

Fluoride, Fluoridated Toothpaste Efficacy And Its Safety In Children - Review

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ABSTRACT

Early childhood caries is one the arising prevalent chronic disease that can affect their life in many different aspects. Fluoride by far is one of the effective ways in declining the prevalence of caries and its progression. The use of fluoride has been recommended for more than 50 years to prevent and control dental caries. The recommendations for its use with infants and children have been modified during this time in an effort to maximize the caries-preventive effect and minimize the risk of dental fluorosis. It has ability to counterbalance the loss of mineral in the oral cavity caused by production of acids in biofilm by minimizing the demineralization of the tooth structure. Its local effect is desirable when considering that it is needed where the caries disease is occurring. Children younger than 5 years tend to swallow toothpaste while brushing. Older children are more able to spit out toothpaste consistently after brushing. Due to this, there have many types of fluoride that can be used in form of gel, liquid and even tablets. The methods of fluoride use can be divided into community-based population, individual and professional use. It had been accepted by most panelists that fluoride is able to maintain a low prevalence of dental caries in young children though it can also be related as a dominant factor of dental fluorosis. Therefore, the scope of the research was to study the effectiveness the use of fluoride and fluoridated toothpaste, also their safety on prevention of dental caries in primary dentition.

Keywords: Fluoride, toothpaste, prevalence, prevention, dental caries, primary dentition, children

INTRODUCTION

According to the American Academy of Pediatric Dentistry, caries is defined as "a biofilm (plaque)-induced acid demineralization of enamel or dentin, mediated by saliva". On the other hand, early childhood caries (ECC) is "the presence of one or more decayed (non cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child between birth and 71 months old or younger". Early childhood caries have been a serious oral health care among the society. Its usually initiated when the maxillary central incisors start to erupt and can spread rapidly to adjacent to other teeth [1]. This dental problem is very afflictive in adolescent and toddlers all over the world. ECC is a multifactorial disease [2]. The causes are including a susceptible host, presence of plaque, diet intake of fermented carbohydrate, high exposure to cariogenic microorganism such as *Lactobacillus* and *Streptococci mutans*. Beside, *Streptococcus mutans* are considered the most cariogenic initiator of all the oral *Streptococci* [3]. Other non-scientific factors are related to demographical areas, practice of oral hygiene, parental attitudes, economy status, temperament of the child, habit of mouth breathing, siblings, pacifiers dipped in honey, maternal nutrition, psychosocial issues, feedings habit and

frequent use of medications [4-10]. It is said that there is high prevalence of caries among children in different ethnicity and various North American aboriginal population which emphasized that ethnicity can also contributed to the factor of tooth decay in children [11,12]. It is very important to take serious action tooth decay in children as ECC is identified as a serious public health problem though it is not life threatening as in severe trauma cases. However, the neglect of ECC can be the cause of pain, bacteremia, compromised chewing ability and also overdose toxicity of analgesics taken during early stages. It also lead to malocclusion in secondary dentition, boost down self esteem, problem in phonetics and suboptimal health in long term period [13,14]. In addition to this, the child's growth development and weight gain is stunted due to dental caries, which can be reversed after complete oral rehabilitation [15]. Based on study done by Hallett KB in 2003, she described the ECC as a social, political, behavioral, medical, psychological, economical and dental problem [16]. Also, it is endemic disadvantage to the children regardless of their race, ethnicity and culture. They are suffering from diseases, poverty, lack of education, and parental employment [17]. Other than this, the children are exposed to medical

