A Comparative Study of Retentive Levels of Fluoride in Saliva at Different time intervals After Tooth Brushing With Conventional Sodium Fluoride Containning & Newer Fluoride Containing Bioactive Glass Dentifrice In Children- An In Vivo Study.

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Abstract

Introduction: Fluoridated toothpastes are one of the best sources of fluoride which effectively protects both deciduous and permanent teeth from caries. The different forms of fluoride available in toothpastes differ in the mechanisms by which they protect against caries. The fluoride concentrations in saliva and dental caries have been reported to be inversely related to the efficiency of caries prevention. With the help of newer fluoridated toothpastes effective caries prevention can be obtained by retention of fluoride in mouth for a longer duration of time.

Aim: The aim of this study is to check fluoride levels in saliva following toothbrushing with two different types of fluoridated toothpastes Sodium fluoride (NaF) and fluoride containing bioactive glass to check their efficacy in caries prevention and to check amount of fluoride retained post tooth brushing.Methods and materials:30 children in the age group of 3 to 6 years were randomly assigned into two groups as follows: 15 children using dentifrice containing 500 ppm of NaF (Colgate for kids) which is the control group and 15 children using dentifrice containing fluoride incorporated in bioactive glass form (Elsenz) which is the test group.Salivary samples were collected prior to brushing, at an interval of 30 minutes and at an interval of 1 hour, respectively and then the fluoride content were determined in it.

Results: There is a rise in the salivary fluoride levels after brushing with fluoride incorporated bioactive glass containing toothpaste at an interval of 30 minutes and 1 hour individually from baseline while with NaF there is a rise at 30 minutes but it nears to the baseline at 1 hour.

Conclusion: The study concluded that fluoride incorporated bioactive glass containing toothpaste showed salivary fluoride retention up to an hour in comparison to NaF containing toothpaste. Thus, newer technology dentifrice's with lower fluoride content and with long lasting performance should be adapted for paediatric age group.

Key words: Fluoridated dentifrice, Sodium Fluoride, bioactive glass, salivary retention.

Introduction

The battle against tooth decay is continued since many decades. Many techniques and materials have evolved during this period to prevent and arrest caries. Fluorides have been proved to be one of the effective means of anticaries agents and its benefits for preventing dental caries have been known for over 65 years[1]. The repeated uses of fluorides are of critical importance for the control and prevention of dental caries in both children and adults. Numerous controlled clinical investigations have consistently demonstrated the cariostatic properties of fluoride provided in a variety of forms[2]. The fluoride levels in the oral cavity are generally relatively low as it is cleared from the mouth due to salivary secretion and swallowing. Therefore the effect of fluoride after using oral care products on bacteria is limited. Regarding its mode of action in caries prevention the consensus today is that fluoride is mainly effective by enhancing the remineralization of initial caries defects and by inhibiting the demineralization that would lead to caries initiation or progression. It should be emphasized that fluoride is effective when present in the oral cavity and not after it has been swallowed[3].

Fluoridated toothpastes are the corner stone of caries prevention and are the most cost-effective means for the control of dental caries. The fluoride concentrations in saliva and dental caries have been reported to be inversely related to the efficiency of caries prevention[4]. Since tooth brushing with fluoridated toothpastes is the easiest and most logical way to deliver fluoride into the mouth, it is widely used by persons of all ages[5].

Fluoride in toothpastes comes in various chemical forms, as organic fluoride- amine fluoride and other inorganic fluoride-sodium fluoride, stannous fluoride, sodium monofluorophosphate and also fluoride incorporated in bioactive glass. In toothpastes, ionically bound fluoride and covalently bound fluoride is used. The different forms of fluoride differ in the mechanisms by which they protect against caries. It is thought that monofluorophosphate exchanges with orthophosphate in the enamel and afterward an intra-crystalline transposition of F- and OH+ takes place, whereby fluorapatite is formed. Therefore, the caries-protective effect is

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limited by the number of the reactive molecules in the crystal lattice. If MFP is hydrolyzed, then fluoride, which is released, reacts with dental hard tissue like ionic calcium compounds. Ionically bound fluoride is deposited primarily as a CaF_2 layer on the dental hard tissue during brushing. With time, this reservoir is used up and the fluoride concentration of the enamel and saliva increases[4].

