EFFECTS OF DIFFERENT CONCENTRATIONS OF FLUORIDE TOOTHPASTE IN PREVENTION OF DENTAL CARIES

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S.S.SHIVANNI
Undergraduate
Saveetha Dental College,
Saveetha University,
Chennai, India

Dr.GANESH.J
Senior lecturer,
Department of pedodontics
Saveetha Dental College,
Saveetha University,
Chennai, India

Corresponding Author
Dr.Ganesh.J
Senior lecturer
Department of pedodontics
Saveetha Dental College,
Saveetha University,
Chennai, India

***Abstract*: Use of fluoride has been a major factor in the decline in the prevalence and severity of dental caries. When used appropriately, fluoride is both safe and effective in preventing and controlling dental caries. Although pit and fissure sealants, meticulous oral hygiene, and appropriate dietary practices contribute to caries prevention and control, the most effective and widely used approaches have included fluoride use. The relative role of enamel fluoride in caries prevention has become increasing during the last two decades. No significant relationship gas been demonstrated between caries experience of the individual and fluoride content of the enamel. Furthermore, the fluoride content in surface enamel between teeth developed in low and fluoride areas is too small to explain any significant effect on dissolution rate of the enamel.**

***Keywords*: Fluoride, Dental caries, Enamel, prevention, oral hygiene**

INTRODUCTION:

Dental caries is an infectious, multifactorial disease affecting most people in developing countries. Fluoride reduces the incidence of dental caries and slows or reverses the progression of existing lesions (i.e., prevents cavities). Although pit and fissure sealants, meticulous oral hygiene, and appropriate dietary practices contribute to caries prevention and control, the most effective and widely used approaches have included fluoride use. Fluoride modalities are effective, inexpensive, readily available, and can be used in both private and public health settings, their use is likely to continue [1]. Fluoride is the ionic form of the element fluorine, the 13th most abundant element in the earth's crust. Fluoride is negatively charged and combines with positive ions to form stable compounds. Such fluorides are released into the environment naturally in both water and air. Fluoride compounds also are produced by some industrial processes that use the mineral apatite, a mixture of calcium phosphate compounds. In humans, fluoride is mainly associated with calcified tissues because of its high affinity for calcium. Fluoride's ability to inhibit or even reverse the initiation and progression of dental caries is well documented [2-5]. The success of water fluoridation in preventing and controlling dental caries led to the development of fluoride-containing products, including toothpaste (i.e., dentifrice), mouthrinse, dietary supplements, and professionally applied or prescribed gel, foam, or varnish[6]. Dental caries, otherwise known as tooth decay, is one of the most prevalent chronic diseases of people worldwide; individuals are susceptible to this disease throughout their lifetime. Dental caries forms through a complex interaction over time between acid-producing bacteria and fermentable carbohydrate, and many host factors including teeth and saliva. The disease develops in both the crowns and roots of teeth, and it can arise in early childhood as an aggressive tooth decay that affects the primary teeth of infants and toddlers. Risk for caries includes physical, biological, environmental, behavioural, and lifestyle-related factors such as high numbers of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, poor oral hygiene, inappropriate methods of feeding infants, and poverty. The approach to primary prevention should be based on common risk factors. Secondary prevention and treatment should focus on management of the caries process over time for individual patients, with a minimally invasive, tissue-preserving approach [7].

RELATION BETWEEN FLUORIDE AND DENTAL CARIES:

