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Research Article

Effectiveness of Topical Fluoride on Dental Caries: A Literature Review

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Received: January 21, 2020; **Published:** February 12, 2020

Abstract

Background: Topical fluoride in numerous types has been used for years to avoid caries. Present models for raising the anti-caries effects of fluoride (F) representatives emphasize the importance of maintaining a cariostatic focus of F in oral fluids.

Aim: The aim of this literature review was to discuss the efficiency and types of topical fluoride used in pediatric dentistry.

Materials and Methods: Comprehensive search method was conducted using several electronic databases including; Medline/PubMed, and Embase, for relevant articles concerning the topical fluoride effective on dental caries in children, which were published up to October, 2019. The keywords used were "pediatric dental caries" "effectiveness", "topical fluoride".

Results: Three hundred and nineteen articles were reviewed as well as some references of selected articles. Thirty-two studies described the efficacy of topical fluoride to arrest dental caries.

Conclusion: Fluoride varnish appears to be an efficient treatment for the reversal of incipient carious lesions in primary and permanent dentition; however, further well-designed randomized controlled trials are still needed for the effectiveness of topical fluorides in the treatment of these lesions.

Keywords: *Pediatric Dental Caries; Effectiveness; Topical Fluoride*

Introduction

Early childhood caries (ECC) is the term utilized to define the existence of decomposed, missing or repaired teeth in the milk dentition of children more youthful than six years of ages [1]. It is considered among one of the most widespread disorders in youth, influencing 60% to 90% of youngsters around the world [1]. Caries in children are typically complicated and costly to handle and prescription antibiotics, general anesthesia and health center admission might be required for therapy.

Although fluoridated toothpastes and the proceeded use of fluoride in different forms work in decay avoidance, ECC is still prevalent among children in disadvantaged areas in both developed and developing countries [1]. Unattended decayed teeth trigger troubles with sleeping and consuming and influences children's growth and development [2]. The International Federation of Dentistry (FDI) reported that ECC is just one of the major reasons for school absence in several countries [2]. It can progress quickly, causing pain and infection

and affecting child's oral health associated lifestyle. Such troubles could end up being severe and harmful [3]. In spite of the decrease of dental caries in adults, a rise of caries prevalence among preschool children has taken place in many countries [2]. In Southeast Asia, tooth cavities are very widespread in preschool children. Their average decay occurrence was 79%, and their caries experience in terms of decomposed, missing out on and loaded milk teeth rating was 5.1 [3]. The situation appears more serious in low-income countries. For example, caries occurrence among 6-year-old children in Cambodia was as high as 91%, and their mean caries score was 7.9 [4]. In Vietnam, high decay frequency (74%) and a large percentage of neglected corroded teeth (95%) were observed [5].

As a result, prevention of dental caries in children and adolescents has become a top priority for dental services. Fluoride in its different delivery forms including gels, foams, mouthrinses and varnishes has been considered to be a cornerstone in caries prevention and the main cause for improving dental health of children and adolescents during the last 40 years [6].

Professionally-applied topical fluoride treatments are efficacious in reducing prevalence of dental caries. The most commonly used agents for professionally-applied fluoride treatments are five percent sodium fluoride varnish (NaFV) and 1.23 percent acidulated phosphate fluoride (APF) [7].

Other topical fluoride products, such as 0.2 percent sodium fluoride (NaF) mouthrinse and brush-on gels/pastes also have been shown to be effective in reducing dental caries in permanent teeth [8].

Topical fluoride is effective at reducing caries in vulnerable children and is commonly prescribed to patients in various different forms during treatment.

Aim of the Study

The aim of this literature review was to discuss the efficiency and types of topical fluoride used in pediatric dentistry.

