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Review on Efficacy and Alternative Approaches for Fluoride Toothpaste Used in Younger Children

Sujatha Padi*

Sree Sai Dental College and Research Institute, Andhra Pradesh, India

Abstract

Every child has a right to get proper oral health care. According to the American Dental Association, water fluoridation is the best way to prevent caries in primary and permanent dentition. It has been proven to reduce caries in children by 60% in primary teeth and 35% caries reduction in permanent dentition over the past 60 years. American dentistry of Pediatrics recommended using fluoridated toothpaste as soon as the first tooth erupts in the oral cavity for those who are at high risk of caries and small pea size amount of fluorinated tooth for all children greater than 2 years. It is clearly evident that fluorinated toothpaste results in caries reduction but in contrast, there are few chances of getting mild fluorosis. The purpose of the review is to brief about the advantages and disadvantages of using fluorinated toothpaste in young children and the introduction of a few natural alternatives to Fluoride which are safe and efficient as Fluoride in toothpaste.

Keywords: Fluoride; Fluorosis; Theobromine; Myrrh; Sodiummonofluorophosphate

Abbreviations: FDA: Food and Drug Administration; PPM: Parts Per Million; CDA: Canadian Dental Association; PTD: Probably Toxic Dose

Introduction

Fluoride toothpaste has been recommended to use for kids for a long time to reduce caries activity. Is it safe to use fluoridated toothpaste for children younger than 6 years? Still, a lot of controversies exist. Wright et al. [1] stated that United States Food and Drug Administration (FDA) recommended that all fluorinated toothpaste should label that for children younger than 6 years a pea-sized amount should be used and for infants less than 2 years prior consultation with dentists is a must. Limeback et al. [2] mentioned that Canadian Dental Association (CDA) suggested to use non-fluorinated toothpaste for kids less than 3 years and for children 3 to 5 years where Fluoride in drinking water is less than 0.5 ppm (parts per million) are supposed to use 0.25 mg of Fluoride supplementation.

Australian guidelines suggested that for kids younger than 17 months we must avoid fluorinated toothpaste and for children 18 months up to 5 years are supposed to brush twice a day with toothpaste containing 0.4-0.55 mg/g of Fluoride and for children older than 6 years standard fluorinated toothpaste containing 1 mg/g of Fluoride is preferred [3].

All this inconsistent information regarding fluorinated toothpaste confuses health care professionals and caregivers in their way of guiding the best for children.

Fluoride in toothpaste

Wefel et al. [4] mentioned that first fluorinated toothpaste for the therapeutic purpose was introduced in the market during mid of 1950. Different compounds of Fluoride which are used in fluorinated toothpaste are Sodium Fluoride (NaF), Ammonium Fluoride (NH_4F), Stannous Fluoride (snf), sodium monofluorophosphate (Na_2PO_3F) [5].

Amount of Fluoride in toothpaste is given by most of the manufactures as "part per million" (ppm/f). Most of the dentifrices marketed in the US are formulated to contain either 1000 ppm F or 1100 ppm F in the form of sodium Fluoride or sodium monofluorophosphate. FDA has approved high strength Fluoride containing dentifrices with 1500 ppm F only for adults and children greater than 6 years who live in non-fluorinated areas or who are at high caries risk. But in Europe under EU directive 76/768/EEC, toothpaste are cosmetic products and dentifrices containing Fluoride concentration more than 1500 ppm are available over the counter [6].

