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A REVIEW ON FLUORIDE GEL FOR PREVENTION OF DENTAL CARIES

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ABSTRACT
This review aims to evaluate the effectiveness of professional topical fluoride application on the prevention of dental caries in primary and permanent dentition. The aim of this paper is to present scientific background to understand the importance of each method of fluoride use considering the current caries epidemiological scenario, and to discuss how individual or combined methods can be used based on the best evidence available. Topical Fluoride has been the primary human action of dental caries hindrance for many decades. There are Various mechanisms that kind it advantageous including inhibiting pathology, enhancing remineralization, and inhibiting microorganism maturation. This paper represents the development, mechanism of action, and manner of use of various fluoride products. Topical fluoride applications are indicated for patients with active smooth surface caries and for patients in high caries risk groups. Both APF gel and fluoride varnish are effective and can be recommended for caries prevention in primary and permanent teeth. For children under the age of 6, only 2.26% fluoride varnish is recommended.

KEYWORDS: Fluoride, caries prevention, Acidulated Phosphate Fluoride, Professionally applied topical fluoride, children, dentistry.

INTRODUCTION

Dental decay is considered a very important oral health problem because it is a multi- factorial oral disease that affects hundreds of millions of people throughout the world. A decline in caries prevalence has occurred in most advanced countries since 1970, however, dental caries is the most common chronic disease in the world, affecting between 60% and 90% of school children and the majority of adults.[1]

Fluoride is widely considered the cornerstone of modern dentistry. Because of its cariostatic properties, fluoride has been increasingly added to preventive dentistry in the form of toothpaste, gels, and mouth rinses. The presence of fluoride in an acidic environment reduces the dissolution of calcium hydroxyapatite. The main action is inhibition of demineralization of enamel and retarding growth of the biotypes. When bacteria metabolize sugars, they decrease the pH in saliva through the production of lactic acid. A fall in pH below the critical level of hydroxyapatite (pH 5.5) leads to demineralization of enamel and results in caries. Because the fluoride ion coating is only partial, if the pH falls below level 5.5, the uncoated parts of the crystal will undergo dissolution on certain parts of the tooth. When the pH rises above the critical level of 5.5, the increased level of fluoride ion leads to remineralization, because it absorbs itself into the enamel and forms fluorohydroxyapatite. Fluoride gels are easy to handle due to their high viscosity.[2]

One fluoride gels frequently used in clinics is 0.2% sodium fluoride gel. It is a topical gel containing 900 ppm fluoride with calcium phosphate. It delivers calcium phosphate on the tooth surface to cause demineralization of enamel caries.[3] Another fluoride gel used in clinics is 1.23% acidulated phosphate fluoride gel (APF). APF gel is an acidic and highly concentrated gel and evidence-based clinical recommendations for its topical application on teeth are once a year to four times a year,

depending upon the age and severity of the disease. The gel consists of 1.23% fluoride, which is equal to 12.3 mg of fluoride for every 1 ml.[4] American Dental Association recommended clinical use of 1.23% acidulated phosphate fluoride after reviewing the 71 trials, where the efficacy of various topical fluoride caries-preventive agents was reviewed.[5] However, it has been reported in many studies that APF gel after professional application causes accidental ingestion of fluoride by children and adults and is well retained by oral mucosa.[6] Stannous fluoride gel 0.4% has also been accepted as clinically effective as per US FDA.[7]

Factors involved in caries etiology are cariogenic bacteria, fermentable dietary sugars, and susceptible tooth surfaces. The activity of cariogenic bacteria involves the formation of organic acid that can contribute to the solubilization of minerals (e.g., calcium, phosphate) from the tooth surface (demineralization). Under favorable conditions, a reversal phenomenon with a mineral gain is possible (remineralization). If the demineralization process prevails, visually detectable caries lesions occur. The caries disease process is dynamic, it may progress, stop, or even reverse. The proper assessment of the grade and activity of the caries lesion is challenging.[7-8]