Methodology

Comprehensive search method was conducted using several electronic databases including; Medline/PubMed, and Embase, for relevant articles concerning the topical fluoride effective on dental caries in children, which were published up to October, 2019. In our search method, Mesh terms used included “pediatric dental caries”, “effectiveness” and “topical fluoride”. We further screened references of included studies for more relevant studies to be included in this review. Restrictions were applied to English language published studies with human subjects.

Results

Three hundred and nineteen articles were reviewed as well as some references of selected articles. Thirty-two studies described the efficacy of topical fluoride to arrest dental caries.

Discussion

Dental caries

Primary teeth erupt from 6 months and are shed by the early teenagers. The permanent dentition replaces the primary teeth from the age of 6 years and is complete by age 21. Teeth are most at risk to cavities soon after they emerge; for that reason, the height ages for dental caries are 2 - 5 years for the primary teeth and early teenage years for the irreversible teeth. In established nations, there is a fad for older adults currently to keep their teeth for longer, however, if the periodontal recede with age the origins of the teeth come to be exposed, and, being reasonably less mineralized than the tooth crowns, are vulnerable to decay referred to as 'origin decays' [9].

Dental caries takes place because of demineralization of enamel and dentine (the tough tissues of the teeth) by organic acids created by bacteria in oral plaque through the anaerobic metabolic procedure of sugars derived from the diet plan [10]. When sugars or various other fermentable carbohydrates are consumed, the resulting fall in dental plaque pH brought on by natural acids enhances the solubility of calcium hydroxyapatite in the oral hard cells and demineralization happens as calcium is lost from the tooth surface. The pH at which demineralization happens is commonly described as the essential pH and is about 5.5. Saliva is just one of the mouth's natural defenses versus this procedure. Saliva promotes remineralization, i.e. it is capable of transferring mineral in porous locations where demineralization of enamel or dentine has occurred. Saliva is super-saturated with calcium and phosphate at pH 7; this prefers the deposition of calcium. If a demineralized sore is formed, it will be remineralizer; although this is a slow-moving procedure that competes with elements that cause demineralization.

The growth of decay calls for sugars and microorganisms to take place however is affected by the vulnerability of the tooth, the microbial profile, amount and top quality of the saliva, and the time for which fermentable dietary carbohydrates are readily available for bacterial fermentation. *Streptococcus mutans* (*S. mutans*) and *Streptococcus sobrinus* are essential microorganisms in the growth of dental caries (Figure 1).