Traditional toothpastes containing NaF, SnF_2, $MnFPo_4$ when used it showed an immediate 'high' of fluoride in the mouth, but that this drops rapidly as the toothpaste is washed away by salivary flow, so that after around only 100 minutes the amount of fluoride that remains is below therapeutic levels. Even at high concentrations, the fluoride is rapidly washed away, so the effect is only short term. A further drawback is that high concentrations of fluoride form calcium fluoride (fluorite) instead of fluorapatite, which is required for effective remineralization. In large quantities fluorite can form a whitish crust on the tooth surface, which was previously thought to act as a reservoir of fluoride, but research has shown that this is not the case, it is completely insoluble, and does not release fluoride at all. By contrast, the fluoride containing bioactive glass toothpastes (Fluorocalciumphosphosilicate) releases fluoride slowly around 8 to 12 hours and is therefore used more effectively. Bioactive glasses are pH sensitive as they dissolve faster under acidic conditions than neutral or basic conditions. Thus when faced with an acid challenge as a result of bacteria metabolizing sugars, the glass dissolves quickly and releases calcium, phosphate and optionally fluoride ions to minimize the acid dissolution of the enamel apatite crystals. As it dissolves, the glass structure in such toothpastes provides a slow release vehicle for the fluoride, calcium and phosphate together, enabling it to form fluorapatite, which is more stable and resistant to acid conditions.

Keeping this in mind the following study was undertaken to evaluate the amount of salivary fluoride retention following the use of fluoridated dentifrices namely Elsenz toothpaste and Colgate kids toothpaste, thereby promoting the use of alternative fluoridated toothpaste for caries prevention on a mass scale.

Materials and Method

The following materials were used:-

1. Fluoridated toothpastes:-

(A)Elsenz Toothpaste contains 530 ppm of Fluoride in the form of Fluorocalcium-phosphosilicate (Fluoride containing bioactive glass).

(B)Colgate Kids Toothpaste contains 500 ppm of Fluoride in the form of sodium fluoride.

2. Toothbrush

3. Plastic container (for saliva collection)

Before data collection, the purpose and procedure of the study was explained to the parents of children in the age group of 3 to 6 years from the municipal schools of Ahmedabad district in Gujarat state and written informed consent was obtained from the parent/guardian of each patient. The children underwent a dental examination performed by a single examiner which involved diagnosis of all the surfaces of the teeth and soft tissues of the oral cavity. The inclusion and exclusion criteria was as follows:- Caries free children; marked intraoral soft tissue pathology; subjects with a history of taking antibiotics 3 months before or during the course of study, medically compromised patients, children undergoing orthodontic therapy respectively.

Children were randomly assigned to two groups as follows:-

1. Control group:- 15 children using dentifrices containing fluoride in the form of sodium fluoride (Colgate for kids)
2. Test group :- 15 children using dentifrices containing fluorocalciumphosphosilicate (Elsenz)

Samples of saliva were collected into plastic specimen containers as whole unstimulated saliva for a period of 2 minutes by spitting method. Baseline saliva sample was collected 2 hours post prandial. Children were instructed to brush their teeth under assistance for 2 minutes. After brushing, the children were instructed to rinse their mouth with 10 ml of tap water for 10 seconds. Further, instructions were given to pool the saliva in the mouth and then expectorate in a sterile plastic container at an interval of 30 minutes and 1 hour. Plastic container was sealed and fluoride analysis was done through HI-729 Fluoride Low Range Handheld Colorimeter, Checker®HC of Hanna instruments. Results were obtained and analyzed. Results of the study were tabulated and evaluated using paired t test and independent t-test using Statistical Package for the Social Sciences (SPSS version 20.0) for Windows. Confidential interval for mean was considered to be 95% and p value <0.05 considered significant.