problem such as stunted growth development compared to caries free infants and maternal complications afterbirth [18]. Preventive methods should be applied at earlier stage of ECC to prevent serious dental problems later, which can be costly due to treatment with hospitalization under sedation or general anesthesia. The prevalence of ECC in developed countries is estimated to be from 1 to 12 percent including group of immigrants and aboriginal Canadians [19]. Jose and King evaluated that Kerala state had caries prevalence of 44 percent, 12 percent of severe ECC and dmft was found to be 1.84. This evaluation was done based on the association of ECC and feeding habits and oral hygiene practices among the preschool children. Other results showed the children having lower socioeconomic status and with poor oral hygiene were likely to develop caries lesions [2]. Due to its high prevalence, many interventions have been done to target down its control and prevention purpose. This includes the use of fluoridated toothpastes, topical applied fluorides, fluoridated municipal water and pit and fissure sealants [20]. The uses of fluoride toothpastes have been demonstrated for more than 50 years back for control of caries lesions. It is mainly used with infants and children to increase the preventive effect and decrease risks of dental fluorosis. In most cases, young kids aged from 5 years and below tend to swallow their toothpastes while brushing [21] and unlikely in case of older children. They have ability to spit out toothpaste consistently. This event creates awareness among the researchers that high prevalence of dental fluorosis at early age can be due to habit of swallowing toothpaste while brushing. Besides, many researches have concluded that brushing with fluoride toothpaste can minimize the risk of dental caries among school-aged children [22]. Based on the U.S. Food and Drug Administration (FDA) recommends that a pea sized amount should be used for children aged below than 6 years and those children younger than 2 years must have consultation with dentist before use of toothpaste [23,24]. Recently, the American Dental Association recommends brushing with water only for children younger than 2 years and followed by a pea sized amount of toothpaste from 2 to 6 years of age [24]. The interception of all oral diseases provides rehabilitation on the necessary disease components that includes three levels of prevention. There are four preventive factors in the caries imbalance; acronym of SAFE. The first S denotes for saliva and sealant and A is for antimicrobial or antibacterial agents. F and E denote for fluoride and effective life styles respectively [25]. The goal of this review was to study the effectiveness the use of fluoride and fluoridated toothpaste, also their safety on prevention of dental caries in primary dentition.

PREVALENCE OF ECC

Age

The detailed examinations of oral cavity are not easily accomplishable because the children at young age are not easily accessible and most of them are not cooperative to dentist and dental treatment. This raises up the difficulty of determine the prevalence of ECC in preschool children and thus, there are no separate criteria for evaluating the classification and extent of dental caries in children below 3 years due to varied number of erupted teeth [26]. Previous studies showed the caries lesions increases gradually with age. Children with the age of between 44 to 48 months have higher caries prevalence with 37.2 percent compared to group of younger children. The increase prevalence of dental caries with age is mainly due to increase number teeth eruption that will be exposed to oral environment and cariogenic challenge. Plus, the dietary habit and hygiene practices in children are also identified as causable agents [19].

Low Birth Weight

Low birth weight and preterm babies are the period to be vulnerable at high exposure of streptococcal colonization with low immunization levels. At this stage, they are also favoring the development of enamel hypoplasia and salivary disorders [27]. The finding is recent studies stated that 27 percent of low birth weight were associated with ECC, as same as found in a study by Shulman [28]. Further researches are in high demand to correlate between low birth weight and prevalence of dental caries in school children in order to differentiate from normal birth weight children. The scope of the research can include the relationship between enamel defects and caries, and role-play of birth complications in dental caries.

Socio-economic Status

There are many ways that economy can affect the risk of caries that includes health issues, degree of education and life styles. Individual with poor social class are susceptible to caries risk as they have less accessibility to health care information and other deprived factors. A research was done to find the correlation between caries prevalence and low socio-economic status in the aspect of income. The result showed high prevalence of dental caries in people with low income and vice versa. This is in concordance with the findings of some previous study [2,16,29]. People having low socio-economy are having difficulty in the terms of financial and social that compromises their ability to seek for professional oral health care services and to live healthily. Their welfare is comprised as well as reduces resistance to oral and health diseases [2].

Educational Status of the Mother

Mothers are well known as the primary caregivers to their children. Their education level is importantly contributed to the association of ECC. In the study with 1500 samples revealed that 38 percent of

