane—based lacquer. Fluor protector leaves a clear transparent film on the teeth. Another varnish that has been tested in Norway called CAREX, contains a lower fluoride concentration [1.8% fluoride]. The caries preventive efficacy of this new varnish was found to be equivalent to that of Duraphat (Marya ,2011) .

6.3.1 Application of Fluoride Varnish

Teeth should be relatively dry before applying fluoride varnish. The paint brush that comes with the product is used to paint the varnish on all selected tooth surfaces (Figure

6) . Patients should be instructed that some varnishes leave a temporary, yellow stain that can last for 24 hours. In addition, patients should not eat abrasive food or brush their teeth until the next morning for optimum effectiveness. Fluoride varnish has shown promising results in preventing early childhood caries in young children and in treating exposed root surfaces in adults. It has also been recommended that adults not drink alcohol for the first 4 hours following fluoride varnish application as it dissolves the varnish. Hypersensitive reactions have infrequently been reported to the wood rosin used in the varnish (Harris, et al., 2014) .

(Figure 6): Fluoride varnish application (Marya , 2011)

6.3.2 Fluoride varnish for old people

randomised clinical trials concluded that fluoride varnish had a positive effect on root caries in the elderly(Eksrand et al , 2007) Varnish application together with individualised oral hygiene instruction (OHI) was more effective in preventing new root caries than OHI alone and more effective in root caries control than 5000 ppm and 1450 ppm fluoride toothpaste (significantly for the latter). Fluoride varnish and OHI led to a 64 per cent reduction in root caries when compared to OHI alone. The number need to treat1 was 3.1 and those treated withvarnish were at a significantly lower relative risk2

for developing new root caries.(Tan *et al* , 2010) Chlorhexidine varnish and silverdiamine fluoride (SDF) solution both showed better results than OHI alone. Elderly persons receiving fluoride varnish had a relative risk of 0.26 of developing new root caries with this figure standing at 0.27 for chlorhexidine and 0.19 for SDF solution. Fluoride varnish application in comparison to twice daily use of 1450 ppm fluoride toothpaste resulted in a significantly lower number of active root caries and many more active baseline lesions became sound or arrested. Few arrested baseline lesions became active in the treatment groups NaF varnish (1 lesion) and 5000 ppm F toothpaste (3 lesions) in comparison with the control (12 lesions) from a total of 395 baseline lesions (Eksrand et al , 2007) .

6.4 Fluoride Containing Oral Prophylaxis Paste

Fluoride containing prophylaxis paste is not a substitute for topical fluoride solution or gel application for caries susceptible children. A thorough polishing of teeth with rubber cup may remove a thin and highly mineralized outer layer of enamel. A fluoride containing oral prophylaxis paste should be used which may help to replenish the mineral that are abraded during polishing.

Commercially available fluoride containing paste are:

1. APF-Silicon dioxide paste.
2. SnF2-Zirconium silicate paste (Srivastava , 2011).

6.5 Restorative Material Containing Fluoride

Fluoride - releasing dental restorative materials can provide an additional benefit in preventive dentistry. Although not currently available in the United States, a fluoride - releasing amalgam has demonstrated recurrent caries inhibition at enamel and dentin restoration margins. (Skartveit , 1999) Likewise, both chemical - cured and light - cured glass ionomer cements have demonstrated caries inhibition at these restoration margins. (Donly , 1999) Fluoridereleasing resin composites and sealants have also

consistently demonstrated recurrent caries inhibition at enamel margins, yet there are conflicting results concerning whether caries inhibition occurs at dentin margins. (Rawls, 1991) Preliminary studies indicate that glass ionomer cement and fluoride - releasing resin composite have synergistic effects with fluoride rinses and fluoridated dentifrices in the remineralization of incipient enamel caries. (Bynum , 1999) The materials could act as a fluoride delivery system. Upon exposure to additional external fluoride, the material surface undergoes an increase in fluoride. This fluoride is subsequently released and has demonstrated inhibition of demineralization and even the occurrence of remineralization at the adjacent tooth structure. Further clinical research to evaluate these fluoride - releasing restorative materials should provide more information for clinical recommendations (Harris *et al* , 2014) .

6.6 Fluoride Containing Devices (Slow Release)

As the current scientific consensus regards a constant supplyof low levels of fluoride, especially at the biofilm/ saliva/dental interface, as being of the most benefit in preventing dental caries, it is reasonable to expect a positive effect on caries prevalence of a treatment able to raise intraoral fluoride concentrations at constant rates, without relying on patient compliance. Considering that intraoral levels of fluoride play a key role in the dynamics of dental caries, it has been suggested that the use of controlled andsustained delivery systems can be considered as a means of controlling dental caries incidence in high-risk individuals. Thereafter, a topical system of slow and constant fluoride release were considered. There are three types of slow-release fluoride devices: the copolymer membrane type, developed in the United States, and the glass bead, developed in the United Kingdom. More recently, a third type, which consists in a mixture of sodium fluoride (NaF) and hydroxyapatite (Marya ,2011) .