Results

There is a rise in the salivary fluoride levels of Fluorocalcium phosphosilicate containing toothpaste at an interval of 30 minutes and 1 hour individually from baseline while with NaF there is a rise at 30 minutes but it nears to the baseline at 1 hour. Statistically significant results were obtained in both the groups on analysis. (chart 1, chart 2, chart 3).

Comparison of the Fluoride difference in 30 minutes and 1 hour between the two groups shows that F difference is higher in Elsenz group and is statistically significant with a p value of 0.004 and <0.001 respectively.(table 1, table 2)

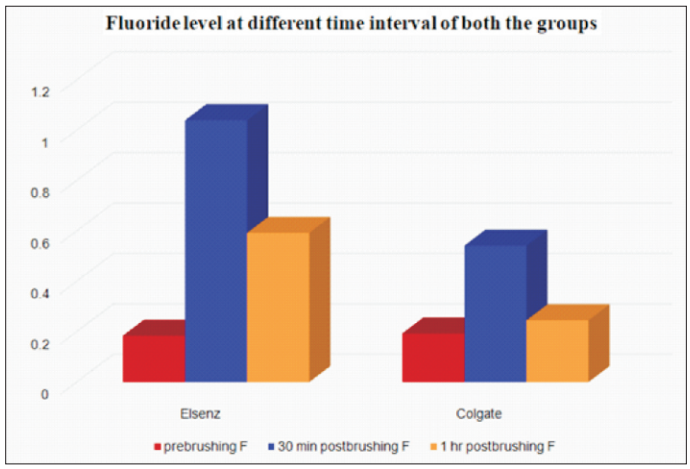

Chart 1:Comparison of Fluoride levels at different time intervals of individual group

Group			Mean	Std. Deviation	P value
Elsenz	Pair 1	prebrushing F	0.184667	0.043403	<0.001
		30 min postbrushing F	1.04	0.51901	
	Pair 2	prebrushing F	0.184667	0.043403	<0.001
		1 hr postbrushing F	0.592667	0.226856	
	Pair 3	30 min postbrushing F	1.04	0.51901	0.006
		1 hr postbrushing F	0.592667	0.226856	
Colgate	Pair 1	prebrushing F	0.193333	0.048206	0.003
		30 min postbrushing F	0.542	0.37331	
	Pair 2	prebrushing F	0.193333	0.048206	0.017
		1 hr postbrushing F	0.245333	0.058538	
	Pair 3	30 min postbrushing F	0.542	0.37331	0.004
		1 hr postbrushing F	0.245333	0.058538	

Table 1:p value after paired t test for association of the F levels between time periods of both the groups.