children whose mother had no schooling were affected with dental caries. There was statistically significant less prevalence of caries in children whose mothers had received higher education. It emphasizes there was a strong correlation between educational status of the mother and dental caries prevalence. Uneducated mothers usually have less exposure and lack information regarding to oral health care and therefore giving less concern about this as such [19]. ECC is related to the improper feeding patterns. For instances, prolonged bottle feeding beyond more than one year, on demand breast feeding and nursing bottle during bedtime. These patterns are the etiology to increase of fermentable carbohydrates in their oral cavity. It increases the exposure of primary dentition to the carbohydrates and promotes the colonization of streptococci mutans in between the teeth, saliva and dental plaque. The children are in window of infectivity period when their oral cavity are predisposed to bacteria by the transmission from their mothers in the first 2 years of life. The earlier the exposure of bacteria the increase risk and severity of ECC among them [13]. There were 30 percent of breast fed children, 12.7 percent were bottle fed and remaining 57.2 percent were both breast and bottle fed. The prevalence of caries risk of those children was taken into record. The prevalence is relatively higher in children who exclusively in breast fed than bottle fed children. A study conducted in Brazil and United States also stated the same result as mentioned [19]. Based on the on demand breast feeding pattern whom practiced by 554 mothers, 164 (29.6%) of the children had caries. In the meanwhile, 202 (26.7%) out of 755 children of whom the mothers' did not practice on demand breast feeding were having caries. Increase breast feeding for a longer period of time can decrease the plaque pH, thereby increasing prevalence of dental caries. This can be prevented by reducing on demand breast feeding and introduction of regular cup at 12 months old. As suggested by American Academy of Pediatric Dentistry guidelines, the child's mouth should be cleaned regularly after the eruption of first primary tooth [30].

Oral Hygiene Habits

In reviewing the oral hygiene habits, the variables are frequency of brushing, brushing under supervision, type of dentifrice used, use of mouthwash and dental floss. The preschool children do not have full understanding or have the dexterity in maintaining good oral hygiene. Parental guidance and assistance is significantly needed in minimize the risk of dental caries at their age. Besides, tooth brushing by parents or caretakers has essential potential in reducing dental plaque and optimal saturating the oral environment with fluoride. This is supported by previous study that reveals children whose tooth brushing under supervision has less prevalence of dental caries than those of tooth

brushing by themselves. Thereby, the participation of parents in tooth cleaning is much important and should be emphasized. Most of the preschool children are likely to brush their teeth once daily. Tooth brushing pattern with more than one time a day is effectively can spare the teeth from getting ECC with the use of fluoridated toothpaste and supervision of parents. The corner stone of dentifrice is fluoride; it has played a major role in anti caries therapies nationwide. Its impact of use had significantly declines the caries prevalence in which a concentration of 1450ppm was shown to reduce dental caries. Non fluoridated toothpastes (Anchor, Meswa) or fluoridated toothpaste (Colgate, Pedsodent) which contain more than 1000ppm of fluoride. A soft bristle is the most preferable toothbrush for young children because their likelihood of gingival tissue and increased efficiency in proximal surfaces cleaning [19].

UNDERSTANDING THE FLUORIDE EFFECT

Caries has been understood as a multifactorial disease that can only occur under presence of necessary factors. The fermentable carbohydrates must present that it promotes acidic environment under accumulation of the biofilm, thereby slowly mineralizes the tooth structure. Other determinant factors are saliva and fluoride, which both have preventive effect upon the dental caries. These two factors clear out the fermentable carbohydrates and acidic component by buffering system by saliva and demineralizing effect by fluoride. In details, the fluoride physicochemically induces precipitation of mineral on the tooth in form of fluorapatite after removal of acidic component or during the remineralization of tooth. Its deposition on the tooth mineral must be regarded as reducing continuous loss of mineral induced by the combination of necessary and determinant factors. Fluoride has no ability in affecting the accumulation of biofilm and acid production in the oral cavity. The concepts of fluoride such as "fluoride strengthening teeth", "increase resistance to acids" and " reduces acid production" are no longer accepted because clinically the fluoride has no relevant to the reduction of caries [31,32]. It can only chemically reduce mineral loss, which can be maximizing the effect by using various methods of delivery.