Dental caries is an infectious, transmissible disease in which bacterial by-products dissolve the hard surfaces of teeth. Unchecked, the bacteria can penetrate the dissolved surface, attack the underlying dentin, and reach the soft pulp tissue. Dental caries can result in loss of tooth structure, pain, and tooth loss and can progress to acute systemic infection.Cariogenic bacteria reside in dental plaque, a sticky organic matrix of bacteria, food debris, dead mucosal cells, and salivary components that adheres to tooth enamel. Plaque also contains minerals, primarily calcium and phosphorus, as well as proteins, polysaccharides, carbohydrates, and lipids. Cariogenic bacteria colonise on tooth surfaces and produce polysaccharides that enhance adherence of the plaque to enamel. Left undisturbed, plaque will grow and harbour increasing numbers of cariogenic bacteria. An initial step in the formation of a carious lesion takes place when cariogenic bacteria in dental plaque metabolise a substrate from the diet and the acid produced as a metabolic by-product demineralises the adjacent enamel crystal surface. Demineralisation involves the loss of calcium, phosphate, and carbonate. These minerals can be captured by surrounding plaque and be available for reuptake by the enamel surface. Fluoride, when present in the mouth, is also retained and concentrated in plaque.Fluoride works to control early dental caries in several ways. Fluoride concentrated in plaque and saliva inhibits the demineralisation of sound enamel and enhances the remineralization of demineralised enamel[8,9]. As cariogenic bacteria metabolize carbohydrates and produce acid, fluoride is released from dental plaque in response to lowered pH at the tooth-plaque interface [10]. The released fluoride and the fluoride present in saliva are then taken up, along with calcium and phosphate, by de- mineralized enamel to establish an improved enamel crystal structure. This improved structure is more acid resistant and contains more fluoride and less carbonate [11-15] .

Fluoride also inhibits dental caries by affecting the activity of cariogenic bacteria. As fluoride concentrates in dental plaque, it inhibits the process by which cariogenic bacteria metabolize carbohydrates to produce acid and affects bacterial production of adhesive polysaccharides [16]. In laboratory studies, when a low concentration of fluoride is constantly present, one type of cariogenic bacteria, Streptococcus mutans, produces less acid [17-20]. Whether this reduced acid production reduces the cariogenicity of these bacteria in humans is unclear [21].

Saliva is a major carrier of topical fluoride. The concentration of fluoride in ductal saliva, as it is secreted from salivary glands, is low — approximately 0.016 parts per million (ppm) in areas where drinking water is fluoridated and 0.006 ppm in nonfluoridated areas [22]. This concentration of fluoride is not likely to affect cariogenic activity. How- ever, drinking fluoridated water, brushing with fluoride toothpaste, or using other fluoride dental products can raise the concentration of fluoride in saliva present in the mouth 100- to 1,000-fold. The concentration returns to previous levels within 1–2 hours but, during this time, saliva serves as an important source of fluoride for concentration in plaque and for tooth remineralization [23].

Applying fluoride gel or other products containing a high concentration of fluoride to the teeth leaves a temporary layer of calcium fluoride-like material on the enamel sur- face. The fluoride in this material is released when the pH drops in the mouth in response to acid production and is available to remineralize enamel [24].

In the earliest days of fluoride research, investigators hypothesized that fluoride af- fects enamel and inhibits dental caries only when incorporated into developing dental enamel (i.e., preeruptively, before the tooth erupts into the mouth) [25,26]. Evidence supports this hypothesis [27-29], but distinguishing a true preeruptive effect after teeth erupt into a mouth where topical fluoride exposure occurs regularly is difficult. However, a high fluoride concentration in sound enamel cannot alone explain the marked reduction in dental caries that fluoride produces [30,31]. The prevalence of dental caries in a population is not inversely related to the concentration of fluoride in enamel [32], and a higher concentration of enamel fluoride is not necessarily more efficacious in preventing dental caries [33]. The prevalence and severity of dental caries in the United States have decreased substantially during the preceding 3 decades [34] National surveys have reported that the prevalence of any dental caries among children aged 12–17 years declined from 90.4% in 1971–1974 to 67% in 1988–1991; severity (measured as the mean number of decayed, missing, or filled teeth) declined from 6.2 to 2.8 during this period [35-38]

These decreases in caries prevalence and severity have been uneven across the general population; the burden of disease now is concentrated among certain groups and persons. For example, 80% of the dental caries in permanent teeth of U.S. children aged 5–17 years occurs among 25% of those children. To develop and apply appro- priate and effective caries prevention and control strategies, identification and assessment of groups and persons at high risk for developing new carious lesions is essential [39]. Caries risk assessment is difficult because it attempts to account for the complex interaction of multiple factors. Although various methods for assessing risk exist, no single model predominates in this emerging science. Models that take multiple factors into account predict the risk more accurately, especially for groups rather than persons. However, for persons in a clinical setting, models do not improve on a dentist's perception of risk after examining a patient and considering the personal circumstances [40]. Children and adults who are at low risk for dental caries can maintain that status through frequent exposure to small amounts of fluoride (e.g., drinking fluoridated water and using fluoride toothpaste). Children and adults at high risk for dental caries might benefit from additional exposure to fluoride (e.g., mouthrinse, dietary supplements, and professionally applied products). All available information on risk factors should be con- sidered before a group or person is identified as being at low or high risk for dental caries. However, when classification is uncertain, treating a person as high risk is prudent until further information or experience allows a more accurate assessment [41].