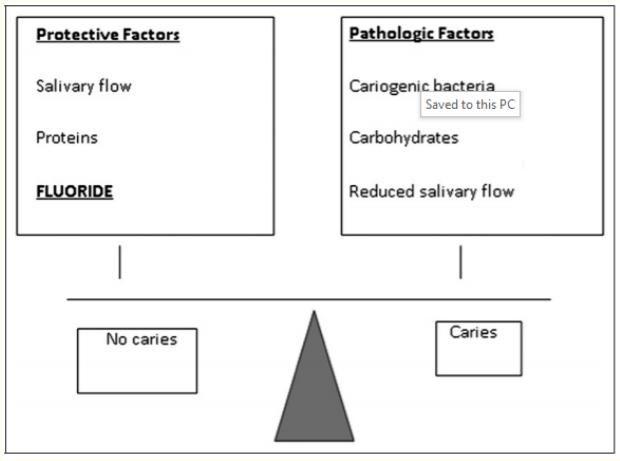

Figure 1: *Ongoing balance between caries protective and pathologic factors.*

The mechanism of fluoride action

When the fluoride ion exists in the saliva in the ideal concentration, the main and crucial activity of fluoride becomes questionable [11]. Hydroxyapatite is the main mineral in charge of establishing the permanent tooth enamel after the growth of the teeth is ended up [12]. During tooth ageing, the enamel is constantly exposed to numerous demineralization procedures, however likewise essential remineralization procedures, if the appropriate ions are present in the saliva. These procedures can either compromise or strengthen the enamel. The existence of fluoride in an acidic atmosphere lowers the dissolution of calcium hydroxyapatite. The major action is inhibition of demineralization of enamel, which is accomplished through different systems. There are different cariogenic microorganisms in the plaque liquid one of the most vital being *S. mutans*. When microorganisms metabolize sugars, they create lactic acid which reduces the pH in saliva [11]. When the pH falls listed below the critical degree of hydroxyapatite (pH 5.5), the procedure of demineralization of enamel occurs and cavities is created. At the start, the procedure is reversible, and it is possible to minimize the development of new sores with proper safety nets. If fluoride exists in plaque fluid, it will reduce the demineralization, as it will adsorb right into the crystal surface area and shield crystals from dissolution (Figure 2) [13]. Because the fluoride ion layer is just partial, the uncoated parts of the crystal will

certainly undergo dissolution on certain parts of the tooth, if the pH drops below level 5.5. When the pH rises above the vital degree of 5.5, the boosted level of fluoride ion results in remineralization, because it absorbs itself into the enamel and kinds Fluor hydroxyapatite (Figure 3) [14]. After repeated cycles of demineralization and remineralization, the outer parts of enamel may change and become more immune to the acidic atmosphere as a result of a decreased essential pH degree of newly formed crystals (pH 4.5) [12]. Fluoride's most important effect on the occurrence of caries is its role in the remineralization and demineralization of tooth enamel. It has likewise been proposed, that the fluoride ion can influence the physiology of microbial cells, which can indirectly affect demineralization. Fluoride ions affect microbial cells through numerous devices. One of them being a direct restraint of mobile enzymes - glycolytic enzymes, H+ATP-ases). It influences cellular membrane layer permeability and reduces cytoplasmic pH, causing a decrease in acid generation from glycolysis [11].