Early signs of caries consist of non-cavitated carious lesions (i.e, initial or white spot lesions). If the carious lesion is not controlled, further loss of teeth minerals occurs and leads to a cavitated lesion. Early detection, proper diagnosis, and the use effective remineralization therapies (eg, fluorides) are essential for the management of non-cavitated carious lessons. Fluoride has been considered a very important factor in the decrease in the prevalence and severity of dental caries in developed countries.[8]

Topical fluorides are of two types

1. Professionally applied topical fluorides: In the year 1942, Bibby discovered that the use of sodium or potassium fluoride caries can be reduced in the case of children. Mainly 5000-19000ppm i.e, 5-19mgF/ml concentration of fluoride is used.
2. Self-applied topical fluorides: 200-1000ppm i.e, 0-1mgF/ml fluoride concentration is used.[9]

Table 1: Types of topical fluorides.[10]

Professionally applied topical fluorides	A. 2 percent Sodium Fluoride B. 8 percent Stannous Fluoride C. 1.23 percent Acidulated Phosphate Fluoride D. Fluoride varnishes • Duraphar (sodium fluoride) • Fluorprotector (silane fluoride)
	• Carex E. Fluoride foam F. Fluoride prophylactic pastes G. Fluoride containing restorative products
Self applied topical fluorides	A. Fluoride Dentrifices B. Fluoride mouthrinses C. Fluoride gels

Indications

1. Patients with a carious tooth.
2. Children just after tooth eruption period.
3. Patients who are under medication to reduce salivary flow or have undergone head and neck radiation.
4. Mentally or physically challenged persons.
5. Patients who have undergone periodontal surgery when the roots have been exposed.
6. Patients having a dental prosthesis.
7. Eating disorder patients.
8. Patients who have undergone any restorative procedures.

Professionally Applied Topical Fluorides

A. 2 percent Sodium Fluoride: This technique was given by Knutson. Powder and liquid forms are available. It is made by adding 0.2gm of powder in 10ml. of distilled water. 4 weekly applications of 2%NaF at 3,7,11 and 13 ages.[10]

Method of application: Teeth should be cleaned and polished, Isolate and dry by using cotton rolls, Apply quadrants, Apply for 3 minutes with a cotton applicator, Repeat in remaining quadrants, and Instruct the patient to avoid eating or drinking or rinsing for half an hour.[11]

Figure 1: Sodium Fluoride.

Mechanism: Sodium Fluoride reacts with hydroxyapatite crystal to form a product i.e, Calcium Fluoride. Then there will be choking off i.e, reduction in the rate. Further Calcium Fluoride reacts with hydroxyapatite to form Fluoridated hydroxyapatite. It leads to an increase in fluoride concentration by converting the tooth surface into the stable in nature and caries resistant.

Advantages: Stable, Acceptable taste, Non- irritating, and No discoloration.[11-13]

Disadvantages: The patient has to make four visits in a few days.

B. 8 percent Stannous Fluoride: It was given by Muhler. This technique involves the use of Stannous Fluoride in powder form. It is made by dissolving 0.8gms of powder in 10ml. Distilled water. The resultant solution is acidic.

Method of Application: Teeth should be cleaned and polished, Isolate and dry with cotton rolls, Apply the solution using the cotton applicator on all teeth surfaces, Repeated loading is done and swabbing is done for 4 minutes, Patient is allowed to expectorate after removal, and A six-monthly interval should be advised for next appointment.

Figure 2: stannous fluoride.

Mechanism of action: Stannous Fluoride reacts with Hydroxyapatite to form Stannous Tri- fluorophosphate. The product formed is very much useful for the reduction of caries. The stability of the product is also great. Tin hydroxy phosphate is also formed. It is the reason behind the metallic taste which is one of the disadvantages.

Advantages: The frequency of appointments is less.

Disadvantages: Metallic taste, Gingival irritation, Brown pigmentation, and Each time fresh solution has to be prepared.

C. 1.23 percent Acidulated Phosphate Fluoride: The solution is known as Brudevold's Solution. Available as a solution or gel. The solution is made by adding 20 gms of NaF in 1lit. of 0.1M Phosphoric acid and adding 50% Hydrofluoric acid. For the preparation of gel, Methylcellulose gelling agent is added to the solution. Other gelling agents like hydroxyethyl cellulose may be used. Frequency- Twice a year.[11-13]

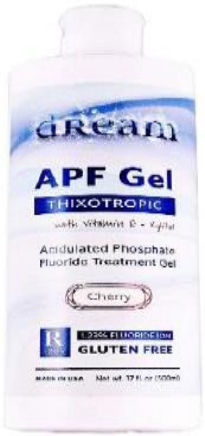

Figure 3: Acidulated Phosphate fluoride.