STRENGTHS AND LIMITATIONS OF FLUORIDE MECHANISMS

The mechanism of fluoride to control caries is best in ionic form that it counterbalances the loss of mineral tooth by precipitating back the fluorapatite in the tooth structure. The fluoride can induced the precipitation of minerals on teeth structure even its concentration is as low as 0.02ppm F. This effect resulting in delayed mineral loss at subclinical stages for a life of an individual daily. The effect of fluoride is much desirable when the concentration is low, presentable in the oral cavity with the perfect timing

(available continuously where the caries is taking place). Nevertheless, the limitations of the use of fluoride must be noted down. It does not affect the carbohydrates and biofilm production. In addition to that, if there is a great loss of mineral and a white spot lesion is seen, the mechanism of fluoride to control caries is compromised. It can only help in arresting the progression of the caries thereby causing a shiny appearance on the surface of the lesion but the porous areas underneath will remain. This can be explained by the surface polishing and remineralization action of the fluoride [33].

METHODS OF FLUORIDE USE AND EFFICACY

There are many different ways and strategies used to deliver fluoride into the oral cavity like community-based population, individuality, professional and combinations of these. In the approach of community-based, it is considered the most successful method for the past 50 years in the term of its effectiveness and safety [34]. The fluoridated water must be ingested continuously to ensure its effectiveness and it returns to the oral cavity through secretion of saliva through salivary glands. There have been no additional effect add on it so far. However, most of people living in a fluoridated area (about 0.02 ppm F) are more prone to get dental fluorosis compared to those living in non-fluoridated area (about 0.01 ppm F) because only a micromolar range of fluoride are needed to control caries continuously. Hence, a small increase in its concentration will give an intense effect. Coming to the individual methods of fluoride use, fluoride toothpastes and rinses are most commonly used. Fluoridated toothpaste is much significant and effective to control caries as it is combined with mechanical removal of accumulation of biofilm in the oral cavity. When it is used for tooth brushing regularly, the concentration of fluoride in the saliva and biofilm is high for some minutes. It takes 1 to 2 hours of fluoride to reach the baseline in the saliva. As in biofilm, fluoride concentration is maintained even 10 hours after brushing. Its efficacy is mainly based on the concentration. Fluoridated toothpaste containing 1000 to 1500 ppm F is proven highly effective in caries control and it is known as conventional fluoride toothpaste. A high concentration toothpaste containing fluoride (5000 ppm F) is launched for the purpose of control root caries and some evidences showed it is more efficient than the conventional fluoride toothpaste. In the aspect of dental professionals, the commonly used fluoride products are fluoride gels, varnishes and glass ionomer powder containing fluoride. The main effect of the professional fluoride application is major done by the production of fluoride released from calcium fluoride-like deposits. Fluoride gel has a high range of concentration from 9000 to 12300 ppm F and varnish has 22500 ppm F. A reaction will occur when either one of these is applied in the oral cavity in addition to the increase of fluoride

concentration in it. The reaction that occur between soluble fluoride in the product and tooth mineral resulting in production of calcium fluoride-like deposits and fluorapatite namely. This condition favors the precipitation of the mineral. The released calcium fluoride-like deposits act as reservoir that they slowly release fluoride into the oral cavity to enhance remineralization and raise down demineralization. Instead, fluorapatite is only incorporated within the crystal lattice and is not being released into oral cavity. In regard to this, many interventions have been done to ensure the source of slow release of fluoride into the cavity is maintained. Therefore, fluoride-releasing dental materials have been introduced in the purpose to control the "secondary caries" that progress underneath the restoration. For example, glass ionomer restoration contains fluoride in their formed biofilms. The fluoride is then slowly released to act by inhibiting demineralization around the restorations [33].

USE OF DIETARY FLUORIDE SUPPLEMENTS

The sources of dental fluorosis are namely water, toothpastes, beverages, foods, dietary fluoride supplements and professional dental products. An estimated two thirds of mild to moderate dental fluorosis was arising from people living in an area with non-fluoridated water attributed to the use of fluoride supplement in the first life of young children. In cases of a community living with fluoridated water, 13 percent of them were associated with fluorosis, which was believed because of the consumption of inappropriate fluoride supplements. Every practitioner should consider all the possible source of a patient's fluoride intake during examination thought it is not easy to assess comprehensively. Most of the people consume fluoride in order to prevent risk of caries despite having lack understanding of its benefit and risk. The concern of the getting caries outweighs concern about developing enamel fluorosis in children. Therefore, there is always limitation of fluoride supplements that the recommendation by expert panel is only for children who are above than 16 years of age. Also, the supplement of fluoride can be given to young kids that have high risk of developing caries under supervision of parents or caretakers. Dietary fluoride supplement such as fluoride lozenges or tablets are capable to exert a direct topical effect in the oral cavity. Liquid forms of fluoride are introduced to the infants that can be used with dropper. It is very important for every practitioner to ensure patient's adherence to supplement regimen for maximum therapeutic benefit [35].