Benefits of using fluorinated toothpaste

As Chandiki et al. [7] stated, dental plaque is defined as "a specific but highly variable structural entity consisting of microorganisms and their products embedded in highly organized cellular matrix." This is also called as a dental biofilm. The bacteria in the biofilm metabolize and synthesize polysaccharides, organic acids from sugars. These will further strengthen the structural integrity of biofilm and provides protection to bacteria within biofilm from hostile influences. Murata et al. [8] explained that Fluoride prevents dental caries by disrupting biofilm which is the principal constituent of dental plaque which in turn responsible for dental caries. Fluoride inhibits glycolysis, acidogenicity and disrupts the biofilm. Kanduti et al. [9] mentioned that Fluoride helps in remineralization of enamel. Fluoride incorporated in the enamel replaces calcium and phosphorus and thus strengthens the tooth and makes enamel more acid resistant thus reducing demineralization [10]. Fluoride prevents tooth decay by forming fluorapatite crystals which are more acid resistant [11]. Proctor and Gamble discussed in their article that stannous Fluoride prevents the accumulation of Fluoride, act as an antigingivitis, anti-sensitivity agent and protects the tooth from caries [12].

Toxic effects of fluoride

Denbesten et al. [13] stated that dental fluorosis is a developmental defect of enamel due to subsequent deposition of Fluoride during tooth development. Dental fluorosis reduces the mineral content of enamel and increases porosity. Mild dental fluorosis appears as white opaque chalky enamel due to hypomineralised Enamel in mild cases, but in

***Corresponding author:** Sujatha Padi, Sree Sai Dental College and Research Institute, Andhra Pradesh, India, E-mail: sujathapadi@gmail.com

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severe dental fluorosis pitting, loss of enamel surface occurs leading to secondary staining.

Everette [14] in his article clearly mentioned that excess Fluoride not only effects enamel but also has systemic effects like skeletal fluorosis. Fluoride directly interacts with bone matrix and converts carbonated hydroxylapatite crystals into carbonated fluorapatite thus reducing bone strength. Fluoride also acts on osteoblasts and osteoclasts due to its anabolic effect it increases the bone mass, the newly formed bone lacks normal structure and strength. Connett [15] in Fluoride Alert. org informed that Fluoride may cause osteoarthritis. It is defined as a progressive disorder of joints caused by gradual loss of articular cartilage with secondary changes in bone and synovium.

Based on an article published by Harvard's The Lancet weighs on the toxins causing autism and ADHD, Sarich [16] stated that excess systemic Fluoride may cause birth defects in young children. Fluoride accumulates in the bloodstream and it can pass the blood brain barrier causing cancer, cognitive abnormalities, and even birth defects in unborn children. Fluorides can pass the placenta in pregnant women.

Guo et al. [17] in their studies found that excess systemic Fluoride may lead to immune suppression. Fluoride is an essential element for bone growth and to prevent dental caries in mild doses. But severe toxicities may lead to life-threatening problems affecting major systems of the body. Fluoride affects the spleen and suppresses the proliferation of lymphocytes leading to a declining population of both T and B Lymphocytes and even reducing their activation.

Peckham et al. [18] in their study explained how excess systemic Fluoride will lead to neurotoxicity. The use of Fluoride at high doses has a negative impact on cognitive development. Fluoride reduces child IQ slightly in higher doses. Excess Fluoride even exacerbates hypothyroidism because Fluoride has a capacity of binding with iodine and obstructing synthesis of T3 and T4 [19,20].

Acute fluoride poisoning

The toxic dose of Fluoride is usually explained in terms of Probably Toxic Dose (PTD).

PTD is defined as the minimum dose that causes toxic signs and symptoms. Whitford [21] stated that PTD is defined as a dose that causes toxic signs and symptoms including death, and that should trigger immediate intervention and hospitalization. Fluoride toxicity causes a variety of signs and symptoms. Symptoms may appear within minutes of exposure or sometimes they are delayed. Most of the Fluoride toxicity symptoms are gastrointestinal but they can also affect neurological and cardiovascular systems too. Whitford [21] in his article stated that Fluoride concentration of 5 mg/kg is considered as PTD because it can cause serious consequences [22].