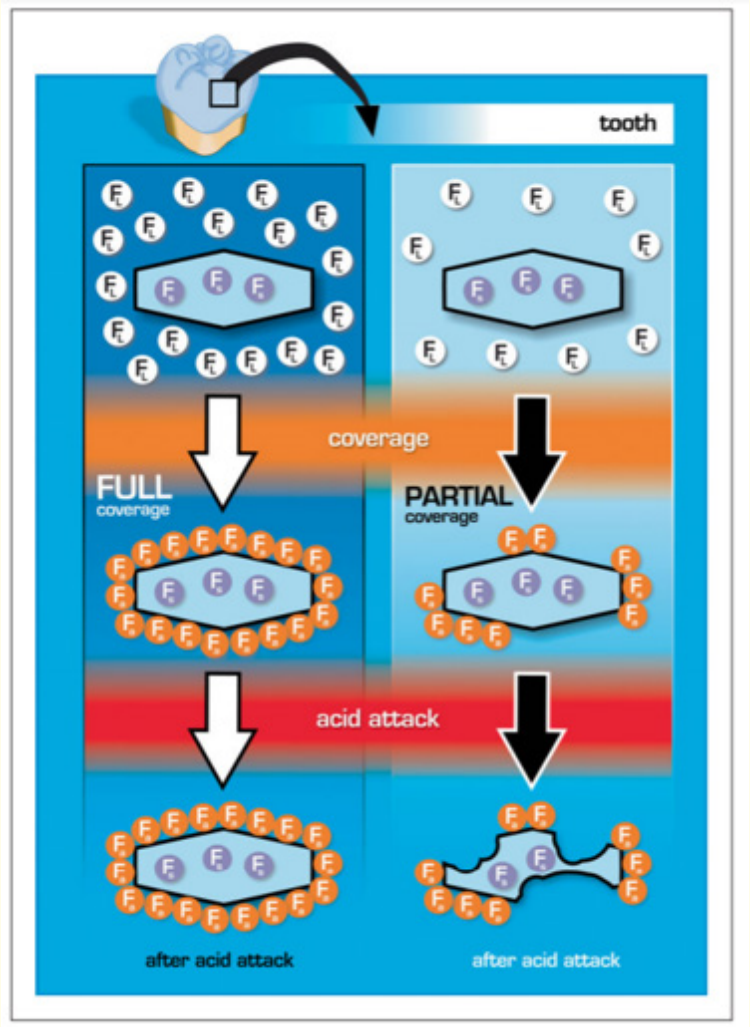

Figure 2: *Occasions occurring at the subsurface of enamel upon a cariogenic acidic obstacle. Fluoride (FL) permeates at the subsurface together with the acids, adsorbs to the surface of the crystal and also shields it from dissolution (left diagram). When protection is partial, exposed sections of the crystal will certainly dissolve (right diagram) [13].*

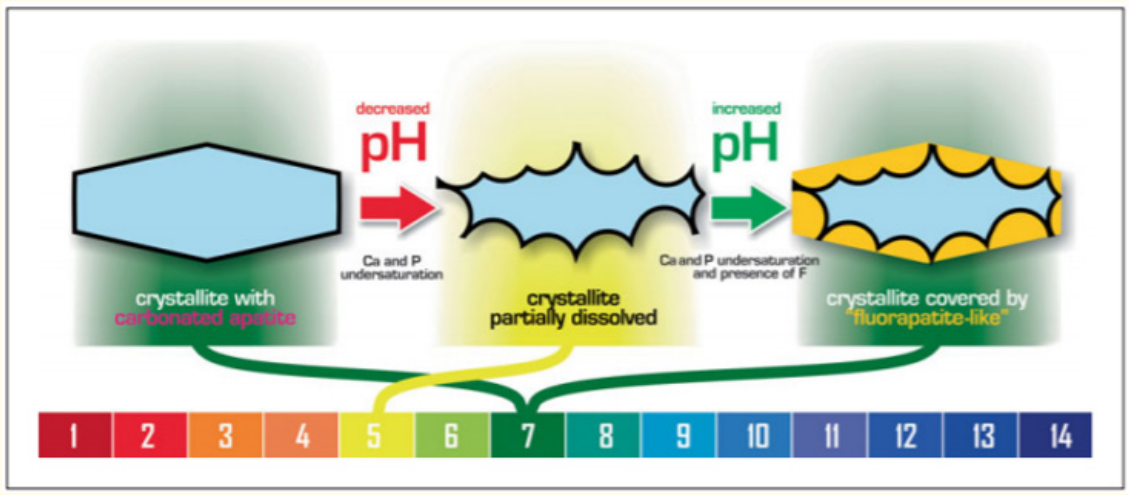

Figure 3: *Schematic representation of remineralization taking place in the existence of fluoride. Fluoride quicken the procedure of remineralization and also leads to the precipitation of a coat poor in carbonate and also abundant in fluoride on the partially demineralized original crystallite. This makes the tooth framework a lot more resistant to subsequent acidic difficulties [14].*

Topical fluorides

Topical fluorides are defined as "delivery systems which supply fluoride to revealed surface areas of the irreversible and milk teeth, at raised focus for a neighborhood safety result and are therefore not planned for consumption" [15]. Topical fluorides can be separated into two wide categories: a, professionally used (e.g. varnish, gel, foam, slow-release fluoride devices) and, b, self-applied (e.g. toothpaste and mouth rinse). Except for fluoride toothpaste, which is the most widely made use of topically applied fluoride worldwide, topical fluorides are generally advised for people or populations that are thought about to be at moderate or high caries risk, after thinking about various other exposures to fluoride.

Fluoride varnish

Given that their introduction in the 1960s, fluoride varnishes have come to be one of the most commonly utilized PATF (professionally applied topical fluoride) in Europe [16]. The most usual types of NaFV are Duraphat (2.2% F) and Fluor Protector (0.1% F). The benefit of varnish is its capacity to abide by tooth surface areas, which prolongs connection time between fluoride and enamel and boosts fluoride uptake into the surface layers of enamel.