Method of Application: Solution: Oral prophylaxis should be done. Isolate and dry with cotton rolls. Then the solution is applied for four minutes. The patient is instructed to keep his/her mouth close and not to eat or drink anything for a half-hour Gel: Mouth trays are used. The patient should be in an upright position. If we use Suction it can be easier to do the procedure or else it might be difficult and clumsy. The tooth should be dried. Enough gel should be used but not more than 2-2.5gms per tray. Should be applied for four minutes.

Mechanism of action: Initially, dehydration occurs. Shrinkage of hydroxyapatite crystals occurs. Then hydrolysis and Dicalciurn Phosphate dehydrate (DCPD). The penetration of fluoride ions occurs and forms fluorapatite.

Advantages: Stable, No staining, and Self applicable.

Disadvantages: Acidic taste and Glass can't be used as a container.[12-14]

D. Fluoride Varnishes: It is a temporary material that allows the fluoride to adhere to the tooth surface for a longer duration.

Advantages: Well accepted and safe. Requires minimal training.

Duraphat (NaF): First fluoride varnish which was tested. Consists of 2.26 percent Sodium Fluoride or 22.6mgF/ml. In the presence of saliva, it becomes a hard yellowish-brown coating. The effectiveness of Duraphat is between 30 to 45%.

Figure 4: Fluoride varnish.

Floor protector (Silane Fluoride): Discovered in 1970. Consists of 70000ppm Fluoride. The main ingredient in this product is Silane Fluoride.

Carex: Tested in Norway. Consists of 1.8% Fluoride. Its efficacy is equivalent to Duraphat.

Method of application: At first oral prophylaxis should be done. Dry and isolated with cotton rolls. First mandibular arch then maxillary arch. Small amounts (0.3-0.5ml or 2drops) of varnish should be dispensed, by using single tufted brush starting proximal surfaces. After that patient is advised to sit opening the mouth for 4minutes. Instruct the patient to avoid rinsing or drinking and also eating any solid food. Advised for taking liquid or semisolid for 18 hours.

E. Fluoride Foam: 0.92% F (9200ppm) at pH 4.5. and Commercially available.

Advantages: Less in density and better flow, Lighter than conventional gel, so an only small amount is needed and Doesn't require suctioning so offers home use.

Disadvantages: Retention is less.

Figure 5: Fluoride foam.

F. Fluoride Prophylactic pastes: Prophylactic pastes containing Sodium Fluoride was developed in 1946. In 1960 Stannous Fluoride containing paste was discovered. Nowadays various new products are available like pastes containing Zirconium silicate and Acidulated Phosphate Fluoride silicone dioxide paste etc.

Functions: These pastes contain abrasive materials which remove the deposits present over the teeth. Polishing the tooth surface as well as the restoration. In the case of periodontal or cosmetic reasons, these pastes are recommended. Various studies demonstrate that alone these pastes can't be the effective cariostatic method.

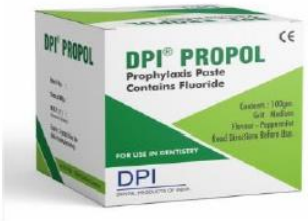

Figure 6: Fluoride prophylactic pastes.

Table 2: Comparison between the effectiveness of professionally applied topical fluoride agents.

Agents	2% Sodium fluoride	1.23%APF	8% Stannous Fluoride	Fluoride varnish
The concentration of fluoride (ppm)	9200	12300	19500	22600
Effectiveness in caries reduction (in%)	29	22	32	38

Self-Applied Topical Fluorides

A. Fluoride Dentifrices: Fluoride dentifrices play a big role in the reduction of caries in view that it requires lively participation utilizing the patient to have any effect. It has been demonstrated that the patient who brushes twice a day or greater with 1000ppm or 1500ppm or 2500ppm fluoride dentifrices have substantially reduced caries prevalence. Some of the fluoride products which have been examined for use as dentifrices are Sodium Fluoride (0.2%), Stannous Fluoride (0.4%), Sodium monofluorophosphate (0.76%), Acidulated phosphate fluoride, and Amine Fluoride.