Fluoride concentration is generally measured in ppm. Water with 1 ppm Fluoride means 1 g of Fluoride per 106 ml of water. The currently accepted minimal lethal dose of Fluoride is 5 mg/kg. The toxic doses for individuals: PTD=5 mg/kg for 1-2 year old child; 10 kg=50 mg F PTD for 5-6 year old child, 20 kg=100 mg F PTD for an adult, 60 kg=3000 mg [23]. When the Fluoride level reaches PTD we used to get acute toxicity symptoms like excess salivation, tremors, weakness, convulsions, shallow breathing, nausea, vomiting, abdominal pain, diarrhoea and eventually leads to shock.

Natural alternatives to fluoride in toothpaste

A few natural alternatives were available recently to substitute Fluoride in a toothpaste. According to Dr. Edward [24], some of the natural alternatives to Fluoride are Neem, Ozonated olive oil, Coconut Oil, Oregano oil, Myrrh.

Lakshmi et al. [25] mentioned in her article about the potential medicinal values of *Azadirachta indica* (Neem). Neem tree has astringent and antiseptic properties. Neem bark and leaf extracts are most effectively used in preventing caries and gum diseases. Neem is a natural antibacterial agent. The antimicrobial effects of Neem have been reported against *S. mutans* and *S. faecalis*. It is also effective against periodontal pathogens, and oral acidogenic bacteria responsible for caries and dental plaque [26]. Coconut oil is commonly available edible oil. It is unique because it contains medium chain fatty acids of which 45% to 50% is lauric acid. Lauric acid has anti-inflammatory and antimicrobial effects. It is proven to reduce plaque-induced gingivitis.

Thusar et al. [27] in her article mentioned the benefits of using thymol oil. The essential oil of Thyme is obtained from the leaves and flowers tops of perennial herbaceous plants and shrubs that are native to Europe by steam distillation method. Thyme oil has many medicinal properties and is effective in treating gastritis, enterocolitis and mouth thrush. It also has antibacterial properties which are effective in treating dental caries. Thymol component of Thyme inhibit the growth of oral pathogens and in combination with other essential oils like Clove oil reduces dental caries [28].

Myrrh (*Commiphora molmol*), the medicinal herbs main constituents are the resin, gum, and volatile oil. In cases of Pyorrhea, it helps to promote healing. Topical application of Myrrh is used to treat oral infections [29].

BT Amaechi et al. [30] mention about Theobromine a natural, organic compound found in chocolate and it is important in dentistry. Theobromine is the active ingredient in Rennou, TM, the patented chocolate extract found in Theodent toothpaste. After treating the Enamel surface of human teeth with Theobromine it was found that Theobromine increased the size of apatite crystals which form tooth Enamel. These large crystals strengthen the Enamel making teeth resistant to bacterial acid erosion thus reducing tooth sensitivity, prevents caries and decay. The microhardness of tooth Enamel after treating with Theobromine is at a greater rate than Fluoride.

Artificial alternatives to fluoride in toothpaste

Pepla et al. [31] conducted a study about nanohydroxyapatite and based on their work they found the benefits of nanoparticles in dentistry. The Japanese company Sangi co. Ltd who was interested in synthetic hydroxyapatite purchased the rights from NASA (US National Aeronautics and Space Authority) in 1970. Sangi co. Ltd launched the toothpaste that could repair the tooth enamel which contains for the first time Nano Hydroxyapatite (Apadent) in 1978. The nanohydroxyapatite in toothpaste has a strong ability to bind with proteins and fragments of plaque and bacteria. Due to the small size of particles, it not only increases the surface area to which proteins can bind but also acts as a filler in repairing small holes and depressions on the enamel surface. In 2006, Europe introduced the first toothpaste containing synthetic hydroxyapatite as an alternative to Fluoride for remineralization and repair of tooth enamel. This biometric Hydroxyapatite protects the teeth by creating a new layer of synthetic enamel around the teeth, rather than hardening the existing layer with Fluoride, that chemically changes into calcium halophosphate.