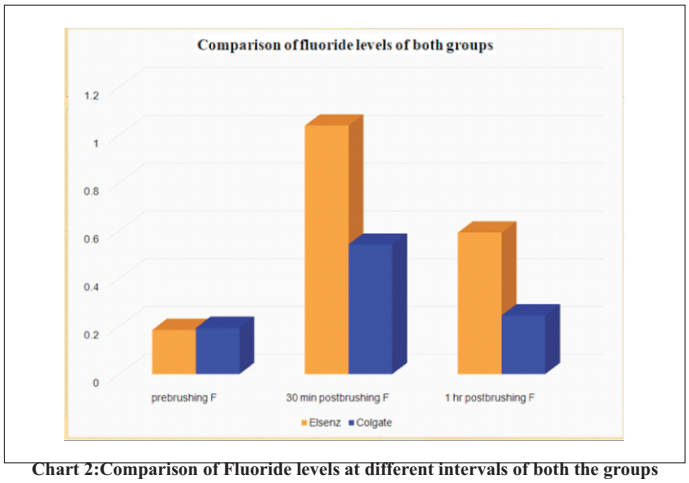

Chart 2:Comparison of Fluoride levels at different intervals of both the groups

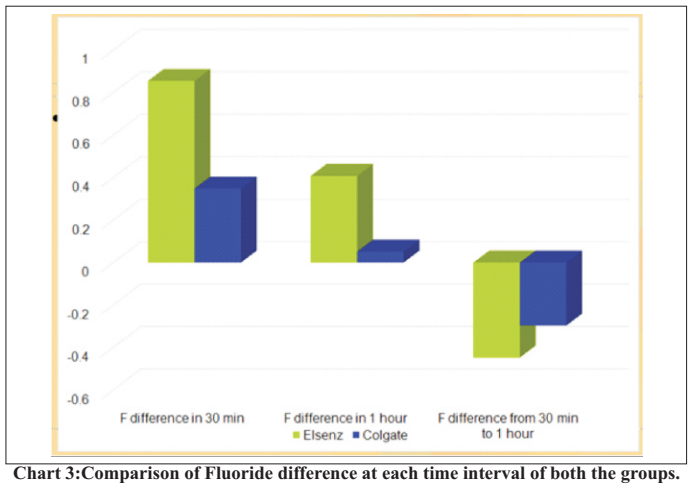

Chart 3:Comparison of Fluoride difference at each time interval of both the groups.

	Group	Mean	Std. Deviation	P value
Prebrushing F	Elsenz	0.184667	0.043403	0.609
	Colgate	0.193333	0.048206	
30 min postbrushing F	Elsenz	1.04	0.51901	0.005
	Colgate	0.542	0.37331	
1 hr postbrushing F	Elsenz	0.592667	0.226856	<0.001
	Colgate	0.245333	0.058538	
F difference in 30 min	Elsenz	0.855333	0.499998	0.004
	Colgate	0.348667	0.374163	
F difference in 1 hour	Elsenz	0.408	0.243668	<0.001
	Colgate	0.052	0.074085	
F difference from 30 min to 1 hour	Elsenz	-0.44733	0.533244	0.363
	Colgate	-0.29667	0.338034	

Table 2: p value after independent t test for comparison of two groups

Discussion

Fluoride concentration in whole saliva has been related to the efficacy of caries prevention. Those forms of fluoridated toothpasteswhich contain less concentration of fluoride and has its sustained release in the mouth, stays in the oral cavity for a longer period of time and shows more property of caries prevention and less chances of fluoride ingestion leading to fluorosis.

The source of fluoride plays an important role for the release of fluoride from its reservoir and its retention in saliva. Sodium fluoride (NaF) is instantly dissociating in saliva, Sodium monofluorphsphate ($NaMFPO_4$) requires hydrolysis to release free fluoride ions and amine fluoride may bind to organic constituents in saliva and plaque and releases fluoride slower than the other two. Higher fluoride concentrations may result in the formation of a CaF_2 layer on the enamel surface which also may serve as fluoride reservoir. The different dissolution properties of different fluoride formulations may lead to different salivary fluoride concentrations after tooth brushing, consequently affecting the caries protective effect of salivary fluoride content[5].

Bioactive glass incorporated with fluoride, calcium and phosphate ions has particles which chemically bind to the tooth surface, dissolving slowly over several hours to release them into saliva. The ions precipitate and crystallize to form fluorapatite over dentin surface and within dentinal tubules. This sustained release of fluoride ions rebuilds and strengthens enamel[8]. Under normal conditions in the mouth, the hydroxyapatite mineral in tooth enamel is in dynamic equilibrium with the calcium, phosphate and hydroxyl ions in saliva, but under acidic conditions, this

equilibrium is shifted, the pH in the mouth falls, and demineralization will occur. As the bioactive glass particles dissolve, releasing phosphate, calcium and fluoride ions to form fluorapatite, the pH will increase. There is an additional 'smart' effect too, during acid attack at lower pH, the glass dissolves faster so that the neutralization effect takes place more rapidly[9].