In a high-risk community, youngsters that obtained at least two varnish applications per year showed a 37% reduction in mean decays increment for a 4-year period compared with a control group [17]. Similarly, the efficiency of fluoride varnish was sustained in 24 - and 48-month contrast studies of varnish and dental sealants [18]. In the 24-month record, compared with the control group, the use of fluoride varnish led to a 66% decrease in DMFS on non-fissured surface areas and a 38% reduction on fissured surfaces. Nevertheless, in both records, dental sealants were found to have premium performance for the prevention of decay.

Fluoride gel and foam

Fluoride gel applications are extra frequently made use of in the United States (US) and Canada. Gels are used in Styrofoam mouth trays, and one of the most commonly utilized gel is 1.23 percent APF. Fluoride foams are reasonably current items that resemble gels but have not been evaluated in scientific tests.

The effectiveness of PATF gels has been documented in numerous medical researches. A meta-analysis was performed by van Rijkom., *et al*. [19] on published data between1970 and 1992 on the caries-inhibiting effect of fluoride gel treatment in children. The overall ordinary stopped portion was 22% showing great evidence of effectiveness in permanent teeth. Every one of the PATF research studies utilized APF gel, application frequency varied from 1 - 2 times each year, and the ages of children ranged from 6 - 15 years.

Slow-release fluoride devices

Over an extended period (1 - 2 years) without the demand for normal professional involvement or patient conformity, the objective of a slow-release fluoride tool is to generate a constant amount of fluoride intra-orally. The intra-oral tools presently in operation are of two types: the copolymer membrane gadget and the fluoride glass grain tool. The devices are usually affixed to the buccal surface of a posterior tooth either by direct bonding, or through an orthodontic band or plastic brace. While there is evidence from *in vivo* trials that slow down launch fluoride devices can generate a continuous rise in salivary fluoride levels to the day, randomized control tests are needed to determine the caries-inhibiting effect of slow-release fluoride tools [20].

Silver diamine fluoride

Silver diamine fluoride ($Ag(NH_3)_2F$) has been advocated as a representative to apprehend cavitated decay sores in addition to protecting against the formation of new lesions, specifically in resource-poor circumstances where accessibility to dental care is restricted [21]. Silver diamine fluoride (SDF) is an inexpensive item that is quick and easy to apply, especially those children who are young and difficult to manage, and can be utilized by qualified non-dental health professionals. SDF is commercially offered at concentrations from 10% approximately 38%, with the latter focus containing 44,800 ppm fluoride. The device of activity of SDF is thought to be through a combination of remineralization (development of fluorapatite) and anti-microbial effects of silver [22]. Evidence for the performance of SDF at stopping and arresting cavities is presently limited in both amount and high quality. More well-designed tests that can overcome the trouble of blind result assessment, and that think about any type of potential damaging results and the safety and security of SDF are required to establish if SDF has a role in the management of dental caries.

Fluoride mouthrinses and toothpaste

Mouthrinses consisting of fluoride are recommended as part of a caries-preventive strategy for high caries risk patients, such as patients undertaking orthodontic treatment or patients with hyposalivary function. These mouthrinses commonly consist of 100-500 ppm fluoride and are used once or twice daily. Fluoride mouthrinse having 900 ppm fluoride has traditionally been used in once a week or biweekly school-based mouth-rinsing programs in children in non-fluoridated areas with high caries prevalence. There is also some evidence for the performance of fluoride mouthrinse at stopping root caries [23].

The 1960s brought direct consumer advertising of fluoride toothpaste (FTP). Toothbrushing with FTP is a valuable delivery system for topical fluoride. After brushing with FTP, fluoride levels come to a head in saliva and afterwards continue to be at low concentrations for 2 to 6 hours, giving fluoride for enamel remineralization (Table 1) [24]. FTP has several benefits, including that FTP works topically, is commonly offered in grocery and drug stores, does not require a prescription, and is inexpensive.