Discussion

American Academy of Pediatrics suggested the usage of fluoridated

toothpaste as soon as the first tooth erupted in the oral cavity for the kids who are at high risk of caries. And also mentioned only smear (an amount equal to the size of a rice grain) of fluorinated toothpaste is enough for infants. Child caregivers should be extremely cautious when using fluorinated toothpaste for young children as there are chances of swallowing excess Fluorinated toothpaste. Fluorinated toothpaste slightly more than the prescribed amount may cause dental Fluorosis. If a high quantity of Fluorinated toothpaste is swallowed by accident it will cause poisonous effects. For children younger than 2 years it is difficult to split excess toothpaste so there are more chances to engulf. Fluoride source is not only by Fluorinated toothpaste but also by water Fluoridation, meat, bone broth, seafood, etc. All these totally should not exceed a pea-sized amount of Fluoride per day. It is difficult to calculate how much Fluoride each kid received daily. CDA suggested using non Fluorinated toothpaste for kids less than 3 years. Australian guidelines mentioned that kids less than 17 months must avoid Fluorinated toothpaste and for children, 18 months to 5 years 0.4 mg/g to 0.55 mg/g should be used. These irrelevant distinct guidelines confuse parents and child caregivers. It is clinically proven from the research studies that Fluoride at 1000 ppm to 1500 ppm concentration reduces caries activity. Fluoride concentration at this level in the toothpaste may cause dental fluorosis. However, Fluoride is ineffective in preventing dental caries at a concentration less than 250 ppm, so, if we reduce the concentration of Fluoride to eliminate toxic effects it is no longer useful for therapeutic purposes. Fluoride toxicity may even lead to systemic effects such as skeletal fluorosis, lowered IQ in kids, and prenatal death. If there are any even minute chances of systemic toxic effects no parent will take a risk to use them to prevent caries for their child. Some natural alternatives are coming in the market which is as efficient as Fluoride in preventing dental caries, gingivitis and plaque accumulation with no side effects even if they are accidentally swallowed. Recently, the American Dental Association (ADA) recommended the Department of Health and Human Services (HHS) to reduce the optimum level of Fluoride in the community after system from 1 ppm to 0.7 ppm. This indicates there is a need for rethinking about the Efficacy and safety of Fluoride. Due to serious toxic effects of Fluoride, I think this is the time to take clinical trials on natural alternatives to Fluoride a step forward.

Conclusion

It is evident and clinically proven that Fluoride is very efficient in preventing demineralization and promoting demineralization. However, it also causes dental fluorosis if the excess amount is taken by children of 6 years and younger. It is necessary for the dentist to take in consideration of child's age, caries risk and daily intake of Fluoride from other sources before prescribing Fluoride toothpaste. All the health care professionals and child caregivers should be educated on usage of fluorinated toothpaste considering child's age, brushing frequency, brushing technique and other oral hygiene aids. Further clinical research should be conducted in finding alternatives to Fluoride which are efficient and effective in preventing tooth caries and importantly with very minimum or no side effects.