The recommended durations for tooth brushing using fluoridated dentifrices, mouth rinsing, and spitting out should be 1-2 minutes, 5 seconds, and once, respectively. Moreover, mouth rinsing should only be performed once using 10-15 ml of water[6]. Sjögren et al found that salivary fluoride levels following tooth brushing decreased 1-2 times after a single rinsing, and 4-5 times after a double rinsing compared to no rinsing[10]. In the present study, for the age group of children between 3 to 6 years fluoridated dentifrices used were in the concentration of 530 ppm (fluoride incorporated in bioglass) and 500 ppm (fluoride content in the form of NaF) and the children brushed their teeth for 1 minute and rinsed their mouth with 10 ml of tap water for 10 seconds. The pre brushing salivary samples were collected 2 hours post prandial and children were instructed not to eat food for an hour post brushing which is similar to a study done by Sjögren et al, who stated that eating immediately after brushing led to a 12-15 times reduction in salivary fluoride levels[10].

The use of stimulated saliva was considered inappropriate for the present study as stimulated saliva will increase the rate of fluoride clearance and will artificially lower the fluoride levels at subsequent sample points[11]. Furthermore, the fluoride concentration in experimentally stimulated saliva is not a true reflection of the fluoride concentration bathing the teeth, due to the diluting effect of stimulated ductal saliva. The importance of unstimulated salivary flow rate in the clearance of fluoride from the oral cavity was supported in the present study.

In the study done by Sjögren and Birkhed, TISAB buffer solution was added in the collected salivary sample and fluoride analysis was carried out using a fluoride sensitive electrode (ORION 96-09, Orion research, Cambridge, Mass., USA)[12]. While in a study done by Zero DT et al, the sample vials were stored at 4°C for later analysis (no longer than one month) and saliva flow rates were determined by measurement of the volume of each saliva sample by use of an adjustable digital pipette (P-1000, Rainin Instrument Co., Wobum, MA) and calculated in mL/min, the fluoride concentrations found in the test dentifrices, mouthrinse, and saliva samples were determined by a microdiffusion method (Taves, 1968), which measures total acid diffusable fluoride[13]. In the present study fluoride analysis was done through HI-729 Fluoride Low Range Handheld Colorimeter, Checker®HC ofHanna instruments. It is easier to use, more accurate than chemical test kits, dedicated to a single parameter and more convenient due to its small size. It allows immediate fluoride analysis post sample collection and is available to check fluoride in the concentration of 0.00 to 2.00 ppm. Thus more accurate and faster results are obtained.

Mina Hirose et al evaluated sodium fluoride (NaF) and sodium monofluorophosphate (MFP) tooth pastes on salivary fluoride levels after toothbrushing. The results indicated that the NaF type of dentifrice retains more fluoride in saliva than that of MFP.While in the present study fluoride incorporated in bioactive glass type of dentifriceshowed better retention than that of NaF[6].

In this study there was salivary fluoride retention upto 1 hour with both the toothpastes.While similar study by Ingle NA, Sirohi R, Siwach A with dentifrices containing 458 ppm and 1000 ppm of fluoride showed that there was considerable fluoride retention after brushing with fluoride dentrifices[4].

In the present study the salivary fluoride level for fluoride incorporated in bioactive glass containing dentifriceis more at 60 minutes interval but for NaF containing toothpaste at 60 minutes interval the levels had reached the baseline levels which is similar to the study done byNagpal D I, Damle S G for dentifrice containing 1000ppm fluoride and 500ppm fluoride[7].

In this study long term follow up period for both the toothpastes is required, so as to determine the fluoride retention of NaF containing andfluoride incorporated in bioactive glass containing toothpastes post 1 hour of brushing.

Conclusion

Fluoride dentifrices have been accepted for their effectiveness in caries prevention and are the most cost-effective means for the control of dental caries.The newer technology dentifricescould be a means of reducing the fluoride content of the toothpastes in children while ensuring adequate concentrations are maintained for longer.

Therefore, Fluorocalciumphosphosilicate dentifrices may provide a new direction for caries prevention.

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Conflicts of Interest: Nil.

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