Mechanism of action: There are two mechanisms of action. One of them is, MFP ions are integrated into the hydroxyapatite crystal. Then there will be the release of fluoride ion, which is further replaced by hydroxyl corporations to form the product called fluorapatite. The second mechanism is, MFP ions itself is integrated into the crystals having alternative products like one or many phosphate groups. As caries activity becomes more in the tooth surfaces, there will be a decrease in the pH level, but by using the fluoride toothpaste, the enamel which has become demineralized can be made back to the original condition, so it is one of the easy and successful method of dental caries prevention.

How to use the dentifrices: To prevent further caries, people of almost every age group should use the fluoride toothpaste. The kids under the 6 years age group should also be advised to use but under the supervision of an adult otherwise immoderate ingestion of fluoride can occur. In kids, only a very small amount (less than 5mm) approximating the 'pea-size' have to be placed on the brush.

B. Fluoride Mouth rinses: Over the preceding years, fluoride mouth rinsing has flip out to be an effective and important method of prevention of caries. Various fluoride products used as mouthwashes are Sodium Fluoride, Stannous Fluoride, Amine Fluoride, etc.

Among all of these, Sodium Fluoride is mainly used. For the school-based programs, 2gm Sodium Fluoride is added in 1-liter water. By its regular use, caries reduction occurs by 20- 30 percent. For personal use, tablets are there ie, 200mg Sodium Fluoride tablets in 5 teaspoons of water. It is best for mouthrinse for a family who uses it regularly.[13-15]

The most widely used fluoride gels are acidulated phosphate fluoride (APF) with 1.23% (12,300 ppm) fluoride ion and 2% sodium fluoride (NaF) with 0.90% (9050 ppm) fluoride ion. Typically, fluoride gel application consists of using a gel loaded tray held in the mouth for 4 min. There is a 30 min restriction for rinsing, eating, and drinking after the treatment to allow the teeth to absorb the fluoride and help repair the existing lesion with less soluble minerals.[16-17]

Regular use of professionally applied fluoride gel is likely beneficial only for persons at high caries risk, especially those who do not live in areas with fluoridated water or do not brush their teeth daily with fluoride toothpaste.[18]

An early study conducted by Brudevold et al. showed that an acidic environment increases the fluoride intake by enamel, justifying the highly acidic formulation (pH of approximately 3.0) of fluoride gels.[19]

Some studies reported non-significant differences between the test and control group, regarding professionally applied fluoride gel.[20-22]

The European Academy of Paediatric Dentistry (EAPD) does not recommend the use of fluoride gels under the age of 6 years due to the danger of swallowing. In permanent dentition, EAPD moderately recommends 2 to 4 applications per year in appropriately sized trays, in an upright position, associated with suction devices during and after application to reduce swallowing, and interdiction to eat or drink 20-30 min after fluoride gel application.[23]

The Australian Research Center for Population Oral Health (ARCPOH) recommended the use of high concentration fluoride gels (more than 1.5 mg/g fluoride ion) to be used for people aged 10 years or more who are at an elevated risk of developing caries.[24]

Recently, atmospheric plasma activation of a hydroxyapatite enamel-like model proved to be almost twice as effective regarding fluoride incorporation from a 1450 ppm fluoride gel (Fluor Protector, Ivoclar Vivadent, Schaan, Liechtenstein) than usual gel application. Furthermore, a certain antimicrobial and biofilm modulation was observed.[25]

Recent Advances in Topical Fluoride: At present, there is a drop in the caries prevalence across countries. More and more children are turning caries- free nowadays. Many types of research are also going on in the production and utilization of newer fluoride products. Various fresh and new fluoride products are launched day by day, i.e, fluoride mouth rinses, fluoride whitening agents, toothpaste, fluoride varnishes, etc. Stannous Fluoride Sodium Hexametaphosphate (SFSH), a new fluoride product was presented against the caries problem of various patients. It was used in the mid-2005- 2006 year as a composition of the dentifrice. Researches revealed that Silver Diamine also used as an effective material currently. Also, more and more fluoride-containing restorative products are used nowadays rather than usual restorative products. Fluoride varnishes have a higher rate of effectiveness than that of Sodium and