RISK FOR ENAMEL FLUOROSIS

The proper amount of fluoride helps prevent and control dental caries. Fluoride in- gested during tooth development can also result in a range of visually detectable changes in enamel opacity (i.e., light refraction at or below the surface) because of hypomineralization. These changes have been broadly termed enamel fluorosis, certain extremes of which are cosmetically objectionable [42]. (Many other developmental changes that affect the appearance of enamel are not related to fluoride [43]. Severe forms of this condition can occur only when young children ingest excess fluoride, from any source, during critical periods of tooth development. The occurrence of enamel fluorosis is reported to be most strongly associated with cumulative fluoride intake during

enamel development, but the severity of the condition depends on the dose, duration, and timing of fluoride intake. The transition and early maturation stages of enamel development appear to be most susceptible to the effects of fluoride [44]. These stages occur at varying times for different tooth types. For central incisors of the upper jaw, for ex- ample, the most sensitive period is estimated at age 15–24 months for boys and age 21– 30 months for girls [45,46]. The very mild and mild forms of enamel fluorosis appear as chalklike, lacy markings across a tooth's enamel surface that are not readily apparent to the affected person or casual observer [47,48]. In the moderate form, >50% of the enamel surface is opaque white. The rare, severe form manifests as pitted and brittle enamel. After eruption, teeth with moderate or severe fluorosis might develop areas of brown stain [49]. In the severe form, the compromised enamel might break away, resulting in excessive wear of the teeth. Even in its severe form, enamel fluorosis is considered a cosmetic effect, not an adverse functional effect [50,51]. Some persons choose to modify this condition with elective cosmetic treatment.

Fluoride Toothpaste

Fluoride is the only nonprescription toothpaste additive proven to prevent dental caries. When introduced into the mouth, fluoride in toothpaste is taken up directly by dental plaque [52–54]and demineralized enamel [55,56] .Brushing with fluoride toothpaste also increases the fluoride concentration in saliva 100- to 1,000-fold; this concentration returns to baseline levels within 1–2 hours [57]. Some of this salivary fluoride is taken up by dental plaque. The ambient fluoride concentration in saliva and plaque can increase during regular use of fluoride toothpaste. Studies of 2–3 years duration have reported that fluoride toothpaste reduces caries experience among children by a median of 15%–30% [58,59]. This reduction is modest compared with the effect of water fluoridation, but water fluoridation studies usually measured lifetime — rather than a few years' — exposure. Regular lifetime use of fluoride toothpaste likely provides ongoing benefits that might approach those of fluoridated water. Combined use of fluoride toothpaste and fluoridated water offers protection above either used alone [60]. Children who begin using fluoride toothpaste at age <2 years are at higher risk for enamel fluorosis than children who begin later or who do not use fluoride toothpaste at all [61,62]. Because studies have not used the same criteria for age of initiation, amount of toothpaste used, or frequency of toothpaste use, the specific contribution of each factor to enamel fluorosis among this age group has not been established.

Fluoride toothpaste contributes to the risk for enamel fluorosis because the swallow- ing reflex of children aged <6 years is not always well controlled, particularly among children aged <3 years .Children are also known to swallow toothpaste deliberately when they like its taste. A child-sized toothbrush covered with a full strip of toothpaste holds approximately 0.75–1.0 g of toothpaste, and each gram of fluoride toothpaste, as formulated in the United States, contains approximately 1.0 mg of fluo- ride. Children aged <6 years swallow a mean of 0.3 g of toothpaste per brushing and can inadvertently swallow as much as 0.8 g. As a result, multiple brushings with fluoride toothpaste each day can result in ingestion of excess fluoride. For this reason, high-fluoride toothpaste (i.e., containing 1,500 ppm fluoride) is generally con- traindicated for children aged <6 years.

CONCLUSION:

From this study we conclude that, fluoride is a safe and effective agent that can be used to prevent and control dental caries. Using higher concentration of fluoride in toothpaste helps in the prevention of dental caries than low concentration.

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