References

1. Wright JT, Hanson N, Ristic H, Whall CW, Estrich CG et al. (2014) Fluoride toothpaste efficacy and safety in children younger than 6 years: A systemic review. J Am Dent Assoc 145: 182-189.
2. Limeback H, Ismail A, Banting D, DenBesten P, Featherstone J et al. (1998) Canadian consensus conference on the appropriate use of fluoride supplements for the prevention of dental caries in children. J Can Dent Assoc 64: 636-639.
3. Spencer AJ (2006) The use of fluorides in Australia: guidelines. Aust Dent J 51: 195-199.
4. Wefel JS, Faller RV (2018) A history and update of fluoride dentifrices. Procter and Gamble.
5. Sebastian ST, Siddana S (2015) Total and free fluoride concentration in various brands of toothpastes marketed in India. J Clin Diagn Res 9: 9-12.
6. Zero DT (2006) Dentifrices, mouthwashes, and remineralization/caries arrestment strategies. BMC Oral Health 6: S9.
7. Chandki R, Banthia P, Banthia R (2011) Biofilms: A microbial home. J Indian Soc Periodontol 15: 111-114.
8. Murata RM, Branco-de-Almeida LS, Franco EM, Yatsuda R, dos Santos MH et al. (2010) Inhibition of *Streptococcus mutans* biofilm accumulation and development of dental caries *in vivo* by 7-epiclusianone and fluoride. Biofouling 26: 865-872.
9. Kanduti D, Sterbenk P, Artnik B (2016) Fluoride: A review of use and effects on health. Mater Sociomed 28: 133-137.
10. Lata S, Varghese NO, Varughese JM (2010) Remineralization potential of fluoride and amorphous calcium phosphate casein phosphopeptide on enamel lesions: An *in vitro* comparative evaluation. J Conserv Dent 13: 42-46.
11. Pharmacy Times (2014) The role of stannous fluoride in maintaining oral health. Procter and Gamble.
12. Abanto Alvarez J, Rezende KM, Marocho SM, Alves FB, Celiberti P et al. (2009) Dental fluorosis: exposure, prevention and management. Med Oral Patol Oral Cir Bucal 14: 103-107.
13. Denbesten P, Li W (2011) Chronic fluoride toxicity: Dental fluorosis. Monogr Oral Sci 22: 81-96.
14. Everett ET (2011) Fluoride's effects on the formation of teeth and bones, and the influence of genetics. J Dent Res 90: 552-560.
15. Connett M (2012) Effects of water fluoridation on teeth: Dental fluorosis vs. tooth decay. Fluoride Action Network.
16. Sarich C (2014) Harvard says fluoridated water is causing cognitive disorders.
17. Guo H, Kuang P, Luo Q, Cui H, Deng H et al. (2017) Effects of sodium fluoride on blood cellular and humoral immunity in mice. Oncotarget 8: 85504-85515.
18. Peckham S, Awofeso N (2014) Water fluoridation: A critical review of the physiological effects of ingested fluoride as a public health intervention. Scientific World Journal 2014: 1-10.
19. Pujara N, Pujara P (2015) Fluoride toxicity-a systematic review. IJSR 4: 2784-2788.
20. Ly J, Shin RD (2017) Fluoride toxicity medication. Medscape.
21. Whitford GM (1987) Fluoride in dental products: Safety considerations. J Dent Res 66: 1056-1060.
22. Garg S, Dobhal A, Khanduri M, Mehra A (2013) Case reports of acute fluoride toxicity. J Dent Sci 5: 73-75.
23. Steven Gilbert (2014) Recognition and management of fluoride toxicity.
24. Group E (2015) The 5 best natural alternatives to fluoride. Global Healing Center.
25. Lakshmi T, Krishnan V, Rajendran R, Madhusudhanan N (2015) *Azadirachta indica*: A herbal panacea in dentistry-An update. Pharmacogn Rev 9: 41-44.
26. Peedikayil FC, Sreenivasan P, Narayanan A (2015) Effect of coconut oil in plaque related gingivitis-A preliminary report. Niger Med J 56: 143-147.
27. Thosar N, Basak S, Bahadure RN, Rajurkar M (2013) Antimicrobial efficacy of five essential oils against oral pathogens: An *in vitro* study. Eur J Dent 7: 71-77.
28. Gambhir RS, Singh J, Bhardwaj A, Kaur A, Dhaliwal JS (2016) Herbal formulations: The next level in oral care. IJGP 10: 114-119.
29. Cision (2013) Dental Research: Theobromine, the chocolate-based active ingredient in Theodent™ toothpaste, works better than fluoride to strengthen teeth. PR newswire.
30. Amaechi BT, Porteous N, Ramalingam K, Mensinkai PK, Ccahuana Vasquez RA et al. (2013) Remineralization of artificial enamel lesions by theobromine. Caries Res 47: 399-405.
31. Pepla E, Besharat LK, Palaia G, Tenore G, Migliau G (2014) Nano-hydroxyapatite and its applications in preventive, restorative and regenerative dentistry: A review of literature. Ann Stomatol (Roma) 5: 108-114.