FLUORIDE TOOTHPASTES (Benefits and Risks)

Fluoridated toothpastes are by far the most common approach for caries control nowadays. They are known as the dentifrices, which have less fluoride level and contains abrasives. They can be differentiated from fluoride prophylactic pastes based

on the their fluoride concentrations, amount of abrasives, methods of use and frequencies of application. Fluoridated toothpastes usually contain 1000/1100 ppm F of fluoride; both toothpastes with higher and lower than conventional fluoride levels are commercially available in many countries. Many evidences showed a great effectiveness of low fluoride containing toothpastes in caries control. However, there was still some debating of their efficacy that some research proven a high level of fluoride in toothpaste can confer greater protection to the teeth in addition to increase prevalence of dental fluorosis. Fluoride toothpastes are culturally approved in preventing caries and it can be used conveniently and easily available in many countries. Since 1940s, more than 100 clinical trials had been conducted to investigate the efficacy of fluoride toothpastes. During late of 1970s, toothpastes containing fluoride were accepted worldwide as a best form of caries control. Many developed countries were selected as the benchmarking against the standard fluoride toothpastes, which the trials were not so extensively investigated based on placebo-controlled trials in children. Younger children are more prone to have chronic ingestion of toothpastes that they likely love to swallow larger amounts and it can be enough to cause fluorosis. Thus, children under 6 years of age are highly recommended to tooth brushing under supervision of their parents or caretakers. More than that, these children also at risk of acute toxicity of fluoride. Accidental swallowing of one third of a toothpaste tube (45g) or two thirds (90g) is a life threatening for a 1 years old or for 5 to 6 years old kids respectively. Though acute toxicity is very rare, the toothpaste tubes must be always kept away from the reach of young children [36].

NON-FLUORIDE CARIES PREVENTIVE AGENTS

Non-fluoride agents are the alternative intervention in reversing dental caries. They are the adjunctive therapeutics agents in minimizing effect of mineralization and loss of tooth structure. For instance, sucrose-free polyol chewing gums, xylitol dentifrices, chlorhexidine, chlorhexidine with thymol, calcium-containing agents, iodine, triclosan and casein derivatives. Sucrose-free polyol chewing gums seem plausible in increasing rate of food clearance from oral cavity and increase production of saliva. They are also helpful in balancing the pH in mouth by neutralizing plaque acids form and so, declining the incidence of dental caries. The panelists believed that supervised gum chewing in children at high risk of caries could have positive effects in caries control. Majority of the panels suggested parents or caretakers of healthy children older than 5 years of age with high risk of experiencing caries to consume these sucrose-free polyol chewing gums after every meal. Xylitol candy, lozenges and syrup are recommended to use after meals. The suggested

dose was 5 to 8 grams per day (divided into two or three dose for maximum effect). Though they are not in the form of gum, parents or caretakers are advised to supervise their children to prevent episode of choking as in use of hard candy. Topical chlorhexidine products are marketed in the United States as 1:1 mixture of chlorhexidine-thymol varnish and a 0.12 percent of chlorhexidine gluconate mouthrinse. These products were believed to reduce *Streptococcus mutans* in oral cavity temporarily though most of the related investigations did not show statistically significant correlation in reduction of caries and the use of chlorhexidine. They are by far mostly use to reduce incidence of root caries in elderly people [37].

Conclusion

In parallel, it is important for the community to have full understanding of the effective use of fluoride in preventing the dental caries in this 21st century. Every individual is encouraged to brush daily at least once with fluoride toothpaste. Many scientific evidences demonstrated that fluoride toothpaste is effective in use for reducing the progression of caries. All children should use an appropriate amount of fluoride toothpaste by for the purpose of substantial decline in dental caries rate. Parental brushing and close supervision are necessary to reduce consumption of toothpaste for children younger than 6 years old.

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