7 Self Applied Topical Fluoride

7.1 Fluoride Dentifrices :

Investigation into effectiveness of adding fluoride to tooth-paste has been carried out since 1945 and covers a wide range of active ingredients in various abrasive formulations. Fluoride compounds that have been tested for caries-inhibitory properties include sodium fluoride, acidulated phosphate fluoride, stannous fluoride, sodium monofluorophosphate and amine fluoride. Most toothpaste nowadays contain sodium fluoride or sodium monofluorophosphate as active ingredient, usually in concentration of 1000–1100 mg F/g (Marya , 2011) .

The National Health and Medical Research Council (NHMRC) review found mixed evidence on the benefit of higher fluoride concentration toothpaste. Of the four studies included in this review, three studies showed no difference between lower versus higher fluoride concentrations (ie, 500 ppm vs 1100 ppm, 500 ppm vs 1450 ppm and 1100 ppm vs 2800), while one study showed higher concentrations to be more effective than lower concentrations (ie, 2200 ppm and 2800 ppm vs 1100 ppm).

The authors of the National Health and Medical Research Council (NHMRC) review also analysed the findings of one further study, calculating the change in the dental caries score between lower versus higher fluoride concentrations (David , 2002) The Results of this study showed that the proportion of dental caries-free children after 5 years was significantly greater in the 1450 ppm toothpaste group (50%) compared with the 440 ppm toothpaste and no toothpaste groups (both 42%) (Srivastava , 2011).

Fluoridated toothpastes were included in a systematic review of programmes for prevention of early childhood dental caries. Two of the studies included in the review compared differing strengths of toothpaste. According to their study's results, the authors concluded that at 250 ppm fluoride toothpaste is less effective for dental caries

prevention in permanent dentition than toothpaste containing 1000 ppm fluoride or more (Ammari *et al* , 2007) .

No studies were found investigating the efficacy of toothpaste containing 5000 ppm fluoride concentration (Harris *et al* , 2014) .

7.1.1 Composition of Toothpast

I. Polishing material (abrasive), is one of the most important ingredient to remove food particles remaining on the teeth. Materials used include aluminum phosphate.

II. Foaming material, serves to assist the action polishing materials by wetting the teeth and food particles left on the teeth and also serve as mucus emulsifier in the mouth. Materials used as foaming agent is SLS (sodium lauryl sulfonate) by trade name texapon, FAME, etc...

III. Materials moistener (moisturizer), serves to prevent drying and hardening of the toothpaste. Materials often used include glycerin, propylene glycol, etc..

IV. Binder, serves to prevent separation of ingredients in toothpaste. Materials used include sodium alginate.

V. Sweetening matter, serves to also write a sweet taste in toothpaste. Materials used include saccharin.

VI. Flavoring agent, serves to provide aroma and flavor in pasta and avoid feeling of nausea. In addition, to increase the freshness of toothpaste. Materials used peppermint oil.

VII. Preservative, serves to maintain the physical structure, chemical and biological toothpaste. This material should not toxic. Preservative sodium benzoate used.

VIII. Fluoride materials, is one substance that serves for the growth and health of teeth, coating the tooth structure and resistance to decomposition process and trigger

mineralization. The flour give the effect of detergents and chemical elements harden tooth enamel coating. Fluoride is widely used is one of sodium fluoride (NaF). Provision of fluoride toothpaste is recommended for 0.05% - 0.08%, due to excess of fluoride will cause damage to health. The authors recommend that in making toothpaste without fluoride does not matter (Croll TP, DiMarino J, 2017).

7.2 Fluoride impregnated dental floss: Dental floss is an important component of the oral hygiene aids. Dental floss helps in removing the plaque from interproximal area of tooth, if the interproximal area receives the benefits of additional fluoride during dental flossing this may increase its value as a caries preventive aid. Gilling BRD (1973) utilized sodium fluoride and stannous fluoride, successfully developed and patented several formulas of fluoridated dental floss because of unknown sample size and lack of clinical data no definitive conclusion about its cariostatic effectiveness could be made. Commercial floss containing fluoridated soluble wax was made. Unfortunately there is no clinical or laboratory data available regarding efficacy of fluoridated floss so the product was withdrawn by the manufacturing company (Srivastava , 2011) .

7.3 Fluoridated chewing gum: Fluoridated chewing gum has been used for delivering fluoride to the enamel surface but its clinical cariostatic effect needs further investigation. (Srivastava, 2011).