Stannous Fluoride.[26-27]

CONCLUSION

From the various researches and clinical investigations, it was concluded that topical fluoride is one of the easy to use and effective method of caries prevention. It is cariostatic for all age groups. One of its advantages is fluorosis generally doesn't occur due to topical fluoride application. On the other hand, these products might have some side effects like nausea it is high in cost than water fluoridation. Nowadays newer products are discovered and examined for a better purpose which will be more and more useful for the reduction of caries prevalence. Professionally applied fluorides are useful and recommended for caries prevention in patients with an elevated risk of dental decay, especially in patients with active caries on smooth tooth surfaces, in children with special oral health needs, or orthodontic patients Prevention of dental caries in temporary and permanent dentition can be done effectively using APF gel or fluorinated varnishes. For children under the age of 6, only 2.26% fluoride varnish is recommended.

The European Academy of Pediatric Dentistry and the American Dental Association have similar recommendations regarding topical fluoride applications based on caries-risk assessment. Community water fluoridation is seen by both organizations as an important element in a complex approach of caries prevention, to which is added the use of topical fluoride in relation to caries-risk assessment. Australian authorities recommend the use of local fluoridation for patients at high risk of caries development, using gels for children aged 10 years and older, while fluorinated varnishes are recommended for children under 10.

REFERENCE

1. Aneta Munteanu, Alina-Maria Holban, Mihaela-Rodica Pauna, Marina Imre, Alexandru-Titus Farcațiu and Cătălina Farcasiu, Review of Professionally Applied Fluorides for Preventing Dental Caries in Children and Adolescents, applied sciences.
2. Bansal A, Ingle NA, Kaur N, Ingle E. Recent advancements in fluoride: A systematic review. J Int Soc Prev Community Dent, 2015; 5(5): 341-6. https://doi.org/10.4103/2231-0762.165927
3. Lussi A, Buzalaf MAR, Duangthip D, Anttonen V, Ganss C, João-Souza SH, et al. The use of fluoride for the Prevention of dental erosion and erosive tooth wear in children and adolescents. Eur Arch Paediatr Dent, 2019; 20(6): 517-27. https://doi.org/10.1007/s40368-019-00420-0
4. Baik A, Alamoudi N, El-Housseiny A, Altuwirqi A. Fluoride varnishes for preventing occlusal dental caries: a review. Dent J., 2021; 9(6): 64. https://doi.org/10.3390/dj9060064
5. Slayton RL, Urquhart O, Araujo MW, Fontana M, Guzmán-Armstrong S, Nascimento MM, et al. Evidence-based Clinical practice guideline on nonrestorative treatments for carious lesions: a report from the American Dental Association. J Am Dent Assoc, 2018; 149(10): 837-49. E19. https://doi.org/10.1016/j.adaj.2018.07.002
6. Warreth A, Abuhijleh E, Almaghribi MA, Mahwal G, Ashawish A. Tooth surface loss: a review of literature. Saudi Dent J., 2020; 32(2): 53-60. https://doi.org/10.1016/j.sdentj.2019.09.004
7. Fiorillo L, Cervino G, Herford AS, Laino L, Cicciù M. Stannous fluoride effects on enamel: a systematic review. Biomimetics, 2020; 5(3): 41. https://doi.org/10.3390/biomimetics5030041
8. Urquhart, O.; Tampi, M.P; Pilcher, L., Slayton, R.L.; Araujo, M.W.B., Fontana, M.; Guzmán-Armstrong, S.; Nascimento, M.M., Nový, B.B., Tinanofí, N., et al. Nonrestorative Treatments for Caries: Systematic Review and Network Meta-analysis. J. Dent. Res., 2019; 98: 14-26. [Cross Ref] [PubMed]
9. Medjedovic E, Medjedovic S, Deljo D, Sukalo A. Impact of fluoride on dental health quality. Mater Sociomed, 2015; 27(6): 395-398. Doi:10.5455/msm. 2015.27.395-398
10. Kanduti D, Sterbenk P, Artnik B. Fluoride: a review of use and effects on health. Mater Sociomed, 2016; 28(2): 133-137. Msm.2016.28.133-137
11. Aoun A, Darwiche F, Al Hayek S, Doumit J. The Fluoride Debate: The Pros and Cons of Fluoridation. Prev Nutr Food Sci., 2018; 23(3): 171-180.
12. Tenuta LM, Cury JA. Fluoride: its role in dentistry. Braz Oral Res., 2010; 24(1): 9-17.
13. Møller IJ. Fluorides and dental fluorosis. Int Dent J., 1982; 32(2): 135-147.
14. Chu CH, Mei ML, Lo EC. Use of fluorides in dental caries management. Gen Dent, 2010; 58(1): 37-80.
15. Šket T, Kukec A, Kosem R, Artnik B. The history of public health use of fluorides in caries prevention. Zdr Varst, 2017; 56(2): 140-146.
16. Adair, S.M. Evidence-based use of fluoride in contemporary pediatric dental practice. Pediatr. Dent., 2006; 28: 133-134. [PubMed]
17. Centers for Disease Control and Prevention. Other Fluoride Products. U.S. Department of Health and Human Services. Available online: https://www.cdc.gov/fluoridation/basics/fluoride-products.html (accessed on 1 October 2021)
18. Center for Disease Control and Prevention. Recommendations for using fluoride to prevent and control dental caries in the United States. MMWR Recomm. Rep., 2001; 50: 1-42.
19. Brudevold, F: Savory, A., Gardner, DE; Spinelli, M., Speirs, R. A study of acidulated fluoride solutions I In vits effecta un enamel. Arch Oral Bal., 1963; 8: 167-177.
20. Ferreira, M.A.; Latorre, M.; Rodrigues, C.S.; Lima, K.C. Effect of regular fluoride gel application on incipient carious lesions. Oral Health Prev. Dent., 2005; 3: 141-149. [PubMed]
21. Ersin, N.K.; Eden, E.; Eronat, N.; Totu, F.I.; Ates, M. Effectiveness of 2-year application of school-