Age	Fluoride concentration	Daily use	Daily mount
6 months - 2 years	550 ppm	2x	Pea size
2 - 6 years	1000 ppm	2x	Pea size
6 years over	1450 ppm	2x	1 - 2 cm

Table 1: *Recommended use of fluoride toothpaste for children. Source: European Academy of Paediatric Dentistry (EAPD), 2009 [24].*

Dental fluorosis

The aim of usage fluoride in order to avoid cavities is to rise the benefits regarding decreased cavities degrees while danger of dental fluorosis is declining. Fluorosis is a disturbance in enamel development that occurs if excess fluoride is consumed throughout tooth development. The occurrence of fluorosis differs from nearly imperceptible great white lines on the tooth to matching and discoloration of the tooth. The seriousness of fluorosis is associated with the timing, duration of direct exposure and dose of fluoride consumed [25].

Records indicate that the frequency of dental fluorosis ranges from 3 to 42 percent in areas where fluoride is low and between 45 and 81 percent in locations with around 1 mg fluoride/L water [3]. Enamel fluorosis as well as skeletal fluorosis are found in large areas of India, Thailand, in the Rift Valley of East Africa and many Arab States [3].

Efficiency of fluoride

At the 2007 WHO World Health Assembly, a resolution was passed that universal accessibility to fluoride for caries avoidance was to be part of the basic right to human health [26]. When used appropriately, fluoride is equally safe and efficient in hindering and also regulating tooth decay. Society water fluoridation has been connected with the decrease in caries occurrence in USA adolescents, from 90 percent in at least one permanent tooth among those aged 12 - 17 years in the 1960s to 60 percent in 1999 - 2004 [27].

Fluoride is the only nonprescription toothpaste supplement verified to prevent dental caries. If proposed inside the mouth, fluoride in toothpaste is occupied immediately by dental plaque as well as demineralized enamel [28]. Studies of 2 - 3 years period have revealed that fluoride toothpaste decreases caries experience among children by a median of 15% - 30% [28-30].

A meta-analysis of eight medical tests on caries increment in kindergarten children shows that tooth brushing with fluoridated toothpaste considerably lowers tooth decay incidence in primary teeth [31]. Applying no more than a smear or rice-size amount of fluoridated toothpaste for children less than three years old might reduce danger of fluorosis.

A clinical study published in 2008 illustrated that low fluoride as well as regular toothpastes were equally efficient to regulate caries in caries-inactive children, but low fluoride toothpastes used by caries-active children resulted in a raised number of incipient lesions after a single year, while the regular type can control the appearance of new lesions [32]. This was further described by a recent research showing that low fluoride toothpastes are unable to regulate caries under an elevated cariogenic challenge [32]. The combination of fluoride toothpaste and fluoridated water provides protection above either used alone [29]. Since water fluoridation is not available in many regions, toothpaste could be the most essential origin of fluoride globally.

Meta-analyses of 23 clinical tests, most with twice yearly application, prefers the use of fluoride varnish in primary and permanent teeth [32]. Unit dosages of fluoride varnish are the only professional topical fluoride agent that are suggested for children younger than age six [32]. Meta-analyses of placebo-controlled tests revealed that fluoride gels, applied at three months to one-year intervals, additionally are effective in minimizing decay in permanent teeth [6].

The European Academy of Paediatric Dentistry (EAPD) recommends the use of appropriate fluoride toothpaste in conjunction with good oral hygiene to be the basic fluoride regimen [32]. The most effective way to avoid tooth decay is teeth brushing two times a day. Parents need to use the advised quantity of toothpaste and help or supervise their children with teeth brushing [32].

Conclusion

Fluoride varnish appears to be an efficient treatment for the reversal of incipient carious lesions in primary and permanent dentition. Moreover, more well designed randomized controlled trials still needed to further support our findings and establish evidence-based practice.

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Volume 16 Issue 3 March 2020