7.4 Fluoridated mouth rinses

Mouth rinses can also deliver significant fluoride to the oral cavity. There is in fact evidence that fluoridated mouth rinses are effective even when there is regular use of fluoridated toothpastes and the drinking water is optimally fluoridated (Adair 1998; Marinho *et al*. 2003a; Marinho *et al*. 2004). Fluoride rinses have been tested at two main concentrations of fluoride: 0.05% NaF (225 ppm fluoride, which is recommended for daily use), and 0.2% NaF (900 ppm fluoride, which is recommended for weekly rinse).

There are other concentrations on the market, and these generally have much lower levels of fluoride to reduce the risk of excess fluoride ingestion and dental fluorosis in children who still have growing teeth as seen in Table 1 (Marinho *et al*. 2004).

Table 1 : Fluoride concentration in mouth rinses (Marinho *et al*. 2004).

Fluoride concentration in the mouth rinse	PPM F (recommended doses)
0.63% SnF_2 or 0.153% F	1528 (use daily as prescribed)
0.2% NaF or 0.09% F	900 (use as a weekly rinse as directed by the manufacturer)
0.05% NaF or 0.0225% F	225 (use once daily as directed by the manufacturer)
0.44 NaF mg/mL or 0.2 mg F/mL	200 Acidulated to pH 4 (5 mL/day)
0.0221% NaF or 0.001% F	100 (use once daily as directed by the manufacturer)
0.00219% SnF_2 or 0.00531% F	53.1 (use once daily as directed by the manufacturer)

8. Factors affecting fluoride efficiency

The amount of fluoride taken up post- eruptively by tooth mineral is affected by many factors – grouped into – tooth condition, treatment formulation (Perter, 2004).

(a) Tooth condition

Tooth age**:** an inverse relationship between enamel fluoride uptake and the age of tooth has been shown.

Natural fluoride concentration**:** enamel with a high natural fluoride content will dissolve less and therefor will need less fluoride.

Enamel defects**:** such as open carious lesion. Incipient caries (white spots), micro cracks, hypo mineralized areas, and the margins of some restorations need larger amount of fluoride than sound enamel because of their porosity and surface.

Dentine \ cementum: much more fluoride is acquired by dentine or cementum than by enamel form topical application.

(b) Treatment formulation

Fluoride agent: fluoride uptake by enamel from particular agent is dependent upon different PHs. different fluoride concentration, and result in the formation of different fluoride containing compound.

pH: lowering the ph. of fluoride treatment solution result in partial dissolution of enamel crystal surface > the ionic calcium thus formed reacts to form CaF2 and therefore an increase total fluoride uptake.

Fluoride concentration: fluoride uptake by sound, intact enamel increase almost linearly with increase in fluoride concentration of the treatment solution.

Formulation components: thickening agent like hydroxylethylcellulose increase the viscosity, but tend to decrease the rate of fluoride diffusion. Humectant such glycerol were found to reduce fluoride uptake.

Abrasive: abrasive used in prophylaxis pastes and dentifrice react with fluoride therapy decreasing the amount available for reaction with enamel. Sodium momofluorophosphate is found to be compatible with dentifrice abrasive (Peter, 2004).

9.Fluoride Risks and Toxicity

Risk is the potential for realization of unwanted negative consequence of an event. There have been few physical problems reported from the therapeutic use of either topical or systemic fluoride. These are gastro intestinal disturbance, extrinsic staining of the teeth, gingival mucosal irritation skeletal fluorosis and dental fluorosis, that is permanent and has the potential of causing psychological problems depending upon its severity (Peter, 2004).

The fluoride compounds differ widely with respect to fluoride bioavailability and hence in their acute toxic potential. The differences in toxic potential of different fluoride compounds are related to various factors such as solubility of the compound, cation content of the compound, e.g. stannous fluoride is slightly more toxic than sodium fluoride because high doses of tin ion adversely affect the kidney and other organs. Other factors influencing the toxicity include route of administration, age, rate of absorption, and acid-base status. It can be *chronic* or *acute* toxicity. Chronic refers to long term ingestion of fluoride in amounts that exceed the approved therapeutic level.

Acute toxicity: Acute means rapid intake of an excess doseover a short period time.Acute fluoride poisoning is rarely seen.

Conclusion

Fluoride is one of the most effective tools for caries prevention whether in the water supply or in a topical agent as proved by many laboratory research's, animal experiments and clinical trials . despite it's long standing history and use , clinicians should have basic knowledge of products and of the safe use of these products. Communication to the patient is an important adjunct to maximize the benefit and minimize the risk . form its early history to the present time , fluoride remains an effective , evidence based modality for caries prevention throughout the life span .

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