based chlorhexidine varnish, sodium fluoride gel, and dental health education programs in high-risk adolescents. Quintessence Int., 2008; 39: 45-e51.
22. Bonow, M.L.M.; Azevedo, M.S.; Goettems, M.L.; Rodrigues, C.R.M.D. Efficacy of 1.23% APF gel applications on incipient carious lesions: A double-blind randomized clinical trial. Braz. Oral Res., 2013; 27: 279-285. [CrossRef]
23. Toumba, K.J.; Twetman, S.; Splieth, C.; Parnell, C.; Van Loveren, C.; Lygidakis, N.A. Guidelines on the use of fluoride for caries prevention in children: An updated EAPD policy document. Eur. Arch. Paediatr. Dent., 2019; 20: 507-516. [Cross Ref]
24. Do, L.G. Guidelines for use of fluorides in Australia: Update 2019. Aust. Dent. J., 2020; 65: 30-38. [CrossRef]
25. Zarif, M.E.; Yehia, S.A., Biţă, B.; Sătulu, V.; Vizireanu, S.; Dinescu, G.; Holban, A.M.; Marinescu, F.; Andronescu, E.; Grumezescu, A.M., et al. Atmospheric pressure plasma activation of hydroxyapatite to improve fluoride incorporation and modulate bacterial biofilm. Int. J. Mol. Sci., 2021; 22: 13103. [Cross Ref]
26. Whelton HP, Spencer AJ, Do LG, Rugg-Gunn AJ. Fluoride Revolution and Dental Caries: Evolution of Policies for Global Use. J Dent Res., 2019; 98(8): 837-846.
27. Ferreira de Oliveira MAMAF, Celeste RK, Rodrigues CCR, Marinho VCC, Walsh T. Topical fluoride for treating dental caries. Cochrane Database Syst Rev., 2018; 2018(2): CD003454.